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Inflation mechanisms, expectations and monetary policy

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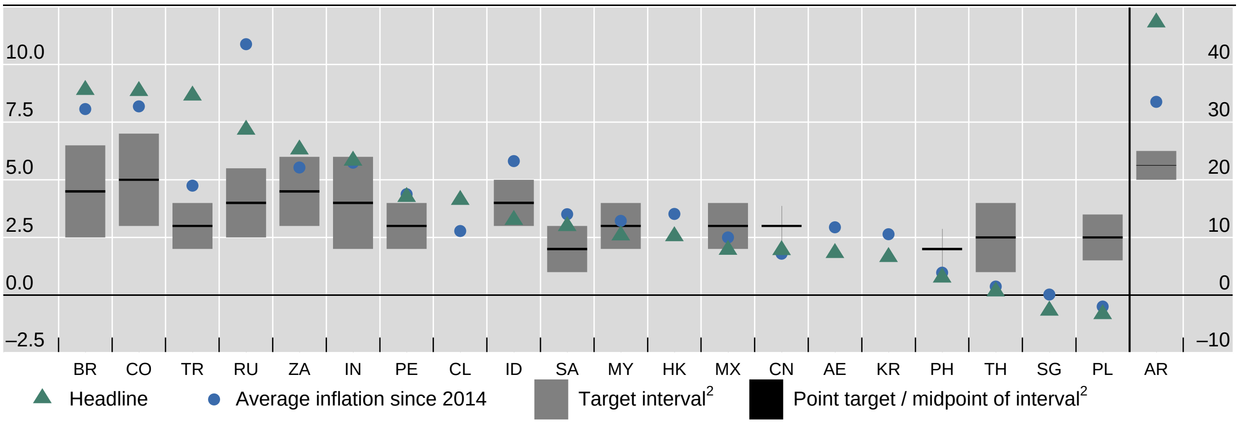
Abstract

Inflation has been off-target for some time in many economies, both advanced and emerging (Graph 1). Whereas advanced economies (AEs) have mostly seen inflation below target, the experience among emerging market economies (EMEs) has been mixed. Inflation has been below target in several EMEs in Asia and central and eastern Europe, but above target in some Latin American economies as well as in Russia, South Africa and Turkey.

Headline inflation and inflation targets[1]

In per cent Graph 1



AE = United Arab Emirates; AR = Argentina; BR = Brazil; CL = Chile; CN = China; CO = Colombia; HK = Hong Kong SAR; ID = Indonesia; IN = India; KR = Korea; MX = Mexico; MY = Malaysia; PE = Peru; PH = Philippines; PL = Poland; RU = Russia; SA = Saudi Arabia; SG = Singapore; TH = Thailand; TR = Turkey; ZA = South Africa.

[1] Annual inflation rate as of June 2016; for Indonesia, Korea, Peru, Thailand and Turkey, July 2016. For Argentina, shown on the right-hand scale, the inflation rate is based on the consumer price index for the City of Buenos Aires. [2] For countries following an inflation targeting strategy.

Sources: Datastream; national data; BIS calculations.

This chapter reviews the recent experience of EMEs, drawing heavily on the BIS background notes and central bank contributions prepared for a meeting of EME Deputy Governors held in Basel on 28–29 January 2016 and collected in this volume. The first section discusses two major changes in international prices that influenced inflation in recent years: the drop in commodity prices and the appreciation of the US dollar. The second section takes a step back and looks at the inflation process, ie the dynamics of inflation and its response to shocks. The third section considers inflation expectations and the fourth draws conclusions for policy. Boxes 1 and 2 discuss the measurement of inflation and of inflation expectations, respectively.

Keywords: Inflation, emerging markets, exchange rate pass-through, Phillips curve

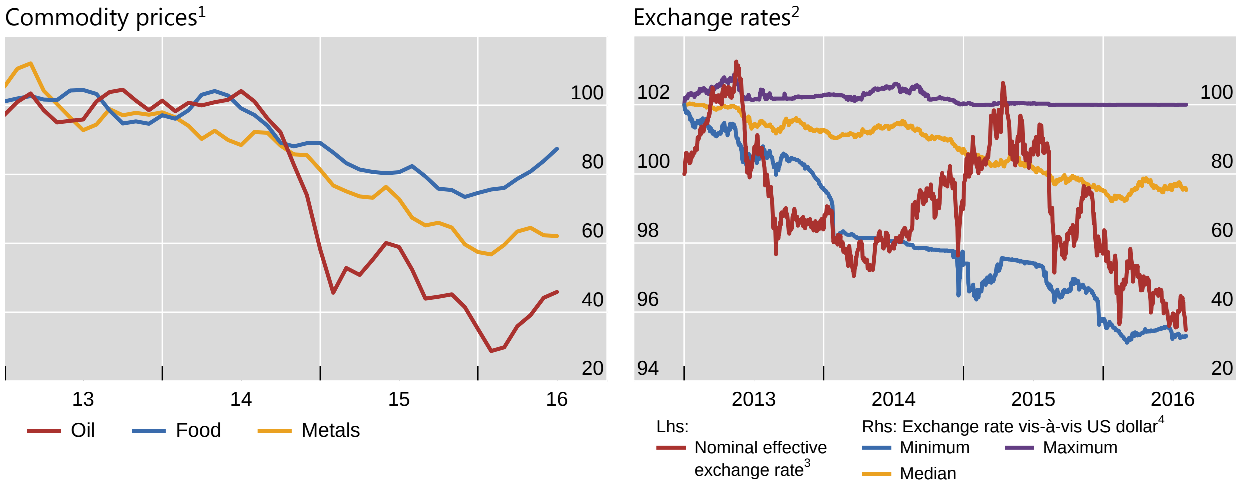
JEL classification: E31, E52, F62

Inflation: proximate global determinants

The sharp decline in commodity prices, in particular that of oil, has pushed down inflation around the world. But in many EMEs, a sharp depreciation of currencies since the taper tantrum of 2013 has more than offset this force, pushing inflation well above target.[1] In several countries, this has added to domestic factors driving inflation outside the central bank's comfort zone.

Commodity prices, in particular that for oil, fell sharply between mid-2014 and early 2016, although they rebounded somewhat afterwards (Graph 2, left-hand panel). Part of the decline probably reflected weaker demand, but supply factors also played a key role.

Commodity prices and exchange rates | Graph 2



[1] The IMF's primary commodity prices; oil = crude oil (petroleum), price index: 2005 = 100, simple average of three spot prices: Dated Brent, West Texas Intermediate and Dubai Fateh; for food, food price index: 2005 = 100, which includes price indices of cereal, vegetable oils, meat, seafood, sugar, bananas and oranges; for metals, metals price index: 2005 = 100, which includes price indices of copper, aluminium, iron ore, tin, nickel, zinc, lead and uranium. [2] An increase means an appreciation of the local currency. [3] Aggregate for emerging market economies; weighted average based on the GDP and PPP exchange rates of Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand and Turkey. [4] Bilateral exchange rates; beginning of 2013 = 100.

Sources: IMF, Primary Commodity Prices Database; national data; BIS calculations.

Against the backdrop of a generalised strengthening of the US dollar in the wake of the anticipated and actual normalisation of US monetary policy, most EME currencies depreciated in recent years. They fell sharply against the dollar during the taper tantrum of 2013 and continued to trend down until early 2016 (Graph 2, right-hand panel). In trade-weighted terms, the depreciation was generally much smaller, as most trading partners' currencies also weakened. That said, most trade tends to be

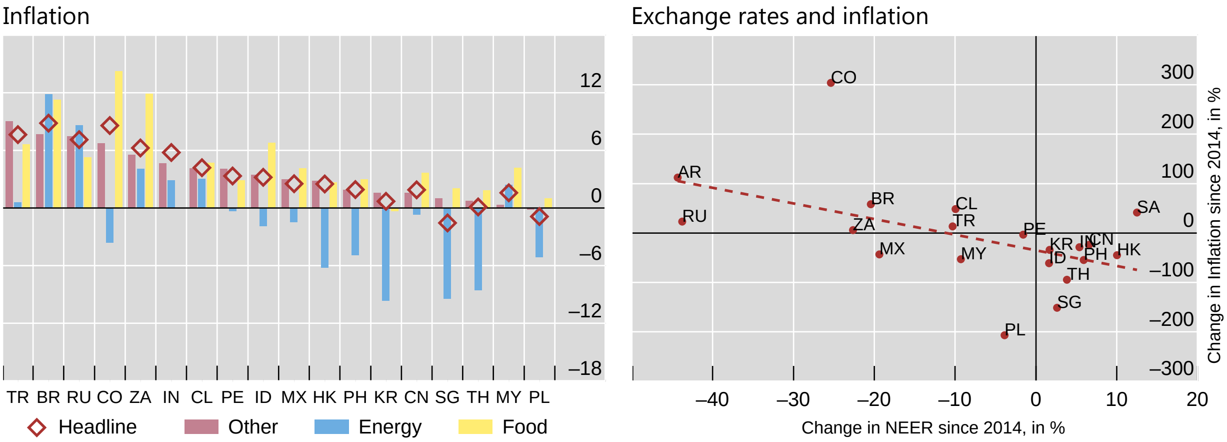
[1] These two international price developments are not independent. A key factor behind the depreciation of EME currencies against the US dollar was the increase in the risk premia facing commodity exporters. In some cases, this was compounded by domestic weaknesses.

invoicedin US dollars, so trade-weighted exchange rates may understate the inflationary pressures resulting from the depreciation, at least in the short term.

Tumbling energy prices dragged down headline inflation in most Asian EMEs, but inflation in other goods categories also tended to be low (Graph 3, left-hand panel). In part, this reflected the (relative) strength of the currencies of those economies[2] (right-hand panel) as well as other factors, such as the policy response and characteristics of the inflation process.

Exchange rates and inflation

Graph 3



AR = Argentina; BR = Brazil; CL = Chile; CN = China; CO = Colombia; HK = Hong Kong SAR; ID = Indonesia; IN = India; KR = Korea; MX = Mexico; MY = Malaysia; PE = Peru; PH = Philippines; PL = Poland; RU = Russia; SA = Saudi Arabia; SG = Singapore; TH = Thailand; TR = Turkey; ZA = South Africa. NEER = nominal effective exchange rate.

Sources: National data; BIS calculations.

The picture looks very different in countries that experienced sharp exchange rate depreciations. There, energy prices actually increased in domestic currency terms, often at rates exceeding headline inflation.

Interestingly, lower international food prices appear to have had a negligible impact on headline inflation. In fact, food prices rose in all countries, in most cases by more than the headline inflation rate. In some countries, especially in South America, food production fell for weather-related reasons (see Vargas-Herrera, in this volume). The wedge between domestic and global prices might have reflected trade barriers or the fact that food was mostly produced and consumed locally, with international markets affecting only a limited subset of prices.

2 Overall, the relationship between exchange rate depreciation and inflation shown in the right-hand panel of Graph 3 is robust to the use of bilateral exchange rates against the US dollar. The main change is that the depreciations tend to be larger, ie countries tend to move somewhat to the left.

Box 1

Measuring inflation

Measuring inflation is a highly technical issue that only rarely captures the public's, or even economists', attention. At the same time, it involves many choices that could have significant consequences for policies and outcomes.

In practice, most central banks tend to use the consumer price index (CPI) as their main gauge of inflation, although they usually also look at a variety of other inflation measures. This is not only the case in most AEs but also in EMEs. In fact, 16 out of the 22 EME central banks surveyed for this volume target the consumer price index (see Patel and Villar, in this volume). If anything, the dominance of the CPI as the central measure of inflation has strengthened in recent years. For example, the Bank of Thailand switched from targeting core inflation to the CPI, although it still uses the core rate in both internal analysis and communication with the public.

Central banks also use other price indices when assessing economic conditions. These could be producer prices, the deflator for consumption expenditure or various types of core measures, constructed using statistical tools or by simply excluding certain prices from the index. The various indices can send very different signals. At the moment, several countries, including China and the Czech Republic, are seeing a wide divergence between the CPI and the PPI, reflecting the very different composition of the two indices (Skořepa et al, in this volume). In the case of China, less than half of the CPI basket consists of consumer goods and the remainder is made up of services, which by construction are not part of the PPI. In addition, the PPI is heavily tilted towards capital goods, with consumer goods making up less than one quarter of the index. This can make the PPI a good measure of slack in the manufacturing sector but not of the cost of consumption.[1] Many central banks also construct a variety of core measures to gauge underlying inflation pressures.[2] But often it is not clear which index is preferable. For example, the Bank of Israel has done extensive work on core measures but was not able to find one that dominated the others (Baudot-Trajtenberg and Offenbacher, in this volume). Instead, it is now increasingly looking at disaggregated prices.

Using measures other than the CPI raises communication problems, especially if the discrepancy with headline inflation is large.[3] Some central banks therefore limit their communication relating to core measures and focus instead on headline inflation. Others, for instance the Bank of Thailand, are quite happy to refer to different measures. In Thailand, this is undoubtedly made easier by the fact that the central bank used to target core inflation in the past.

There are a number of both conceptual and practical issues arising from the measurement of inflation.

First, no single measure of inflation is representative of the behaviour of the whole population. Consumption baskets differ across individuals and households, and any price changes short of a uniform increase in all prices in the economy will have distributional effects. This may undermine the credibility of inflation measures, as the experience of individual groups may differ significantly from the picture painted by the aggregate price index. Research by the Bank of Israel shows that different types of household indeed face very different price changes, but these tend to wash out over time. Unfortunately, this is not the case everywhere. In Turkey, the prices of food, alcohol and tobacco have outpaced headline inflation over the last 10 years. This has penalised poor households, which tend to spend more of their income on such items. The higher inflation rate faced by the poor has also prompted a sizeable increase in the minimum wage, which is expected to feed into overall inflation.

[1] Some countries, for instance Chile, do not look at the PPI at all. The PPI mainly reflects the prices of a number of very specialised goods, few of which are consumed domestically. [2] Core measures of inflation tend to be constructed either by excluding certain prices from the index or through statistical filtering techniques, although model-based measures are also used. For example, the Colombian central bank uses a DSGE model to filter out supply shocks from the headline inflation rate (Vargas-Herrera, in this volume). [3] Analysis based on disaggregated prices is even more difficult to communicate.

Second, changes in administered or regulated prices may not reflect the state of the economy, especially in the short term. This opens up a wedge between any measure linked to welfare – which should include such price changes – and one intended to capture economic conditions that can be influenced by monetary policy. That said, the problem goes away over longer horizons, because most administered prices do follow other prices over the medium to long term.

Third, the treatment of housing remains an open and important issue (see Patel and Villar, in this volume). In Hong Kong, housing rents explain approximately one half of inflation variability (Hong Kong Monetary Authority, in this volume). Since changes in house prices take one to two years to feed into actual rents, house prices tend to be a good predictor of inflation. In addition, they are correlated with commercial rents, which feed through to the prices of services.

The inflation process

The inflation process, which captures the dynamics of inflation and its response to shocks, has changed considerably in recent decades. This section discusses four important developments that have been observed in many EMEs: (i) a decline in inflation persistence; (ii) a flatter Phillips curve (ie a lower responsiveness of inflation to domestic slack); (iii) an increased role of inflation expectations; and (iv) a lower exchange rate pass-through.

Econometric estimates generally find a decline in ***inflation persistence***. For a broad panel of EMEs, Arslan et al (in this volume) find that the autoregressive component of quarterly inflation fell from an estimated 0.5 in the period from 2000 to mid-2008 to around 0.25 in the period from mid-2008 to 2015. This finding is broadly consistent with the responses to a survey of central banks conducted for the meeting: seven institutions reported a decline in persistence and only two an increase – with 10 reporting no significant change.

The exact causes of the decline are not clear. One possible explanation is the decline in inflation itself. Inflation persistence tends to be highly correlated with the level of inflation, perhaps because of inflation inertia reflecting explicit or implicit contract indexation or (backward-looking) expectations. There are some signs that the degree of inertia has come down, although it is still far from negligible in some economies, such as Brazil (Volpon, in this volume). In addition, a more credible anti-inflation commitment could also have played a role. But one cannot rule out that at least part of the decline was the result of a string of favourable shocks driving down both inflation and persistence.

Another major change in the inflation process concerns the relationship between economic slack and inflation, ie the ***Phillips curve***. That said, the evidence is less solid.. The Phillips curve appears to have become flatter only in some economies. For instance, Chang et al (in this volume) present evidence that in Korea the Phillips curve broke down around 2012. Likewise, inflation in Indonesia also seems to have become less responsive to domestic demand (Hendar, in this volume). By contrast, the Phillips curve seems to be alive and well in Singapore (Choy, in this volume). The panel estimates in Arslan et al do not show any significant change in recent years: both pre- and post-crisis estimates of the relationship between the output gap and inflation yield a coefficient that is statistically indistinguishable from zero, although the post-crisis estimates gain in precision. It is unclear whether this reflects differences across countries or difficulties in estimating potential output.

The typical marginal influence of domestic slack on inflation may be a consequence of globalisation. For example, Arslan et al provide evidence that increasing trade integration has raised the role of global factors in the inflation process. Adding a measure of the global output gap to the Phillips curve often increases considerably the explanatory power in single country regressions (Borio and Filardo (2007), Choy (in this volume), Direkudomsak (in this volume)). This, however, could not be detected in the panel estimates obtained by Arslan et al, where the coefficient on a global output gap turned out to be insignificant.

In Asia, the global factors determining the inflation process seem to be complemented, or even superseded, by regional factors. In Singapore. global factors ceded some ground to regional factors as production networks in Asia have become more integrated and business cycles more synchronised (Choy, in this volume).

By contrast, the evidence for a ***greater role of inflation expectations*** is somewhat stronger. For instance, econometric results for the Philippines find a clear increase in their impact (as measured by the AP Consensus Forecast) from around 2010, alongside a decline in inflation persistence (Guinigundo, in this volume). In addition, inflation expectations themselves appear to have become more forward-looking. Moreover, the weight of such expectations seems to have increased in Korea (Chang et al, in this volume). Central banks have recognised this development and are collecting more numerous and diverse measures of expectations than in the past (see Box 2).

Box 2

Measuring inflation expectations

EME central banks appear to be using more numerous and diverse measures of inflation expectations than in the past, as indicated by the survey results presented in Sousa and Yetman (in this volume). Most central banks use surveys of professional forecasters, households and, to a lesser extent, non-financial firms' inflation forecasts in their policy analysis. Countries with an active market for inflation-indexed financial instruments also use the prices of these contracts to extract inflation expectations.

The expectations of inflation held by households and firms are often criticised as poor predictors of inflation outcomes. As shown by Sousa and Yetman, most measures of inflation expectations are biased and do not take into account all information available at the time. In some countries, expected inflation is more closely related to current and past inflation than to actual outturns. In Colombia, the discrepancy between expected inflation and outcomes is related to movements in oil and food prices prior to the time at which the survey was conducted but it is not clear whether this is because of persistent shocks or the imperfect credibility of the central bank (Vargas-Herrera, in this volume). In the Philippines, the correlation between expected and actual inflation has gone up since the implementation of inflation targeting (Guinigundo, in this volume). The most important variable for explaining forecast errors is the deviation of inflation from target, although wage growth, past inflation and inflation volatility also play a role in this regard.

The ***decline in exchange rate pass-through*** is well documented. Traditionally, exchange rate pass-through, over both the short and the long term, has been higher in EMEs. A key driver was higher, more volatile and more persistent inflation. With inflation now low and stable, prices and wages tend to change less frequently, which should reduce pass-through. Estimates in Arslan et al find that the pass-through appears to have fallen in the early 2000s and to have remained stable since the onset of the Great Financial Crisis (GFC) of 2007–09. Admittedly, estimates using a linear model show some increase in pass-through after the taper tantrum of 2013. But this appears to reflect large exchange rate depreciations rather than a structural change: large depreciations, such as the ones experienced by many EMEs in recent years, tend to feed more quickly into domestic prices. For example, Quispe and Rossini (in this volume) estimate that the pass-through of depreciations is more than twice as large as that of appreciations. Similarly, the sharp depreciation of the Chilean peso in 2008–09 was passed on almost one-to-one into consumer prices, whereas the pass-through that followed smaller changes in the exchange rate was much more contained in 2002–14 (Naudon and Vial, in this volume). This could reflect menu costs – the benefits of small price adjustments may not exceed their costs – as well as market power that allows price setters to keep the windfall gains of higher profits on imports after an appreciation but protect margins after a depreciation. So, even if pass-through is structurally lower today than it was 20 years ago, it could still be sizeable. For example, the recent depreciation of the ringgit led to a rise in the inflation expectations of Malaysian households. There is also evidence that firms are resetting their prices more frequently than in the past, with some retailers passing on depreciations one-to-one (Singh, in this volume).

A related question is which exchange rate matters most. Conceptually, one would expect a trade-weighted exchange rate to matter more than any bilateral exchange rate. Under the current circumstances, this would mean that the recent appreciation of the dollar might have been largely offset by the parallel depreciation of the euro. In practice, things are not so clear. For example, recent research (eg Gopinath (2015)) suggests that the currency of invoicing matters more than the currency of the trade partner. Since much of world trade is denominated in US dollars, the dollar may matter more than what is suggested by its share in trade-weighted effective exchange rate indices. This is supported by research by the Turkish central bank, which found that a rough mix of two thirds US dollar and one third euro generates larger pass-through estimates than trade-weighted nominal effective exchange rates (NEERs).

Another factor affecting the extent of exchange rate pass-through is the degree of dollarisation (or "euroisation" in central and eastern Europe). In Peru, as a legacy of the hyperinflation experienced a quarter of a century ago, some CPI items are directly indexed to the US dollar, which pushes up pass-through. In addition, about one half of all economic contracts are denominated in US dollars, which boosts pass-through even further (Quispe and Rossini, in this volume).

Policy implications

In recent years, the inflation process in EMEs appears to have become more similar to that in AEs. All four changes documented in the previous section – lower persistence, a flat(ter) Phillips curve, a stronger role for inflation expectations and a lower exchange rate pass-through – are reminiscent of the experience of AEs since the 1990s. To the extent that they represent a fundamental change in how the economy responds to shocks, they have a bearing on how policy should be set.

With lower inflation persistence, the effects of transitory shocks to inflation fade away more quickly. Similarly, a flatter Phillips curve and lower exchange rate pass-through imply that fluctuations in domestic output and exchange rates have a smaller impact on inflation. All this should increase central banks' ability to "see through" shocks to inflation and react only to possible second-round effects – as long as medium-term inflation expectations remained anchored around the target.

But the greater importance of inflation expectations could be a mixed blessing: it could create the potential for sharp swings in inflation (and presumably output) should price setters lose confidence in the ability or willingness of the central bank to deliver price stability. In such a situation, a flat Phillips curve and low exchange rate pass-through could make monetary policy less effective in stabilising the economy. If, for instance, inflation expectations were to rise, a sharper fall in economic activity would be needed to contain inflation.

Long periods of off-target inflation increase the risk that inflation expectations become unanchored. While long-term inflation expectations generally appear to be anchored (Sousa and Yetman, in this volume), there are signs in some countries that medium-term expectations are becoming less sticky. For instance, inflation expectations three to five years ahead, extracted from the yield curve of break-even inflation rates in Israel, dropped sharply in late 2015–early 2016, which could indicate that market participants do not expect the central bank to bring inflation back into the target range even at longer horizons (Baudot-Trajtenberg and Offenbacher, in this volume). At the other end of the spectrum, Vargas-Herrera (in this volume) reports a rapid increase in the probability that long-term inflation expectations could become unanchored.

Central banks have responded to the risk of unanchoring in different ways. Many have adjusted interest rates swiftly to bring inflation back to target. The Czech Republic introduced an exchange rate commitment to boost inflation, although this measure has not succeeded so far in bringing inflation back to target (Skořepa et al, in this volume). In Korea, the central bank has lowered its inflation target from 2.5% to 2%, despite criticism that this is too low for a country with high potential growth (Chang et al, in this volume). In Latin America, the central banks of Chile, Mexico and Peru repeatedly raised their policy rates in order to defend the value of their currencies and quell inflation, despite moderate to weak growth.

Hungary provides an interesting example of what it takes to get inflation expectations anchored. Inflation expectations in that country used to be higher than those in other countries in the region and predominantly backward-looking (Gábriel et al, in this volume). This reflected persistent upward pressure on inflation from the large fiscal deficit and tax increases aimed at containing it. This changed after the GFC, when the government cut the deficit and was able to reduce administered prices. As a result, household inflation expectations fell to levels below the inflation target, similarly to what happened in neighbouring countries, and remained at that level despite fluctuations in headline inflation rates.

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Measuring inflation

Nikhil Patel and Agustín Villar[1]

Abstract

This note focusses on key issues-both conceptual and practical- with regard to the measurement of inflation such as the tradeoff between different measures and the incorporation of prices not fully determined by market forces of supply and demand. It also draws on a recent survey of emerging market economy central banks conducted by the BIS to highlight specific issues faced by these economies and how the resulting inflation indices differ across countries.

Keywords: Price index, Inflation measurement

JEL classifications: E31, P24, P44

[1] Bank for International Settlements. Diego Urbina provided excellent research assistance. The paper draws on a recent BIS survey of emerging market economy central banks that was conducted specifically for this meeting.

Introduction

Broadly considered, there are two main rationales for measuring inflation. First, inflation reduces welfare. Second, inflation provides an indication of the degree of slack or short-term developments in the economy.[2] The weight given to these respective elements will determine the definition of inflation used.

How to measure inflation is a highly technical issue and involves many choices that could have significant consequences for the level and dynamics of the series one would like to construct. At the same time, it is important to measure inflation in a transparent and credible way, one that is understood by different constituencies of society. That said, if the measurement of inflation relies on cost of living estimates across different groups of the population, such a measurement could vary across groups; targeting the cost of living index relevant to one specific group might not be appropriate for another group.

This note reviews different aspects of inflation measurement. Section 1 discusses what is to be measured. Section 2 reports on alternative prices indices and their possible biases. Section 3 deals with the challenges faced by emerging market economy (EME) central banks in appropriately defining and measuring inflation, focusing in particular on the treatment of administered prices and owner-occupied housing across a surveyed sample of EME central banks.

1. What are we trying to measure?

Inflation acts as a tax on money: high and volatile inflation rates affect negatively the demand for money. To the extent that money provides services valued by consumers and producers, inflation imposes a welfare cost. Moreover, inflation can result in relative price changes in the presence of nominal price and wage rigidities (Vedrin (2015)), which can create significant welfare costs. How large these welfare costs are depends, inter alia, on the competitive structure of the economy, government interference, market imperfections and financial factors. As a consequence, central banks care about the level and variability of inflation.

The theoretical basis of inflation measurement is the concept of a "composite good" whose price is measured by a cost-of-goods index. A special case of a cost-of-goods index is the cost-of-living index (Wynne (2008)), which derives the choice of goods to be included in the index and their weights from the theory of consumer behaviour. The relative importance of different goods and services changes in response to changes in prices and preferences. A fixed bundle of goods is therefore likely to become less representative as time elapses. Popular cost-of-living indices are the CPI and retail price index (RPI), both of which measure the rate of change in the prices of goods and services consumed by households.[3]

2 Of course, the degree of slack in an economy and other short-term developments are also affected by other factors not reflected in current inflation rates.

3 The difference between these two indices is more historical than conceptual. The RPI originated as a measure of the cost-of-living needed to maintain healthy living conditions in a working class household in the United Kingdom. However, over time its scope expanded to include all major categories of household expenditure. The CPI, which was originated in the United States, initially valued the expenditure of a clerical urban wage-earner. Later on, coverage was extended to all urban

While changes in a cost-of-living index come very close to what most people intuitively understand by the term "inflation" (Lebow and Rudd (2008)), it is not clear that this is what central banks want to target since monetary policy affects only a subset of prices in the economy. For this reason, central banks usually do not react to the first round effects of changes in prices resulting from changes in indirect taxes or administered or regulated prices, even if they are included in the index targeted. One possibility would be to exclude such prices from the index altogether. We will return to this issue later.

A related problem is that the cost of living may fluctuate because of transitory shocks that cannot be addressed by monetary policy. Many central banks therefore use different measures of "core" inflation that eliminate some of the most volatile price components or those most affected by transitory shocks (for instance, highly seasonal food prices). We will discuss core inflation in the next section, when we look at the actual indices used by EME central banks.[4]

The downside of dropping specific price categories is that the resulting narrow index may become less representative of the actual cost of living. This compounds the problem that different parts of the population have different consumption patterns and thus face price changes which can differ significantly even from the broadest price index. This problem tends to be especially acute in EMEs, where a larger fraction of income is spent on items with volatile prices (such as food).

Producer price indices (PPI) or the GDP deflator provide an alternative to the CPI or similar cost-of-living indices. For economies vulnerable to terms-of-trade shocks, targeting the PPI or the GDP deflator might help preserve price stability, as fluctuations in the nominal exchange rate can counter movements in the terms of trade. Central banks would then react to any changes in producer prices that are not absorbed by exchange rate movements (Agénor and Pereira da Silva (2013)).

2. What indices do EME central banks use?

Responses to our survey questionnaire reveal that EME central banks use a relatively narrow set of measures of inflation in their monetary policy assessment, with the changes in the CPI playing a central role (Table 1). Most central banks target inflation measures based on the CPI – 16 out of the 22 responses received. A small number of central banks replied that they did not target inflation directly as measured by a price index. This group of central banks base their monetary policy strategy on the targeting of the external value of the currency although the CPI still plays a central role as a measure of inflation.[5]

None of the EME central banks that participated in the survey targets a measure of inflation based on an index other than the CPI (for instance, producer prices or the GDP deflator). This overwhelming preference for targeting the CPI suggests that central banks do not see the shortcomings of the CPI, such as the high share of

consumers. In both cases, the prices used in the index are obtained by regular nationwide sampling while the weights pertaining to each price category are derived from household budget surveys.

4 From a statistical point of view, more volatile price categories tend to reduce the precision of the price index estimates. In some cases, price categories with a comparably small relative weigh may make a big contribution to variation in the overall index.

5 Central banks targeting the exchange rate appear to have considerable leeway in keeping inflation low and stable. However, they still need to wrestle with considerable challenges in securing price stability. The note submitted for this meeting by the Hong Kong Monetary Authority describes some of those challenges.

regulated or administered prices in EMEs, as insurmountable obstacles in the achievement of their monetary policy objectives. In particular, by choosing the CPI over other measures of inflation, EME central banks appear to place greater weight on the welfare cost rationale for measuring inflation than on measures of slack or short-term developments.

The widespread use of the CPI as the preferred price index in inflation targeting and other monetary policy strategies in EMEs seems to reflect a number of perceived advantages. First, the CPI is relatively easy to understand and is the best available measure of the cost of living faced by consumers. Second, it is familiar to large segments of the population, regularly reported in the news media, used as a reference for the provision of government benefits or contracts and is widely followed as an indicator of macroeconomic stability. Finally, it is available at a relatively high frequency and is not subject to many revisions, enhancing its transparency and use in monetary policy (Moreno (2010)).

What measure of inflation and for what?

Summary of questionnaire responses — Table 1

	Target[1]	Other uses[2]		
		Set policy	Forecasting	Assessment of policy stance
CPI	16 (22)	13 (15)	16 (18)	15 (18)
CPI (core)	…	10 (12)	13 (14)	13 (15)
Import prices[3]	…	1	7	2
GDP deflator	…	1	2	2
Producer price index	…	2	8	7

[1] Total number of countries that provided information in parenthesis. [2] Number of countries using the CPI (headline) for inflation targeting and for other uses. [3] Chile uses external prices instead of import prices for forecasting purposes.

Source: BIS survey.

Central banks that target inflation as measured by the CPI also make use of the inflation index for other aspects of their monetary strategy. Of the 16 central banks that target consumer price inflation, 13 replied that they also make use of CPI inflation to set their policy (Table 1). This reveals consistency between the measured target and the use of this measure in setting the policy rate. The three central banks that do not set policy on the basis of the CPI tend to use a narrower measure. A few central banks do not target consumer price inflation in their monetary policy but instead forecast it (three central banks) and use the forecasts to assess the policy stance (three others) or set policy (two others).

Many central banks also rely on measures of “core inflation” to forecast inflation, assess the policy stance and set policy. There is a large overlap in the central banks that make use of a “core inflation” measure as part of their monetary policy strategy with those that target a measure of consumer price inflation. But “core” can mean different things to different countries. It may exclude highly volatile prices (eg those of foodstuffs and fuel), non-monetary expenditures (eg imputed housing costs for owner-occupied property or rents) or the effects of changes in taxes, subsidised prices or rents, and administered prices.

Biases in the measurement of inflation

While the CPI has a central role to play in the monetary policy framework of many EMEs, there are reasons to believe that it may be biased. The most common arguments suggest that it typically overestimates inflation. This bias reflects substitution effects, household heterogeneity, and quality improvement and product replacement effects. Unless the weights are revised frequently, the index will become less representative as goods with larger price increases tend to be demanded less and those with lower prices increases or price decreases tend to be demanded more. The obvious solution lies in a more frequent updating of the index. However, this comes at the cost of more frequent expenditure surveys and possibly also perceptions of index manipulation.

Heterogeneity of household income is a significant potential source of bias in EMEs. The weights of the CPI are often based on the average share of expenditure from different groups in society. Because the distribution of expenditure tends to be skewed, the index is likely to overweight the expenditure patterns of the more affluent segments of society. This problem might be more serious in EMEs where the distribution of income is more unequal. The impact on the inflation rate is less clear: it would depend on the relative prices changes taking place in the economy. If the prices of goods prominent in the expenditure of households at the higher end of the income distribution scale are growing faster than those of groups at the lower end, the measurement of inflation will be biased upwards.

The implications of overestimation have often been flagged in other areas of public policy such as fiscal policy and the assessment of economic competitiveness. For example, an upward bias may drive up pensions and social spending more rapidly than justified by changes in the cost of living. If it is not anticipated, the systematic overestimation of the inflation rate due to a bias can also have significant consequences for perceived real interest rates and thus for saving and investment as well as monetary policy.

The replies to the survey show that half of the 16 central banks have estimates for the potential bias in CPI inflation, although the type of bias and even sometimes the sign vary across countries. The central banks of Malaysia, Poland, Russia and Thailand estimate an upward bias. In Chile, by contrast, the quality bias in the clothing category imparts a negative bias to inflation as estimated by the CPI. In Malaysia, the heterogeneity of income is a motive for considerable control of surveys carried out at five-year intervals. The substitution bias is also monitored with surveys carried out every six months in order to adjust expenditure shares.

3. Some practical issues in measuring inflation

Prices of goods and services that are not freely determined in the market present a challenge to inflation measurement. Conceptually, it is not always clear whether and to what extent these prices should be incorporated in an inflation measure used for conducting monetary policy. Moreover, given the difficulty of estimating and inferring prices in the absence of explicit markets, it is not always feasible to implement an optimal index even if one attempts to base it on firm conceptual grounds.[6] Central banks therefore face the complex task of striking a balance between practice and

[6] For instance, while in theory it may be optimal to fully incorporate the cost of owner-occupied housing (an issue discussed in detail below), in practice this may not be feasible in the absence of good proxies for the cost of owner-occupied housing, given the lack of actual market prices.

theory when deciding how such prices should be treated in their preferred inflation measure. This section covers two prominent prices that fall into this category, namely administered and regulated prices, and the prices of owner-occupied housing services. It also summarises how central banks in our survey deal with them.

3.1 Administered and regulated prices

Governments typically regulate the prices of certain goods and services. These obviously include goods and services provided by the government itself, such as public transport, health care and education, but also other goods that are considered essential.[7] It is in the treatment of administered prices that the tension between the welfare cost and slack measurement rationales for measuring inflation come to the fore. On the one hand, if such prices are mainly driven by social and political concerns, they cease to be good indicators of slack in the economy or of short-term developments more generally. On the other hand, these prices represent a significant share of the consumption basket in most EMEs and hence warrant inclusion as a gauge of the cost of living.

According to questionnaire responses, the share of administered and regulated prices varies substantially across countries (Appendix Table 3.1). It is as high as 34.6% in Thailand and less than 5% in India. As expected, food, energy and government services are the most prominent categories.

The survey also highlights how central banks differ in their treatment of administered and regulated prices, and in balancing the trade-offs mentioned above. At one extreme, these prices are incorporated fully in the inflation measure (eg in Peru). At the other extreme, they are dropped from the index altogether (eg in Hungary and Poland).[8] In between, many central banks choose to downplay administered and regulated prices through different means, often retaining scope to exercise discretion and judgment in the presence of large movements.[9]

The Bank of Thailand provides a slightly different and interesting alternative. It uses an inflation measure that attempts to explicitly exclude only government measures (such as an increase in excise taxes) from regulated prices. This has the advantage of retaining goods with administered prices to maximise the coverage of the inflation measure while at the same time preventing government actions (which are presumably not directly linked to the state of the economy) to affect it. Taking this approach further, another option might be to estimate shadow prices for regulated goods and services by using, for instance, estimates of the cost of production. That said, this would make the measure less transparent and timely and no longer indicative of the cost of living.

Regulated prices often give rise to black markets and underground economies. More generally, the informal sector of an economy, which in some cases is fairly sizeable (39–42% of GDP for the Philippines according to the estimates of Schneider

7 This, for instance, is the case for fuels such as kerosene and liquefied petroleum gas (LPG) in India.

8 The core inflation measure computed by the National Bank of Poland excludes administered and regulated prices. As discussed above, different countries work with different definitions of core inflation.

9 For example, while regulated and administered prices are incorporated in the inflation measure used by Korea, steps are taken to exclude transitory changes due to institutional shifts unrelated to economic forces.

et al (2010)), presents a challenge for inflation measurement since these prices are excluded from the computation of economic indices.

3.2 Measuring the price of housing services

Housing services, whether explicitly accounted for by rental payments or implicitly incorporated in owner-occupied housing estimates, account for a large proportion of total household expenditure. But houses tend to be big-ticket items that are purchased infrequently, so the cost of the implicit services provided must be estimated.[10] This could be done by including house prices directly in the measure of inflation, for instance through the net acquisition approach that measures the average change in the price paid by a household to acquire a home, or by estimating implicit rents. Yet another option is to follow the user cost approach, which covers various costs of home ownership such as interest payments on mortgages, taxes, insurance, repairs and maintenance costs (see McCarthy and Peach (2010) and Cecchetti (2007) for discussions of how those issues are being addressed in advanced economies).[11]

Our survey responses show that EME central banks address these issues in very different ways. As a result, the share of housing in the inflation measures varies widely, ranging from 1.2% in Hungary to 31.7% in Hong Kong SAR (Appendix Table 3.2).

While rental prices are relatively easy to obtain and are incorporated by all the surveyed countries, with the exception of Peru, Saudi Arabia and the United Arab Emirates, the extent to which owner-occupied housing is covered differs widely. Some central banks choose to exclude owner-occupied housing completely (Chile, Hungary, Korea, Malaysia, the Philippines, Poland, Russia and Turkey).[12] This could be either because they prefer to work with an inflation measure that is representative only of market prices or because it is not feasible to obtain satisfactory measures. Among the central banks that do incorporate owner-occupied housing in their inflation measure, the rental equivalence approach is nearly the unanimous choice (Appendix Table 3.2).[13] This is consistent with Gillingham (1983), who argues that this is preferable on both theoretical and empirical grounds.

Even in the case of rents, central banks in our survey highlight potential sources of bias. Typically, the longitudinal nature of most surveys implies that newly constructed houses are often underrepresented, leading to a downward bias in measured inflation. Central banks address this issue in several ways. For instance, some countries report using rotating samples and replace a certain fraction of the sample at a specific frequency.[14] Recognising the problem posed by lags between construction of new housing units and their full incorporation in the rental

[10] From the point of view of national income accounting, homeowners living in their own houses are assumed to pay themselves a market rent, which appears as consumption expenditure in GDP. The rationale is that if some or all homeowners become renters or vice versa, GDP should not be affected.

[11] See Poole et al (2005) for a detailed description and comparison of these methods.

[12] This is also the approach taken in computing the Harmonised Index of Consumer Prices (HIPC), the primary inflation measure used by the ECB to set monetary policy for the euro area.

[13] The only exceptions are Israel, which in addition to the rental equivalence approach gives a small weight to the cost of insurance and legal services; Chile, which reports using repairs and maintenance services; and the Czech Republic, which reported using the user cost approach in the past, but switched to the rental equivalence approach in 2007.

[14] One thirty-sixth of the sample is replaced in Korea every month, while one third is replaced by Turkey every year.

computation programme, the Czech Republic makes annual adjustments based on finalised construction works and liquidated housing.

Survey attrition, small sample coverage and changes in neighbourhood quality are some of the other sources of bias that affect the measurement of housing services for both tenant and owner-occupied units. Israel, for instance, identifies the small sample of rental housing units as a major potential source of bias and uses a hedonic estimation routine to address it.

Sometimes the biases are not easy to minimise, and central banks may be left with little choice but to use an inflation index that excludes housing inflation to reflect inflationary pressure, as is done by Thailand.

Appendix

Administered and regulated prices

Summary of survey responses; as a share of preferred inflation measure — Table 3.1

	Overall weight on preferred inflation measure	Sectors	
Chile	9.9	Gasoline	3.5
		Electricity	2.7
		Drinking water	1.9
		Transportation by subway	1.3
China	…	Agricultural goods	3.0–5.0
		Petrol	3.0–5.0
		…	…
		…	…
Colombia	15.2	Urban public transportation	4.8
		Fuel	2.9
		Electricity	2.9
		Water/sewage	2.6
Czech Republic	16.9	Housing, water, electricity, gas and other fuels	11.6
		Health	1.7
		Transport	1.2
		Restaurants and hotels	0.9
Hungary	17.8	Regulated services and medicines	10.5
		Regulated energy	7.3
		…	…
		…	…
India	…	Fuel group – administered kerosene prices and subsidised liquefied petroleum gas prices	1.8
		Food group – prices of food items distributed through the Public Distribution System (PDS)	0.6
		…	…
		…	…
Indonesia	18.0	Transport, communication, and financial services	9.7
		Housing, water, electricity, gas, and fuel	5.1
		Prepared food, beverages, cigarette, and tobacco	3.1
		Health	0.0
Israel	…	Education	4.2
		Energy	3.1
		Food	2.4
		Municipal taxes	2.3
Korea	…	Public services	8.6
		Electricity and water and gas	4.9
		…	…
		…	…
Malaysia	…	Utilities and energy (excluding fuels for personal transport equipment)	4.5

		Alcoholic beverages and tobacco	2.2
		Food (controlled price)	1.1
		Transport services	0.9
Mexico	14.8	Gasoline	3.7
		Electricity	3.6
		Public transportation	2.0
		Liquefied petroleum gas	1.6
Peru	...	Electricity	2.9
		Telephone	2.9
		Water	1.6
		...	...
Poland	...	Energy	9.4
		Services	5.2
		Electricity	4.4
		Gas	2.5
Russia	...	Public utilities	5.7
		Housing services other than apartment rentals	2.6
		Local railway and municipal transportation	1.6
		Vital medicines	0.8
Singapore	...	Electricity	3.2
		Bus fares	1.4
		Train fares	1.2
		Household services and supplies: government levy for foreign domestic worker	0.8
South Africa	18.5	Petrol	5.7
		Electricity	4.1
		Education	3.0
		Communication	76.0
Thailand	34.6	Core	19.9
		Energy	11.4
		Raw foods	3.3
		...	...
Turkey	...	Energy	6.9
		Alcoholic beverages and tobacco	4.8
		...	...
		...	...
United Arab Emirates	...	Gas, electricity and water	5.2
			...
			...
			...

Source: BIS survey responses.

Housing rental cost in the CPI

Table 3.2

	Market rent	Imputed rent based on: Net acquisition approach	Rental equivalent approach	User cost approach	Other	Share in price index (%)
Chile	YES	...	...	...	...	4.20
China	YES	...	YES	...	...	20.00
Colombia	YES	...	YES	...	...	18.59
Czech Republic	YES	...	YES	...	...	13.82
Hong Kong SAR	YES	...	YES	...	...	31.70
Hungary	YES	...	...	...	...	1.20
India	YES	...	YES	...	...	10.10
Indonesia	YES	...	...	...	...	8.57
Israel	YES	...	YES	...	...	24.80
Korea	YES	...	...	...	...	9.28
Malaysia	YES	...	...	...	...	17.20
Mexico	YES	...	YES	...	...	17.20
Peru	...	...	YES	...	...	2.40
Philippines	YES	...	...	...	YES	13.80
Poland	YES	...	...	...	...	1.20
Russia	YES	...	...	...	...	2.90
Saudi Arabia	...	...	...	...	...	20.50
Singapore	YES	...	YES	...	...	22.90
South Africa	YES	...	YES	...	...	0.00
Thailand	YES	...	YES	...	...	15.40
Turkey	YES	...	...	...	...	5.10
United Arab Emirates	...	...	...	...	...	39.00

Source: BIS survey responses.

Core inflation measures used by central banks

Summary of survey responses Table 3.3

Chile	CPI (core): CPI without foods and energy
China	…
Colombia	CPI (core):
Czech Republic	CPI (core): excluding fuels
Hong Kong SAR	…
Hungary	CPI (core): adjusted for the effects of indirect taxes
India	…
Indonesia	CPI (core) CPI (volatile foods) CPI (index-administered prices)
Israel	CPI (core): excluding energy, food, fruits and vegetables
Korea	CPI (core)
Malaysia	CPI (core)
Mexico	CPI (core)
Peru	CPI (core)
Poland	CPI (core): CPI net of food and non-alcoholic beverages and energy Inflation net of administered prices
Philippines	CPI (core)
Russia	CPI (core)
Saudi Arabia	…
Singapore	CPI (core): excludes accommodation and private road transport costs
South Africa	CPI (core) Administered prices
Thailand	CPI (core) Core inflation excluding government measures and rent
Turkey	CPI (core): excludes unprocessed food and alcohol-tobacco
United Arab Emirates	CPI excluding rent

Source: BIS survey responses.

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The inflation process

Yavuz Arslan, Martina Jašová and Előd Takáts

Abstract

This paper documents three major and favourable inflation dynamics in emerging market economies (EMEs). First, the level of inflation has moderated in EMEs and has been broadly stable since the early 2000s. Second, inflation persistence has declined over the past decade. Third, EME exchange rate pass-through, both short-term and long-term, has also declined after the financial crisis. In addition, the paper shows that the role of global factors on inflation is larger for EMEs that are more open to trade.

Keywords: Inflation, exchange rate pass-through

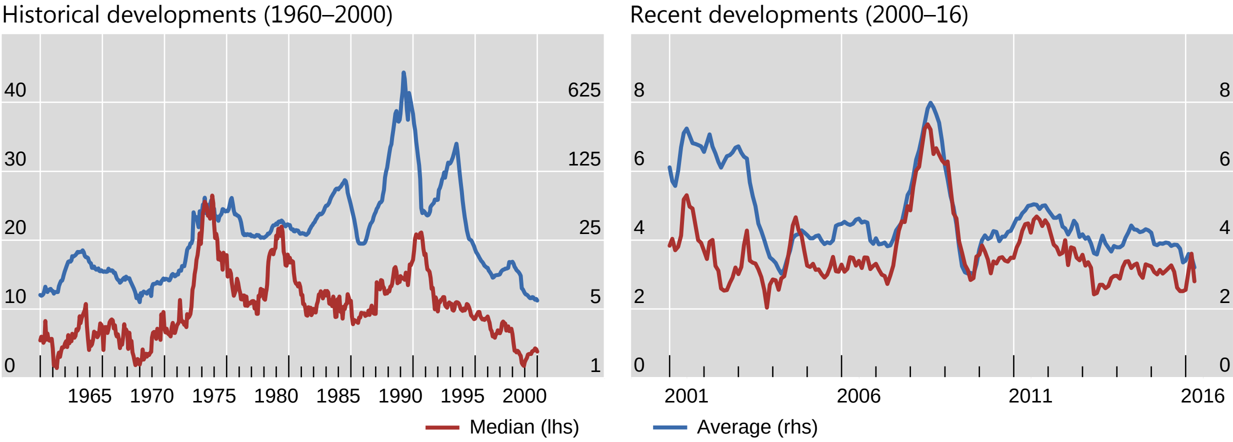
JEL classification: E31, E58, F31

Introduction

Inflation has moderated in emerging market economies (EMEs) since the 1990s (Graph 1). The decline is similar to, but steeper than, that in advanced economies. This is in stark contrast with the previous few decades: in the 1970s the two oil crises raised inflation rates in many EMEs; and in the 1980s average inflation accelerated further, with some experiencing hyperinflation (left-hand panel). Yet, after the mid-1990s average inflation began to slow, and by the 2000s it was fluctuating in a narrow and stable range (right-hand panel).

EME inflation[1] has moderated to low levels from historical highs

In per cent — Graph 1



[1] Year-on-year change in consumer price index. Unweighted median and average for Algeria, Argentina, Brazil, China, Chile, Colombia, the Czech Republic, Hungary, Hong Kong SAR, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Singapore, South Africa, Thailand and the United Arab Emirates since January 1960 or later depending on data availability.

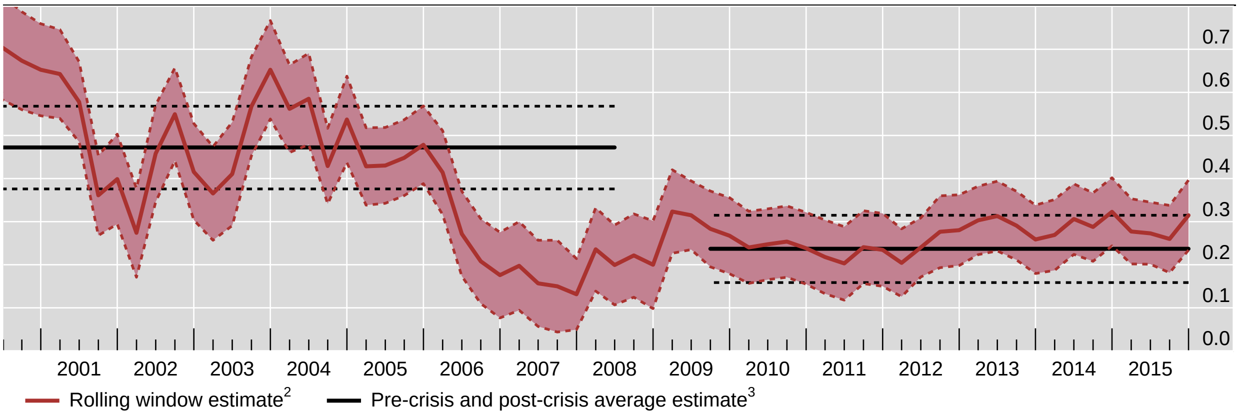
Sources: CEIC; Datastream; Global Financial Data; national data.

Inflation persistence also seems to have declined over the past 15 years (Graph 2, red trend line). The rolling estimates suggest that persistence started to recede even before the financial crisis, though assessing the significance of such changes is difficult over shorter horizons. Yet, persistence is clearly lower in the broad post-crisis period than in the pre-crisis period (compare black solid lines and dotted confidence bands). Lower inflation persistence is usually interpreted positively because it implies that past inflation trends have less of an effect on inflation, facilitating its control.[1]

[1] Of course, when thinking about monetary policy, one is interested in endogenous inflation persistence, ie the degree to which past inflation drives current inflation, and not in accidental or purely statistical inflation persistence, such as that arising from persistent shocks. Reflecting this, the baseline estimation controls for some likely shocks: the business cycle, global factors such as the shock of oil price movements or the financial crisis (through time fixed effects), and exchange rate movements. That said, the decline in persistence is present even if these controls are excluded. Furthermore, it is robust to different specifications.

Inflation persistence has also declined over the past decade[1]

Graph 2



[1] Persistence is defined as the autoregressive coefficient δ from the equation A1 in the Appendix. [2] Results for six-year rolling window. [3] Results for periods Q1 2000–Q2 2008 (pre-crisis) and Q3 2009–Q4 2015 (post-crisis).

Sources: Jašová et al (2016); IMF, *International Financial Statistics* and *World Economic Outlook*; CEIC; Datastream; national data; BIS calculations.

Declining persistence is broadly consistent with the questionnaire responses: seven responding EMEs found that persistence declined while only two reported an increase – with 10 reporting roughly no change (for details, see Appendix Table A1). Yet, these responses also highlight that the averages, for both the level and the persistence of inflation, are not necessarily representative for all EMEs.

In principle, the moderation of inflation and the fall in its persistence are good news. But while this might imply easier central bank control or better anchored expectations, other factors, less influenced by central banks, may also have been at work. In fact, our understanding of the inflation process, even in advanced economies, is highly imperfect (BIS (2015) and the Bank of Korea note by Chang, Choi and Park in this issue). And, as some economists have highlighted, inflation has displayed confounding dynamics that are not captured by conventional models (Faust and Leeper (2015)).

This paper explores the inflation process in EMEs. It discusses analytic issues along two dimensions: short vs long-term and local vs global. To understand changes over time and across EMEs, we examine four selected drivers: (1) Phillips curve output gap responses (as a short-term domestic driver); (2) exchange rate pass-through (as a short-term global driver); (3) age structure (as a long-term domestic driver); and (4) trade (as a long-term global driver).

Potential inflation drivers

When thinking about the factors driving inflation, two dimensions might be useful: domestic and global factors, on the one hand, and short-term (ie business cycle) and long-term (ie low-frequency) factors, on the other (Table 1). A typical New Keynesian model would consider domestic drivers that exert their effect over the business cycle (top left-hand cell). The standard Phillips curve, in its most parsimonious form, includes inflation expectations as well as wage or output gaps. In addition, simple extensions for small open economies often include the exchange rate or import prices to account for relevant international effects.

However, it seems that inflation is increasingly shaped by global factors – and these global factors are not necessarily fully captured by the exchange rate. For instance, there is evidence that inflation has become less reactive to domestic factors and more susceptible to global ones (eg Borio and Filardo (2007) and the Central Bank of Malaysia note by Singh in this issue). These global effects can work at both high and low frequencies. Global food and commodity prices seem to operate on a frequency similar, though not identical, to that of the business cycle (top right-hand cell). For instance, they pushed inflation up and down in many EMEs around the global financial crisis. Yet, global factors can, in principle, work at lower than business cycle frequencies: for instance, the increased contestability of labour and goods markets associated with the entry of former communist countries in the trading system as well as with technological development (bottom right-hand cell).

Potential inflation drivers — Table 1

	Domestic	*Global*
Short-term (high-frequency, business cycle horizon)	Phillips curve	Exchange rates, commodity prices (oil and food), invoicing and funding currencies
Long-term (low-frequency)	Demographics, education, (female) labour force participation, labour share of income, credit cycles	Trade, globalisation, technology, (global demographics)

Furthermore, some domestic drivers might also shape inflation over the longer term. Researchers, like Faust and Leeper (2015), have highlighted long-run changes in age structure (demographics), education, (female) labour force participation, the labour share of income and credit cycles as potential drivers. While not uncontroversial, thinking about these drivers could be especially relevant for EMEs, as these factors often evolve faster there than in advanced economies.

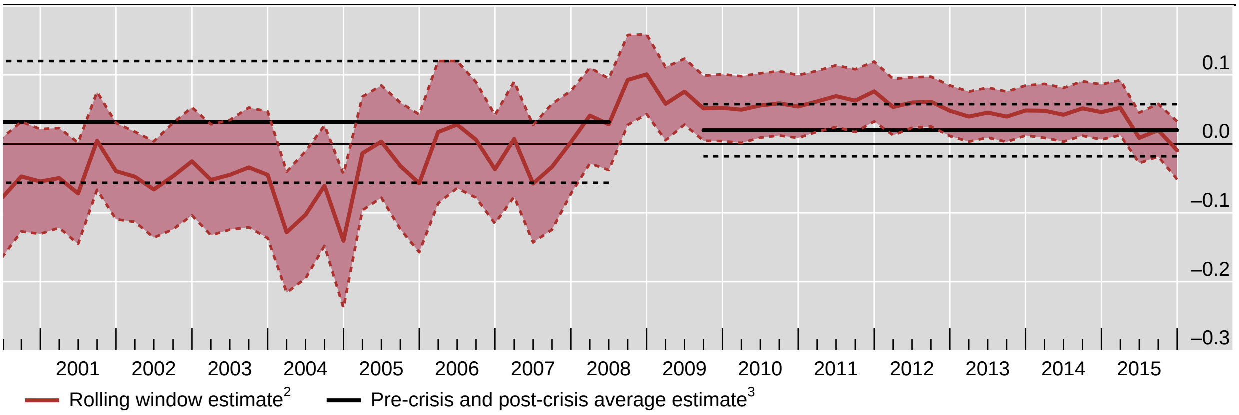
In what follows, we structure the discussion along these two dimensions. In particular, we examine: (1) Phillips curve output gap responses as a short-term domestic driver; (2) exchange rate pass-through as a short-term global driver; (3) age structure as a long-term domestic driver; and (4) trade as a long-term global driver.

II.1 Phillips curve output gap responses

Evidence is accumulating that in advanced economies the Phillips curve has flattened, ie that inflation has become less responsive to domestic slack. Is this true of EMEs?

Indeed, the impact of the domestic output gap seems to be mostly insignificant for EMEs as a group (Graph 3, red trend line). The rolling window estimates tend to be insignificant or only marginally significantly different from zero (red dotted confidence band). Furthermore, both the pre- and post-crisis estimates show that the output gap responses are consistently statistically insignificant, though the post-crisis estimates seem to be suggest this more precisely (black lines and dotted black confidence intervals). These results are consistent with the conjectures in Borio and Filardo (2007) and in the Central Bank of Malaysia note by Singh in this issue.

The impact of the domestic output gap in inflation seems insignificant — Graph 3



[1] The impact of the domestic output gap is defined as the coefficient ϕ from the equation A1 in the Appendix. [2] Results for six-year rolling window. [3] Results for periods Q1 2000–Q2 2008 (pre-crisis) and Q3 2009–Q4 2015 (post-crisis).

Sources: Jašová et al (2016); IMF, *International Financial Statistics* and *World Economic Outlook*; CEIC; Datastream; national data; BIS calculations.

While for the "average" EME, the domestic output gap does not seem to be statistically significant, this result should be treated cautiously. First, as usual, much heterogeneity remains across EMEs.[2] Second, and more importantly, although the estimates generally hover around zero, the response is marginally statistically different from zero in many subperiods (see red confidence band of rolling window estimates for in the 2005–07 and 2010–2015 periods).

II.2 Exchange rate pass-through

Main trends in pass-through

Given recent large exchange rate depreciations in many EMEs, the question naturally arises: to what degree do exchange rate movements pass through to inflation? And has this pass-through changed?

Traditionally, exchange rate pass-through, over both the short and the long term, has been higher for EMEs than for advanced economies. That said, a key facilitator of this higher pass-through was higher, more volatile and more persistent inflation. When inflation is low and stable, prices and wages tend to be stickier, which in turn reduces the pass-through (Taylor (2000)). Indeed, Choudhri and Hakura (2006) and Devereux and Yetman (2010) find a positive and statistically significant relationship between the pass-through to domestic prices and the average inflation rate across

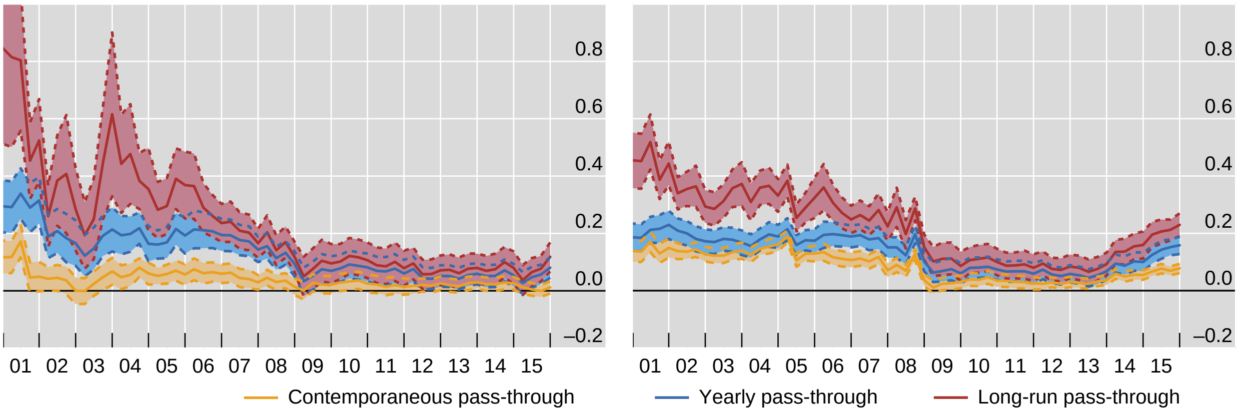
[2] For instance, the note from the Monetary Authority of Singapore by Meng in this issue shows that domestic output drives inflation significantly in Singapore over the full 1994–2013 period – and this result might also generalise to the post-crisis period.

countries and periods. Hence, the observed moderation in average inflation rates (Graph 1) along with the decline in inflation persistence over the past decades (Graph 2) would suggest a smaller pass-through in EMEs.[3]

Pass-through declined post-crisis

Nominal effective exchange rate pass-through to consumer prices, six-year rolling windows — Graph 4

Pass-through estimates for non-linear specification[1] — Pass-through estimates for linear specification[2]



[1] Pass-through results are derived from the equation A1 in the Appendix. [2] Pass-through results are based on the same method as explained in the Appendix excluding quadratic and cubic changes in exchange rates, ie. $\pi_{it} = \alpha_i + \beta_t + \delta\pi_{it-1} - \sum_{j=0}^{3}\gamma_j \Delta NEER_{it-j} + \phi ygap_{it} + \varepsilon_{it}$.

Sources: Jašová et al (2016); IMF, *International Financial Statistics* and *World Economic Outlook*; CEIC; Datastream; national data; BIS calculations.

Indeed, average EME exchange rate pass-through estimates, both short-term and long-term, have declined post-crisis (Graph 4, left-hand panel). This basic pattern does not depend on the precise specification, including the length of the estimation window. It is similar for all three pass-through estimates: the contemporaneous (yellow line), the yearly (blue line) and the long-run (red line). Furthermore, the levels and patterns of the pass-through estimates are almost identical whether we use changes in the nominal exchange rate or the US dollar bilateral exchange rate (see details in Jašová et al, 2016). Interestingly, the note from the Magyar Nemzeti Bank by Gábriel, Molnár and Várhegyi identifies a similar decline in pass-through – although there it starts slightly later, around 2010.

However, controlling for non-linearities is crucial to properly assess the extent of recent pass-through developments. Exchange rate movements increased during and after the taper tantrum (ie after May 2013). These larger exchange rate movements are expected to pass through stronger to consumer prices than smaller movements, because they are more likely to overcome the menu costs associated with price changes. Consequently, simple linear pass-through estimates, which ignore these non-linearities, would suggest some increase in pass-through after the taper tantrum (Graph 4, right-hand panel) – while such an increase is not visible in models that take non-linearities into account (left-hand panel).

[3] Conversely, as the Central Bank of Malaysia note by Singh in this issue also shows, more openness and more market-based price determination can increase pass-through.

The questionnaire responses are broadly consistent with the panel estimates. Ten EMEs found weakening pass-through and only two a strengthening one; five respondents saw no change (see Appendix Table A1 for country-specific details).

Furthermore, the questionnaire responses and the country papers confirm that EME experiences are likely to be heterogeneous.[4] Hence, our results above should only be read as broad, cross-country trends which might provide guidance for all EMEs. Yet, repeating the analysis for subsamples, such as EMEs with free-floating exchange rates, inflation targeting regimes or large shares of commodity exports, suggest that the main trend of declining pass-through is present broadly among EMEs (results available upon request). Of course, smaller differences remain. For instance, inflation targeters have seen a larger than average fall in pass-through under all three time horizons, which confirms the findings in eg Choudhri and Hakura (2006) that inflation targeting regimes can moderate the extent of pass-through. Yet, these country group estimates should be treated cautiously as the estimates are becoming less stable as we shrink the sample size.

While the above results indicate a clear trend in pass-through, some caution is warranted in interpreting them. The analysis largely assumes that the response to the exchange rate is invariant to the factors driving it.[5] Unfortunately, many forms of heterogeneity cannot be fully controlled in a macroeconomic panel setup. For instance, evidence is accumulating that pass-through might be larger for global shocks than for country-specific shocks (Forbes (2015)). The analysis aims to control for this by including time fixed effects to capture global shocks. However, this control is imperfect: it cannot capture the impact of the global shock that affects EMEs differently.[6]

Foreign currency debt and exchange rate pass-through

As noted earlier, there is considerable variation in exchange rate pass-through across countries or groups thereof. Here we ask the question whether foreign currency debt can be one of the sources of this heterogeneity.

Theoretically, FX debt can influence exchange rate pass-through via, for instance, the "risk-taking channel" of exchange rates. Fluctuations in exchange rates alter the riskiness and availability of credit by affecting the strength of those companies that borrow in foreign currency (Bruno and Shin (2014)). This, in turn, may also influence pricing behaviour. Indeed, in their Jackson Hole paper Gilchrist and Zakrajsek (2015) find that financial conditions, in their case largely linked to domestic debt, have such

4 For instance, the note from the Central Bank of the Republic of Turkey by Kılınç, Tunç and Yörükoğlu shows that pass-through seems to be higher in Turkey than in Mexico and links this observation to different sizes of current account deficits.

5 For instance, exchange rate movements which are perceived to be more persistent are likely to have a larger pass-through, as the note from the Czech National Bank by Skořepa, Tomšík and Vlček argues.

6 Furthermore, excluding global shocks this way also implies that the estimates are derived only from cross-sectional variation – and the resulting omission of time variation means also that the analysis might underestimate the full extent of pass-through. Running our specification without time fixed effects suggests that excluding time variation indeed lowers the estimates. When global shocks enter the estimates, the estimated pass-through increases. Yet, the basic pattern – the post-crisis drop and post-taper tantrum jump – remains broadly unchanged. For details see Jašová et al (2016).

an effect. They find that, during the 2008 financial crisis, while financially constrained firms increased their prices, unconstrained ones decreased theirs.

We estimate an extended version of the equation in the footnote of Graph 4 and find that the level of FX debt is associated with higher exchange rate pass-through.[7] In particular, we extend the model by including the interaction of the level of FX debt (percentage of GDP) and the percentage change in the nominal effective exchange rate (ΔNEER), alongside the level of FX debt and the policy interest rate as additional explanatory variables.[8] We add policy rates because the level of FX debt can also influence the policy rates due to financial stability concerns. The results show that the coefficient of the interaction term is significantly negative, which indicates higher pass-through for higher FX debt levels.[9]

II.3 Age structure and inflation

Demographic change, particularly in the age structure of the population, may also influence inflation over the long term. Reflecting this, there is much discussion about the impact of the ageing and retirement of baby boomers in the United States. Understanding the impact of a changing age structure is also relevant for EMEs. The casual distinction between "young" EMEs and "old" advanced economies is, if not a myth, an overgeneralisation. For instance, the Korean population is already older than the US population – and the Chinese and Brazilian populations will be so in five and fifteen years, respectively.[10]

These changes in the age structure might affect inflation dynamics. Former Governor of the Bank of Japan Shirakawa (2011a,b) suggested that the rising population share of the old can drastically weaken the economic outlook, which in turn could exert deflationary pressures. In a similar view, President Bullard of the Federal Reserve Bank of St Louis (Bullard et al (2012)) argued that the old's preference for lower inflation can reduce inflation in ageing societies. Faust and Leeper (2015) also discuss age structure as a potential, though not well understood, inflation driver.

Indeed, some researchers have found a seemingly robust empirical correlation between age structure and inflation in advanced economies (Juselius and Takáts (2015b)).[11] Accordingly, a larger share of the dependent population (ie young and old) is inflationary (ie associated with higher inflation), and a larger share of the

7 We do a similar analysis with credit growth instead of the level of FX debt. The results show that, during depreciation periods, more credit growth is associated with lower pass-through. The findings provide additional support to the importance of financial conditions in price level dynamics.

8 To better identify the risk-taking channel, it is necessary to run the regressions with bilateral exchange rates as well.

9 We find suggestive evidence from sectoral analysis by using the questionnaire responses that provide the sectoral level price, credit and FX debt level. In particular, we find that, for the manufacturing sector, the level of FX debt is associated with higher pass-through. For agriculture, we do not find significant results. We could not perform the analysis for the other sectors due to data availability.

10 Population age measures as median age; projections from United Nations (2015).

11 Estimates using data on 22 advanced economies over the 1955–2010 period. The uncovered relationship is robust in subsamples and subperiods, including in the most recent (1995–2010) period. It also holds under different estimation techniques (see also Aksoy et al (2015) for a simpler setting).

working age population deflationary (ie associated with lower inflation).[12] To see this relationship, consider the left-hand panel of Graph 5.[13] The horizontal axis lists the age cohorts: 0–4 years old, then 5–9 years old, etc. The vertical axis shows the inflationary impact of the respective cohort. For instance, the inflationary impact of the 10–14 age cohort is around 0.5%. This means that an increase in the population share of the 10–14 cohort by 1 percentage point will increase inflation by 0.05 percentage points.[14] The inflationary impact of the full population age structure can be obtained by multiplying, one by one, each cohort's impact by the share of that cohort in the population – and summing these up for all cohorts. The impact of the young and the old is inflationary (positive values) and that of the working age cohorts disinflationary. The narrow confidence band (dotted line) shows that the estimates are precise.

Firmly identifying a similar low-frequency impact for EMEs is not feasible because the long-term inflation series include huge shocks, such as episodes of crises and hyperinflation (Graph 1). These large shocks would mask any slow-moving, relatively small changes, such as the impact of age structure. Yet, the age structure impact might not be completely irrelevant for EMEs. Combining the age cohort impact estimates obtained for advanced economies with the age structure of EMEs prevailing today, the resulting effect could explain around one third of the cross-sectional variation of average inflation across EMEs over the last three years (Graph 5, right-hand panel). Importantly, this prima facie evidence suggests that age structure should not be entirely dismissed as a potential factor.

The potential impact of age structure on inflation is relevant for policymakers for two main reasons. The relative importance of demographics is naturally greater at low inflation rates. And Juselius and Takáts (2015b) also find that it can explain a large part of the observed inflation persistence and trend decline in their sample of advanced economies.

12 While population growth, especially that of the working age population, also seems relevant, its effect is small and its inclusion does not affect the age structure results.

13 The smooth pattern reflects the population polynomial technique from Fair and Dominguez (1991). Important, simple age cohort estimates, though econometrically not ideal, show a very similar picture.

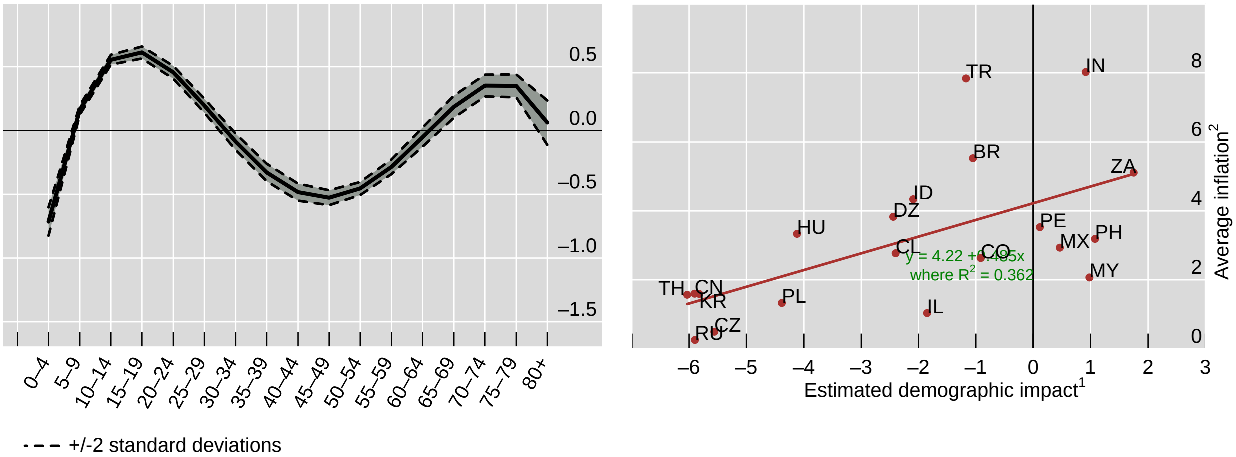
14 As total population share adds up to 100%, we implicitly assume in this example that the coefficients on the cohorts with declining population share are zero.

Age structure and inflation: a puzzling link

In per cent | Graph 5

Advanced economy data suggest a link between age structure and inflation…

…and the link is not refuted in EME data either



[1] Estimates are obtained by applying the age cohort coefficients estimated for advanced economies to 2014 age cohort data from emerging market economies. [2] Average inflation over 2012–14.

AE = United Arab Emirates; AR = Argentina; BR = Brazil; CL = Chile; CN = China; CO = Colombia; CZ = Czech Republic; DZ = Algeria; HU = Hungary; ID = Indonesia; IL=Israel; IN = India; KR = Korea; MX = Mexico; MY = Malaysia; PE = Peru; PH = Philippines; PL = Poland; RU = Russia; SA = Saudi Arabia; TH = Thailand; TR = Turkey; ZA = South Africa

Sources: Juselius and Takáts (2015a); United Nations (2015); BIS data.

II.4 Globalisation and inflation

Undoubtedly, over the past 15 years, central banks across the EMEs have become more credible, and that has played the key role in affecting the dynamics of inflation. At the same time, EMEs have become much more integrated into the global economy through both trade and financial channels. It is natural to expect that globalisation also has some role in the inflation process through higher competitive pressures, lower tradable goods prices and the increased role of global factors.

There is growing evidence consistent with this hypothesis. For instance, by using an advanced country data set, Borio and Filardo (2007) find that global factors (measured by the global output gap) are important in explaining domestic inflation and that the influence of global factors has been increasing.[15] Similarly, Pain et al (2006) find that globalisation has contributed to lower inflation in OECD countries. In a disaggregated industry-level analysis, Auer et al (2013) find that European producer prices fall more than 3.2% when lower-wage-country manufacturing volumes rise by 1% above trend. On the other hand, Bernanke (2007) and Kohn (2006) argue that the effects of globalisation on US inflation dynamics are likely to be small.

While most of the evidence regarding the influence of globalisation on inflation is from advanced country studies, it is reasonable to expect similar effects for EMEs.

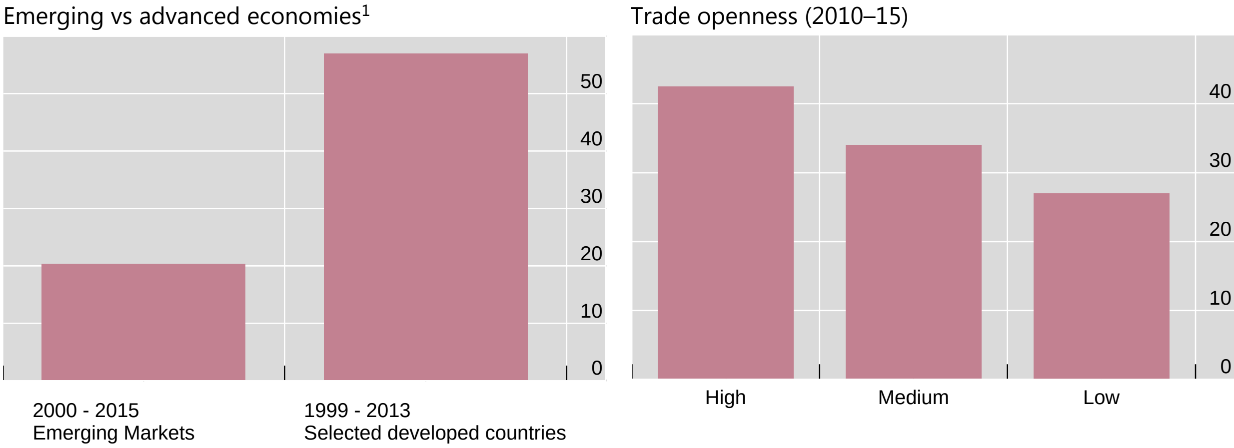
[15] More recent references are BIS (2014).

With larger trade flows, markets became more competitive, making deviations of tradable goods prices from the prices in other markets less likely. That said, the share of inflation variance explained by the first principal component (the common factor across EMEs) has increased only slightly, from 21% in 2000–07 to 23% in 2010–15. Moreover, it remains half as large as the corresponding value for the advanced economies (Graph 6, left-hand panel). This could reflect the large diversity among EMEs. As Graph 6 (right-hand panel) shows, in the EMEs that are most open to trade, the common factor is as important for inflation as in the advanced economies. As trade openness declines, the role of the common component also declines.

Variance explained by the first principal component[1]

In per cent

Graph 6



[1] Emerging economies: Algeria, Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand, Turkey and the United Arab Emirates. Advanced economies: Australia, Canada, France, Germany, Italy, Japan, Spain, Sweden, Switzerland, the United Kingdom and the United States. Total trade/GDP between 2010 and 2015 is the measure of trade openness. The eight countries with the largest values of total trade/GDP are in the "high" group, with the next eight countries in the "medium" group and the remainder in the "low" group.

Source: BIS (2014).

We extend the panel estimates presented in the previous sections to explore the role of globalisation in inflation dynamics. In particular, we interpret the time dummies in the regression as global factors that are common to the emerging economies that we have in the data. In theory, time dummies should capture global factors including global slack, but also oil, energy and food prices, which are very important for the inflation processes of most EMEs.[16] To analyse the role of trade openness, we gradually increase the trade openness of the sample by incrementally excluding observations that correspond to lower trade openness (lower trade/GDP). For each level of exclusion, we estimate the model with and without time dummies.

Our results are consistent with the hypothesis that trade integration increases the role of global factors (Graph 7, left-hand panel). Specifically, the values on the

[16] We should note that the coefficient of time dummies gives only the average response to various shocks. The effects of specific shocks may vary.

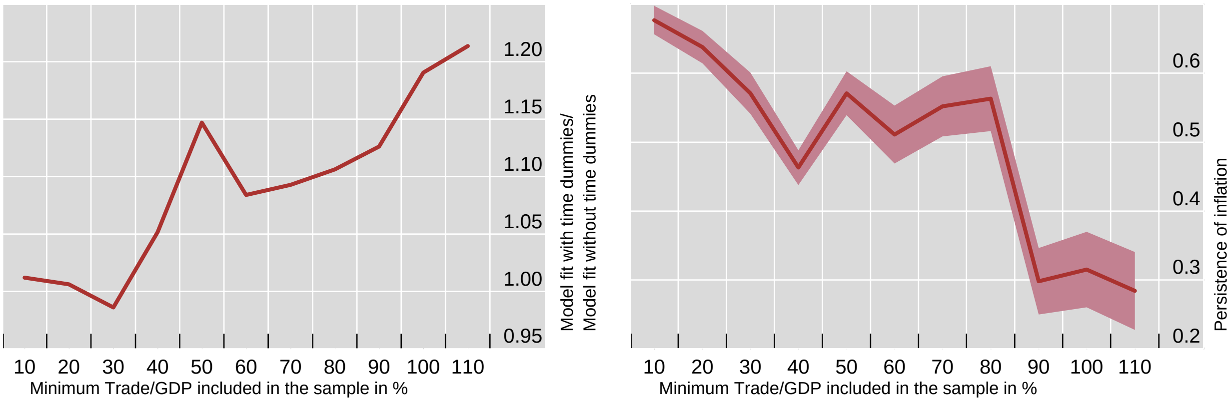
horizontal axis represent the minimum trade/GDP ratio included in the sample. The values on the vertical axis represent the fit of the model with time dummies relative to the one without. We find that adding time dummies improves the fit more as the sample becomes more trade-open.

One other important finding emerges from the analysis: inflation persistence declines considerably as trade openness increases (Graph 7, right-hand panel). This supports the argument that globalisation increases competitiveness and makes price deviations from other countries less likely.

Trade openness and inflation[1]

Graph 7

Do global factors explain inflation better for economies that are more trade-open?[2] | Globalisation and inflation persistence



[1] Results are derived from the equation $\pi_{it} = \alpha_i + \beta_t + \delta\,\pi_{it-1} + \gamma_1 \Delta NEER_{it} + \gamma_2 \Delta NEER_{it-1} + \gamma_3 \Delta NEER_{it-2} + \gamma_4 \Delta NEER_{it-3} + \lambda ygap_{it} + \varepsilon_{it}$, where α_i are country fixed effects and β_t time (quarter) fixed effects; π_{it} is the log change in CPI in country i in quarter t; $\Delta NEER_{it}$ is the log change in the nominal effective exchange rate in country i in quarter t; and $ygap_{it}$ is the output gap. The estimates are obtained in a dynamic panel-data setup using the generalised method of moments following Arellano and Bond (1991) and Roodman (2006) for Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand and Turkey . [2] The fit of the model is calculated by dividing the variance of the predicted values to data. On both graphs, the horizontal axis denotes the minimum trade/GDP ratio included in the data.

Sources: IMF, *International Financial Statistics* and *World Economic Outlook*; Bloomberg; CEIC; Datastream; national data; BIS calculations.

Appendix graphs and tables

Inflation persistence and exchange rate pass-through after the financial crisis — Table A1

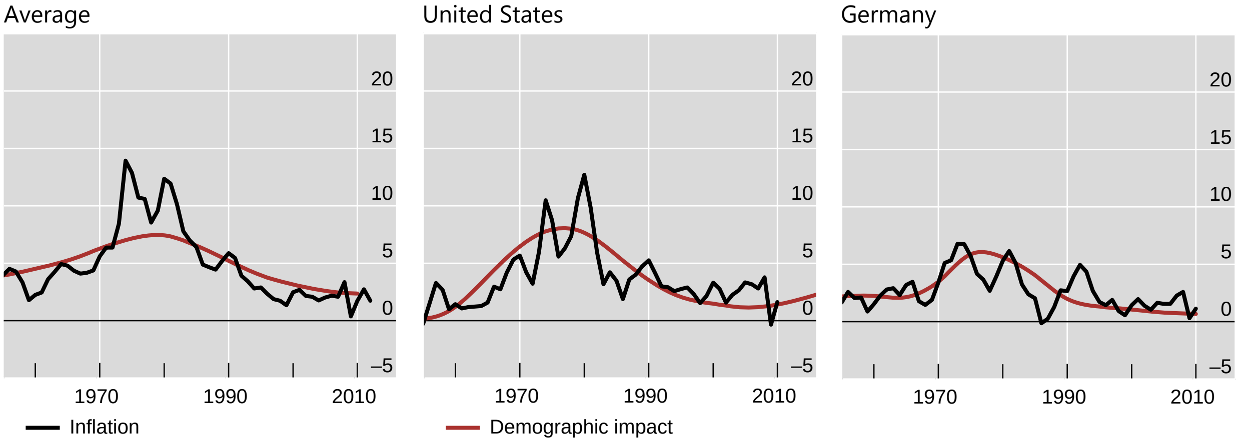
Country	In the post-2008 period, did inflation persistence…			In the post-2008 period, did exchange rate pass-through…		
	…weaken (become less persistent)?	…remain stable?	…strengthen (become more persistent)?	…weaken (become less persistent)?	…remain stable?	…strengthen (become more persistent)?
Algeria						
Argentina						
Brazil						
Chile		X[1]			X[5]	
China	X			X		
Colombia		X			X	
Czech Republic		X			X	
Hong Kong SAR						
Hungary	X			X		
India			X	X		
Indonesia		X		X		
Israel	X[2]			X[6]		
Korea		X[3]		X[7]		
Malaysia	X				X	
Mexico		X		X		
Peru			X			X
Philippines	X[4]			X[8]		
Poland		X		X		
Russia		X				X
Saudi Arabia		X			X[9]	
Singapore						
South Africa	X			X		
Thailand	X			X		
Turkey		X			X	
United Arab Emirates						

[1] There is some evidence that core inflation has become more persistent since mid-2013. A rolling AR(1) and AR(2) process is estimated for inflation and core inflation to evaluate the evolution of inflation persistence. [2] Slightly – depends on sample. [3] Empirical evidence on inflation persistence in the post-2008 period is mixed. According to a standard TVP autoregressive model, the change in inflation persistence depends on which measure of inflation is used: inflation persistence based on headline CPI is estimated to have increased in the post-2008 period, whereas inflation persistence based on core CPI is estimated to have remained unchanged. Meanwhile, if a standard TVP autoregressive model is augmented with stochastic volatility, inflation persistence is estimated to remain unchanged in the post-crisis period regardless of the measure of inflation. [4] Based on the estimates of the BSP Center for Monetary and Financial Policy, the coefficient of lagged inflation in the Phillips curve (ie measure of inflation persistence) declined from 0.489 in the 2002–08 period to 0.389 between 2009 and Q2 2015. This implies that inflation persistence in the Philippines weakened between these periods. [5] See Justel and Sansone (2015). [6] This was actually mainly due to a drop in dollar indexation of housing in 2007. [7] Estimation results based on various empirical models suggest that exchange rate pass-through declined in the post-2008 period. [8] Exchange rate pass-through in the post-2008 period weakened; coefficient declined from 0.07 (ie in 2002–08) to –0.15 (ie from 2009 to Q2 2015). [9] Indirect pass-through.

Source: National data.

Age structure credibly explains the evolution of low-frequency inflation

Benchmark specification, in per cent — Graph A1



Source: Juselius and Takáts (2015b).

Appendix: Estimating exchange rate pass-through

Reported exchange rate pass-through results based on Jašová et al. (2016).[17] The exchange rate pass-through model is specified as:

$$\pi_{it} = \alpha_i + \beta_t + \delta\pi_{it-1} - \sum_{j=0}^{3}\gamma_j \Delta NEER_{it-j} - \sum_{k=0}^{3}\mu_k \Delta NEER_{it-k}^2 - \sum_{l=0}^{3}\nu_l \Delta NEER_{it-l}^3 + \phi ygap_{it} + \varepsilon_{it} \tag{A1}$$

Here, π_{it} denotes log differences in quarterly seasonally adjusted consumer price indices (CPI) in country i in quarter t; $ygap_{it}$ is the domestic output gap, calculated by employing a standard univariate Hodrick-Prescott filter with a standard smoothing parameter. The real GDP series start in 1994 Q1 or later, depending on data availability; ΔNEER is the (change in the log of) the nominal effective exchange rate (BIS data). The estimation period is Q1 1994 – Q4 2015. To capture any non-linearities in the exchange rate pass-through, we extend the specification to include quadratic and cubic changes in exchange rates.

The panel contains 23 EMEs: Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Israel, Korea, Mexico, Malaysia, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand and Turkey. We control for country heterogeneity that may arise from different historical inflation developments, and exchange rate and monetary policy regimes, by including country fixed effects, denoted as α_i. Moreover, the model includes time fixed effects β_t to control for global factors. However, panel estimates only reflect average trends and hence should be treated with caution in drawing conclusions about an individual country, particularly in the context of the heterogeneous emerging economies.

To estimate the pass-through we use a technique that accounts for potential endogeneity of exchange rate movements (GMM). Recent studies emphasise that it is useful to account for common shocks that affect both inflation and exchange rates (Shambaugh, 2008; Forbes, 2015; Aron and Muellbauer, 2014). The robustness of these results is also tested by using within-group estimator (as reported in Jašová et al. (2016)).

The model works with contemporaneous exchange rate changes and three additional lags. This structure enables to capture exchange rate pass-through over the period of one year and is consistent with optimal lag structure tests (Akaike and Bayesian information criteria).

The linear part of the exchange rate pass-through is estimated in three versions: contemporaneous, yearly, and long-run. Contemporaneous exchange rate pass-through is defined as the quarterly coefficient in the model, i.e. γ_0. Yearly pass-through is defined as the sum of yearly coefficients, i.e. $\gamma_0 + \gamma_1 + \gamma_2 + \gamma_3$. Long-run pass through is defined as yearly pass-through divided by one minus the coefficient on lagged inflation, i.e. $(\gamma_0 + \gamma_1 + \gamma_2 + \gamma_3)/(1\text{-}\ \delta)$. Since an increase in the NEER

17 For more details on methodology and robustness see Jašová et al (2016).

reflects an appreciation of the local exchange rate, these coefficients enter the equation with a negative sign.

The core analysis is performed using rolling regressions, where the window in the main specification is set to six years. These results are robust to different rolling window sizes as well as full window estimates.

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Inflation expectations and monetary policy

Ricardo Sousa and James Yetman[1]

Abstract

Emerging market central banks have come to rely on an increasing number of measures of inflation expectations from a variety of sources. We highlight some of the empirical limitations of the various measures, and argue that different measures are likely to be best suited for different purposes. We discuss what drives inflation expectations based on central bank survey responses, and provide evidence that inflation expectations in emerging market economies have become more strongly anchored over time.

Keywords: Emerging market central banks, inflation expectations, surveys

JEL classification: E31, D84, E58

[1] Bank for International Settlements. Agne Subelyte provided excellent research assistance. This paper draws on the BIS survey of participating central banks conducted for the meeting of Emerging Market Deputy Governors.

Introduction

Inflation expectations generally play at least two important roles in central banking. First, as important inputs into price and wage setting, they provide a summary statistic of where inflation is likely to be headed. Second, they may be used to assess the credibility of the central bank's inflation objective.

Some measures of expectations are likely to be better suited for some purposes than others. All have different limitations. Not surprisingly, then, central banks rely on a range of measures.

In this paper, we start by summarising how different central banks in emerging market economies (EMEs) measure inflation expectations, and for what purpose. Next, we compare the relative performance of the different measures using a variety of metrics. Then, we provide empirical evidence on what inflation expectations, in the form of inflation forecasts from professional forecasters, imply for the degree of anchoring of inflation expectations, based on updated results from Mehrotra and Yetman (2014).

Measurement of inflation expectations

EME central banks appear to be using an increasing number and variety of measures of inflation expectations than in the past. Table 1 reports the number of survey measures, by type, both now and at the time of our questionnaire on central bank inflation expectations conducted for a meeting in 2009 (BIS (2010)). The increase is especially evident for inflation targeting central banks, including those in Hungary, Poland and Russia, which collect the highest number.[2] The fixed exchange rate currency regimes are exceptions: Hong Kong SAR, Saudi Arabia and the United Arab Emirates do not rely on such measures, not least since the central bank credibility in those economies drives expectations of the exchange rate, rather than inflation.[3]

Measures of inflation expectations can be classified as (i) forecasts based on surveys of professional forecasters; (ii) forecasts based on surveys of households or firms; and (iii) market price-based measures.

Professional forecasters' inflation forecasts are widely used. These economic agents are frequent and careful monitors of inflation developments. They are likely to be better informed and to respond faster than other agents. In some cases, the forecasts are collected by the central bank itself (eg Poland), but often they are obtained from external sources, such as Consensus Economics (eg Peru and Thailand).

Such surveys are used for a variety of purposes. Some purposes derive from their usefulness as predictors of inflation, including: (i) influencing policy decisions (Hungary, India and Thailand); (ii) gauging economic confidence (the Czech Republic, Indonesia, Poland, Singapore and Thailand); and (iii) gauging short-term inflationary pressure (Thailand). Others relate to their value for assessing policy credibility, namely: (iv) checking how well inflation expectations are anchored (Indonesia, Israel,

2 As the note from the Philippines discusses, firms' and consumers' views on the future path of inflation play an important role in inflation targeting regimes.

3 See, for instance, the note from Saudi Arabia. In addition, the note from the Czech Republic discusses the implications of a temporarily fixed exchange rate on inflation expectations.

Malaysia and Singapore); and (v) testing the formation of expectations (Poland).[4] In China, Colombia, Mexico, Peru, the Philippines, Poland, Russia, South Africa and Turkey, they serve most of these purposes.

Number of survey measures of inflation expectations used by central banks[1] Table 1

Economy	2009	2015	Memo item: inflation targeter:	
			2009	2015
Brazil	1	4	X	X
Chile	1	3	X	X
China	.	2	X	X
Colombia	2	3	X	X
Czech Republic	3	3	X	X
Hong Kong SAR	0	0		
Hungary	2	5	X	X
India	1	3		X
Indonesia	2	5	X	X
Israel	1	3		
Korea	2	4	X	X
Malaysia	.	3		
Mexico	1	2	X	X
Peru	.	2	X	X
Philippines	1	3	X	X
Poland	2	5	X	X
Russia	.	6		X
Saudi Arabia	0	0		
Singapore	.	3		
South Africa	1	2	X	X
Thailand	.	3	X	X
Turkey	2	3	X	X
United Arab Emirates	.	0		

[1] As reported by central banks in response to BIS questionnaire; see Table A1 in the appendix (and Table A1 in Moreno and Villar (2010), pp 84–90) for details. Information about inflation targeters comes from Jahan (2012), updated based on central bank websites. A dot indicates missing data. An "X" indicates that the economy has an inflation targeting regime.

One limitation of forecasts from professional forecasters is that most externally provided inflation forecasts are fixed event forecasts and hence relate to different horizons for the inflation rate in a given calendar year, whereas surveys of expectations collected by central banks themselves are typically at fixed horizons. In the case of fixed event forecasts, the forecast horizon varies through the year, and may become shorter than the policy horizon. In contrast, fixed horizon forecasts are more easily comparable over time and easier to use for policy purposes. For instance, inflation targeters may be most interested in inflation expectations one to two years

[4] As the note from Singapore points out, well anchored expectations may help to explain why surveys provide good forecasts of near-term inflation outcomes.

ahead, as this is the horizon where monetary policy will have its greatest impact, and may have less use for shorter horizon forecasts (eg Svensson (1997)).

Another limitation is that professional forecasters face incentives to make relatively extreme forecasts in order to maximise their publicity value. Being correct when other forecasters are also correct is unlikely to attract attention; in contrast, being correct when everyone else is wrong may have considerable marketing value.[5] Consequently, forecasts by professional forecasters may be likely to deviate from the expectations of inflation used by price-setters and decision-makers in the economy.[6]

The second way to measure inflation expectations is via surveys of households and firms. These are generally used to assess the credibility of the central bank and the degree to which inflation expectations are anchored. In some cases they are also used to assess the degree of economic confidence (the Czech Republic, Indonesia, Korea, Malaysia, Peru, the Philippines, Russia, Singapore and Turkey) and gather additional evidence missed by other measures (Poland and Thailand).

Expectations of households and firms are often criticised as poor predictors of inflation outcomes, given that they are too heavily influenced by food and energy prices. Despite this, if agents act on the basis of biased expectations, then it is important to understand the nature of that bias, since it will affect spending, pricing and wage setting.

Unfortunately, measures of firms' expectations are not widely available. Coibion and Gorodnichenko (2015) suggest using consumers' expectations as a proxy, since firms' expectations are likely to be similar. Kumar et al (2015) find that managers of firms tend to: (i) have a poor knowledge about the dynamics of inflation; (ii) be unaware of the central bank's goals; and (iii) display expectations that are not well anchored.

One risk common to all the measures discussed so far is that the corresponding economic agents are not directly compensated based on the accuracy of their stated forecasts (Schuh (2001)).[7] Accordingly, a subset of central banks uses measures extracted from financial market instruments (eg break-even inflation rates between nominal and real bonds) (Gürkaynak et al (2010); De Pooter et al (2014)).[8] These are also typically available at high frequency, on a timely basis, and are often based on

5 For example, Laster et al (1999) suggest that publicity may be more important than accuracy in terms of attracting customers and maximising profits, and Lamont (2002) finds that well established forecasters with strong reputations tend to produce less accurate, and more extreme, forecasts.

6 Alternatively, if an inflation targeting central bank becomes highly credible, the dominant option for forecasters who are simply trying to be as accurate as possible – especially at longer horizons – may be to use the target as their inflation forecast, at which point forecasts may become uninformative, except as a measure of credibility (Morris and Shin (2005)).

7 For instance, Lim (2001) finds that financial analysts overestimate corporate earnings in order to get inside information to improve accuracy. Given the preference that firms' managers have for favourable forecasts (because they help to support higher capital market valuations and their own compensation), they typically refrain from providing non-public information about their firm to analysts that make unfavourable forecasts, even if these simply reflect weaker fundamentals. As a result, analysts' forecasts are biased. In principle, the same kind of compromise could influence the performance of survey-based measures of inflation expectations.

8 For an analysis of the factors that are priced into the inflation (or deflation) risk premium, see the note from Mexico. For instance, while changes in the price level can affect inflation risk compensation by creating intertemporal wealth distortions, a more developed financial system can help reduce these costs.

transactions among a large number of market participants. Moreover, they are often based on inflation outcomes at a constant horizon.

The instruments used vary. Our survey indicates that inflation-indexed government bonds are followed by a growing subset of emerging market central banks (eg Chile, Colombia, Israel, Korea, Peru, Poland, Russia, South Africa and Thailand) (see Table A2 of the Appendix). For the Philippines and Thailand, financial market expectations of inflation are inferred from nominal interest rates, based on the secondary bond market. Israel retrieves inflation expectations from the difference between non-indexed and indexed interest rates of commercial banks, while Chile uses the cost of buying insurance against inflation outcomes and the pricing of inflation swaps.

Yet, even where financial market indicators of inflation expectations are available, these have a mixed record. For example, Bauer and McCarthy (2015) show that market-based inflation expectations are poor predictors of future inflation compared with surveys of professional forecasters, and contain little forward-looking information about future inflation. This is partly because market-based measures reflect not just the expected level of inflation, but also market liquidity and the value of insurance against alternative inflation outcomes (Hördahl (2009)). For Brazil, Chile and Mexico, De Pooter et al (2014) find that one-year inflation compensation tends to be too low over the long run, and sensitive to macroeconomic news. Differences in the risk premium or the incorporation of expectations of large-scale asset purchases by the central bank into investors' portfolio decisions can also reduce the usefulness of market-based measures as predictors of inflation. Finally, if the underlying markets in which these instruments trade is relatively underdeveloped, the prices may reflect the views of only a small subset of market participants.

The performance of inflation expectation measures

How well do different survey-based measures of inflation expectations perform in forecasting inflation? Table 2 reports summary statistics of the forecast errors. We focus on the mean forecast error (ME) and the root mean squared error (RMSE). These are widely used measures of accuracy. The ME is the average forecast error, where a positive (negative) number indicates that actual outcomes are higher (lower) than forecasts on average. It gives the same weight to all forecast errors.

In contrast, the RMSE is a measure of the magnitude of the forecast errors, ignoring their sign. It weights large forecast errors more heavily than small forecast errors. For most measures, the sample starts around 2000, but for some it begins only much more recently. We also test formally whether forecast errors are unbiased (Holden and Peel (1990)). Some results stand out.

Forecast accuracy and bias of different survey-based measures of expectations[1]

Table 2

Economy	Survey number	Name of survey/measure	Start date	ME	RMSE
Brazil	(1)	Market Expectations System CPI (IPCA)	2000	0.67***	1.85
	(2)	Market Expectations System CPI (INPC)	2000	0.57***	1.79
	(3)	Market Expectations System General Price Index (IGP-DI)	1999	–0.64***	3.33
	(4)	Market Expectations System General Price Index (IGP-M)	1999	–0.62***	3.30
Chile	(5)	EEE (Economic Expectation Survey)	2001	0.06	1.86
	(6)	EOF (Survey of financial operators)	2009	0.13	1.09
Czech Republic	(7)	Inflation expectations (financial market)	1999	–0.55***	1.25
	(8)	Inflation expectations (managers of non-financial corporations and companies)	1999	–0.64***	1.25
Hungary	(9)	Quantitative_Household_Tárki-MNB	2002	–10.03***	10.22
	(10)	Quantitative_Corporation_Tárki-MNB	2005	–3.66***	5.07
Israel	(11)	Expectations (professional forecasters)	2001	–0.11	1.61
	(12)	Consumer survey	2012	–3.41***	3.54
	(13)	Business tendency survey	2013	–1.37***	1.48
Korea	(14)	Consumer survey index (BOK)	2002	–0.75***	1.23
	(15)	Consensus Economics survey (financial corporations)	2000	–0.13**	0.84
Malaysia	(16)	BNM Consumer Sentiment Survey	2005	–3.13***	3.35
	(17)	Analysts' Consensus forecast	2013	–0.17	1.18
Peru	(18)	Survey to analysts and the financial system	2002	0.28***	1.13
	(19)	Survey of macroeconomic expectations (economic analysts)	1999	0.39	1.15
	(20)	Survey of macroeconomic expectations (financial corporations)	2001	–0.11	1.27
	(21)	Survey of macroeconomic expectations (non-financial corporations)	2002	0.05	1.39
Philippines	(22)	Consumer Expectations Survey	2007	–4.00***	4.46
Poland	(23)	Consumers: current CPI inflation	2004	–0.00	1.12
	(24)	Consumers: perceived inflation	2004	–2.07***	2.32
	(25)	Consumers: Consumer Perceived Price Index	2004	–1.78***	2.10
	(26)	Financial sector analysts	2004	–0.00	1.16
	(27)	Enterprises: current CPI inflation	2008	–0.03	0.92
Singapore	(28)	Asia Pacific Consensus Forecast	1999	–0.01	1.75
	(29)	SKBI-Mastercard Singapore Index (Headline)	2011	–1.89***	2.31
	(30)	SKBI-Mastercard Singapore Index (MAS Core Inflation)	2011	–1.98***	2.43
Thailand	(31)	Business Sentiment Survey (BSI)	2007	–0.89***	1.97
	(32)	Asia Pacific Consensus Forecast	2004	–0.18	1.71

[1] Colours indicate whether the frequency is monthly, quarterly or annual. Each row corresponds to a different survey-based measure of inflation expectations. To test for bias, we regress the forecast error on a constant ie: $FE_t = \alpha + \varepsilon_t$, where FE_t is the difference between actual inflation and expected inflation and ε_t is the corresponding error term. Forecasts are considered to be unbiased if we cannot reject the null hypothesis that $\alpha = 0$. ***, ** and * indicate significance at the 1%, 5% and 10% levels. The survey-based measures of inflation expectations are those provided by central banks with a forecast horizon of one year.

Source: Authors' calculations.

First, with the exception of Brazil, Chile and Peru, inflation outcomes are significantly lower than inflation expectations, on average. Similar evidence of a bias for advanced economies is found by Öller and Barot (2000) and discussed in Posen (2011). This may partly reflect the slow adjustment of households' inflation expectations and the downward trend of inflation in emerging markets during the period considered (Arslan and Takáts (2016)).[9]

Second, household surveys perform comparatively poorly. For instance, the errors are larger than those of non-financial corporations in Hungary and Israel or financial sector analysts in Poland. This bias is also strong in the case of the Philippines.

In Table 3, we show the mean forecast error (ME) and the root mean squared error (RMSE) of the market-based measures of inflation expectations provided by central banks, and also test whether forecast errors display a bias. As can be seen, the sample period goes back, at longest, to 2006 and the number of measures is also small.

Forecast accuracy and bias of different market-based measures of inflation expectations[1]

Table 3

Economy	Measure number	Name of measure	Start date	ME	RMSE
Brazil	(1)	Inflation indexed government bonds	2006	0.27***	0.68
Chile	(2)	Insurance against inflation (average; in one year)	2010	0.29*	1.20
Peru	(3)	Implicit inflation expectations from inflation-indexed government bonds[2]	2010	0.21***	0.54
Philippines	(4)	One-year bid rate of government securities in the secondary market based on the yield curve	2007	0.80***	1.65
Poland	(5)	Inflation-indexed government bonds (break-even inflation) (IZ 0816)[2]	2009	0.12	1.37
	(6)	Inflation-indexed government bonds (break-even inflation) (IZ 0823)[2]	2011	–0.66***	1.48

[1] Each row corresponds to a different market-based measure of inflation expectations. To test for bias, we regress the forecast error on a constant ie: $FE_t = \alpha + \varepsilon_t$, where FE_t is the difference between actual inflation and expected inflation and ε_t is the corresponding error term. Forecasts are considered to be unbiased if we cannot reject the null hypothesis that $\alpha = 0$. ***, ** and * indicate significance at the 1%, 5% and 10% levels. The market-based measures of inflation expectations are those provided by central banks with a forecast horizon of one year. [2] Based on monthly averages from daily data of yields.

Source: Authors' calculations.

The empirical findings are mixed. In Chile, Peru and the Philippines, there is a significantly positive bias, with inflation outcomes exceeding implicit inflation expectations. In contrast, for one of the market-based measures provided by Poland, the bias is significantly negative, and for Brazil and another measure provided by

[9] In contrast, forecasts made by international organisations have typically underestimated inflation. This can be partly explained by large variations in commodity prices or unexpected hikes in indirect taxes (ECB (2012)). "Budgetary wishful thinking" on the part of government agencies may also play a role (Frankel and Schreger (2013)).

Poland, there is no evidence of a significant bias. In general, the RMSE statistics are similar to those found for the survey-based measures.

Efficiency of different survey-based measures of inflation expectations[1] Table 4

Economy	Survey number[2]	Household expectations?	(1) *F*-stat	(2) β-test	(3) ρ-test
Brazil	(1)	No	19.06***	–0.12	0.94***
	(2)	No	26.85***	–0.19***	0.91***
	(3)	No	124.02***	–0.66***	0.83***
	(4)	No	127.29***	–0.65***	0.81***
Chile	(5)	No	0.30	0.25	0.98***
	(6)	No	6.01***	–0.78***	0.98***
Czech Republic	(7)	No	43.28***	0.25***	0.97***
	(8)	No	15.39***	0.17	0.84***
Hungary	(9)	Yes	1916.32***	–0.47***	0.50**
	(10)	No	268.81***	–0.78***	0.83***
Israel	(11)	No	0.46	0.21	0.97***
	(12)	Yes	794.31***	–0.69***	0.27
	(13)	No	479.34***	2.12***	0.99***
Korea	(14)	Yes	98.27***	-0.45***	0.98***
	(15)	No	2.27	0.17	0.98***
Malaysia	(16)	Yes	546.60***	–1.22***	0.78***
	(17)	No	0.50	–0.18	0.80***
Peru	(18)	No	5.37***	0.23	0.97***
	(19)	No	0.69	–0.07	-0.28
	(20)	No	1.75	–0.49*	0.09
	(21)	No	2.94*	–0.77*	-0.26
Philippines	(22)	Yes	116.38***	–0.77***	0.66***
Poland	(23)	Yes	8.13***	–0.24***	0.92***
	(24)	Yes	294.82***	–0.11	0.88***
	(25)	Yes	333.48***	–0.35***	0.89***
	(26)	No	50.03***	1.60***	1.00***
	(27)	No	0.02	–0.00	0.66***
Singapore	(28)	No	13.82***	–0.41***	0.95***
	(29)	No	76.17***	2.72***	0.92***
	(30)	No	69.93***	3.32***	0.92***
Thailand	(31)	No	19.68***	–0.93***	0.98***
	(32)	No	4.23**	–1.08**	0.83***

[1] Colours indicate whether the frequency is monthly, quarterly or annual. Each row corresponds to a different survey-based measure of inflation expectations, as listed in Table 2. All measures refer to one-year-ahead inflation expectations. To test for efficiency, we regress actual inflation on a constant and the forecast ie: $\pi_t = \alpha + \beta\pi_t^e + \varepsilon_t$, where π_t is the actual inflation, π_t^e is the expected inflation and ε_t is the error term. Forecasts are efficient if we cannot reject the null hypothesis that $\alpha = 0$ and $\beta = 1$. Column 1 displays the *F*-statistic of this joint hypothesis test. Following Barrionuevo (1997) and Pons (2000), we further investigate the sources of forecast inefficiency. Thus we regress the forecast error on the forecast (the so-called β-test) ie: $FE_t = \alpha + \beta\pi_t^e + u_t$, where FE_t is the difference between actual inflation expected inflation, π_t^e is expected inflation and u_t is the error term. Column 2 presents the coefficient estimates of β. We also regress the current-period forecast error on the previous-period forecast error (the so-called ρ-test) ie: $FE_t = \alpha + \rho\, FE_{t-1} + \xi_t$, where ξ_t is the error term. Column 3 presents the coefficient estimates of ρ. ***, ** and * indicate significance at the 1%, 5% and 10% levels. [2] Survey numbers correspond with Table 2.

Source: Authors' calculations.

As well as bias, another statistical feature of interest is whether all the information is utilised efficiently. There are several definitions of such efficiency, and we consider three in particular. The formal definitions are given in the footnote to Table 4. The three tests are as follows (Barrionuevo (1997); Pons (2000)): (i) whether the inflation outcomes are perfectly correlated with inflation expectations and, in addition, average forecast errors are nil (as indicated by the *F*-statistics); (ii) whether the forecast errors are uncorrelated with the forecast itself (referred to as the β-test); and (iii) whether the forecast errors are uncorrelated with their lags (called the ρ-test).

For the survey-based measures of inflation expectations, our results (reported in Table 4) show that, in the majority of cases, inefficiency arises partly because new information is not fully incorporated into forecasts and partly because forecast errors are correlated across time (test (i)). But for some measures for Israel and Peru, the inefficiency can be attributed to the observation that the larger the forecast is, the larger the forecast error will be (test (ii)). And in other cases, including for Chile, the Czech Republic, Israel, Korea, Malaysia, Peru, Poland and Thailand, it is mainly that the past forecast errors tend to be repeated over time (test (iii)). For the market-based measures of inflation expectations, the evidence summarised in Table 5 reveals that, with the exception of Brazil, inefficiency arises because of both the process by which new information is incorporated into forecasts and the correlation of forecast errors across time.

Efficiency of different market-based measures of inflation expectations[1]

Table 5

Economy	Measure number[2]	(1) *F*-stat	(2) β-test	(3) ρ-test
Brazil	(1)	9.96***	-0.08	0.83***
Chile	(2)	17.69***	-1.12***	0.96***
Peru	(3)	7.14***	-1.30***	0.93***
Philippines	(4)	100.49***	-0.46***	0.92***
Poland	(5)	18.25***	1.09***	0.98***
	(6)	77.34***	2.42***	0.99***

[1] Each row corresponds to a different market-based measure of inflation expectations, as listed in Table 3. All measures refer to one-year-ahead inflation expectations. To test for efficiency, we regress actual inflation on a constant and the forecast ie: $\pi_t = \alpha + \beta\pi_t^e + \varepsilon_t$, where π_t is the actual inflation, π_t^e is the expected inflation and ε_t is the error term. Forecasts are efficient if we cannot reject the null hypothesis that $\alpha = 0$ and $\beta = 1$. Column 1 displays the *F*-statistic of this joint hypothesis test. Following Barrionuevo (1997) and Pons (2000), we further investigate the sources of forecast inefficiency. Thus we regress the forecast error on the forecast (the so-called β-test) ie: $FE_t = \alpha + \beta\pi_t^e + u_t$, where FE_t is the difference between actual inflation and expected inflation, π_t^e is expected inflation and u_t is the error term. Column 2 presents the coefficient estimates of β. We also regress the current-period forecast error on the previous-period forecast error (the so-called ρ-test) ie: $FE_t = \alpha + \rho\, FE_{t-1} + \xi_t$, where ξ_t is the error term. Column 3 presents the coefficient estimates of ρ. ***, ** and * indicate significance at the 1%, 5% and 10% levels. [2] Market-based numbers correspond with Table 3. [3] Based on monthly averages from daily data of yields.

Source: Authors' calculations.

Key variables in the evolution of inflation expectations[1]

Table 6

	Past inflation: Level	Past inflation: Volatility	Nominal effective exchange rate	Policy interest rate	Nominal wage growth	Unem-ployment	Industrial production	Others[2]
Brazil	1		3	2	5	7	8	4: (primary) fiscal balance; 6: output surprises; 9: public debt
Chile	1		4	2				3: oil/food prices; world output gap; 5: output gap; CB forecasts
China	1				2			3: asset price growth
Colombia	1	2	4	5				3: output surprises
Czech Republic	3		2		4	5		1: inflation target
Hungary	1	4			3			2: movements in food and regulated energy prices
India	1	3	4	5	2			
Indonesia	1		2	3	4	5		6: asset price growth
Israel	1	4		3		2		
Malaysia	3		2		5	6	4	1: changes in domestic policies
Mexico			3	1		4=		2: commodity price shocks and food price shocks; 4=: (primary) fiscal balance, output surprises and public debt
Peru	1	2	3	4	7=		5=	5=: asset price growth; 7=: output surprises
Philippines	3	4		2	5		6	1: inflation gap (current inflation – target)
Poland[3]	2		4=	4=		7	6=	1: inflation target; 3 inflation perceptions gap; 6= oil prices
Saudi Arabia	2		3	4				1: (primary) fiscal balance
South Africa	1	6	2	4	3	11	10	5: output surprises; 7: (primary) fiscal balance; 8: public debt; 9: asset price growth
Thailand	1	2						
Turkey	1		2	2	4			
United Arab Emirates	1		4		3			2: asset price growth

[1] The numbers in the table indicate a ranking given by central banks of the importance of different variables in driving the evolution of inflation expectations, where 1 signifies the most important variable. [2] Includes write-in responses suggested by central banks. [3] For Poland, the ordering is based on average rankings across the different measures of inflation expectations.

Source: BIS questionnaire.

Focusing on household expectations, these generally exhibit greater bias, and more volatility, than those by professional forecasters. But they may still provide valuable information. For example, Coibion and Gorodnichenko (2015) find that, by using consumer expectations for US inflation in a Phillips curve instead of those of professional forecasters, they can explain the surprising absence of a persistent fall in inflation during the Great Recession. The reason is that consumers' inflation expectations, which respond more strongly to oil prices, actually rose between 2009 and 2011. However, whether this is a more general relationship, or specific to this particular episode, is unclear. Relatedly, Binder (2015) argues that the expectations of "high-income, college-educated, male and working-age people" play the largest role in explaining inflation dynamics in the context of estimating an expectations-augmented Phillips curve. In addition, as many central banks have indicated in their survey responses, inflation expectations are indicators of central bank credibility and the degree of confidence in the economy.

Regardless of the specific measure, most central banks agree on the determinants of inflation expectations (Table 6). Most view past inflation as the most important driver, perhaps reflecting some backward-looking behaviour and/or relatively high, albeit falling, inflation persistence (Arslan and Takáts (2016)). The second most important driver, cited for Colombia, Peru and Thailand, is the volatility of past inflation. Other nominal variables play a very important role for many economies, including the nominal effective exchange rate, the policy interest rate and nominal wage growth. Real variables come next, including the level of unemployment and industrial production, suggesting a looser link between real economic developments and anticipated future inflation.

In addition, institutional factors play a role. Almost all central banks report that the degree of central bank independence and/or the presence of an inflation targeting framework as the most important ones (Table 7). The exceptions are Saudi Arabia ((primary) fiscal balance) and the United Arab Emirates (labour market flexibility), both of which have bilateral exchange rate pegs. Graph 1 appears to confirm a negative relationship between the RMSE of the inflation forecast error from survey-based measures of inflation expectations and degree of central bank independence as proxied by the index developed by Cukierman et al (1992), and updated by Crowe and Meade (2007).

Central banks also cite other institutional determinants, and indicate that these are relatively less important. These include labour market flexibility, trade or financial liberalisation and product market regulations. Their relative importance is reported to have remained broadly unchanged since before the crisis. Hungary stands out as an exception. In 2012, the Hungarian government announced the first round of regulated energy price cuts (affecting district heating, electricity and gas prices), followed by another round in 2014. In the light of the large weight on these items in the CPI, inflation expectations fell considerably. In the Czech Republic, both labour market flexibility and product market regulations are perceived to have gained importance.

Institutional drivers of inflation expectations[1]

Table 7

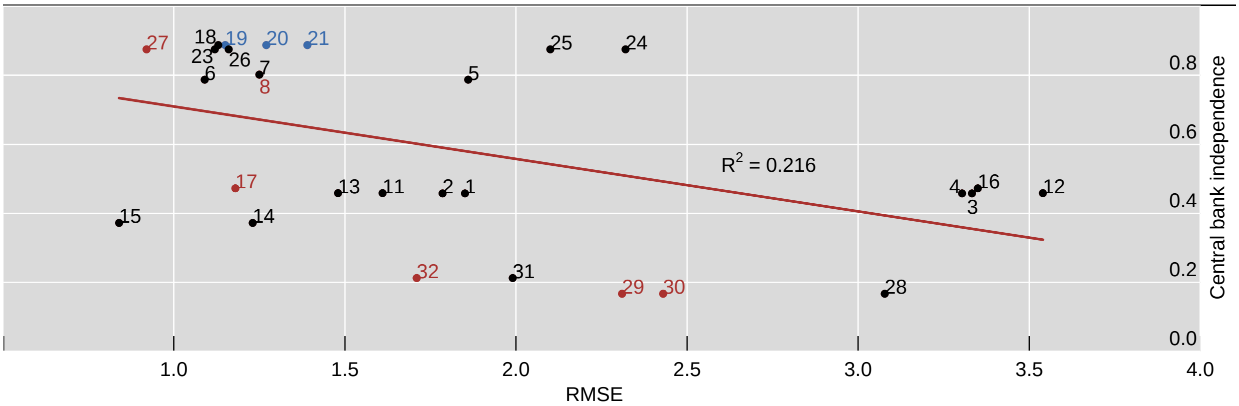
	Central bank independence/ inflation targeting	Labour market flexibility	Trade/ financial liberalisation	Product market regulations
Brazil	1			
Chile	1	2		
Colombia	1	2[2]	4	3
Czech Republic	1	2		3
Hungary	1			2[3]
Indonesia	1			2
Mexico	1	4	3	2
Peru	1			
Philippines	1		2	
Poland	1			
Saudi Arabia			2	1
South Africa	1	2	3	4
Turkey	1	2		3
United Arab Emirates		1		

[1] The numbers indicate a ranking given by central banks of the importance of different institutional factors in driving inflation expectations, where 1 signifies the most important variable. [2] Indexation of contracts. [3] Regulated energy price cuts.

Source: BIS questionnaire.

Inaccuracy of inflation forecasts and central bank independence[1]

Graph 1



[1] Given the small number of observations and the presence of outliers for some measures, surveys where the RMSE differs from the average RMSE by more than one standard deviation are not displayed in the graph. Based on this rule, the surveys with the three largest RMSE (numbered (9), (10) and (22) in Table 1) are excluded. For included surveys, the labels correspond with the survey numbers listed in Table 1.

Sources: Cukierman et al (1992); Crowe and Meade (2007); BIS questionnaire; authors' calculations.

Finally, our survey points to no large discrete shifts in inflation expectations over the past 10 years in most countries. Since inflation targeting generally pre-dates this window, this may not be surprising. However, where central banks do identify a structural shift, they highlight the role of financial crises (in particular, the financial turmoil of 2008–09) (Czech Republic, Hong Kong SAR, Hungary, India, Israel, Korea, South Africa and the United Arab Emirates) or currency crises (South Africa (2008) and Russia (2014–15)). In the Czech Republic, the European sovereign debt crisis and the decision of the Czech National Bank to start using the exchange rate as an additional monetary policy instrument also had a significant effect on inflation expectations, mainly at shorter horizons. And in the United Arab Emirates, the slowdown of the property sector and the slump in property rents (which account for almost one third of the CPI basket) caused a downward shift in inflation expectations. Other central banks emphasise international price pressures (Chile), fiscal consolidation involving indirect tax increases (Hungary, 2009–12), regulated energy prices (Hungary, 2013–14), supply shocks impacting food and/or energy prices (Colombia, Indonesia, Israel and Saudi Arabia) and VAT reforms (the Philippines). Yet, the effect is generally reported as temporary to the extent that long-term inflation expectations are anchored to an inflation target.

Assessing the anchoring of inflation expectations

With the exception of India and the fixed exchange rate regimes in our sample, central banks use measures of inflation expectations to assess central bank credibility and/or the anchoring of expectations. Further, nearly all central banks use inflation forecasts from professional forecasters as one measure. Here, we report some recent research results on central bank credibility based on these forecasts.

Where a central bank has a numerical inflation target, one way to assess credibility is to measure how strongly inflation expectations are anchored to the target, regardless of what happens to inflation in the short term.[10] As the note from Hungary highlights, anchored expectations contribute to monetary policy effectiveness. One simple assessment of the degree of credibility is to test if long-horizon forecasts agree with the inflation target. However, most professional forecasts are available at horizons that are too short to apply this test: such forecasts also reflect shocks that drive inflation away from target, as central banks have limited ability to control inflation at short horizons.

Mehrotra and Yetman (2014) propose a method to deal with this challenge. They model inflation forecasts as a weighted sum of a long-run anchor and the latest available inflation rate at the time that forecasts are made, with the weight on the long-run anchor assumed to decline monotonically with the forecast horizon. Their methodology produces (i) an estimate of the long-run anchor and (ii) an estimate of how sensitive expectations are to this anchor. They argue that this model fits the data well and makes efficient use of the multiple horizons over which professional forecasts are generally available. Here we report some updated results based on their methodology, using median inflation forecasts from Consensus Economics at forecast horizons of up to 24 months.

The values of the estimated inflation anchors generally indicate a high degree of credibility. Graph 2 displays these estimates based on CPI inflation over the 2010–14 period, together with 95% confidence bands and the average inflation target (level or band, where applicable), for a wide selection of EMEs.[11] For China and Hungary, the

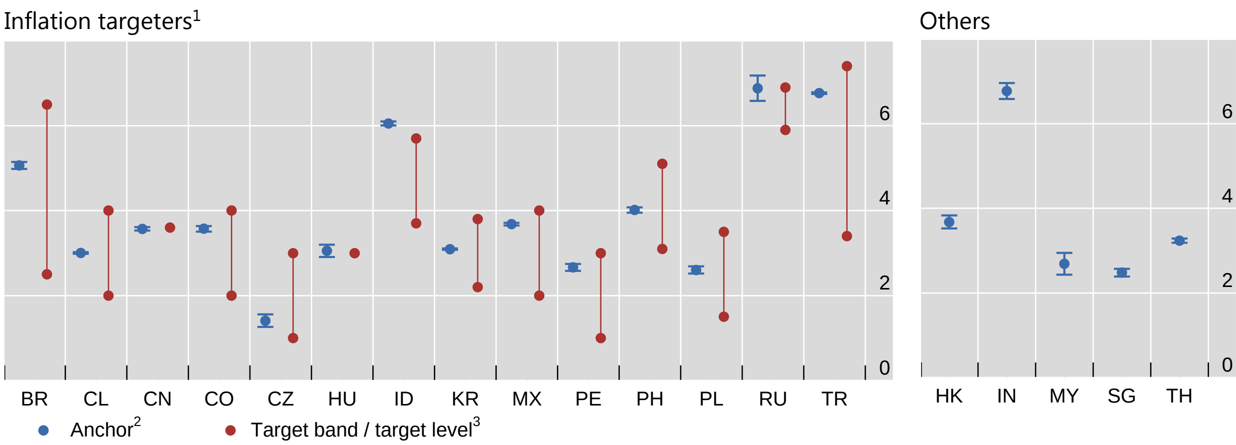
10 See the related discussion in the note from Indonesia.

11 Argentina and Venezuela are missing from the sample as we could not identify an anchor for this sample period because of the very high inflation volatility.

point inflation target is within the 95% confidence band of the estimated anchor. For most other inflation targeting countries, with a band rather than a point target, the estimated anchor is within the band, and very close to its centre in the cases of Chile, Korea, the Philippines and Poland. This possibly reflects a relatively longer period since the adoption of the inflation targeting regime in these countries when compared with other economies. Only in the case of Indonesia does the estimated anchor lie (barely) outside the target band. Interestingly, although the level of the estimated inflation anchors for the non-inflation targeters looks similar to those of the inflation targeters, the confidence bands, while quite tight, are generally larger. Applying the same methodology to rolling samples, the estimated anchors have been trending down for most EMEs over recent years (see Graph A1 in the appendix for detailed graphical evidence).

Estimated inflation anchors and inflation targets

In per cent | Graph 2



BR = Brazil; CL = Chile; CN = China; CO = Colombia; CZ = Czech Republic; HK = Hong Kong SAR; HU = Hungary; ID = Indonesia; IN = India; KR = Korea; MY = Malaysia; MX = Mexico; PE = Peru; PH = the Philippines; PL = Poland; RU = Russia; SG = Singapore; TH = Thailand; TR = Turkey.

[1] Based on policy framework over the 2010–14 period. [2] Estimated inflation anchor based on methodology in Mehrotra and Yetman (2014). Vertical bars indicate 95% confidence bands. [3] Average over the 2010–14 period.

Sources: Consensus Economics; national data; authors' calculations.

This approach also generates estimates of how strongly expectations are anchored, as measured by the weight (between 0 and 1) that forecasts place on the anchor. The weight has increased over time for most economies, but especially at longer horizons for those with inflation targets. For example, focusing on the sample of inflation targeters displayed in Graph 2 above, in rolling samples the average estimated weight on the target at the 24-month horizon (that is, forecasts made in January for the following calendar year[12]) has increased from 0.71 for 2000–04 to 0.92 for 2010–14. By contrast, for non-inflation targeters, while higher at the beginning of the sample, the weight increased by less, from 0.79 to 0.85. At shorter horizons, the improvement was similar in the two groups.

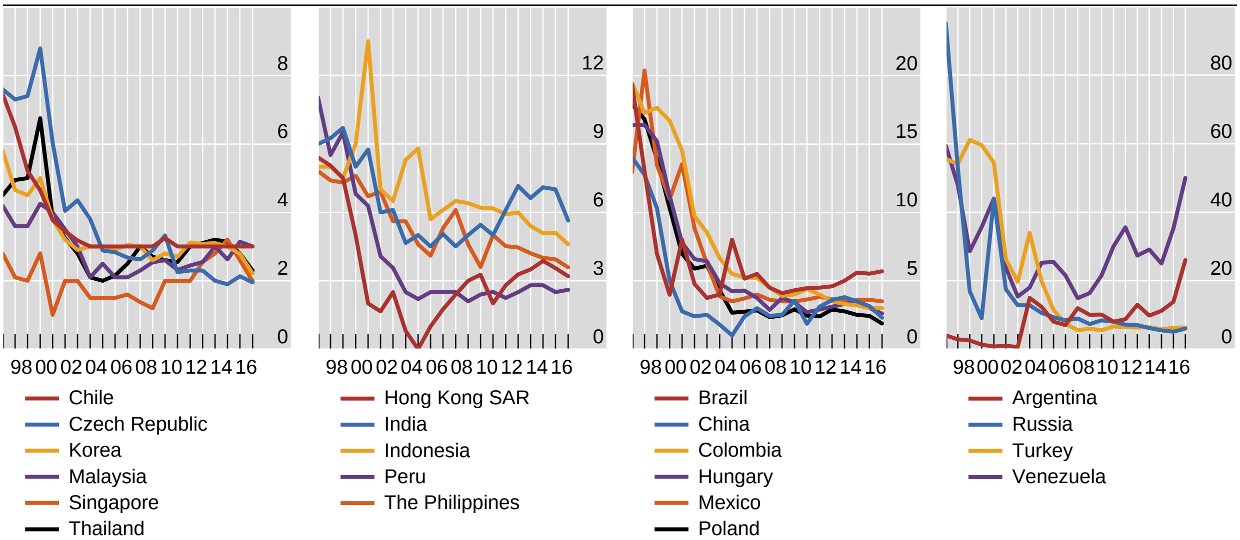
[12] With the exception of India, where the forecasts are based on a year ending in March.

One limitation of this analysis is that any change in the degree of anchoring may take time to influence the estimates, as these are derived from rolling samples. There is an ever-present risk that expectations could become unanchored, as discussed in the note from Columbia. To gain a better sense of such a risk, Graph 3 displays median forecasts at the 24-month horizon (or 23 where 24 is unavailable) from Consensus Economics. This is near the horizon at which inflation expectations should primarily reflect the central bank's perceived policy objective, rather than the anticipated propagation of shocks. With the exceptions of Argentina and Venezuela, recent movements in these forecasts have been limited. And in Turkey and Russia two-year-ahead inflation forecasts go from being highly volatile to stable, despite recent economic and political developments.

Two-year-ahead inflation forecasts[1]

In per cent

Graph 3



[1] For all economies except India, forecasts made in January for the following calendar year (ie January 2015 for 2016); where January forecasts unavailable, February forecasts are used instead. For India, forecasts made in April for the following 12-month period ending in March (ie April 2015 for the April 2016–March 2017 period). Horizontal axis refers to the year being forecast; for India, March years (ie 2016 refers to April 2016–March 2017). Median forecast where individual forecasts available; otherwise mean.

Sources: Consensus Economics; national data.

Appendix

Central bank surveys on inflation expectations

Table A1

Economy	Survey name	Inflation measure	Frequency	Population and number of respondents	Primary use
Brazil	Market Expectations System (IPCA)	CPI	Daily	120 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations, gauging information about confidence
Brazil	Market Expectations System (INPC)	CPI	Daily	120 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations, gauging information about confidence
Brazil	Market Expectations System (IGP-DI)	General Price Index	Daily	120 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations, gauging information about confidence
Brazil	Market Expectations System (IGP-M)	General Price Index	Daily	120 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations, gauging information about confidence
Chile	Economic Expectation Survey (EEE)	CPI	Monthly	60 professional forecasters	Checking anchoring of expectations
Chile	Survey of financial operators (EOF)	CPI	Twice per month	62 financial corporations	Checking anchoring of expectations
Chile	Index of Economy Perception (IPEC)	CPI	Monthly	1,100 households	Gauging information about confidence
China	Rural household depositors survey	CPI	Quarterly	20,000 households	Setting policy, monitoring credibility, checking anchoring of expectations, gauging information about confidence, condition analysis and policy reference
China	Purchasing Manager's Index	PPI	Monthly	3,000 non-financial corporations	Setting policy, monitoring credibility, checking anchoring of expectations, gauging information about confidence, condition analysis and policy reference
Colombia	National Quarterly (NQ)	CPI	Quarterly	70 non-financial corporations, nine financial corporations and three unions	Setting policy, monitoring credibility and checking anchoring of expectations
Colombia	Financial Analysts (FA)	CPI, CPI Core (without food)	Monthly	40 professional forecasters	Setting policy, monitoring credibility and checking anchoring of expectations
Colombia	Sectoral Quarterly (SQ)	CPI	Quarterly	137 non-financial corporations, 30 financial corporations and 8 unions	Setting policy, monitoring credibility and checking anchoring of expectations

Central bank surveys on inflation expectations

Table A1 (cont)

Economy	Survey name	Inflation measure	Frequency	Population and number of respondents	Primary use
Czech Republic	Financial market inflation expectations	CPI	Monthly	15–20 professional forecasters	Monitoring credibility, checking anchoring of expectations and gauging information about confidence
Czech Republic	Statistical Survey of the CNB and Confederation of Industry of the CR in Non-financial Companies	CPI, PPI, wages	Quarterly	150–200 non-financial corporations	Monitoring credibility, checking anchoring of expectations and gauging information about confidence
Czech Republic	European Commission Business and Consumer Survey	CPI	Monthly	1,000 households	Monitoring credibility, checking anchoring of expectations and gauging information about confidence
Hong Kong SAR	The Hong Kong Monetary Authority does not conduct any surveys on inflation expectations				
Hungary	Quantitative survey of households and corporations by Tárki-MNB	CPI	Quarterly	1,000–1,200 households and 350 non-financial corporations	Monitoring credibility and checking anchoring of expectations
Hungary	Qualitative survey for households' inflation by European Commission	CPI	Monthly	1,000 households	Setting policy and checking anchoring of expectations
Hungary	Expectations Reuters: market analysts' expectations	CPI	Monthly	42 professional forecasters	Monitoring credibility
Hungary	Consensus Economics: market analysts' expectations	CPI	Monthly	200 professional forecasters	Monitoring credibility
Hungary	Expected retail sales prices	CPI	Monthly	Min 600–700 non-financial corporations	Guideline for inflation processes
India	Survey of Professional Forecasters	CPI and WPI	Bi-monthly	Around 30 professional forecasters	Policy input
India	Inflation Expectations Survey of Households	Respondents' own consumption basket	Quarterly[1]	5,000 households	Policy input
India	Industrial Outlook Survey	Qualitative response on cost of raw material, selling price	Quarterly	1,200–1,300 (out of panel of 2,500) non-financial corporations	Policy input
Indonesia	Consumer Survey	CPI	Monthly	4,600 households	Gauging information about confidence

Central bank surveys on inflation expectations

Table A1 (cont)

Economy	Survey name	Inflation measure	Frequency	Population and number of respondents	Primary use
Indonesia	Retail Sales Survey	CPI	Monthly	700 retailers	Gauging information about confidence
Indonesia	Business Survey	CPI	Quarterly	Approximately 3,000 financial and non-financial corporations	Checking anchoring of expectations and gauging information about confidence
Indonesia	Macroeconomic Indicators Forecasting Survey	CPI	Quarterly	25–35 professional forecasters	Checking anchoring of expectations and gauging information about confidence
Indonesia	Consensus Forecasts	CPI	Monthly	Approximately 25 professional forecasters	Checking anchoring of expectations and gauging information about confidence
Israel	Professional forecasters	CPI	Monthly[2]	About 15 professional forecasters	Checking anchoring of expectations
Israel	Consumer survey	CPI. Survey conducted by the CBS.	Monthly	About 9,000 households	Not currently in use due to short history
Israel	Business tendency survey	CPI. Survey conducted by the CBS.	Monthly	N/A	Not currently in use due to short history
Korea	Consumer survey index(BOK)	Household's expected inflation for CPI(1 year)	Monthly	2,200 households	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Korea	Consensus Economics survey	Financial corporations' expected inflation for CPI(1 year)	Monthly	15 financial corporations + four research institutes	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Korea	Consensus Economics survey	Financial corporations' expected inflation for CPI(5 year)	Other[3]	15 financial corporations + four research institutes	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Korea	Consensus Economics survey	Financial corporations' expected inflation for CPI(10 year)	Other[4]	15 financial corporations + four research institutes	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence

[1] Additional two bimonthly on pilot basis are being tried for internal use.
[2] Forecasters send data at least once a month.
[3] Semiannual from April 1995 to October 2013 and quarterly from April 2014 onwards.
[4] Semiannual from April 1995 to October 2013 and quarterly from April 2014 onwards.

Central bank surveys on inflation expectations

Table A1 (cont)

Economy	Survey name	Inflation measure	Frequency	Population and number of respondents	Primary use
Malaysia	BNM Consumer Sentiment Survey[5]	General prices and prices of selected categories, one-year-ahead	Monthly	1,000 households	Monitoring credibility, checking anchoring of expectations, gauging information about confidence and assessing growth and inflation outlook
Malaysia	BNM Quarterly Survey of Firms[6]	One-quarter-ahead CPI, average operating cost and selling prices	Quarterly and annual	Approximately 130 non-financial corporations	Monitoring credibility, checking anchoring of expectations, gauging information about confidence and assessing growth and inflation outlook
Malaysia	BNM Consumer Sentiment Survey[7]	General prices and prices of selected categories, one-year-ahead	Monthly	1,000 households	Monitoring credibility, checking anchoring of expectations, gauging information about confidence and assessing growth and inflation outlook
Malaysia	BNM Quarterly Survey of Firms[8]	One-quarter-ahead CPI, average operating cost and selling prices	Quarterly and annual	Approximately 130 non-financial corporations	Monitoring credibility, checking anchoring of expectations, gauging information about confidence and assessing growth and inflation outlook
Malaysia	Analysts' Consensus forecast[9]	One-year-ahead CPI	Monthly	Approximately 30 professional forecasters	Monitoring credibility, checking anchoring of expectations, gauging information about confidence and assessing growth and inflation outlook
Mexico	Bank of Mexico's survey	CPI, core CPI, short and long terms	Monthly	Professional forecasters, non-financial corporations and financial corporations	Monitoring credibility, checking anchoring of expectations and gauging information about confidence
Mexico	Banamex's survey	CPI, core CPI, short and long terms	Biweekly	Financial corporations	Monitoring credibility, checking anchoring of expectations and gauging information about confidence

[5] Survey conducted since 2013 and the data is not published.
[6] Survey covers firms in the manufacturing, construction and services sector and also includes firms' expectation of their performance and outlook.
[7] Survey conducted since 2013 and the data is not published.
[8] Survey covers firms in the manufacturing, construction and services sector and also includes firms' expectation of their performance and outlook.
[9] Published by Consensus Economics Inc.

Central bank surveys on inflation expectations

Table A1 (cont)

Economy	Survey name	Inflation measure	Frequency	Population and number of respondents	Primary use
Poland	NBP Quick Monitoring, enterprises	CPI, prices of final products and services, prices of materials and raw products used for production	Quarterly	More than 1,500 non-financial corporations	Checking anchoring of expectations and testing formation
Poland	NBP SPF, professional forecasters	CPI	Quarterly	Approximately 20 professional forecasters (avg)	Monitoring credibility, checking anchoring of expectations, gauging information about confidence and testing formation
Russia	Public Opinion Foundation	CPI	Monthly	2,000 households	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Russia	Russian economic barometer	PPI	Monthly	200 non-financial corporations	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Russia	Bloomberg consensus	CPI	Monthly	More than 20 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Russia	Reuters consensus	CPI	Monthly	More than 20 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Russia	Interfax consensus	CPI	Monthly	More than 20 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Russia	Manufacturing, Services PMI	PPI, CPI	Monthly	N/A	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Saudi Arabia	The Saudi Arabian Monetary Agency does not conduct any surveys on inflation expectations				
Singapore	Singapore Index of Inflation Expectations (SInDEx)	CPI (All Items and Core)	Quarterly	400 randomly selected individuals from Singapore households	Checking anchoring of expectations and gauging information about confidence
Singapore	MAS Survey of Professional Forecasters	CPI	Quarterly	About 20–30 respondents from the financial sector	Checking anchoring of expectations and gauging information about confidence
Singapore	Asia Pacific Consensus Forecasts	CPI	Monthly	17 analysts, as of October 2015	Checking anchoring of expectations and gauging information about confidence

Central bank surveys on inflation expectations

Table A1 (cont)

Economy	Survey name	Inflation measure	Frequency	Population and number of respondents	Primary use
South Africa	Bureau for Economic Research	CPI	Quarterly	30 professional forecasters, 3,000 households, 1,500 non-financial corporations and 15 trade unions	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
South Africa	Reuters consensus	CPI, PPI	Monthly	30 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Thailand	Asia Pacific Consensus Forecast	CPI (two to eight quarters ahead)	Quarterly	15–20 professional forecasters	Gauging information about confidence and gauging short-term inflationary pressure
Thailand	Asia Pacific Consensus Forecast	CPI (five to 10 years ahead)	Semi-annual	15–20 professional forecasters	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Turkey	Survey of Expectations	CPI	Monthly	110 professional forecasters from financial and real sectors	Setting policy, monitoring credibility, checking anchoring of expectations and gauging information about confidence
Turkey	Business Tendency Survey	CPI, PPI	Monthly	2,659 senior managers of the manufacturing Industry	Gauging information about confidence
Turkey	Consumer Tendency Survey	CPI	Monthly	4,848 households	Gauging information about confidence
United Arab Emirates	The Central Bank of the United Arab Emirates does not conduct any surveys on inflation expectations				

Market-based measures of inflation expectations used by central banks[1]

Table A2

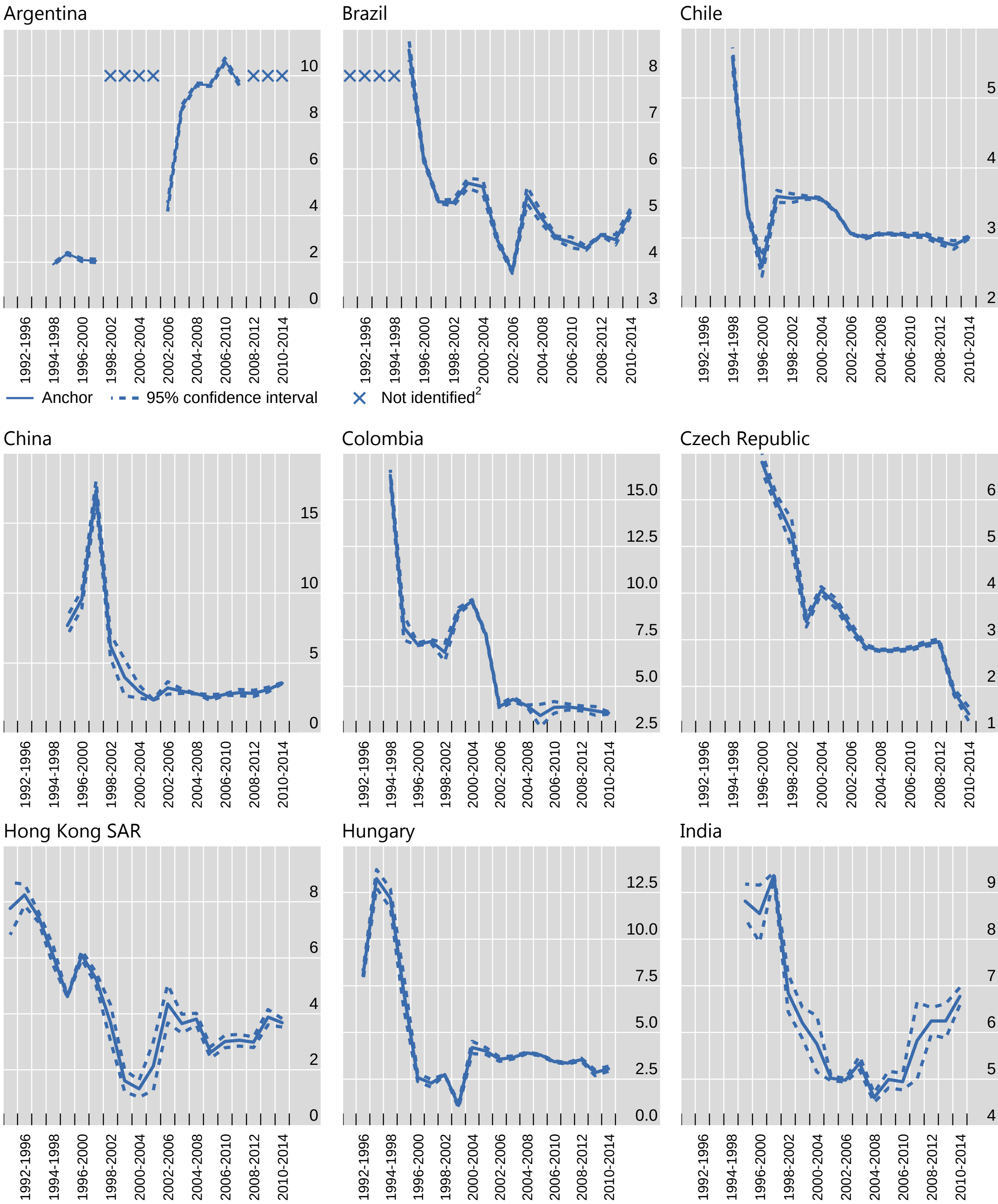
Economy	Measure
Brazil	Inflation-indexed government bonds
Chile	Inflation-indexed government bonds issued by the central bank; Insurance against inflation
China	None
Colombia	Inflation-indexed government bonds (break-even inflation and forward break-even inflation)
Czech Republic	None (no inflation-indexed instruments on the Czech financial market)
Hong Kong SAR	There are inflation-indexed government bonds (iBonds). However, data limitation makes it difficult to infer inflation expectations using these bonds
Hungary	None
Indonesia	None
Israel	Inflation-indexed government bonds; Commercial banks' internal interest rates-difference between non-indexed and indexed interest rates
Korea	Inflation-indexed government bonds (break-even inflation)
Malaysia	None
Mexico	Inflation-indexed government bonds
Peru	Inflation-indexed government bonds
Philippines	Yield curve for government securities in the secondary market
Poland	Inflation-indexed government bonds
Russia	Inflation-indexed government bonds (OFZ-IN № 52001, with par value indexed to inflation)
Saudi Arabia	None
Singapore	None
South Africa	Inflation-indexed government bonds
Thailand	Inflation-indexed government bonds; Inflation expectations extracted from yield curve (for assessing central bank credibility and monitoring anchoring of expectations)
Turkey	Inflation-indexed government bonds (no publicly available data are published)
United Arab Emirates	None

1 A dot indicates missing data.

Estimated inflation anchors and confidence bands[1]

In per cent

Graph A1

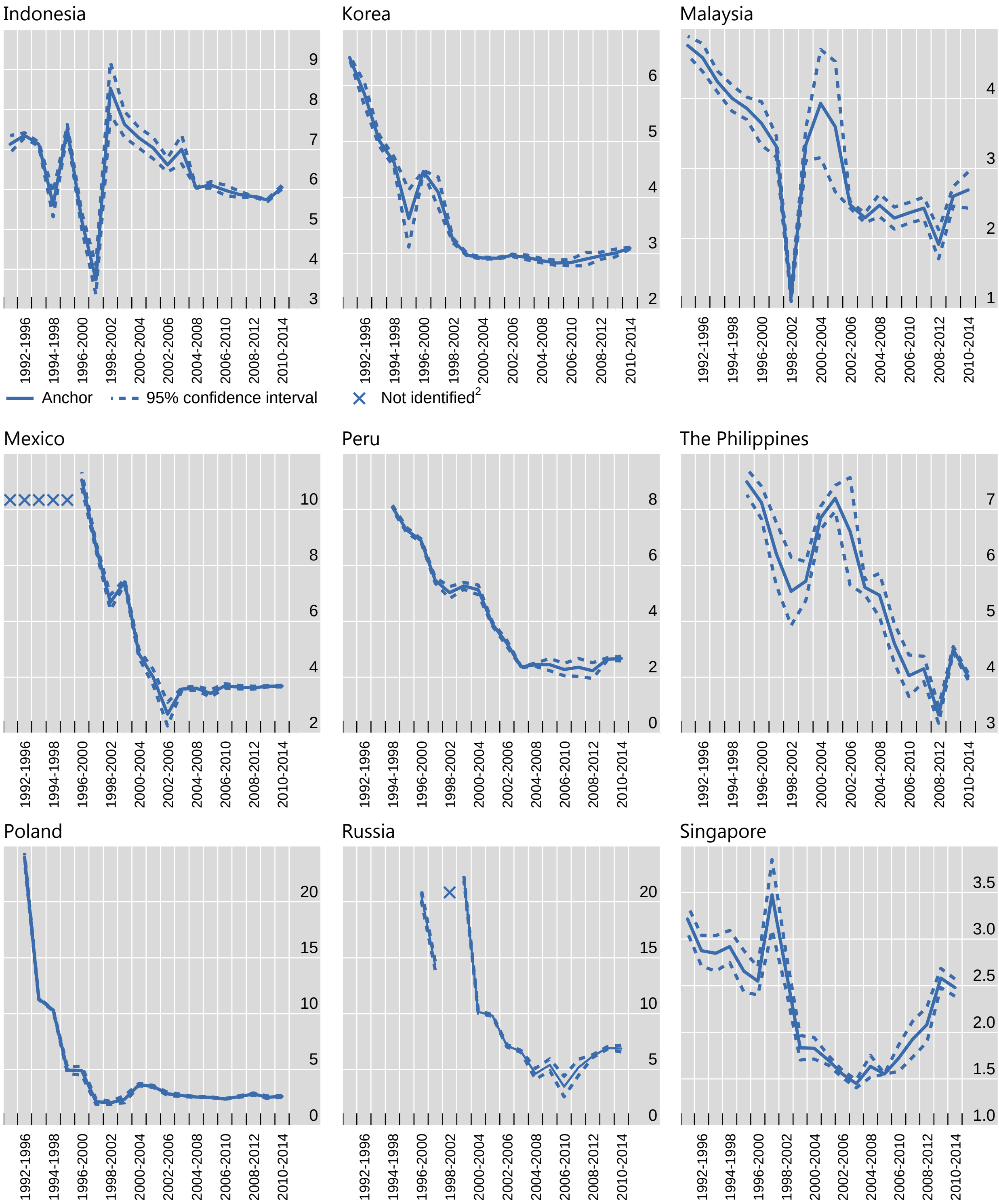


[1] Based on five-year rolling samples, using the methodology in Mehrotra and Yetman (2014). All economies except India: dates refer to calendar years; for India, March years (ie.. 2015 refers to the April 2015–March 2016 period). [2] "Not identified" indicates that the estimates imply little or no weight on an anchor; instead, a model where forecasts only reflect recent inflation fits the data best.

Sources: Consensus Economics; authors' calculations.

Estimated inflation anchors and confidence bands[1]

In per cent — Graph A1 (cont)



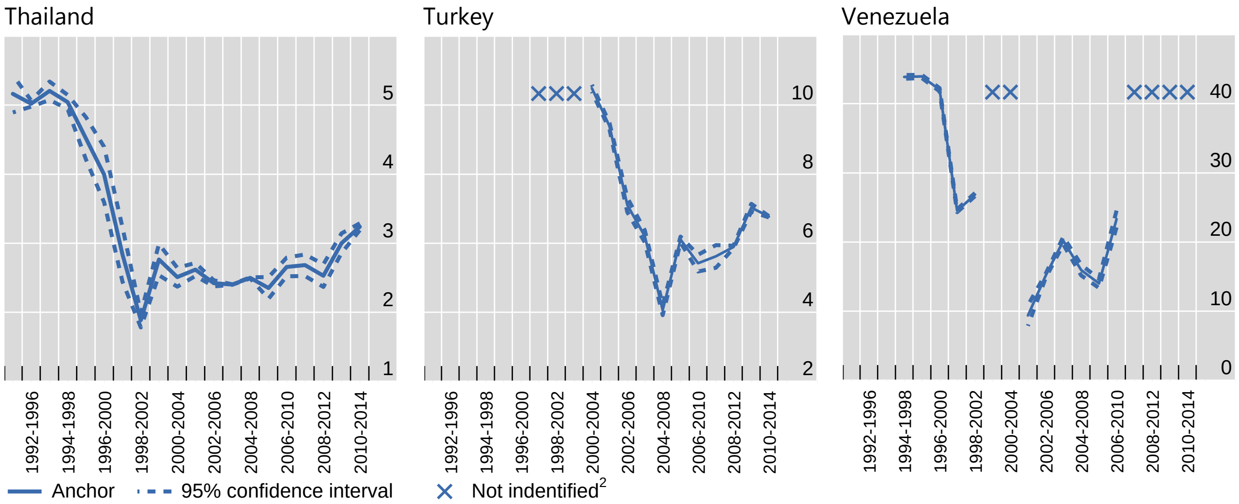
[1] Based on five-year rolling samples, using the methodology in Mehrotra and Yetman (2014). All economies except India: dates refer to calendar years; for India, March years (ie 2015 refers to the April 2015–March 2016 period). [2] "Not identified" indicates that the estimates imply little or no weight on an anchor; instead, a model where forecasts only reflect recent inflation fits the data best.

Sources: Consensus Economics; authors' calculations.

Estimated inflation anchors and confidence bands[1]

In per cent

Graph A1 (cont)



[1] Based on five-year rolling samples, using the methodology in Mehrotra and Yetman (2014). All economies except India: dates refer to calendar years; for India, March years (ie 2015 refers to the April 2015–March 2016 period). [2] "Not identified" indicates that the estimates imply little or no weight on an anchor; instead, a model where forecasts only reflect recent inflation fits the data best.

Sources: Consensus Economics; authors' calculations.

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The transition to inflation targeting in an emerging economy: selected issues

Horacio Aguirre, Mauro Alessandro and Lucas Llach[1]

Abstract

Monetary policy in Argentina is in transition to an inflation targeting regime with a floating exchange rate. As reviewed in this note, several measures have been taken to normalise the functioning of exchange rate and money markets. The next steps will present a number of challenges, many of them common to monetary policy implementation in EMEs. We look at the relationship between objectives and instruments in the monetary policy strategy, the role of the exchange rate, the initial conditions for adoption of inflation targeting, and the types of shock that EMEs are exposed to and how these may influence the strategy adopted.

Keywords: Monetary policy; monetary regime; policy objectives; policy instruments; inflation targeting; exchange rate

JEL classification: E50, E61

[1] Central Bank of Argentina. Note prepared for presentation at the Meeting of Deputy Governors at the Bank for International Settlements, Basel, 28–29 January 2016.

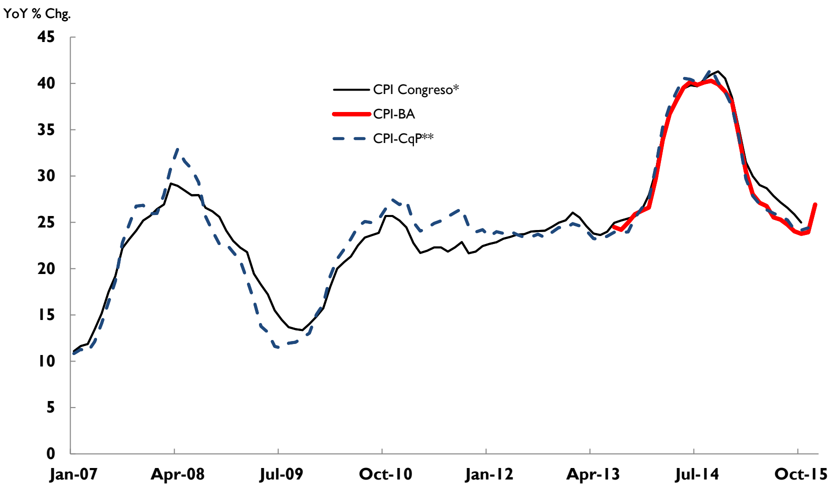
Introduction

Monetary policy in Argentina is in transition to a regime that will shift the relative emphasis between the central bank's various mandates as set out in its charter: monetary stability, financial stability and economic growth. The idea is to pursue those three objectives by moving the first aim to top of the agenda, given that the economy has a history of double-digit inflation rates. In addition, central bank policy will continue to focus on financial stability and the development of the financial system – a matter of potential significance when credit to the private sector stands at less than 15% of GDP. Improving access to financial services and developing new means of payment is the third pillar of this strategy. In this note, we review recent developments in the Argentine economy and outline a number of issues relevant for the transition to an inflation targeting regime.

Economic situation until December 2015

The Argentine economy deteriorated sharply during the first half of the 2010s, presenting a major challenge for the conduct of economic policy, particularly monetary policy. By December 2015, the country had experienced several years of low economic growth, an inflation rate persistently above 25% since 2007 (Graph 1), a burgeoning fiscal deficit, partly funded by the central bank, a system of multiple exchange rates that prevented the generation of exports (already affected by high taxes on foreign sales by the agricultural sector) and foreign investment. These factors, in turn, meant that imports had to be purchased with foreign exchange. Meanwhile, the legal situation of its public debt resulted in a country risk rating that was higher than that of most neighbouring countries.

Retail prices | Graph 1



*The index elaborated by Congress was first released in April 2011; for earlier periods, an average of the indexes provided by a group of private consulting firms was used.
**Index elaborated by the "Cosas que Pasan" website. It is calculated implementing a geometric weighted average of the official price indexes of a handful of provinces. The weights are proportional to the correlations each index had with the CPI-GBA.

Output growth came close to a standstill during the last four years, while public and private consumption increased their share in aggregate demand at the expense of investment. In this scenario of low economic growth, inflation has hovered at around 25% annually since 2007, beyond the rate associated with an unfavourable external environment (2009) or movements in the exchange rate (2014). It has been a decade since double-digit levels of inflation became entrenched in Argentina, far outstripping the international average for the period, which stands at 4.1%. The value of the currency has been correspondingly weakened, driving partially compensating devaluations.

The public finances also showed a systematic deterioration in the past five years, moving from a balanced budget to a large fiscal deficit last year. While revenues grew quickly, primary expenditure increased at an even higher rate, several components of which include automatic adjustment mechanisms, accounting in total for over 60% of primary spending.

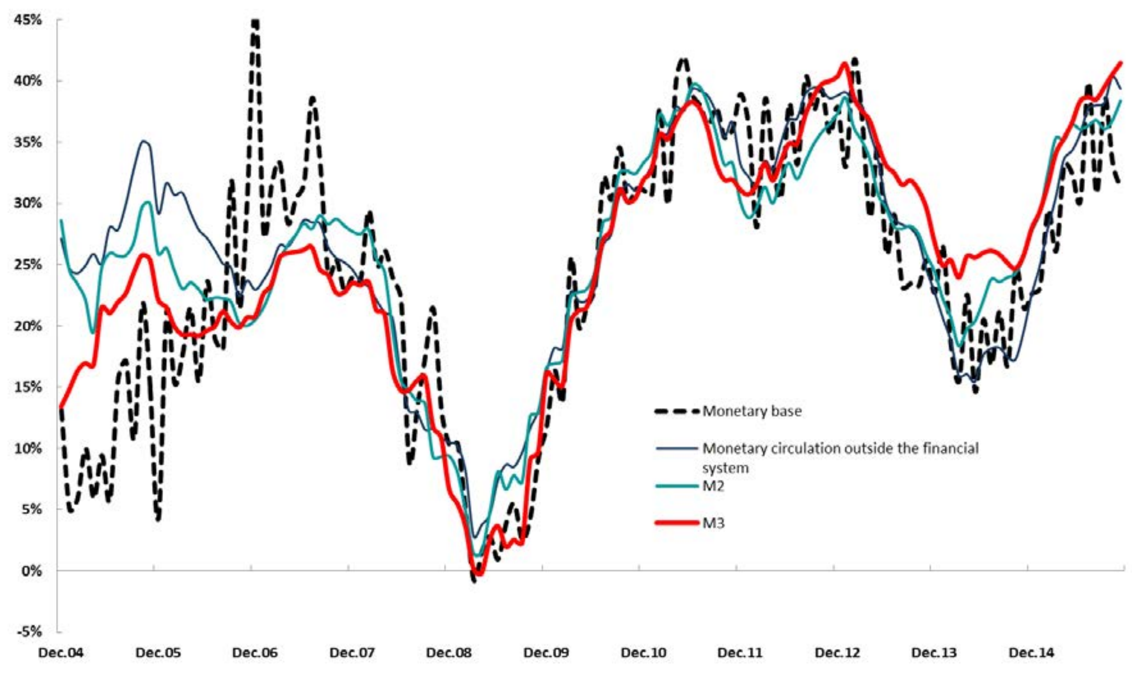
The deterioration in the public finances went together with an increasing reliance by the Treasury on the central bank's assistance, implying an accelerating increase in base money and/or a fall in international reserves. Thus, fiscal dominance prevented the central bank from pursuing the objectives set out in its charter.

Monetary policy was systematically expansionary, so that monetary aggregates increased their annual growth rate from around 20% before the subprime crisis to a range of 30–40% from 2010 onwards, temporarily interrupted between 2013 and 2014 (Graph 2).

Monetary base and local currency monetary aggregates of the private sector

Inter-annual rate of change

Graph 2



While the Treasury's demands for funding translated into an increase of the central bank's liabilities, the use of its international reserves to pay public debt in foreign currency and the deterioration in the external accounts depleted its assets. The trade balance deteriorated from a US$12.2 billion surplus in 2012 to a deficit of approximately US$2.2 billion in 2015. The trade deficit was worsened by the system of multiple exchange rates, which subsidised tourism abroad and the purchase by the public of the central bank´s international reserves, while penalising exports and capital inflows.

Restrictions on the sale of foreign currency, as well as on dividend and royalty payments by foreign companies and on import payments, came into force in 2011 with the aim of reducing demand for foreign exchange. Although these measures were partially effective in containing foreign currency sales by the central bank and in temporarily stabilising the international reserves, it was clear that they also restricted the supply of foreign exchange as well as demand for it, thus severely penalising economic activity. Soon afterwards, international reserves resumed their sharp downward trend.

Combined with an expansionary monetary policy, the inefficient administrative exchange rate scheme raised tensions in the foreign exchange market. These were reflected in the widening gap between the official exchange rate and the one implicitly revealed in the arbitrage of securities denominated in both domestic and foreign currency – and also in the general public's rising demand for foreign currency. Ultimately, the central bank became a net seller of foreign exchange in the spot market and practically the only bidder in the forward market. The situation was soon perceived as unsustainable.

Exchange rate and monetary normalisation

With the change of government on 10 December 2015, the central bank started to normalise monetary policy and the foreign exchange market. The three immediate priorities were to unify the foreign exchange market; standardise open market operations; and restructure the central bank balance sheet.

a) Unification of the foreign exchange market

In line with the new administration's priorities, a single exchange rate was established for all transactions and all restrictions were lifted on current account transactions. Restrictions on capital account transactions remained in place. To deter hoarding, the acquisition of foreign currency continued to be limited to US$2 million a month for businesses and individuals. The backlog of payments for imports owned to the business under the administrative exchange rate was subject to a settlement procedure.

With the announcement of the market exchange rate, the central bank let the exchange rate float freely. Simultaneously, international reserves began to trend upwards again.

b) Changes to the auction of central bank securities

A key channel of monetary intervention in Argentina is the weekly call for bids for the central bank's debt instruments (LEBAC and NOBAC). Before the exchange market was unified, the central bank interest rates on central bank securities rose. The higher interest rate and a more complete term structure, with maturity from 35 days, helped to deal with the monetary overhang.

Additionally, the central bank abandoned caps on loan and deposit interest rates set in line with the interest rates paid on central bank securities. From 17 December 2015, financial institutions have been able to negotiate interest rates freely with their customers. Time deposits in local currency have reversed the downward trend shown during the first half of December.

c) Strengthening the central bank's balance sheet

The policies implemented by the central bank in recent years eroded the quality of its balance sheet, hindering it from meeting its objectives. International reserves significantly reduced their share in total assets, falling from 50% in 2005 to 16% in 2015. Meanwhile, the share of credit to the government in total assets increased, mainly by the placement of non-marketable treasury bills. The exchange of three sets of these securities (those issued in 2006 and in 2010) for marketable and liquid treasury bills, worth US$16 billion, significantly strengthened the central bank's balance sheet.

Monetary and exchange rate policy plans for 2016

As the central bank's primary objective is to seek price stability, which is the principal objective in its Governing Law, policies and measures will focus on ensuring a gradual decline in domestic inflation. While putting in place the above-mentioned reforms, the central bank had already started to take the inflation rate into account in its monetary policy decisions. The announced publication of a new price index in 2016 will allow the central bank to monitor inflation more accurately.

To meet its objective, the central bank relies mainly on the interest rate paid on own securities and on repurchase agreement operations. The growth of monetary aggregates will be consistent with the observed behaviour of domestic prices.

The targeting of monetary aggregates faces significant challenges arising from money demand shocks. This renders difficult to specify an objective in terms of the rate of growth of money. However, the change in policy is meant to reduce the money growth rate considerably in light of the objective of cutting down the inflation rate.

The central bank seeks to communicate its assessment of observed inflation as well as its planned policy measures. The exchange rate will be left to float freely, with the aim of absorbing external shocks and insulating the money market from them. Monetary policy instruments will be used to deal with excess volatility in nominal variables. The medium-term goal is to decouple the behaviour of the nominal exchange rate from that of inflation. This will be accomplished by the adoption of an inflation targeting regime together with a managed floating exchange rate (see Central Bank of Argentina (2015)).

Towards a consistent monetary strategy

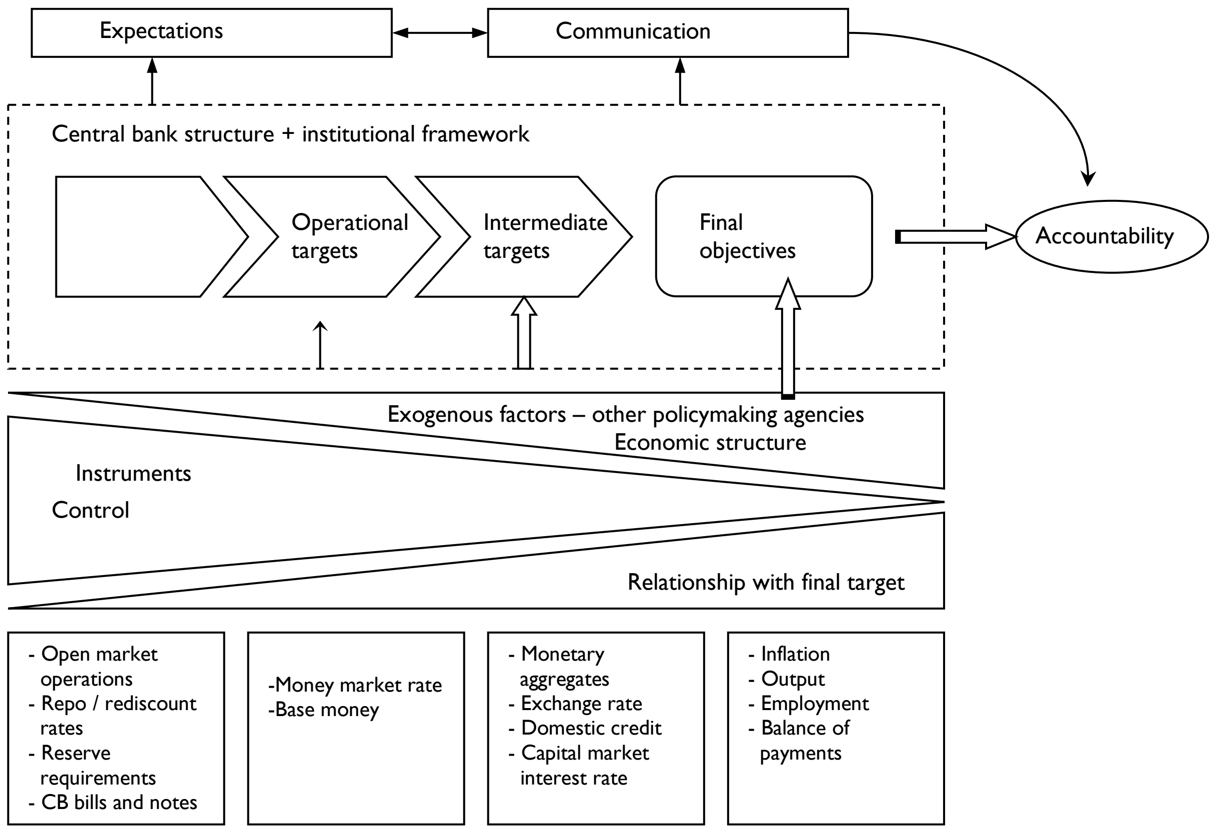
The adoption of a price stability-oriented monetary policy framework raises a number of questions for an emerging market economy (EME) such as Argentina. This section discusses the relation between objectives and instruments in the monetary policy strategy, the role of the exchange rate, the financial system, the initial conditions for adoption of inflation targeting, and more generally, the types of shock that EMEs are exposed to and how these influence the adopted strategy. The aim is to provide an overview of challenges in moving to inflation targeting.

a) Monetary policy strategy

When first introduced, in the early 1990s, inflation targeting was an innovation for EMEs. However, the announcement of a numerical target, the assurance that the central bank would do all in its power to reach the target and its recourse to "all available instruments" in pursuing that aim do not amount to a guarantee that (a) appropriate instruments will be found; (b) operational and intermediate targets will be appropriately defined; or (c) inflation expectations will be effectively "anchored" at the target level.

Central banks do not set objectives or deploy instruments in a vacuum: the institutional structure of the central bank and its relationship with the rest of economic policymaking agencies have to be considered, as do structural (and short-term) features of the economy that constrain policy actions. Exogenous factors (from the point of view of the central bank) gain importance as we get closer to the final targets. At the same time, the central bank's degree of control tends to decrease. In other words, the final outcome of a monetary policy strategy is directly related to the central bank's accountability, but also to the influence of exogenous factors. This makes consistency between instruments, targets and the context of policy actions of the utmost importance. Graph 3 summarises these points.

Monetary regime: basic elements | Graph 3



Source: based on Houben (2000).

The trade-off between the degree of control of instruments/operational targets and relevance of the final target is crucial for the design and implementation of monetary policy strategy. It is also closely related to elements that influence a central bank's targets, such as exogenous factors that are beyond the central bank's reach but determine outcomes that the central bank is concerned about. What Graph 1 should make clear is that the sequence that goes from instruments to ultimate targets is a system whose determination the central bank only partially controls, and therefore the concrete implementation of a monetary policy strategy should openly recognise this. Many discussions of inflation targeting design can be usefully framed in terms of such a scheme. They include the following questions:

- Which are the instruments available to central banks, and which they should develop?
- What is the mapping from instruments to outcomes, ie what are the transmission mechanisms for monetary policy and what is the underlying economic model?
- What particular types of shock is the economy subject to? This not only constrains what instruments the central bank may use, but should also determine what target to set. For instance, EMEs are subject to different shocks from those that affect advanced economies, and of different magnitudes (see Section c).

- What is the institutional framework? This involves not only the formal arrangements but the actual functioning of institutions and their interplay.
- What are the macroeconomic and financial conditions at large, including the fiscal stance, the external situation and the financial system? Traditionally, "fiscal dominance" was traditionally viewed as a key determinant of monetary policy (see Section d), while, in Latin American economies, external conditions have largely been regarded as playing that role. However, the 2007–08 crisis highlighted the relationship between financial system performance and monetary policy as a key factor for monetary policy. As monetary policy influences not only the business cycle but financial cycles too (Borio (2012)), an inflation targeting policy that focuses only on inflation and output growth misses an important dimension that ultimately affects the entire economy, rather than being "contained" within the financial system.

The foregoing implies that there is no single strategy or monetary regime that is suitable for all countries, and not even for the same country all the time. This insight is even more important when a transition to a new monetary policy framework is implemented. In what follows, we touch on three particular points that illustrate different challenges faced by such an implementation, in terms of instruments, targets and exogenous shocks.

b) Shocks, target and policy dilemmas

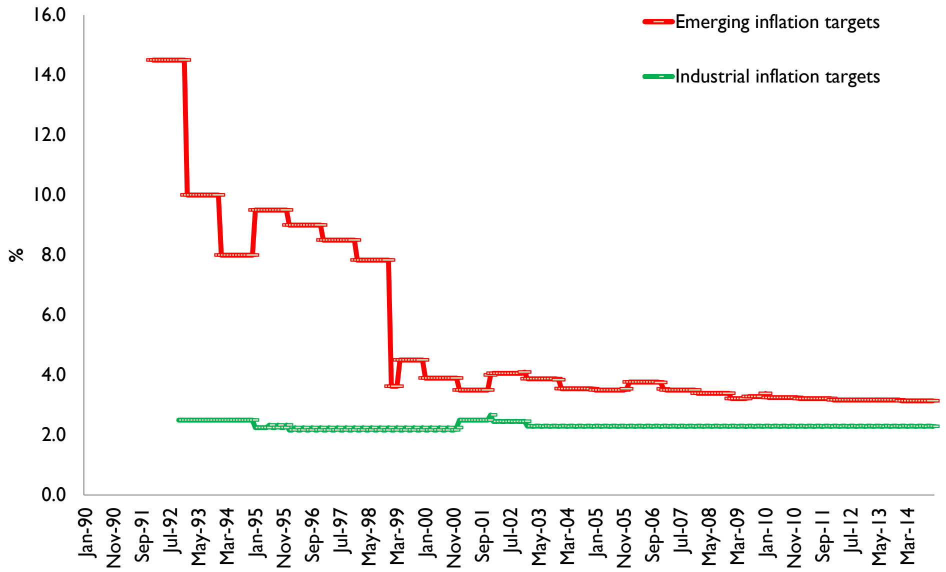
The shocks faced by EMEs are different in kind and magnitude from those that affect advanced economies. Supply shocks disrupt, among other things, the balance that policymakers seek to strike between the inflation target and stabilising the output gap relevant for welfare (Blanchard and Galí (2005)). Thus, accommodating supply shocks to protect economic activity may mean accepting higher inflation. In this way, a shock can influence the choice of monetary policy in at least two ways: by opening up or worsening policy dilemmas (nominal vs real stabilisation), or, in the case of inflation targeting, by making it harder to achieve the target. Indeed, inflation targets should take potential shocks into account in their rate, compliance horizon, and other terms.

A comparison of advanced economies' inflation performance vis-à-vis target with that of EMEs reveals some differences. EMEs' targets have remained above those of advanced economies over time, even if the difference has decreased in the last decade and a half (Graph 4a). But the targets of Latin American are above the EME average. Likewise, EMEs tend to exceed their targets, and by more and for longer than advanced countries do (Graphs 4b and c). These graphs are comparable with the results in Roger and Stone (2005). It is worth pointing out that the only episode in which deviations from target in advanced economies were similar in size and sign to EMEs' was during the Icelandic financial crisis – but this is precisely the type of shock that is more frequent in EMEs.

Indeed, while the mean deviation from target is positive in EMEs, it is close to zero in advanced ones (and negative if the Icelandic crisis is excluded); the median deviation in advanced countries is also zero, while it is positive in EMEs (Table 1). Within the latter group, Latin America shows a higher mean and median deviation from targets than do other EMEs as a group. Finally, the volatility of deviations from target in EMEs, as measured by the root mean squared deviation, is over 100% that of advanced countries (excluding the Icelandic crisis). The key point is that the relative performance against targets could be a function of the shocks experienced by different economies and this should be taken into account in the design of the monetary policy strategy.

Inflation targets in emerging markets and advanced economies

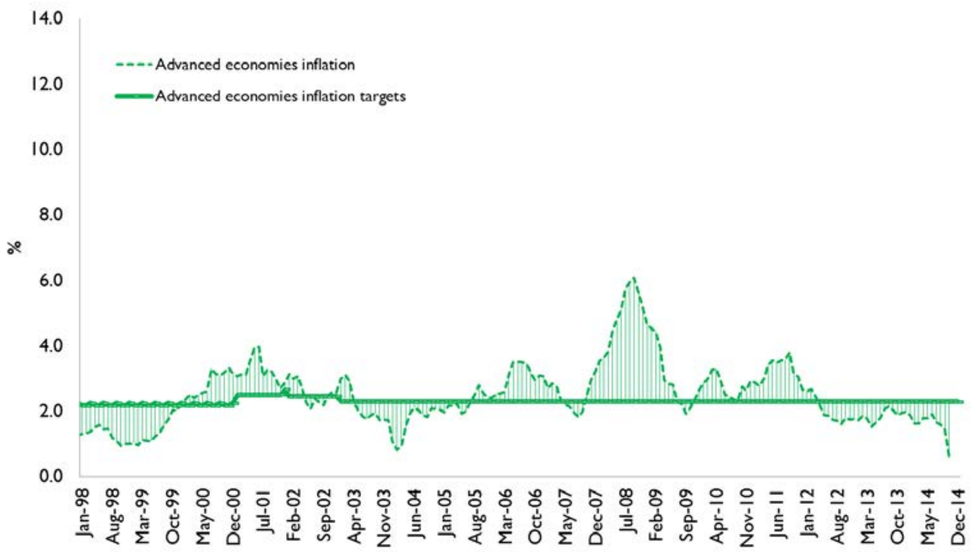
Graph 4 (a)



Sources: IMF, *International Financial Statistics*; central banks; author's calculations.

Inflation outcomes relative to target: advanced economies, 1998–2014

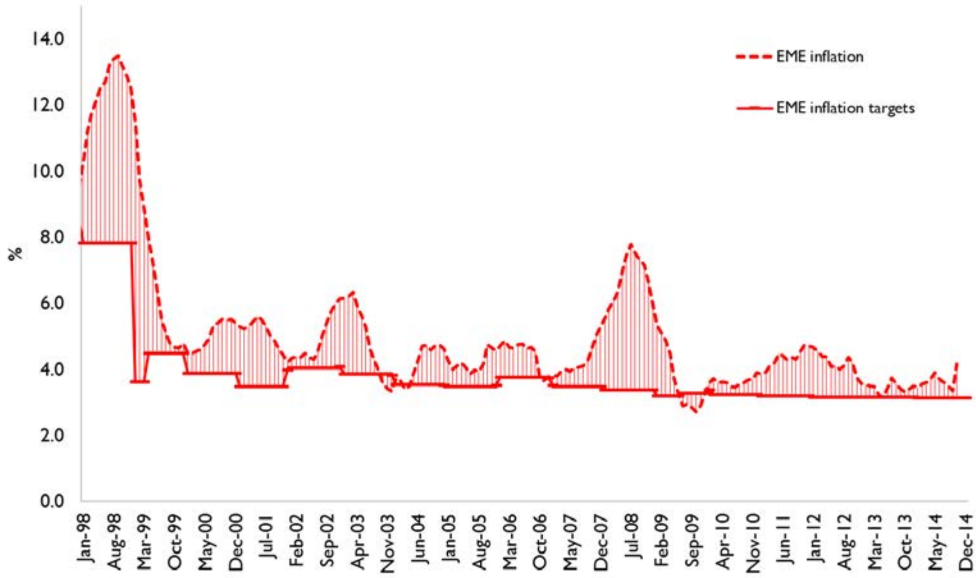
Graph 4 (b)



Sources: IMF, *International Financial Statistics*; central banks; author's calculations.

Inflation outcomes relative to target: emerging market economies

Graph 4
(c)



Sources: IMF, *International Financial Statistics*; central banks; author's calculations.

Note: deviations from targets are calculated from centre of target ranges for countries with band targets.

Inflation outcomes relative to target or centre of target ranges, 1992–2014

Table 1

COUNTRIES	MEAN DEVIATION	ROOT MEAN SQUARE DEVIATION	MEDIAN DEVIATION
EME (total)	**0.75**	**5.57**	**0.60**
EME (non LA)	0.50	5.63	0.33
EME (LA)	1.14	5.48	0.99
Advanced economies	**0.27**	**4.47**	**0.02**
Advanced economies (excl. Crisis)	**0.08**	**2.38**	**0.02**

Sources: IMF, *International Financial Statistics*; central banks; author's calculations.

The current situation in Latin America serves as an illustration: a "sudden stop" in capital flows associated with US monetary policy tightening has coincided with a real appreciation of the dollar and lower commodity prices. Exchange rate depreciation should take the brunt of the necessary adjustment, helping to boost output. But, at the same time, this may lead to inflationary pressures. To offset such pressures, monetary policy needs to tighten, but this will also weigh negatively on economic activity.

The conventional view in much of Latin America is that, thanks to the successful anchoring of inflation expectations, countries will be more capable than before of sustaining real exchange depreciations without much pass-through to inflation. However, inflation is gradually picking up in several countries, and it seems inappropriate to use pass-through estimates based on the experience of recent years to forecast the impact of a shock on the scale of the one currently assailing the region.

The combination of tighter monetary policy and falling commodity prices also poses risks to financial stability. While a financial crisis is unlikely to happen in Latin America, episodes of financial instability associated with the rise in corporate debt cannot be ruled out. This is not the "classic" currency mismatch problem of foreign currency liabilities in the financial system, but rather the foreign currency debt of corporations that do not generate income in that currency. And the financial system could still be affected by corporate solvency problems that feed through to the banks.

It should also be noted that, while many corporations are hedged against currency movements, the counterparties for such hedges are local central banks, which cannot provide liquidity in foreign currency. Moreover, monetary tightening in the United States could result in capital outflows, entailing a certain amount of financial disruption. If capital outflows from EMEs drain their markets of liquidity, and if Latin American central banks cannot fully accommodate the demand for foreign exchange, the trade-off between internal and external stabilisation may become more pronounced.

c) Monetary policy instruments and the role of the exchange rate

Inflation targeting has become closely associated with the use of short-term, nominal interest rates as policy instruments and a freely floating exchange rate. While a central bank may in principle use any instrument at its disposal, interest rates are seen as the primary policy tool. The analytical underpinnings of this view are found in the New Keynesian model with an interest rate rule. This implies that other variables will react endogenously, including the nominal exchange rate (even if rules can be devised where interest rate is also a function of exchange rates; see Taylor (2001)). Close links have therefore developed between inflation targeting, interest rate rules and floating exchange rates (Bernanke et al (1999), Bernanke and Woodford (2005), Mishkin (2006)). However, the policy debate has usually focused on the distinction between inflation and other objectives, including exchange rates. When analysing the role of exchange rates in inflation targeting regimes, Stone and Roger (2009) note that emerging economies' "sharper focus on the exchange rate may cause some confusion about the commitment of their central banks to the inflation target and may also complicate policy implementation".

Indeed, the role of the exchange rate is more prominent in EMEs' monetary and financial stability frameworks. Measures such as systematic foreign exchange interventions or liquidity supply to the money market through multiple instruments have long been part of EMEs' policy "toolboxes", even in countries with inflation targeting regimes. Inflation targeting in Latin America differs systematically from the "Taylor rule-cum-pure floating" formula supposedly associated with Chang (2008). Far from being a deviation from best practice in monetary policy by the region's countries, it reflects the need to shield the economy from abrupt changes in international financial conditions. Indeed, countries that have adopted inflation targeting and a foreign exchange regime that differs from a purely floating one do not necessarily pay inflationary costs – in some cases, managed floating has been associated with lower inflation (Aguirre and Burdisso (2008)). Berganza and Broto

(2011) outline the dilemma between fulfilling the conditions for “strict inflation targeting” and a freely floating exchange rate, and “flexible inflation targeting”, a de facto managed floating exchange rate. They find that, although inflation targeting leads to higher exchange rate volatility than alternative monetary regimes, foreign exchange interventions in some economies that operate under an inflation targeting regime have been more effective in reducing volatility than some non-inflation targeting jurisdictions have. This type of policy has come to be known as “unconventional” but the label applies largely to advanced economies, whereas in the EME world such measures are not necessarily associated with exceptional responses to the international financial crisis (see García-Cicco and Kawamura (2014) for modelling of such responses).

Exchange rate intervention does not need to be linked to a higher or lower degree of monetary autonomy. It should rather be seen as one additional tool that the central bank may potentially use to reduce the volatility of the business cycle. For instance, Escudé (2009) shows, in the context of a dynamic stochastic general equilibrium (DSGE) model, that managed floating, together with an interest rate policy, is optimal for a large set of alternative policymakers’ preferences with different weights to the volatility of different variables. While the model is calibrated for the Argentine economy, its design is perfectly adaptable to inflation targeting economies (as it includes a Taylor rule with an inflation target). Aguirre and Grosman (2010) use a structural model to assess empirically whether a managed floating regime is associated with lower volatility of key macroeconomic variables than under a pure floating or a fixed exchange rate regime – and their findings suggest lower volatility under managed floating.

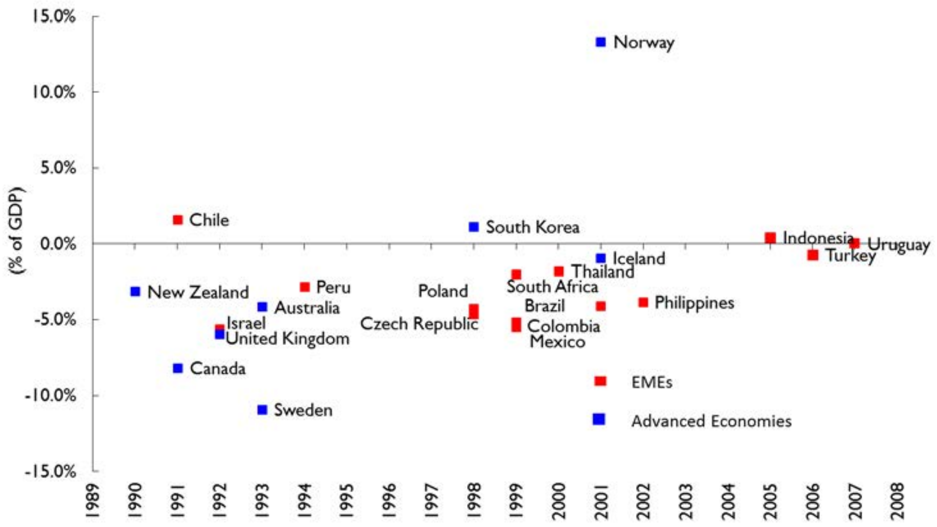
Thus, while actual performance depends on the specific circumstances of each economy, there are reasons to believe that a managed float actually enhances the possibility of achieving different policy objectives – indeed, it may not necessarily clash with a price stability objective. With a floating regime, the exchange rate acts as a shock absorber, but it can be managed to tame excess volatility that may weigh on price and financial stability.

d) Macroeconomic policies and initial conditions

The prerequisites for a successful inflation targeting regime, as for any other type of policy regime, include central bank independence, instrument independence, fiscal solvency, the absence of external dominance and a sound financial system. The importance of fiscal solvency for monetary policy, especially in EMEs, is well established: high fiscal deficits and too great a debt burden hinder the central bank in steering monetary and credit growth.

Still, evidence shows that not all countries that have adopted inflation targeting fulfilled all the economic, technical and institutional conditions deemed necessary for its success. In the case of fiscal solvency, the initial conditions differed considerably across economies (Graph 5) and a considerable number of countries that adopted inflation targeting as their monetary strategy did so at a time when they were sustaining large fiscal deficits. Among these, the advanced economies had the highest fiscal deficits and greater access to international financial markets.

General government balance at the introduction of an inflation targeting framework Graph 5



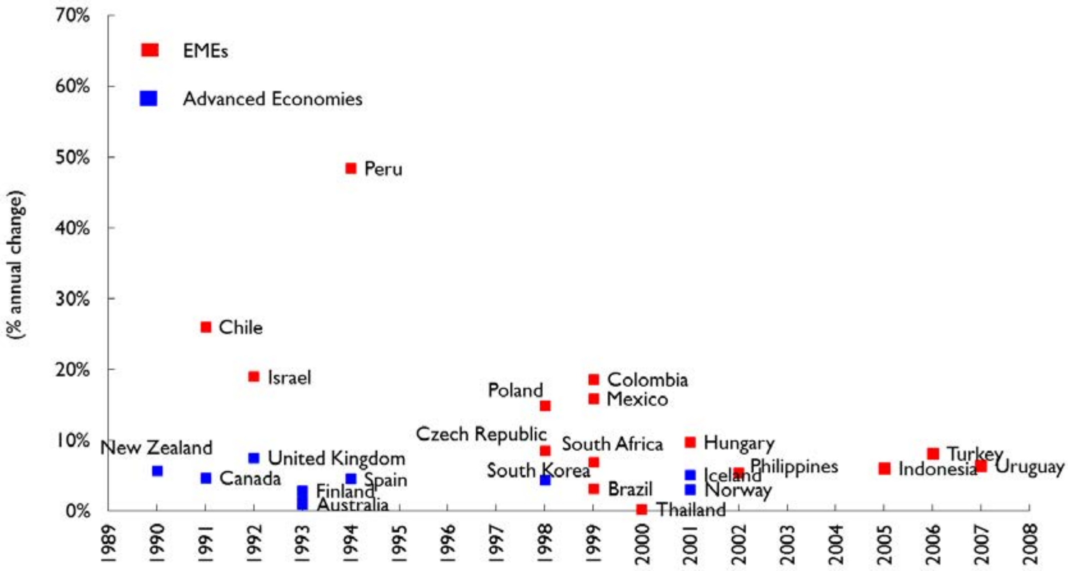
Sources: IMF, *International Financial Statistics*; author's calculations.

Not all countries have implemented inflation targeting together with a fully flexible exchange rate regime. Some have even kept implicit or explicit exchange rate targets with the aim of preventing sharp exchange rate fluctuations and limiting current account imbalances.

Even if it is not a prerequisite for inflation targeting, it is worth looking at the inflation rate at the time when inflation targeting is implemented (Graph 6). In general, EMEs have started from higher inflation rates than in the case of advanced economies. In these cases, inflation targeting helped to bring down inflation from moderate to high levels (10–40% annually). In the case of advanced countries, the motivation could have been to "lock in" price stability gains already achieved.

Lacking the usual prerequisites for inflation targeting does not preclude a country from successfully implementing such a regime. The prerequisites are no more crucial for inflation targeting than for any other monetary policy strategy. Perhaps they could be thought of as standards or benchmarks that indicate how ambitious policymakers can be in putting the scheme in place.

Consumer Price Index percentage change at the time of the introduction of an inflation targeting framework — Graph 6



Sources: IMF, *International Financial Statistics*; author's calculations.

Concluding remarks

After several years of double-digit inflation annual rates, monetary policy in Argentina is in transition to inflation targeting combined with a managed floating exchange rate. The functioning of exchange rate and money markets has seen considerable policy-induced changes. The next step will pose a number of challenges, many of them common to monetary policy implementation in EMEs. Most importantly, the establishment of a consistent framework will have to take into account the specific types of shock that an emerging economy faces.

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Why is inflation so high and volatile in Brazil? A primer

Tony Volpon[1]

Abstract

Inflation dynamics in Brazil are high and volatile. This short paper seeks to shed some light on the features of inflation in Brazil and provides a non-exhaustive list, in the way of a primer, of factors that are especially important. It also offers some suggestions for how monetary policy could deal with these factors to control inflation and bring interest rates closer to international levels.

Keywords: Inflation, determinants, monetary policy

JEL classification: E31, E52, E58

[1] Deputy Governor, Central Bank of Brazil. The opinions are those of the author and do not necessarily reflect those of the Central Bank of Brazil or its board members.

1. Introduction

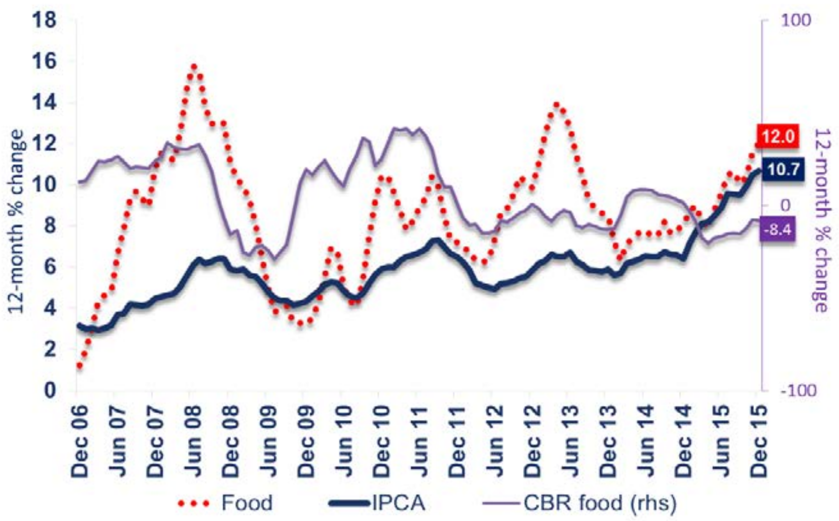
A question often asked is why inflation is so high and volatile in Brazil. The global experience with inflation these last few years should make us very humble in thinking we understand what determines inflation dynamics. Inflation is a complex social phenomenon with many causes and determinants that change in importance over time. This paper offers is a non-exhaustive list, in the way of a primer, of some of the factors that are important in Brazil, and makes some final remarks about how policy could deal with them to bring inflation – and interest rates – closer to international levels.

2. Brazil is a large, closed economy

Brazil is a large and closed economy. The country's land mass, at 8,515,767.05 km^2, makes it larger than continental Europe or the (contiguous) United States. Brazil is also a relatively closed economy: the export and import share to GDP is only 20.2% (as of November 2015).

This matters to inflation because lack of trade means that prices have to react more strongly to internal supply shocks. This is evident, for example, in the high and volatile levels of food prices in Brazil, which have been particularly high lately due to weather-related shocks. Graph 1 shows food price inflation in Brazil (and the lower overall inflation, IPCA) versus the food component of the CRB index for comparison. Notice that in general, there is a correlation between these indices, but there are periods – such as in 2013 – where the correlation breaks down. If Brazil were more open to trade, food imports could respond more rapidly to these shocks, reducing the level and volatility of this important component of inflation.

IPCA and food inflation | Graph 1

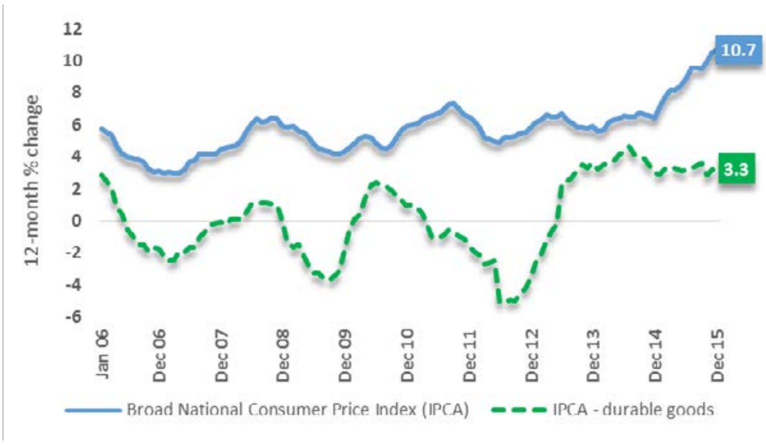


Sources: IBGE; Bloomberg.

One can also note, for example, that durable price inflation, where this sector is much more open to imports, is generally lower than overall inflation, as seen in Graph 2. In short, more openness to trade would increase supply elasticity and so decrease price elasticity to shocks, making inflation lower and less volatile.

IPCA and durable goods inflation

Graph 2



Source: IBGE.

3. The impact of commodity prices/terms of trade on currency and inflation

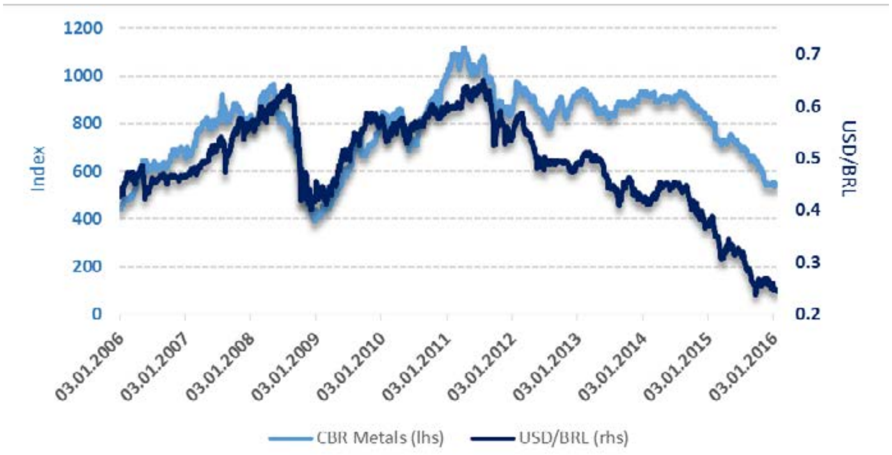
Besides the fact that Brazil is a large, relatively closed economy, two other facts, taken together, complicate its inflation dynamics. Brazil is a low savings economy whose export basket is heavily reliant on commodity exports. The average gross savings-to-GDP ratio over the last five years has been only 17.7% (2010–14).[2] In addition, commodities make up 47.4% of overall exports (December 2010–November 2015).

The interaction between these facts complicates inflation dynamics in the following way: being a low savings economy, periods of rapid growth generate pressure on the current account, demanding offsetting capital inflows. At the same time, the commodity-heavy export basket ties the level of the currency closely to internationally set commodity prices. We can see this, for example, in Graph 3, which plots the USD/BRL exchange rate against the CRB metals index – notice the very close correlation until 2013, after there is a "level" adjustment that still maintained the close correlation. Changes in global commodity prices will thus act as a procyclical shock to the economy, generating alternating periods of currency appreciation and high capital inflows and currency depreciation alongside low capital inflows. These cycles create special challenges for the control of inflation by conditioning the exchange rate, credit and capital market channels in opposite directions. Now, for example, Brazil needs to contend with disinflationary forces through wealth and credit channels versus inflationary forces through the exchange rate channel.

[2] From the World Bank's World Development Indicators.

BRL and CRB Metals

Graph 3



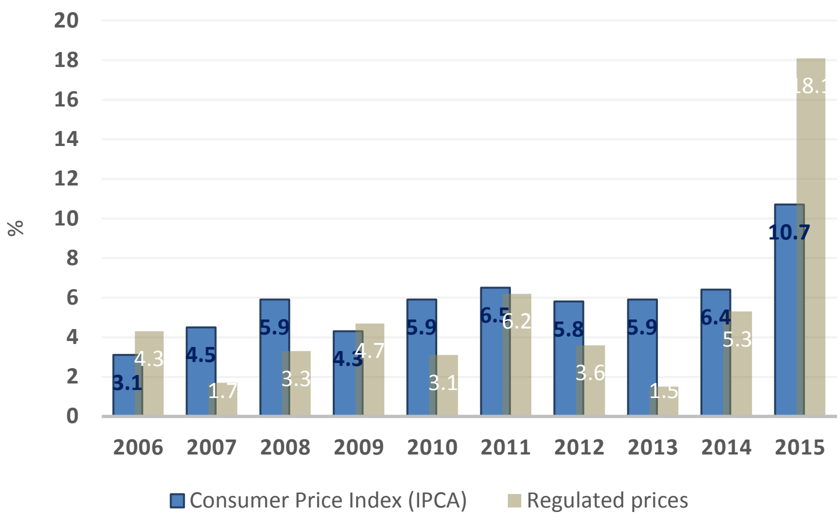
Sources: Central Bank of Brazil; Bloomberg.

4. The role of regulated prices

A large part (23.8%) of Brazil´s CPI basket is composed of prices set by contract or by the government, so-called "regulated" prices. These have created problems for inflation dynamics in two ways, both of which have manifested lately. First, many of these prices are not set according to fixed, transparent formulas. Thus, they may go through long periods being below or, like now, far above overall inflation, as we can see in Graph 4. They may also be used to try to make up for shortfalls in tax revenues. Needless to say, these prices respond much less to changes in monetary policy and can add greatly to inflation inertia.

IPCA and regulated prices

Graph 4



Source: Central Bank of Brazil.

5. Wage indexation

Wages, especially the minimum wage, are presently indexed to past inflation and GDP growth. Given that around 30% of Brazilian workers make something close to the minimum wage, changes to the minimum wage have an impact on the general level of wages in the economy. Whatever its other merits as a point of social policy, the indexation of wages increases inflation inertia and may create additional cost pressures – especially in the labour-intensive service sector – if wages rise above labour productivity, which is what has been happening recently, as seen in Table 1.

The minimum wage, prices and productivity Table 1

Percentage change	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Minimum wage	16.7	8.6	9.2	12.0	9.7	6.9	14.1	9.0	6.8	8.8
Consumer Price Index	3.1	4.5	5.9	4.3	5.9	6.5	5.8	5.9	6.4	10.7
Service Inflation	5.5	5.2	6.4	6.4	7.6	9.0	8.7	8.7	8.3	8.1
Labour Productivity*	1.7	3.4	2.0	-1.5	4.5	2.6	-1.1	3.5	0.6	-

* GDP/ employed person

Source: Central Bank of Brazil.

6. Bifurcation of credit markets and subsidised credit

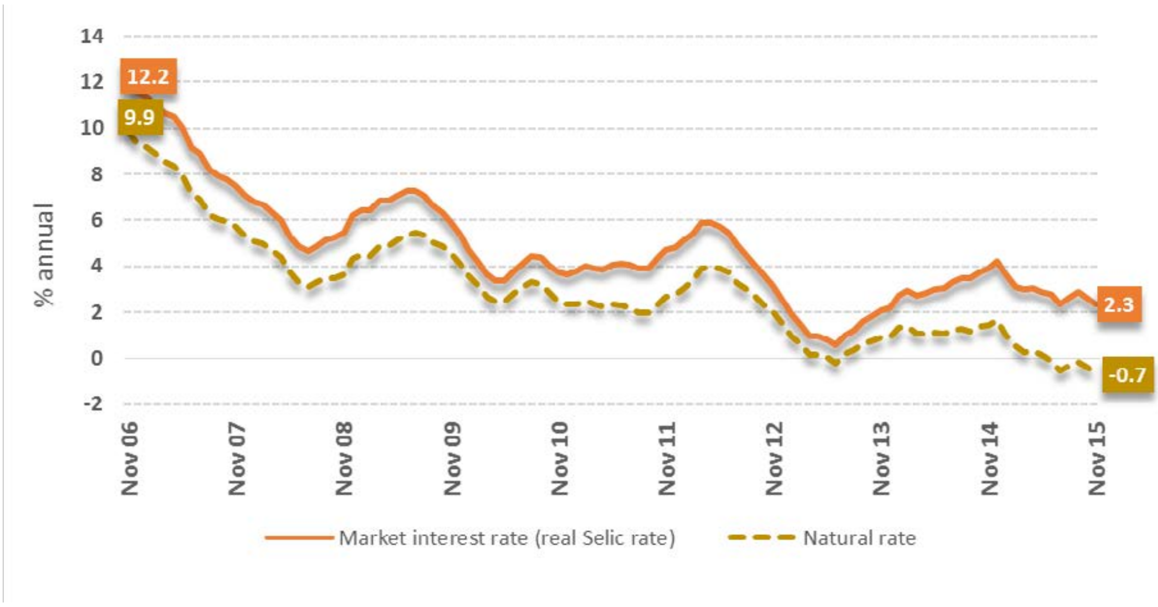
In Brazil, a growing portion of credit is extended through "directed" channels, such as state-owned banks, and receives some sort of subsidy. This type of credit reached 49.2% of overall credit as of November 2015 (Graph 5). Directed credit is much less responsive to monetary policy.

Earmarked Credit/Total Credit Graph 5

Source: BCB.

Regarding the role of directed and subsidised credit, policy lending rates also affect the composition of the economy's "natural" rate, in the sense given by Wicksell. I would argue that the policy equivalent of the natural rate in Brazil is a weighted average of the Selic monetary policy rate and the many other policy rates. Graph 6 offers a rough estimate of what the real policy rate has been in Brazil by showing a weighted average of the Selic rate and the TJLP lending rate used by the Brazilian Development Bank (BNDES), with the weights being the share of directed versus market-set, or "free" credit, discounted by CPI. The graph also shows the real level of the Selic rate for comparison purposes. Despite the recent monetary policy tightening cycle and adjustments to the TJLP, the recent inflation surge has pushed this ex post weighted average real rate into negative territory.

Selic rate and "natural" rate of interest — Graph 6



Note: Twelve-month cumulative, ex post.

Deflated by IPCA.

Source: Central Bank of Brazil.

As in the case of mandated wage indexation, whatever its merits as a tool of industrial policy, directed credit poses problems for the transmission and efficacy of monetary policy through the credit channel, and by forcing the policy-set Selic nominal rate to be, generally speaking, higher to compensate for lower levels of the many policy rates.

7. Brazilian inflation: a combination of factors

What is the combined impact of these factors? First, some of the structural features of the economy naturally propagate exogenous shocks, which affects the volatility of inflation. More volatile inflation leads to more volatility in the policy rate, and all this can contribute to a higher level of the "neutral" real rate because of the demand for a risk premium. Other factors seem to diminish the potency of monetary policy through a variety of channels, especially the credit channel. Others generate higher levels of inflation inertia and increase the incentive to index prices and wages.

8. Conclusion

Addressing all these factors can and should be topics of debate and policy. It is important when addressing some of these issues to realise that changes to make monetary policy more effective do not necessarily have to come at the cost of other policy objectives. For example, financial support for industrial policy goals could come through tax grants instead of loans at subsidised policy rates. In many cases, what may cause problems for monetary policy and inflation outcomes is not the policies themselves, but the way they are implemented. We do not have to sacrifice monetary policy goals to achieve other policy ends.

One final point: none of the above factors impedes the proper functioning of the present inflation targeting regime. The Central Bank of Brazil still has all the necessary tools to deliver inflation at its target. Nonetheless, these factors do make inflation control more difficult and generate costs to society by causing inflation and interest rates to be, in general, higher and more volatile than necessary.

The evolution of inflation in Chile since 2000

Alberto Naudon[1] and Joaquín Vial[2]

Abstract

We analyse the evolution of inflation in Chile over the last decade and a half through the lenses of the new keynesian theory. We do this first by reviewing the evidence relating to the main channels put forward by this framework: the output gap, inflation expectations, indexation to past inflation and the exchange rate. Based on the evidence gathered, we provide an interpretation of the inflation process in Chile. We show that in general terms the evolution of inflation can be explained consistently by the evolution of those elements. Critical to our finding is a differentiation of the dynamics of goods and services inflation.

Keywords: Monetary policy, inflation, Central Bank of Chile, Chile

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1. Introduction

We analyse the evolution of inflation in Chile over the last decade and a half through the lenses of the new keynesian theory. We do this first by reviewing the evidence relating to the main channels put forward by this framework: the output gap, inflation expectations, indexation to past inflation and the exchange rate. Based on this evidence, we then provide an interpretation of the inflation process in Chile. We show that, in general terms, the evolution of inflation can be explained consistently by the evolution of those elements. Critical to our findings is a differentiation of the dynamics of goods and services inflation.

The period analysed coincides with the implementation by Chile of a full-fledged inflation targeting (IT) framework, including a free floating exchange rate and the use of the short-term nominal interest rate as sole monetary policy instrument. The IT framework's objective is to target an inflation rate of 3%, allowing for temporary deviations within a band of ±1% around the target. In practice, this means that the Central Bank of Chile (CBC) sets the interest rate in a way that is consistent with an inflation forecast of 3% two years ahead. The period is also interesting because it covers two significant developments for the global economy: the beginning and the end of the so-called supercycle of commodity prices, and the Great Financial Crisis (GFC) of 2008–2009 and its aftermath.

We begin in Section 2 with a description of the data showing the evolution of Chilean inflation and it main determinants. In Section 3, we briefly review the econometric evidence relating to the Phillips curve and, more generally, to the importance of the output gap, the exchange rate and inflation expectations for the inflation process. In Section 4, we follow up on our analysis by providing an interpretationof the evolution of inflation through the lenses of the evidence presented in the previous sections.

2. Evolution of inflation and its determinants since 2000

During most of the 20th century, Chile's economic history, as was the case in several other South American countries, was marked by high and volatile inflation as well as failed attempts to control inflation. The reasons behind those failures are still open to debate but the fact is that until the second half of the 1990s it is difficult to find periods of one-digit inflation. [3] Things changed noticeably afterwards. During the past twenty years, annual inflation has not been above 10% for even a single month, and most of the time it has been close to the central bank's target. There are two fundamental changes behind this remarkable improvement. First, a coherent fiscal policy was introduced in the late 1970s. It eradicated systematic public sector deficits and, with the implementation of increasingly sophisticated fiscal rules, it aligned fiscal

3 An example of this debate was the intense discussion that took place during a workshop organised by the Central Bank of Chile and the Becker Friedman Institute for Research in Economics in December 2015. On that occasion, a group of Chilean economists were invited to discuss the chapter on Chile of the forthcoming book by Timothy Kehoe and Thomas Sargent on fiscal and monetary policy in Latin America.

expenditures with medium-term macroeconomic targets. This significantly reduced the procyclical behaviour of fiscal policy , in particular that linked to copper prices.[4] The second element was the independence granted to the CBC in 1989 coupled with a clear mandate to keep inflation low and stable. Starting in 1990, the CBC implemented this mandate by setting a numerical target for inflation. The experience was highly successful and, over a period of ten years, the annual inflation rate was reduced from above 20% to around 3% in a context of strong growth and low unemployment.[5] In 2000, the board of the CBC considered that the economy had reached a sufficient degree of maturity to implement a full-fledged IT regime, including a freely floating exchange rate and the use of the short-term nominal interest rate as sole monetary policy instrument.[6] This change, supported by the fiscal policies described above, has been a key policy ingredient in dealing with the Chilean business cycle. In this Section, we describe the evolution of inflation and other relevant macroeconomic variables since the implementation of the IT regime in 2000.

Inflation

As shown in Table 1, since the implementation of IT, the inflation rate has stood on average at 3.3%, which has been slightly above the official target of 3%. Hidden behind this average, however, is an important degree of variability: during the last 15 years inflation has ranged between –2.3% and 9.9% with a standard deviation of 2.1%. Compared with inflation in Advanced Economies (AEs), inflation in Chile is more volatile (see Graph 1). Nevertheless, as shown by the same graph, high volatility of inflation is a common phenomenon in emerging market economies (EMEs). However, when compared with this group of economies, inflation in Chile ranks among the least volatile.

Graph 2 shows the evolution of inflation since 2000. It is evident from this graph that the period between mid-2007 and 2010 was one of particularly high volatility. This is not surprising given that those years were initially characterised by a significant increase in international commodity prices and then by an economic contraction during the GFC of 2008–2009. That said, even if one took those years out of the sample, it would still be true that inflation had fluctuated significantly, ranging between –1% and 6%.

4 From the early 1990s to the second half of the 2000s, gross public debt in Chile declined from 38% of GDP to less than 10%. It now stands at about 17% of GDP. For a more detailed analysis of Chilean fiscal policy during that period, see Arellano (2005).

5 On the reduction of inflation in Chile see, for example, Corbo (1998), and Schmidt-Hebbel and Tapia (2002).

6 The severe recession of 1999, which followed the financial tensions created by attempts to limit the depreciation of the peso during the last phase of the Asian financial crisis, played a key role in convincing the Chilean authorities of the need to move to a freely floating exchange rate regime.

Summary statistics of inflation for the period 2000–2015

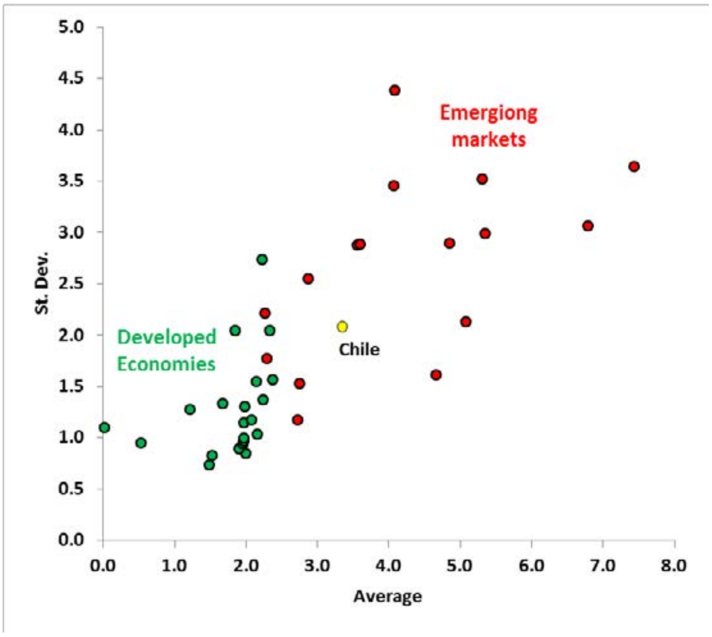
(%) Table 1

	Headline	Core	Goods (core)	Services (core)	Food	Energy
Average	3.3	2.5	–0.2	4.3	4.8	7.0
Median	3.2	2.5	–0.1	4.4	4.3	7.6
Std dev	2.1	1.5	2.3	1.5	5.1	9.5
Max	9.9	7.0	4.9	8.6	20.8	33.5
Min	–2.3	–1.6	–6.1	0.2	–3.0	–18.1

Note: Monthly data from M1 2000 to M11 2015. Core inflation excludes food and energy items, and represents 72.2% of the total of the latest CPI basket. Good (core) and service (core) represent 28.6% and 43.6% of the total, respectively. Food and energy represent 19.1% and 8.7%, respectively.

Inflation: average and volatility

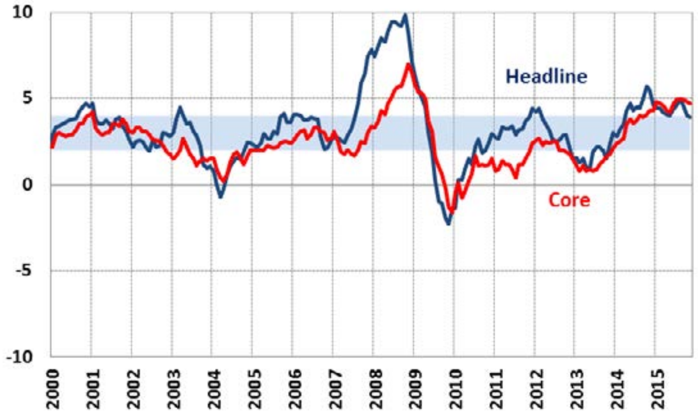
(%) Graph 1



Note: The sample comprises monthly data from M1 2000 to M 11 2015. Advanced economies includes: Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States. Emerging market economies includes: Chile, China, Colombia, Czech Republic, Estonia, Hungary, Iceland, India, Indonesia, Korea, Latvia, Mexico, Peru, Poland, Slovak Republic, Slovenia and South Africa.

Annual headline and core inflation

(%) Graph 2



Note: Monthly data from M1 2000 to M11 2015. Core inflation excludes food and energy items, and represents 72.2% of the total of the latest CPI basket.

Contribution to variance of inflation

(%) Table 2

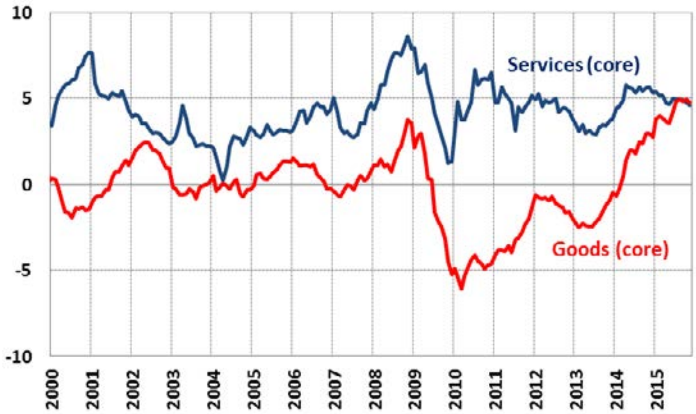
	Core	Goods (Core)	Services (Core)	Food	Energy
Share of variance	50.3	27.6	22.8	40.5	9.2
Share of CPI basket	72.3	28.6	43.6	19.1	8.7

Note: Monthly data from M1 2000 to M11 2015. The contribution reflects the fact that if $y = \sum x_i$, then $Var(y) = \sum Cov(y, x_i)$. The share of the variance is equal to COV (π_{CPI}, π_X)/ V(π_{CPI}) where X is the incidence of the element X on CPI inflation. The share of the CPI basket is the same as in the 2013 basket.

Part of the variance is explained by the presence of highly volatile items in the CPI basket, such as food and energy. Indeed, as shown in Table 1, the standard deviation of these items is two and four times the standard deviation of the headline inflation rate. Table 2 shows the contribution to the variance of the headline inflation rate of four different sets of CPI items. It makes it clear that the contributions of food and energy items to the variance of inflation are larger than their respective shares in the CPI basket. Food, for example, contributes to 40% of the variance with an index weight of only 20%.

Annual goods and services inflation

(%) Graph 3



Note: Monthly data from M1 2000 to M11 2015. Good (core) and Service (core) represent 28.6% and 43.6% of the CPI basket respectively.

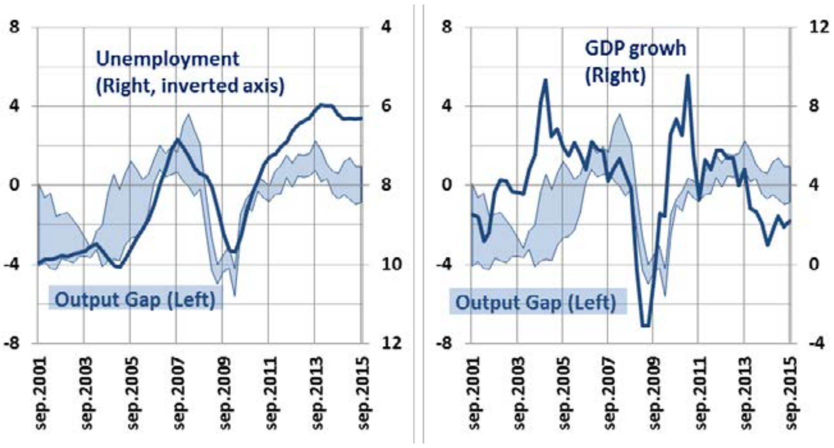
To better understand the dynamics of core and headline inflation, it is important to distinguish between the behaviour of tradable and non-tradable items within core inflation. This separation is to some extent arbitrary since in every item of the CPI basket there are tradable and non-tradable components. In addition, it must be kept in mind that non-core inflation comprises mainly tradable goods (energy and foodstuffs). Nonetheless, especially in a small open economy, the determinants of inflation for each of these items could vary quite significantly. In particular, non-tradable items are more strongly driven by domestic developments and more closely related to excess or deficient demand. On the other hand, tradable items are more strongly exposed to foreign competition and so to international prices and to the evolution of the exchange rate. In practice, in Chile as well as in other small open economies tradables are made up mainly of goods while non-tradables comprise mostly services. Bearing this in mind, we separate core items in these two broad groups. In terms of the share of CPI, these groups represent 28.6% and 43.6%, respectively, of the headline CPI index (and 40% and 60% of the core CPI index).

The behaviour of inflation for both goods and services is shown in Graph 3. It is evident that they have very different patterns, with both series cycling around their own averages but with quite dissimilar means. In particular, since the introduction of IT, the average inflation for core services, our proxy for non-tradables, has been 4.3% compared with only –0.2% for core goods (see Table 1). Services inflation is also less volatile than goods inflation, as shown in Table 2, and although the weight of services in the CPI basket is one and a half times the weight of goods its contribution to headline inflation is basically the same.[7]

[7] The behaviour of the relative prices of tradable and non-tradable goods in Chile is not different from that observed in other countries. See, for example, Jacobs and Williams (2014) who report a similar behaviour for Australia, Steenkamp (2013) for New Zealand, Coto-Martinez and Reboredo (2014) for several OECD countries, and Altissimo et al (2011) for a number of euro area countries.

Output gap, unemployment rate and GDP growth

(%) Graph 4



Note: Quarterly data from Q1 2000 to Q3 2015.

The output gap

The output gap is probably the most frequently mentioned determinant of inflation. However, in practice its role is subject to a large degree of uncertainty because it is very difficult to measure in real time. There are two main problems. First, GDP data are routinely revised as new or better information comes in. Second, as time passes by and new data are added, they frequently alter – often significantly – the performance of the filters commonly used to compute the output gap. This problem is sometimes called "the end-of-sample bias". As shown by Orphanides (2002), Borio et al (2014) and other authors, the second problem makes a major difference in the estimated output gap and creates much uncertainty for the real time appraisal of it. .

At the CBC, we deal with those problems by having recourse to three output gap models that take into consideration different pieces of information. The first model combines a standard Hodrick-Prescott (HP) filter with an IS curve and a new keynesian Philips curve (NKPC). The second model, by using a more general formulation of the trend, information from the labour market and forecasts of the other main variables is design to reduce the end-of-sample bias. Finally, we also run a structural vector autoregression (SVAR) model designed to identify short- and long-run shocks to output. As pointed out by Orphanides (2002), such corrections do not solve the problem entirely but our analysis suggests that they help reduce the bias.[8] In any case, in the end monetary policy decisions take into consideration the results of these models as well as a number of other factors such as the evolution of expectations, and actual and expected current account balances (as indicators of the domestic expenditure gap), estimated using nominal and "long-term equilibrium prices for copper and oil.

The light blue area in both panels of Graph 4 depicts the range within which estimates of the output gap have evolved since 2000. The blue line represents the unemployment rate (inverted axis) in panel (a) and annual GDP growth in panel (b). It

8 See CBC (2015b).

is possible to identify five periods. The aftermath of the Asian financial crisis, during the early part of the 2000s, is characterised by a negative output gap, a high rate of unemployment and a low rate of growth. Next, the four years that preceded the GFC of 2008–2009 were marked by a remarkable recovery of growth and a reduction of the unemployment rate that made the output gap swing from around –3% to over 3%. This outstanding performance coincided with the beginning of the 'supercycle' of commodity prices. This 'supercycle' had long-lasting effects on the Chilean economy, especially through a delayed increase of investment in the mining sector. The effects of the GFC determined the evolution of the output gap during the period running from 2008 to 2010. However, in clear contrast with the Asian financial crisis, a combination of good macroeconomic management and a strong upsurge in copper prices led to a fast recovery of activity, which very quickly pushed the output gap back into positive territory. Finally, since mid-2013 we have seen a period of slower growth but persistently low unemployment. Even though this combination of weaker economic activity and low unemployment is somewhat puzzling, we think that it is consistent with a decline in potential output, which was partly hidden by the effects of the commodity price boom[9] and some degree of labour hoarding in periods of deceleration.[10] At any rate, we think that, in spite of the low rate of growth, the output gap was only slightly negative.[11]

The exchange rate

In small open economies such as Chile, a large share of the goods that are consumed (around 40%), as well as many intermediate goods, are imported. The retail prices of those goods are strongly correlated with the evolution of international prices and the exchange rate. Many locally produced goods also face competition from abroad which means that their prices are correlated with international prices. Empirical evidence suggests that the international price of goods and the exchange rate play an important role. However the evolution of the latter is particularly relevant when prices are invoiced in dollars, which is a common feature of EMEs (Gopinath (2015)).

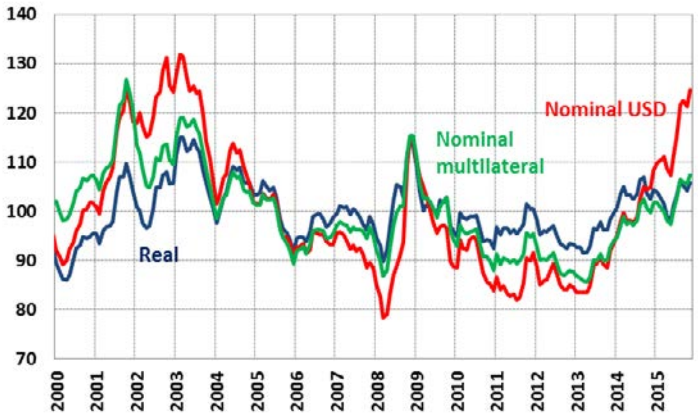
9 See CBC (2015a).

10 The idea of "labour hoarding" is an old one in economics. It posits that because it is costly for firms to adjust employment, they will respond to short-run fluctuations in the demand for goods by changing the degree of effort required from workers. See, for example, Burnside et al (1993) and Sbordone (1996). Meza and Quintin (2007) study the behaviour of several Latin American and Asian economies during the Mexican Tequila crisis of 1994–1995, and report that labour hoarding may have accounted for much of the behaviour of working hours during this episode.

11 See CBC (2015c) for a discussion of the evolution of different measures of economic slack during the last cycle.

Nominal and real exchange rates

(Period average = 100) Graph 5



Note: Monthly data from M1 2000 to M11 2015.

Graph 5 shows the evolution of the nominal value of the peso against the US dollar, the multilateral nominal exchange rate and the real exchange rate. The last two are trade-based weighted averages, deflated by the CPI in the case of the latter. The co-movement between the three rates is evident but in periods characterised by a global appreciation of the US dollar, such as in the early 2000s and in the recent past, the simple nominal rate tends to move faster than both of its multilateral and real counterparts. What is remarkable is that, since Chile adopted a free floating exchange rate,the real exchange rate was very stable despite this was a period characterised by wide swings in commodity prices and capital flows. With the exception of a few brief episodes, the real exchange rate fluctuated within a relatively narrow band of 10%.

In line with our discussion of the output gap, it is possible to distinguish five periods of exchange rate movement[12]: a pronounced depreciation of the peso related to a large extent to a strengthening of the US dollar during the early 2000s; an intense real and nominal appreciation that started in around 2003 and was strongly related to the beginning of the supercycle of commodity prices; a sharp but short lived depreciation as a consequence of the GFC; a new period of appreciation associated with a recovery in copper prices and the increase in global liquidity; and finally a notable period of depreciation linked to the first signals of a reversal of monetary policy in the United States in mid-2013.

Inflation expectations

Graph 6 shows the evolution of inflation expectations one and two-year ahead. The numbers are taken from the Survey of Economic Analysts.[13] Given that in our IT framework policy is operationalised by targeting a two-year-ahead inflation forecast of 3%, the two-year-ahead inflation expectations are a closely watched indicator of

[12] Indeed, the correlation between both the real and the nominal exchange rate, and the output gap is large, ranging between –0.3 and –0.6.

[13] Results were similar when using inflation expectations derived from financial market prices.

policy.[14] As shown by the red line in Graph 5 and by Table 3, during the past 172 months (the period covered by this survey) this indicator has been exactly at 3% for 85% of the time, and above 3.5% for only 1.7% of the time. So far it has never been outside the established range of 2% to 4%, not even in late 2008, when headline inflation reached close to 10%. This outcome has been achieved in spite of very volatile one-year-ahead inflation expectations, which reflected, as mentioned in Section 2, the volatile nature of inflation in Chile

The fact that one-year-ahead inflation expectations have been fairly volatile, but that two–year-ahead inflation expectations have not been, is commonly taken to reflect the credibility enjoyed by the CBC with respect to its commitment and ability to bring inflation back to target. If this is the case, shocks that affect inflation should be viewed as transitory and should therefore not influence long-term inflation expectations. The anchoring of inflation expectations since the introduction of the IT regime has been highlighted in various studies[15] and is a central piece of the CBC's monetary policy strategy. This allows the CBC to respond with flexibility when it thinks that shocks are transitory. However, the experience of 2008 (more on this in Section 4) shows that credibility is not something that should be taken for granted. Indeed, risks to credibility arise in periods when inflation is far from its target or when it remains beyond its band for an extended period of time.

Inflation expectations one and two years ahead — Graph 6

Note: Monthly data from M9 2001 to M12 2015.

[14] For this purpose, we computed different measures of expected inflation that are implicit in financial asset prices. We also used other surveys.

[15] See, for example, De Pooter et al (2014), Rusticelli et al (2015) and Davis (2014).

Inflation expectations one and two years ahead		Table 3
	One year ahead	Two years ahead
Average	3.1	3.0
Std dev	0.6	0.1
Max	6.0	3.9
Min	2.0	2.8
% of time at 3%	28.5	84.9
% of time out of [2.5%–3.5%]	20.3	1.7
% of time out of [2%–4%]	5.2	0

Note: Monthly data from M9 2001 to M12 2015.

3. Determinants of inflation

In this Section, we present evidence relating to the main determinants of inflation in Chile. Our discussion is informed by a small open economy version of the NKPC. [16] In this context, the dynamics of inflation are related to the evolution of the output gap, the exchange rate, inflation expectations, past inflation and the price of foreign goods. More formally, the relationship among these variables and current inflation is usually described by an equation of the following type:

$$\pi_t = \rho E_t \pi_{t+1} + (1-\rho)\pi_{t-1} + \beta x_t + \alpha \Delta q_t + \varepsilon_t,$$

Where π is the inflation rate, x represents the output gap, q is the real exchange rate (or something related to the relative prices of foreign goods) and ε is a residual term. In this equation, ρ is a parameter showing how forward-looking expectations influence the inflation process; β represents the slope of the NKPC; and α describes the degree of exchange rate pass-through (ERPT) typically associated with the openness of an economy.

As noted by Mavroeidis et al (2014) in their extensive review of the literature, the estimation of this kind of equation is subject to great uncertainty because "seemingly innocuous specification changes lead to big differences in point estimates." (p. 172). In particular, the pervasive problem of weak instruments led these authors to conclude that, at least using macro data, it was not possible to get reasonable assurance regarding the value of those parameters. This, of course, does not imply that the NKPC is not valid or relevant since there are good theoretical arguments behind this formulation. However, it is difficult to pin down the exact parameters. With this in mind, we do not attempt to conduct new estimations but we present the

[16] As derived, for example, in Galí and Monacelli (2005). See also Razin and Yuen (2002), and Mihailov et al (2011), In the case of Chile, there is large literature supporting NKPC models; see, for example, various studies conducted by current or ex CBC researchers, including Medina and Soto (2007), Caputo et al (2007) and Caputo (2009).

main conclusions of several studies already published for Chile within this framework.[17]

Output gap

Different estimations of the NKPC for the case of Chile show that the output gap has a positive and statistically significant effect on inflation but that this effect is relatively small.[18] This conclusion is not different from that reached for other countries. More precisely, the coefficient β is typically somewhat below 0.2, meaning that, keeping everything else constant, a 1% increase in the output gap implies a less than 0.2% increase in (annualised) quarterly inflation.[19] Of course, this does not mean that the output gap is not important for inflation since what matters is the present value of all future output gaps. If changes in the output gap were persistent, the overall impact could be much larger.

Noticeably, there is evidence showing that the NKPC is now flatter than in the 1990s,[20] which is in line with what has been found in several other countries.[21] These changes are typically attributed to gains in central bank credibility.

Exchange rate

In any small open economy, especially if its production structure is more concentrated in commodities, an important share of consumption goods is produced abroad or faces a significant degree of competition from foreign producers. In this context, it is not surprising that the exchange rate plays a major role in the dynamics of inflation. What is surprising, however, is that many studies of the NKPC in Chile have not explicitly considered the role of the exchange rate. The CBC, by contrast, attaches great importance to exchange rate considerations and so it plays a central role in our models. In particular, models used at the central bank are consistent with an ERPT of around 0.1%–0.2% a year. As shown in Albagli et al (2015), this number is high when compared with AEs but not that different from coefficients founds in other EMEs.[22]

17 The most comprehensive analysis is contained in Cespedes et al (2005). See also Pincheira and Rubio (2015), and Caputo (2009). The CBC redid much of those estimations and the main results remained valid.

18 It is possible that problems with the measurement of the output gap could be behind those small coefficients. After all, if one were using an incorrectly measured output gap, it would make sense for it not to appear very significant. However, it is important to note that studies that have used a real time ex post output gap have typically coincided in finding low output gap elasticities.

19 Mavroeidis et al (2014) report that most common numbers for AEs are even lower than this. Moreover, they show that, depending on the set of instruments, it is possible to find numbers that range from negative to positive values.

20 See Cespedes et al (2005) and Morandé and Tejeda (2008).

21 See Simon et al (2013).

22 In Albagli et al (2015), the authors analyse a sample of 48 AEs and EMEs and show that the pass-through is typically higher in the latter, and that within the group of EMEs Chile has a high level of pass-through. Indeed, they claim that the higher pass-through of Latin American countries, coupled with the sharp exchange rate depreciations associated with the end of the commodity price boom, could explain why this region has faced higher levels of inflation than other regions of the world.

Justel and Sansone (2015) used Chilean data from 1987 to 2013 to analyse the degree of ERPT to disaggregated CPI data: domestic energy, food and core consumer prices. They found that the ERPT to headline and core inflation was around 15% and 10% a year, respectively, for headline and core CPI. In both inflation measures, the effect of exchange rate movements took three to four quarters to fully take effect. Regarding the evolution of the ERPT, they found that it had decreased since the establishment of the IT regime and had remained fairly stable afterwards. They also reported a significant effect of changes in the exchange rate on food and energy prices, with an ERPT of close to 10% and 50%, respectively.

Bertinatto and Saravia (2015) analysed possible asymmetries in the ERPT. They reported that the ERPT depended on how persistent the exchange rate movement was and also on its direction. In particular, they found that the ERPT had been larger for devaluations than for appreciations of the peso,[23] and that the ERPT was larger the more persistent was the exchange rate change. The authors failed to find a significant relationship between the level of ERPT and the output gap but they also noted that this result should be taken with care. In fact, even though there is no consensus in the literature about the importance of the output gap for the ERPT, several studies have previously found a positive relationship. For example, in a study of 12 euro area countries, Ben Cheikh (2013) found that the ERPT to CPI inflation depended positively on economic activity. In particular, when real GDP was growing above some threshold, the ERPT became larger. Similar results were reported by Goldfajn and Werlang (2000), and Brun-Aguerre et al (2012).

Of course, the degree of ERPT varies considerably across goods given that: (i) different amounts of local service inputs are added to prices; (ii) in some cases it is possible for consumers to switch from imported goods to lower-quality local substitutes; and (iii) there are also differences in the amount of intermediate foreign goods used in the production of local goods.[24]

In the case of Chile, Álvarez et al (2008) used monthly disaggregated import prices to show that such prices at the border and wholesale levels presented a high degree of long-run ERPT; that the ERPT had not declined and that in the short-run wholesale prices seemed to be less sensitive to exchange rate variations. On the other hand, using monthly data for the period ranging from December 1998 to April 2007, and prices for 156 items corresponding to the CPI basket, Álvarez et al (2008) found that the food and transport components exhibited significant ERPT but with a high degree of heterogeneity within the various elements of each category. They also reported a small ERPT for the other categories of the CPI.

Past and future inflation

Evidence regarding inflation expectations shows that they are relevant, with a ρ coefficient of 0.5–0.6.[25] This means that the backward-looking component of the

[23] Similar results are reported in Delatte et al (2012).

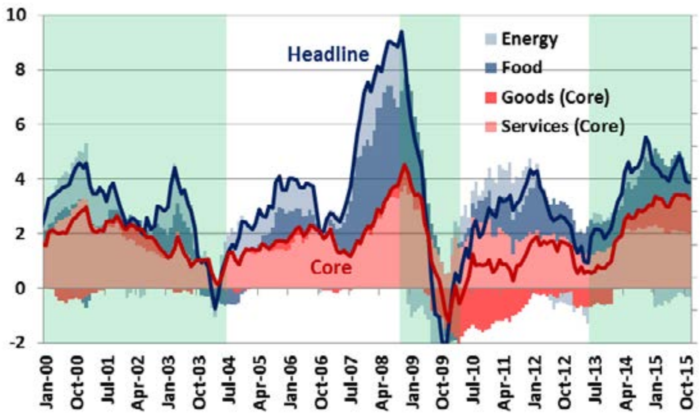
[24] See Burstein and Gopinath (2014) for a complete survey of the relation between local and foreign prices.

[25] It is difficult to determine the empirical relevance of inflation expectations for the current inflation rate. This is not only because of the identification problems discussed by Mavroeidis et al (2014) but also because a strong anchoring of inflation expectations leads to minimal movements in such expectations which makes it difficult to see how change in them could affect current inflation.

NKPC is still relevant and is, in fact, typically slightly above what is found in AEs (Cespedes et al (2005)). There is also evidence that inflation has become less persistent than in the 1990s, a phenomena that has been associated with the implementation of the IT regime and related gains in central bank credibility (Simon et al (2013)).

Inflation and its components

(%) Graph 7



Note: Monthly data from M9 2001 to M 12 2015. Core inflation (red line) represents 72.2% of the total in CPI (2013 basket). It comprises the sum of goods (core) and services (core), which account for 28.6% and 43.6% of total CPI, respectively. Food represents 19.1% and energy 8.7%.

Credibility has been also important in shaping the slope of the Phillips curve. According to several studies, the reduction in the ERPT, of price indexation and of the sensitivity of inflation to the output gap has been related to an increase in credibility (Cespedes et al (2005)), a result which is in line with the evidence for other economies.

Regarding past inflation, as discussed by Herrera and Valdés (2005), indexation has been a long practice in Chile and is still the norm for many contracts, including those setting wages, housing rentals and medium- and long-term credit (including mortgages).[26] Of course, it is less pervasive today than it was in the 1990s. In the case of wages, for example, CBC (2013) shows that, in the short run, between 15% and 35% of past inflation passes to wages, which is far below what it was in the past but still significant.

Finally, inflation expectations themselves are not independent of past inflation. In particular, the research at Central Bank of Chile found evidence that prolonged periods during which inflation was away from a range of 1% around the inflation target affected one-year-ahead inflation expectations. In particular, using a panel of 44 countries with some sort of inflation objective, it found that after 12 months out of a range of 1% around the inflation target, the sensitivity of one-year-ahead inflation expectations to past inflation ($\partial\pi_t/\partial\pi_{t-1}$) went up from 0.16 to 0.21, while the sensitivity to inflation surprises rose from –0.05 to 0.1.

[26] See also Jadresic (1998) and the references cited therein.

4. A view of the inflation process

Graph 7 depicts the evolution of headline inflation and the incidence of each of its components: goods, services, food and energy. The shaded areas divide the period under analysis into five different subperiods during which the direction of inflation changed. Table 4 provides numbers for average inflation in each of these subperiods and the values of several other macroeconomic variables.

The first subperiod covers the initial four years of the 2000s. During this time, headline inflation and, even more clearly, core inflation were on a decreasing path. Behind this behaviour was a sluggish economy fighting to recover from the Asian financial crisis and its aftermath, in addition to an external environment marked by unfavorable terms of trade (high oil and low copper prices) and adverse external financial conditions. In this context, unemployment remained high and the output gap became more negative on a quarter-by-quarter basis. This situation had an impact on non-tradables inflation, approximated in our analysis by the inflation rate for services, which went from above 7% at the end of 2000 to close to zero at the beginning of 2004.

The move to a freely floating exchange rate also played a role, helping the economy to absorb negative external shocks but creating upward pressure on inflation. Specifically, there was a significant depreciation of the peso in both nominal and real terms during the first period, in part as a response to a series of cuts in the Chilean policy rate (from 8.5% to 1.75%) in an environment of global appreciation of the US dollar. Although exchange rate movements put some pressure on inflation, especially on tradable items (such as food, energy and goods) the weak economy meant that inflation remained contained. While core inflation ended above 4% in 2000, it was below 1% by the beginning of 2004. Headline inflation was somewhat higher, because the price of oil increased appreciably in response to conflict in the Middle East, including the Iraq war of 2003.

At the end of this period, the price of copper started to rise and the 'supercycle' of commodity prices changed the course of the Chilean economy for the next decade. It is worth noting that, at the beginning, the change was viewed as a transitory phenomenon and, correspondingly, most of the extra government income was saved and there was no significant change in investment. The new fiscal rule played an important role in this respect since the savings that accrued were considered to be a counterpart to the deficits that allowed to maintain expenditure levels during the period of low copper prices. The fiscal balance went from –0.5% to 7.8% of GDP between 2003 and 2007.

However, as time passed by, both the government and private sector firms became convinced that high copper prices were there to stay. Consequently, internal demand increased, especially investment in the mining sector, helping to close the output gap and reducing unemployment. In particular, during the second period (Q2 2004 – Q3 2008), the output gap went from almost –3% at the beginning of 2004 to only –1% in 2005. By the end of this period (Q3 2008) it was 1.2%. Not surprisingly, non-tradables inflation climbed from 1.1% in Q2 2004 to 7.6% in Q3 2008 and nominal wage growth rose from around 3% to over 8%.[27]

[27] Of course, the rise in the prices of energy and other natural resources in imported inputs also played a role in the acceleration of inflation in the non-tradables sector.

Macroeconomic variables in selected subperiods

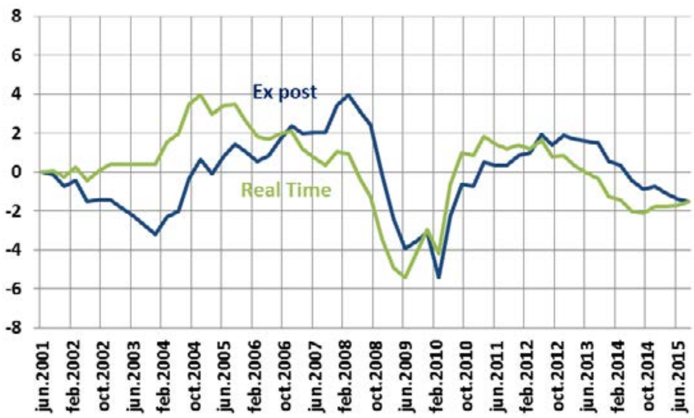
(%, average) Table 4

Panel (a): Inflation						
	Headline	Core	Goods (core)	Services (core)	Food	Energy
Q1 2000–Q1 2004	2.9	2.5	0.1	4.0	1.3	11.6
Q2 2004–Q3 2008	4.3	2.8	0.5	4.0	6.5	10.9
Q4 2008–Q1 2010	2.4	2.6	–0.8	5.0	5.8	–4.2
Q2 2010–Q2 2013	2.6	1.4	–2.8	4.6	5.8	5.2
Q3 2013–Q3 2015	3.9	3.6	2.0	4.8	6.7	0.8
Panel (b): Other macro variables						
	NER	RER	UR	Employment	GDP	Output gap
Q1 2000–Q12004	5.6	4.6	9.8	2.1	3.8	–2.4 [–1.4 ; –2.8]
Q2 2004–Q3 2008	–5.8	–1.5	8.5	2.9	5.8	0.1 [–2.9 ; 1.2]
Q4 2008–Q1 2010	8.6	1.8	8.7	0.5	–0.3	–3.5 [–1.1 ; –5.1]
Q2 2010–Q2 2013	–3.2	–1.9	7.4	4.4	5.8	0.1 [–2.1 ; 1.1]
Q3 2013–Q3 2015	13.2	4.4	6.2	1.7	2.4	0.4 [1.4 ; 0.2]

Note: Quarterly data from Q3 2001 to Q3 2015. All data are period averages. In the case of the output gap, the numbers in brackets are the values of the output gap at the beginning and end of each period.

Ex post and real time output gaps of non-natural resources sectors

(%) Gaph 8



Note: Monthly data from M9 2001to M12 2015. The output gap is computed using an HP filter with a lambda of 1600.

The boom in commodity prices was accompanied by two additional developments that affected inflation during this second period. First, a sharp nominal appreciation of the peso and, to a lower extent, a real appreciation that helped to keep goods inflation under control. Second, the price of copper skyrocketed along with the price of other goods, including food and oil. In this context, with the exception of a few months at the end of 2006, during which the price of oil dropped, plus a transitory slowdown in activity, inflation increased steadily and by the end of

2008 headline inflation had reached almost 10%. At this point, for the first time since the implementation of IT, inflation expectations two years ahead moved significantly above the 3% target, calling into question the capacity of the central bank in bringing inflation back to its target.

From Graph 7 it is apparent that the surprise surge in the price of food was an important part of the escalation of inflation. However, core inflation (ie excluding food items) was also increasing at a fast rate. Indeed, between mid-2007 and the end of 2008 core inflation went from 1.9% to 6.6%. Looking back, it is not very difficult to explain this behavior: most of the determinants of inflation were tilting up, including the output gap which was at its highest level in years and increasing. The strengthening of the peso was helping, but the CBC decided to intervene by buying dollars in an attempt to curb what was seen as a too appreciated currency. (it was also a good opportunity to increase international reserves). Finally, actual and expected inflation started climbing very fast.

With the information at hand at the time, things looked somewhat different. In fact, this episode is a good example of the limitations of real time data. To begin with, computations of the output gap conducted with data to 2007 show that the economy had more economic slack than computations done with later data. This point is shown in Graph 8, where we computed the real-time and the ex-post output gaps for the non-natural resources sectors, a measure of GDP that is more closely related to inflation. One can clearly see from the graph the end-of-sample problem discussed in the previous Section. For 2007 and the initial part of 2008, the real time measure indicates a gap that is close to zero. After incorporating data until 2015, computation of the gap shows that it was between 2% and 4%, which is a considerable difference. Second, it was reasonable to expect a more important effect of the appreciation of the peso because the ERPT in the 1990s was much higher. Finally, the magnitude and persistence of the increase in the international prices of agricultural commodities came as a surprise. These considerations highlight the importance of keeping in mind the limitations imposed by the data and the difficulty in interpreting them when conducting monetary policy.

By the second part of 2007, the central bank initiated a contractionary monetary policy and during the next year and a half it raised the monetary policy rate (MPR) from 5% to 8.25%. However, inflation proved to be very stubborn and the MPR remained below the annual inflation rate throughout this period. In a worrisome development, by September 2008 the MPR had been increased by 300 bp but inflation expectations two years ahead measured at that time reached 3.9%, the highest level ever.

The GFC changed the game. Unemployment increased to almost 11% in a few months and the output gap went back into negative territory within one quarter. In this context, non-tradable goods inflation declined from 8% to less than 2% by the end of 2009. Probably reflecting the dependence of current inflation on past inflation, inflation took a longer time than activity to react. The reduction in the price of oil and food inflation of zero helped too. The peso depreciated quite a bit at the beginning of the third period (Q4 2008 – Q1 2010), keeping goods inflation into positive territory during the last quarter of 2008 and the first half of 2009 but after the recession and the later appreciation of the peso goods inflation became negative. In this context, inflation reached –2% by the end of 2009. A mix of good policies and good luck quickly put the economy back on track.[28] Monetary and fiscal policies were highly countercyclical; with a MPR that went from 8.25% to 0.5% in just seven months and a fiscal deficit that reached 4.4% of GDP. Good luck came in the form of a strong rebound in the price of copper (itself facilitated by the strong Chinese response to the crisis). Copper prices recovered from a minimum of around US$ 1.50 per pound to US$ 3.50 by April 2010. This convinced the government and the private sector that the supercycle was there to stay, propelling mining investment to record highs, which, in turn, reestablished internal demand growth. The output gap also recovered very fast, reaching positive numbers by the end of 2011. In this environment, non-tradable goods inflation recovered rapidly to around 5%, a level above its average of the first decade of the 2000s.

The years between 2010 and mid-2013, the fourth period,were also characterised by a weakness of the US dollar, which was in large part a consequence of the unprecedented expansiveness of US monetary policy and the persistence of high commodity prices. The associated appreciation of the peso pushed down the local price of tradable goods.[29]

Even though copper prices peaked in 2011, the international landscape began to change in mid-2013, the beginning of the fifth period, when the then Chairman of the Federal Reserve (Ben Bernanke) announced that US monetary policy was close to the beginning of a normalisation process. Even though it took a long time before the Federal Reserve actually increased the federal funds rate, the international financial environment for EMEs changed for worse. Additionally, China´s economy began to show signs of a moderation of growth and, consequently, the price of commodities declined. In the case of copper, as for several other industrial commodities, the expansion of supply resulting from the previous investment boom also played a role. In this context, growth in Chile shrunk significantly, coinciding with a major reduction in the investment plans of the large mining multinationals. At almost the same time, after more than a year with inflation (both headline and core) below the target band, the central bank began to signal a relaxation of policy. The first cut in the MPR came into effect on October 2013 and was followed by three additional cuts, for a total reduction of 100 bp by November 2014.

In this context, the nominal exchange rate depreciated by more than 45% with respect to mid-2013. This was one of the largest and most persistent periods of depreciation of the past 30 years. Not surprisingly, the effect on inflation was large. Tradable goods inflation was particularly notable, climbing from –2.5% to 5% between June 2013 and November 2015. The ERPT was a critical element in the evolution of inflation. Recent evidence suggests that it has remained within a range of values consistent with historic patterns but at the highest values within that range. This is also consistent with the empirical evidence discussed above since the ERPT tends to be larger when a depreciation is very persistent.

28 Bad luck also "helped". The earthquake of 2010 prompted the incoming government into further fiscal relaxation to facilitate reconstruction. Infrastructure under private concessions was insured and reconstruction was largely financed by foreign reinsurance companies.

29 Tradable goods inflation reached –6% in March 2010. It is difficult to explain such deflation by referring only to the behaviour of the exchange rate. In fact, there were measurement problems with the prices of some goods (for example, clothes) that introduced a downward bias to inflation during 2010. However, even after those problems were dealt with, goods inflation remained at a very low level (at an average of –2% between Mx 2011 and M6 2013.

In spite of the decline in growth, the output gap remained contained. Two factors explained this. First, by mid-2013 it was in positive territory. Second, potential growth had declined as the economy had become wealthier and productivity growth in natural resources-based sectors had slowed down or had even fallen (as in the case of mining). Our calculations show that Chile's medium-term growth stands at around 3.5%, which is considerably less than the 5% estimated at the beginning of the 2000s. On top of that, several shocks and the necessity to reallocate resources between sectors with the fall in commodity prices have temporarily dampened potential growth to a number closer to 3%. This is consistent with the labour market remaining relatively tight despite low growth, with an unemployment rate of around 6%, net job creation of around 2% and wage growth in the vicinity of 6%. In this context, it is not surprising that non-tradable goods inflation has not declined.[30]

These are difficult times for monetary policy in EMEs. The end of the commodity price boom and of the extraordinary supply of liquidity in the AEs have obliged Latin American countries to confront "reality" faster than previously expected. The impact of the reduction in the price of copper on the economy, on inflation in particular, has already been discussed. We end this Section with considerations relating to the possibility of pursuing an independent monetary policy in the context of rising US policy rates.

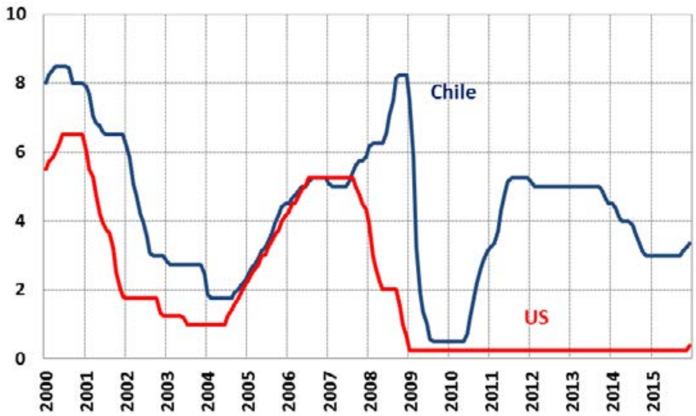
Theoretically, provided that the monetary authorities are willing to let the exchange rate move freely, foreign monetary policy should not impose constraints on the local central bank. In practice, the experience of Chile shows that this is possible, at least to some extent. Graph 9 shows the evolution of Chilean and US MPRs since 2000. From the graph it is clear that during the last eight years movement in both rates have not been closely correlated: when the MPR in the US started to decline after the onset of the GFC, the MPR was increasing in Chile to curb inflation. During 2009, the Chilean MPR was cut aggressively, but in contrast to what happened in the US, by mid-2010 the CBC started to increase local rates as the economy was on a clear path of economic recovery. Finally in 2013, a few months after the Chairman of the Federal Reserve talked about the beginning of policy normalisation in the United States, the MPR was cut in Chile to confront the slowdown related to the end of the supercycle of commodity prices. As mentioned before, the real exchange rate fluctuated within a narrow range during this period of policy divergence, with almost no central bank intervention in foreign exchange markets.

30 There is also evidence showing that the tighter the economy is, the larger the ERPT will be. This could have also played a role since, as mentioned before, the downward correction to the potential rate of growth implied a recognition that there was less slack in the economy. Actually, the ERPT has been somewhat above what was previously expected (and coincided with the revision of the numbers for potential growth).

Monetary policy rates

(%)

Graph 9



Note: Monthly data from M9 2001 to M12 2015.

The other side of the coin is, of course, the evolution of the nominal exchange rate, which in the case of Chile has shown important swings. Is this a reasonable course for monetary policy? In such matters one size definitely does not fit all, which means that it is not possible to make unconditional recommendations. The financial situation of different agents – including in particular the absence of large currency mismatches and a large pool of domestic savings managed by institutional investors – allows the central bank to let the exchange rate play its role of main shock absorber. The exchange rate is particularly important in an economy that requires significant changes in relative prices and where the degree of indexation to past inflation remains high.

Of course, monetary independence does not mean either a zero correlation with the foreign MPR or that international financial conditions are irrelevant. Regarding the first point, it is clear from Graph 9 that during the early 2000s there was a high degree of correlation between the US and Chilean MPRs. This is not unusual since during those years the business cycles in both economies were more or less in tune.

There has been a lot of debate in recent years regarding the second point.[31] Our view is that international financial conditions assume greater relevance in a more financial integrated world but that this situation does not eliminate the benefits of an independent monetary policy. In particular, there is convincing evidence that long-term interest rates in EMEs are affected by developments in international financial markets and that the monetary policy of the Federal Reserve plays a major role.[32] So local financial conditions clearly depend on what the Federal Reserve does. However, the idea that the local MPR has to react mechanically to changes in the US MPR is far from obvious. The best reaction to a movement in the fed funds rate will depend on the medium-term inflationary impact of that movement, and that movement, in turn, will depend on the many other elements shaping the economic landscape.

[31] See Rey (2015a), Rey (2016) and Obstfeld (2015).

[32] For instance, the Federal Reserve's monetary policy has an effect either through its impact on expected future short-term interest rates or on the term premium on long-term interest rates.

5. Concluding remarks

Over the past 10 years, the Chilean economy has been affected to a large extent by the boom in commodity prices and, after 2008, by the GFC and the policy response of advanced economies and China to that episode. The impact of those events on internal demand and relative prices has left a clear mark on the evolution of tradable and non-tradable goods inflation.

In this paper, we reviewed the evolution of the main determinants of inflation in Chile and the empirical evidence that links those variables to the dynamics of inflation. We show that, in spite of significant issues relating to the new keynesian framework, in particular about the ability to identify the elasticities of the Phillips curve, the empirical evidence relating to Chile is broadly consistent with the relevance of the determinants of inflation highlighted by this framework: the output gap, the exchange rate, inflation expectations and past inflation. In the case of Chile, distinguishing between the behaviour of tradable and non-tradable goods inflation is of particular importance.

Our account of the evolution of inflation in Chile shows consistently that periods of low activity, high unemployment and negative output gaps coincide with low levels of inflation, especially in non-tradable items.

The exchange rate matters as well. It is true that the exchange rate pass-through is lower today than it was in the 1990s. But it is still significant. Periods of changes in relative prices as well as terms of trade are typically accompanied by movements in the exchange rate. Changes in the exchange rate are transmitted to local prices, especially those of tradable goods, feeding back into other prices through indexation mechanisms, even though such a channel is less important than it was in the 1990s. Finally, expectations matters too. In the case of Chile, they have been well anchored most of the time, helping to keep inflation under control.

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An underlying inflation gauge (UIG) for China

The People's Bank of China

Abstract

Inflation in China is driven by volatile yet persistent changes in food and energy prices, making it difficult for policymakers and investors to gauge the underlying inflation trend. Traditional core inflation measures either neglect or down-weight the more volatile subcomponents of the CPI and thus risk excluding information that is helpful in gauging current and future trends in inflation. Therefore, economists at the PBoC and BIS have jointly explored and developed a novel underlying inflation gauge (UIG) for China, to complement the traditional core inflation measures. By extracting the persistent part of the common component in a broad data set of price and non-price variables, the UIG avoids the excess volatility reduction that plagues traditional core measures in China's case. Further, the UIG outperforms traditional core inflation measures in forecasting the headline CPI over different samples.

Keywords: Inflation, dynamic factor models, core inflation, monetary policy, forecasting, China

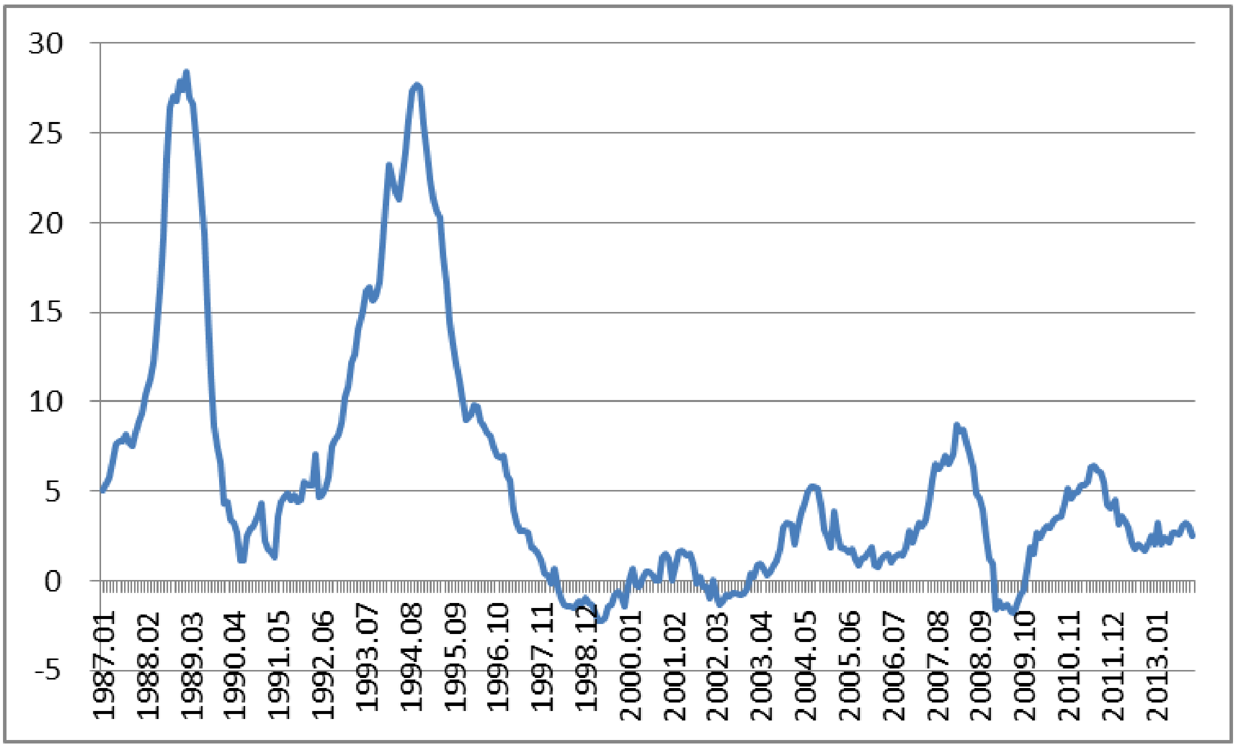
JEL classification: C13, C33, C43, E31, E37, G15

Inflation in China is driven by volatile yet persistent changes in food and energy prices, making it difficult for policymakers and investors to gauge the underlying inflation trend. Traditional core inflation measures either neglect or down-weight the more volatile subcomponents of the CPI and thus risk excluding information that is helpful in gauging current and future trends in inflation. Therefore, economists at the PBoC and BIS have jointly explored and developed a novel underlying inflation gauge (UIG) for China, to complement the traditional core inflation measures. By extracting the persistent part of the common component in a broad dataset of price and non-price variables, the UIG avoids the excess volatility reduction that plagues traditional core measures in China's case. Further, the UIG outperforms traditional core inflation measures in forecasting the headline CPI over different samples.

Chinese inflation dynamics

China's inflation has become lower and less volatile over the past two decades (Graph 1). Between 1987 and 2000, the mean and standard deviation of the monthly year-on-year inflation were 8.8% and 8.7%, respectively. During 2001 and June 2012, however, they dropped to 2.5% and 2.4%, respectively. In this latter period, the Chinese economy experienced three full "well behaved" inflation cycles. Inflation in these three post-2000 cycles was much lower and less volatile than the inflation cycles seen in the 1980s and 1990s. Moreover, China's post-2000 inflation dynamics appear to be more associated with domestic and external cyclical shocks and less related to liberalisation of administered prices.

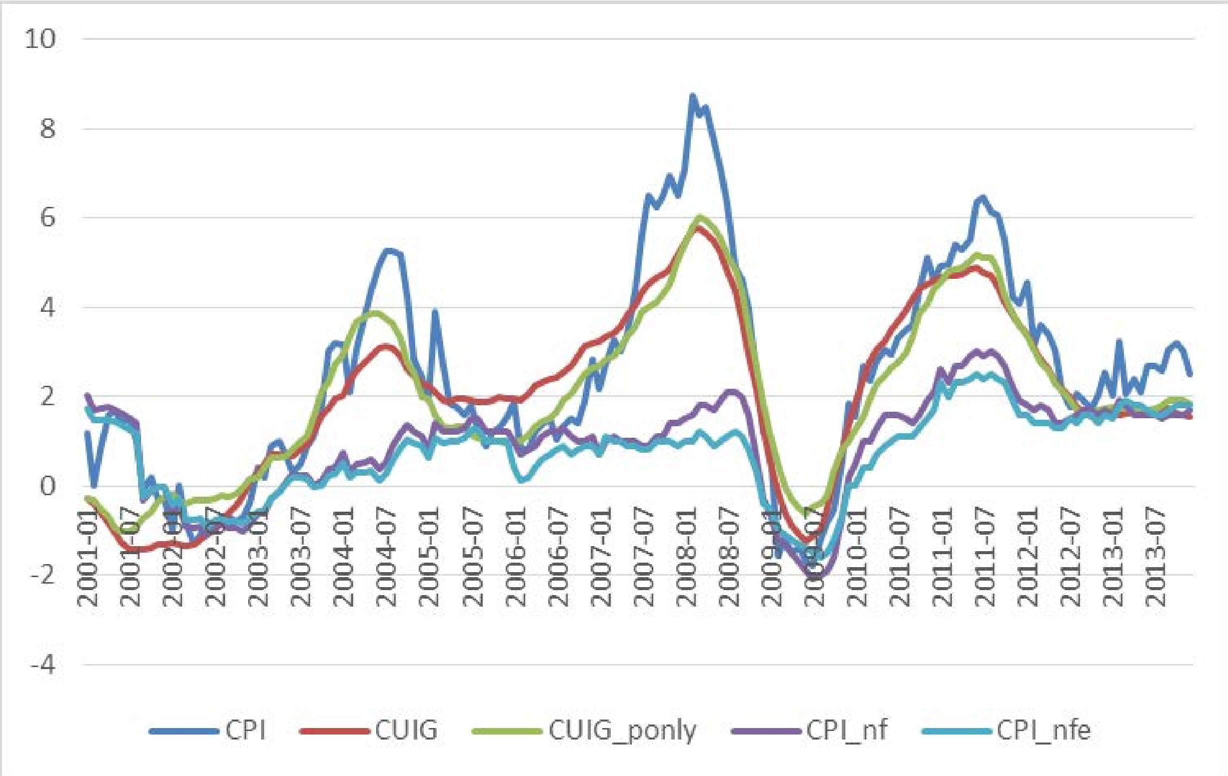
China's CPI inflation dynamics (1987–2013, monthly and year-on-year) Graph 1



Underlying trend in Chinese inflation

Current and prospective inflation matters a lot to monetary policymakers and market participants. Yet headline inflation can be excessively noisy, making it difficult to judge whether a sudden up or down move in the most recent CPI observation should be considered as temporary noise or a change in trend. This has led to the development of core inflation measures, which either fully exclude or down-weight volatile subcomponents of the CPI, such as energy and food prices. However, in the case of China, and in most other emerging markets, food and energy account for a heavy weighting and play an important role in inflation dynamics. Excluding these components may lead to an *excess volatility reduction*. As Graph 2 shows, from 2004 to 2008, China's official core inflation measures such as the CPI excluding food (CPI_nf) and the CPI excluding food and energy (CPI_nfe) stayed close to around 1%, while the CPI itself fell from 5% to 1% and then moved back up to 8%. After getting rid of these volatile but important components, the traditional core measures show little movement, and their usefulness in signalling changes in the CPI is thus limited.

Headline and core inflation measures and underlying inflation gauge for China Graph 2



Therefore, economists at the PBoC and BIS have jointly explored and constructed a novel underlying inflation gauge for China (Amstad, Ye and Ma (2014, 2015)). This "Underlying Inflation Gauge (UIG) for China" adds instead of discards information that potentially could be useful to gauge the trend of inflation. The UIG is essentially an indicator that summarises a broad data set of price, real activity and financial variables that potentially matter for future inflation but retains only the persistent part of such information. The data set starts in 2001, has a total of 473 variables and consists of five major categories: prices (48%), economic activity (35%), the labour market (9%), money and credit (8%), and the financial market (6%). As these variables are updated regularly and throughout the month, the UIG can also be updated regularly and intra-monthly. This feature is particularly useful in times of quick but persistent changes in inflation – the times when policymakers most need guidance. A version of the UIG based on a narrower data set of CPI subcomponents only (UIG_ponly) is also considered.

Technically, the UIG is an application of a dynamic factor model based on Forni et al (2000, 2005). The model summarises the lead and lag relationship of all included variables against inflation in the so-called common component. Stock and Watson (1999) have popularised dynamic factor models. The model type used for UIG retains only the persistent part in the common component, to assure a smooth and non-noisy signal.

This approach has already been applied at a number of the OECD central banks, such as Cristadoro et al (2001) for European inflation and Amstad and Fischer (2009) at the Swiss National Bank. An underlying inflation gauge for the United States has been calculated daily at the Federal Reserve of New York since 2005 (Amstad and Potter (2009), Amstad et al (2016)).

The UIG for China outperforms traditional inflation core measures on several matrices. While the UIG is highly correlated with and smoother than headline CPI inflation, it does not suffer from the excess volatility reduction when compared to core measures. As measured by standard deviation, its volatility of core measures is only 40–50% of that in the headline inflation, while the UIG retains 83% (Table 1). More importantly, the UIG forecasts headline inflation better than traditional core measures, with high statistical significance (Table 2). These results have been robust in classical forecasting exercises (horse races), over different sample horizons and across various partitions of the broad data set. Taken together, this illustrates that *a change in the UIG is not due to noise but can be interpreted as a signal that the underlying trend in inflation is changing*. So, while traditional core measures are easy to construct and communicate, it seems advantageous for policymakers to also follow the complementary UIG that could provide an early, non-noisy signal, especially when inflation dynamics are about to change.

Standard deviation

Sample: January 2001–December 2013 Table 1

	CPI	UIG	UIG_ponly	UCPI	CPI_nf	CPI_nfe
S.D.	2.34	1.95	1.81	1.47	1.12	0.95
Portion (%)	100%	83%	77%	63%	48%	40%

Note: S.D. is Standard Deviation. CPI_nf = CPI excluding food. CPI_nfe = CPI excluding food and energy. UIG_ponly = UIG using only price data. Source: Amstad et al (2014, 2015).

Forecasting performance

Table 2

	Forecasting full period 2006–13 (estimation period:2001–05)			Forecasting crisis period 2008–13 (estimation period:2001–07)		
	RMSE[1]	DM stat[2]	DM p-value[3]	RMSE[1]	DM stat[2]	DM p-value[3]
UIG	2.63	Na	na	2.83	Na	na
UIG_ponly	3.03	2.40	0.01	3.15	1.76	0.04
CPI_nf	3.43	2.70	0.00	3.33	2.91	0.00
CPI_nfe	3.29	1.88	0.03	3.10	1.18	0.12
UCPI	3.74	3.17	0.00	3.59	3.09	0.00
CPI_LAG12	4.11	3.41	0.00	4.28	2.59	0.00

[1] Root Mean Square Errors (RMSE). [2] Diebold-Mariano (DM) statistics. [3] Diebold-Mariano likelihood (DM p-value).

Note: CPI_nf = CPI excluding food. CPI_nfe = CPI excluding food and energy. UIG_ponly = UIG using only price data.

Source: Amstad et al (2014, 2015).

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Inflation expectations and a model-based core inflation measure in Colombia

Hernando Vargas-Herrera[1]

Abstract

Empirical evidence following conventional tests suggests that inflation expectations in Colombia might not be rational, although the period of disinflation included in the sample makes it difficult to verify this conclusion. Inflation expectations display close ties with observed past and present headline inflation and are affected by exogenous shocks in a possibly non-linear way. A model-based core inflation measure is computed that addresses the shortcomings of traditional exclusion measures when temporary supply shocks have widespread effects and are persistent.

Keywords: Inflation expectations, core inflation, supply shocks, monetary policy

JEL classification: E31, E37, E52

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1. Introduction

Since mid-2014, the external conditions of the Colombian economy have changed dramatically. With the sudden and sharp fall in oil prices, the country's terms of trade have rapidly deteriorated, while international financial conditions have tightened. As a result, the currency has experienced a strong depreciation, of around 60% in annual nominal terms. At the same time, weather-related shocks substantially increased food prices twice in 2015. The latest round of price rises is driven by an abnormally strong El Niño phenomenon that is causing an intense drought in the country that is affecting both food and (hydroelectric) energy prices. The coincidence of large currency and supply shocks has pushed CPI inflation beyond 6.5%, well above the 3% target.

This poses a big challenge to the monetary authorities, not only due to the concurrence of two large shocks, but also because, unlike in past depreciation episodes, a reversion of the Colombian peso (COP) to pre-shock values is highly improbable this time, as the currency adjustment follows a persistent and indefinite fall in international oil prices, as well as a long-lasting global liquidity retrenchment process. In contrast, weather-related relative food price shocks tend to be followed by large reversions produced, in part, by a "cobweb-like" behaviour of food prices and quantities. Hence, monetary policymakers must deal with a combination of large inflation shocks of differing characters and persistence.

In this context, the appropriate policy response in an inflation targeting regime crucially depends on the behaviour of inflation expectations. As long as these remain in line with the 3% target, the shocks could be treated as purely transitory events that require only a small tightening of monetary policy. Indeed, if the terms of trade shock produced a contraction of expenditure beyond what is required to maintain a sustainable path for the current account deficit, anchored inflation expectations would allow an expansionary monetary policy response. This is why understanding and monitoring the behaviour of inflation expectations has become a centrepiece of monetary policy analysis and discussion in Colombia. Are inflation expectations formed "rationally", as assumed in our macroeconomic models? If not, how are they formed? How do they respond to the exogenous shocks that have hit the economy? How has this response changed over time (especially since the long-term inflation target was reached)? How to assess the probability of their de-anchoring from target? These are some of the questions that will be addressed in this note on the basis of work done recently at the Bank of the Republic.

Of importance too is the measurement of core inflation in the context of the above-mentioned shocks. Disentangling the core and shock components of rising inflation in the midst of ongoing large and diverse shocks is technically challenging, yet crucial if the evolution of "macro" inflation is to be ascertained and suitable policy responses determined. In the presence of coinciding shocks with differing durations and channels of transmission, exclusion measures may not adequately represent the behaviour of core inflation. Widespread temporary supply shocks (like the COP depreciation shock) may affect a significant portion of the price index basket. Hence, exclusion measures may fail to filter them. Moreover, if the supply shocks are persistent, separating the direct impact of the shocks from their macroeconomic consequences (ie activation of indexation mechanisms, effects of expectations or monetary policy responses etc) becomes increasingly difficult with time. Technically, the derivation of adequate core inflation measures depends on the identification of the supply shocks. Consequently, this note presents a model-based core inflation measure, defined as observed inflation minus the model-identified supply shocks.

2. Characterisation of inflation expectations

In Colombia, inflation expectations are measured on the basis of a monthly survey of professional forecasters, a quarterly survey of a broader set of agents that includes some businesses, academics and labour unions, and bond-derived break-even (BI) and forward break-even (FBEI) inflation rates. Table 1 summarises the main features of these measures, while Graph 1 shows their time series along with the corresponding realised future annual inflation. Both realised inflation and inflation expectations exhibit a downward trend that reflects their gradual convergence to the long-term 3% target. Recently inflation has risen sharply as a result of the aforementioned shocks.

FBEI measures have generally been above realised inflation. This may be due to the fact that, although the 3% long-term target was announced as early as 2001, the exact convergence path was not defined. Thus, the FBEI for two years ahead or more seemingly imply a slower expected convergence path than the actual one. This is also consistent with the findings of González and Hamann (2011), who argue that the high and stable inflation persistence observed in Colombia is related to imperfect information of agents about the inflation target, rather than to indexation.

Monthly survey expectations for annual inflation one year ahead display a low coefficient of variation across respondents (10% on average since 2003), suggesting a small degree of dispersion for this measure (Graph 2). Quarterly survey expectations for annual inflation one year ahead exhibit a slightly greater dispersion (coefficient of variation of 15 % on average since 2003), a feature that may be explained by the more diverse set of respondents (Graph 2). Within sectors of the quarterly survey, the dispersion is also low, with the highest average coefficient of variation corresponding to labour unions (17%). However, the dispersion of expectations of the quarterly survey has reached high levels in some periods, especially around the end of 2009 and the beginning of 2010, after inflation fell steeply and the long-term inflation target was reached.

Are inflation expectations rational?

Table 2 presents the results of the conventional tests for rationality of inflation expectations (see for example Mankiw et al (2003) and Huertas et al (2015) for the case of Colombia). Expectations are deemed as rational if (i) they are co-integrated with realised inflation,[2] (ii) they are unbiased predictors of realised inflation, (iii) they are efficient, ie no further information helps improve their forecast of inflation. As seen in Table 2, co-integration is observed for all measures, but F2BEI3. Survey expectations and BEI1 are found to be unbiased, while all FBEI measures are biased. The lack of co-integration of F2BEI3 and the bias found for FBEI measures are not surprising, given the short sample and the mentioned uncertainty about the convergence path toward the long-term inflation target.

[2] In the sample inflation and inflation expectations appear to be integrated of order 1.

The efficiency requirement is not fulfilled, since there is strong auto-correlation of co-integration residuals. Moreover, in some cases, lagged values of the deviation of inflation from target, the output gap and the change in the policy rate are significantly associated with the co-integration residuals.

Hence, in general, it seems that expectations measures are not rationally formed, at least according to the conventional definition. An additional indication in this regard can be obtained from the comparison of the inflation expectation measures and the rational inflation expectations that are derived from DSGE models estimated with Colombian data.[3] In general, model-based rational expectations are closer to realised future inflation than inflation expectation measures, as suggested by their higher correlation coefficients and lower root mean square errors (RMSE). Conversely, inflation expectation measures seem to have a tighter relationship with contemporaneous inflation than model-based rational inflation expectations do, according to the same indicators (Table 3). These results point to a large influence from present observed inflation in the formation of inflation expectations.

In short, the evidence presented cast doubts about the rationality of inflation expectation measures. However, as stressed by Andolfatto et al (2008), conventional rationality tests may be plagued by short sample problems, and seemingly non-rational expectations may actually be formed rationally in a context of imperfect information about the inflation target and short-term learning dynamics. Indeed, some of the estimations for Colombia are based on short samples (especially for FBEI), while the work of González and Hamann (2011) supports the hypothesis of rational expectations under imperfect information about the inflation target for a significant part of the sample period.

If not rationally, how are inflation expectations formed?

If inflation expectations are not formed rationally, there are several alternative hypotheses regarding their determination. Huertas et al (2015), explore two sets of hypotheses. One states that inflation expectations follow adaptive learning by agents (Pfajfar and Santoro (2010))[4] and the other postulates that measured inflation expectations result from combinations of rational and adaptive expectations, or combinations of the inflation target and adaptive expectations (Heinemann and Ullrich (2006) and Oral et al (2011)).

Under adaptive learning, agents establish a rule to forecast inflation and update it with their forecast error once new data are observed. For the purpose of this note, a simple rule linking inflation expectations to past observed inflation is used (as in Huertas et al (2015)). If there is learning, the coefficient of past inflation will be updated through time. If not, it will be a constant. Table 4 shows adaptive learning (positive learning coefficient, v) for the monthly and quarterly survey expectations, as well as for the F1BEI1 and F2BEI3. The latest estimates of the coefficient of observed past inflation (ϕ_1) range from 0.33 (monthly survey) to 0.70 (BEI1), suggesting again

[3] Three DSGE models with nominal rigidities and "hybrid" Phillips curves are used. The first one, "Patacon", is a complex, open economy model regularly used for policy analysis, simulation and forecast (González et al (2011)). The second one is a simpler tradable/non-tradable model with nominal rigidities. The third one is a traditional textbook, closed economy New Keynesian model.

[4] See Appendix 1 for a brief description of the adaptive learning model.

an important influence of observed inflation on expectations (Table 4). Interestingly, for the expectation measures that exhibit learning, this coefficient declined after 2007 and stabilised around 2009–10, after the long-term inflation target was reached (Graph 3).

If measured inflation expectations were a mix of rational and adaptive expectations, the adaptive component would generally be dominant, as illustrated by the regression results presented in Table 5.[5] The weight of the adaptive part is lower for FBEI indicators, a result that is not surprising, as they forecast inflation at longer horizons. The pre-eminence of the adaptive component remains when measured inflation expectations are expressed as a combination of the relevant inflation target and adaptive expectations (Table 6).[6] This combination fits the data better than the combination of rational and adaptive expectations (higher adjusted R^2).[7]

In sum, inflation expectation measures in Colombia do not seem to conform with the rational expectations paradigm, although the caveats of the conventional tests in this regard are relevant, given the disinflation process experienced during part of the period examined. There is some evidence in favour of adaptive learning and, generally, contemporaneous and past observed inflation have a strong influence on all measures of inflation expectations.

3. Anchoring of inflation expectations

As initially stated, the degree to which inflation expectations remain anchored to the target after an exogenous shock hits the economy conditions the corresponding monetary policy reaction. That is why it is useful to assess how far inflation expectations are anchored. This poses some technical challenges. First, the exogenous shock must be properly identified in order to avoid the possible bias that emerges when endogenous variables are used as regressors. Second, the shocks hitting the economy may differ in nature and persistence. Consequently, an estimated response of inflation expectations would be related to an "average" shock and it may not accurately reflect the response to a specific shock that deviates from the "average". In other words, the estimated response of inflation expectations reflects not only an

5 Following Huertas et al (2015), the regression model

$$\pi^e_{t+s/t} = c_1\pi_{t+s} + (1-c_1)\left[\pi^e_{t/t-s} + c_2\left(\pi_t - \pi^e_{t/t-s}\right)\right] + \varepsilon_t$$

was estimated for all inflation expectations measures $\pi^e_{t+s/t}$. The coefficient c_1 represents the weight of the rational expectations, $1-c_1$ denotes the weight of adaptive expectation and c_2 the speed at which past forecasting errors are corrected.

6 The regression model estimated in this case is similar to the one considered for the combination of rational and adaptive expectations, with the relevant inflation target in place of the realised future inflation:

$$\pi^e_{t+s/t} = c_1 Target_{t+s} + (1-c_1)\left[\pi^e_{t/t-s} + c_2\left(\pi_t - \pi^e_{t/t-s}\right)\right] + \varepsilon_t$$

7 Even though both inflation and the inflation expectations measures are I(1) series, the residuals of the regressions presented in Tables 5 and 6 are generally stationary. Hence, the probability of spurious correlation is small.

"inherent" characteristic of the expectation formation process, but also a combination of that process *and* the particular realisation of shocks throughout the sample.[8]

To address the first issue, two alternative tacks are pursued. First, the deviation of inflation expectation measures from the relevant inflation target is regressed against some exogenous variables that are known to affect the Colombian economy.[9] Secondly, the same deviation is regressed against food supply, general supply, demand and policy shocks that are obtained from a simple semi-structural macro model estimated with Colombian data.[10] The results of these estimations are subject to the second issue mentioned, namely that the estimated responses reflect both the nature of the expectations formation mechanism and the realisation of the shocks themselves. This is especially relevant for shorter-horizon inflation expectations (eg one year ahead).

To address both issues at the same time and account for possible non-linearities in the expectations formation process, a third exercise based on Guarín et al (2015) is presented in which the probability that long-term FBEI expectations will become de-anchored is estimated as a function of exogenous variables.

The relationship between inflation expectations and some exogenous variables and shocks

Changes in the international oil price and the intensity of El Niño phenomenon[11] are associated with deviations of survey-based expectations from the relevant inflation target in the period 2003–15 (Table 7). Increases in the oil price are negatively related with deviations of inflation expectations from the target. This could be due to the currency appreciation that follows a rise in the oil price (oil is a major Colombian export). Increasing intensity of El Niño phenomenon is positively associated with the deviation of survey expectations from the inflation target. This is probably the consequence of the direct and indirect effects of droughts on inflation and one-year-ahead inflation expectations. These results are clear for the quarterly survey at the aggregate and sectoral level, although less so for the monthly survey. Other exogenous variables, such as an international food price index or the intensity of La Niña phenomenon,[12] are not significantly associated with deviations of survey expectations from the inflation target. No significant effects of exogenous variables on BEI or FBEI measures were found.

For the second exercise, food supply, general supply, demand and policy shocks are obtained from a small semi-structural model estimated for Colombia by Bejarano

[8] For example, a supply shock that permanently shifts the price level upwards would produce a response of annual inflation expectations that differs from their reaction to a shock of the same initial size that increases the price level for only a few months.

[9] Estimated regression: $\pi^e_{t+s/t} - Target_{t+s} = a_1 + a_2 \Delta Oil\ Price_t + a_3 El\ Niño_t + \varepsilon_t$

[10] Estimated regression: $\pi^e_{t+s/t} - Target_{t+s} = a_1 + a_2\ Supply\ Shock_t + a_3\ Demand\ Shock_t + a_4\ Policy\ Shock_t + a_5\ Food\ Shock_t + \varepsilon_t$

[11] This intensity index is taken from NOAA (National Oceanic and Atmospheric Administration of the United States Department of Commerce).

[12] La Niña is the opposite of El Niño, ie excessive rain and floods in Colombia.

et al (2015)[13] and are used as independent variables in the regressions for the deviation of expectation measures from the inflation target between 2003 and 2015. Although the shocks are model-dependent, their use helps minimise endogeneity-related bias in the estimation.[14]

For the quarterly survey inflation expectations, a significant positive effect from the general supply shocks on the deviation of expectations from target is obtained. Moreover, this effect has been rising since 2014 (Graph 4). The latest estimate indicates that a 1% general supply shock produces a deviation of quarterly expectations from the target of 0.38% (Table 8, second column). Other shocks do not significantly affect the anchoring of this expectations measure (Graph 4). Similar results are obtained for the sectoral components of the survey (Table 8).

Estimations for the monthly survey inflation expectations point in the same direction (Table 8). Interestingly, positive interest rate shocks reduced the deviations of the inflation expectations from target in part of the sample period (Graph 5). For BEI1 general supply shocks have a significant "de-anchoring" effect only by the end of the sample (Table 8 and Graph 6), while for F2BEI3 this effect is larger (a 1% supply shock increases the deviation of expectations from target by 0.68%). Also, estimations for F2BEI3 yield a significantly *negative* impact of demand shocks on the deviation of expectations from target (Table 8 and Graph 7).

In sum, exogenous shocks seem to have affected the anchoring of inflation expectations. Survey expectations are influenced by changes in the international price of oil and by the El Niño phenomenon, while a robust, positive and recently increasing "de-anchoring" effect of general supply shocks was detected. The latter may be due to a loss of credibility of monetary policy in the past year, the realisation of atypically persistent supply shocks (eg the sharp depreciation of the COP), or both.

Assessing the probability that long-term inflation expectations will become de-anchored

Following Guarín et al (2015), the probability that long-term inflation expectations for Colombia would become de-anchored between 2003 and March 2016 is estimated. This probability is computed for zero, three- and six-month horizons as a function of a set of exogenous variables. By focusing on long-term inflation expectations, the issue of disentangling changes in the credibility of monetary policy from the particular sample realisation of exogenous shocks becomes less severe.

A Bayesian model averaging (BMA) of logistic regression is used to estimate the probability that long-term inflation expectations will become de-anchored. This approach is suitable for dealing simultaneously with both model and parameter uncertainty.[15] The empirical exercises consider monthly data from two sets of information. The first set includes the annual inflation rate of CPI, the F2BEI3 as a proxy of long-term inflation expectations, the inflation target and its range. These

[13] See a brief description of the model in Appendix 2.

[14] The semi-structural macro model is estimated with quarterly variables and yields quarterly series of shocks. Since inflation expectations measures and the target refer to annual inflation, cumulative four-quarter shock series are used in the regressions.

[15] Appendix 3 presents a brief description of Bayesian model averaging.

time series are used to build the proxy for the de-anchoring of long-term inflation expectations. A de-anchoring episode is identified when the FBEI rate is greater than the upper bound of the target range for two consecutive months (Graph 8).[16]

The second set of data considers exogenous variables used as possible explicative factors of the probability of de-anchoring. This set includes annual variations in the international food price index (Spot Index Food, SIF) and the Brent oil price, as well as intensity indexes for the El Niño and La Niña phenomena. By using exogenous variables, endogeneity bias in the estimation is avoided. A dummy variable $\mathrm{D_{IT}} = 1_{\{\mathrm{t<Jan\ 2010}\}}$ to discriminate between periods before and after achieving the long-term inflation target is also included.

The estimated episodes of de-anchoring for zero, three and six months ahead[17] exhibit a very good fit and anticipation of the historical events (Graph 9). Three main results are obtained from this exercise. First, significant effects of exogenous variables (climate and international food and oil prices) on the probability of inflation expectations de-anchoring are found. Table 9 reports statistics of the BMA logistic regression, such as the posterior inclusion probability (PIP),[18] the posterior mean and standard deviation of the coefficients, and their positive sign probability.[19] Only variables with the highest PIP are reported. In general, international food prices and the La Niña phenomenon affect the probability of de-anchoring with shorter lags than those of the oil price or the El Niño.[20] The dummy $\mathrm{D_{IT}}$ has a positive coefficient, which implies a larger probability of de-anchoring before the long-term inflation target was reached.

Second, there seems to be a non-linear effect of exogenous shocks on the de-anchoring of inflation expectations. Whereas no significant relationship between exogenous variables and deviations of FBEI from target were found with linear regression over the whole sample period in the previous section, that relationship appeared when critical, de-anchoring episodes were identified in the estimation of the probability of de-anchoring. Moreover, significant coefficients for exogenous variables were obtained with a non-linear logistical probability function specification. This implies that the sensitivity of the probability of de-anchoring to a shift in an exogenous variable will depend on the particular values of other exogenous variables.

Third, a rapid increase in the probability that long-term inflation expectations would become de-anchored in the second-half of 2015 and the beginning of 2016 for the six-month time horizon is detected, although the predicted probability is still below its threshold (Graph 9 and Appendix 3). This indicates an increasing probability of de-anchoring long-term inflation expectations after the strong depreciation and food price shocks mentioned above. Interestingly, this signal is picked up from the behaviour of exogenous oil price and climate shocks, and not from the behaviour of any endogenous variable.

16 The specific choices of the F2BEI3 and two months in our definition of de-anchoring are based on available data and several exercises on the consistency and robustness of results.

17 These periods correspond to those time spans when the probability for each time horizon is higher than the cut-off probability (see Appendix 3).

18 PIP is the probability that a given variable is included in the regression.

19 The probability that sign of coefficient is positive.

20 The i lags of the regressors are denoted by $\mathrm{L_i}$.

4. A model-based core inflation measure

When short-lived, localised supply shocks hit the economy, exclusion core inflation measures[21] are good proxies of "macroeconomic" inflation and could be trusted as relevant indicators for the macroeconomic diagnostic and forecast, and for the determination of monetary policy responses. However, in the presence of widespread, persistent shocks (such as the large depreciation shock experienced recently in Colombia), the exclusion core inflation measures have shortcomings. In this case, the shock temporarily affects a large fraction of prices in the economy, so that the exclusion measures cannot adequately filter the shock. Furthermore, if the shock is persistent, separating the direct impact of the shock from its macroeconomic consequences (ie activation of indexation mechanisms, effects of expectations or monetary policy responses etc) becomes increasingly difficult with time.

This difficulty is compounded if, as at the current juncture in Colombia, other shocks with different durations and channels of transmission hit the economy. So, not only must policymakers filter out the COP depreciation shock, but they must also distinguish the impact of the El Niño-related droughts and the macroeconomic consequences of both shocks. In this context, a model-based approach may be useful in identifying the "pure" supply shocks and computing a core inflation measure that simply subtracts those shocks from headline inflation. This has the drawback of tying the core measure to a particular model, but it does help address the aforementioned issues.

For this purpose, the small semi-structural macroeconomic model introduced in Section 3 and described in Appendix 2 is used, following Bejarano et al (2015). As mentioned above, the model allows for the existence of non-processed food supply shocks, general supply shocks, demand and monetary policy shocks. The model-based core inflation measure is defined as inflation without non-processed food minus the general supply shock identified with the model. By construction, such measure incorporates all the macroeconomic effects and responses to the supply shocks, but not the shocks themselves.

Graph 10 shows a comparison of the model-based core inflation and the average of four conventional exclusion measures monitored at the Bank of the Republic. The model-based indicator is generally higher than the average of exclusion core inflation rates. The distance between the two measures is notably larger in periods of strong demand pressures (eg 2006–07 or 2011). However, in the last part of the sample, the model-based indicator is below the average of exclusion measures, suggesting that the direct impact of the recent depreciation shock may be overestimated by the latter.

5. Conclusion

Based on the results presented in this note, it may be concluded that conventional core inflation measures in Colombia might be overstating true "macro-economic" inflation at present, due perhaps to the widespread effects of the depreciation shock

[21] Exclusion core inflation measures are subbaskets of the CPI or other price index that exclude specific components known to be affected by transitory supply shocks (eg inflation excluding foodstuffs or energy).

that hit the economy. Given this feature, it is possible that traditional exclusion core inflation measures fail to filter the temporary impact of the exchange rate on local prices. However, the risk of de-anchoring inflation expectations following recent, strong supply shocks is a concern that policymakers must bear in mind. The evidence shows that inflation expectations are closely tied to observed past and present headline inflation. They are also affected by exogenous shocks in a possibly non-linear way such that the combination of large shocks greatly increases the probability of de-anchoring.

Market-based inflation expectations are widely used by market participants and policymakers for decision-making and for inferring the likely monetary policy decisions of central banks. Survey-based inflation expectations are also widely used but are not suitable given the lower frequency of available data. Market-based inflation expectations can be determined in several ways but perhaps the most popular method resorts to the market prices of zero-coupon inflation swaps (Antunes (2015)). Policymakers and finance professionals often use the term structure of Treasury yields to infer expectations of inflation and real interest rates (Haubrich (2012)). Forward inflation compensation – defined as the difference between forward rates on nominal and inflation-indexed bonds – provides us with a high-frequency measure of the compensation that investors require to cover the expected level of inflation, as well as the risks associated with inflation, at a given horizon. If far-ahead forward inflation compensation is relatively insensitive to incoming economic news, then one could reasonably infer that financial market participants have fairly stable views regarding the distribution of long-term inflation outcomes. This is precisely the outcome one would hope to observe in the presence of an explicit and credible inflation target.

Financial indicators for inflation expectations offer two key advantages over survey measures: they are available at a much higher frequency and over a larger number of horizons. Nowadays readings of inflation expectations are available at trading frequency via the break-even inflation rates (BEI rates) computed either through the yield spread between nominal and inflation-linked bonds or from the strongly growing inflation-linked (IL) swap market. This higher frequency of observation, as we will show below, is crucial to identifying shifts in inflation expectations when they occur, changes that may only be seen after an interval in survey data due to their lower frequency of collection. In addition, financial instruments allow for collecting readings of inflation expectations over a large number of horizons, both at short- and long-term maturities, which allow for monitoring developments in inflation expectations at more horizons than survey indicators, and therefore identify the horizons at which relevant changes take place.

Indicators of inflation expectations extracted from financial instruments should be better interpreted as measures of inflation compensation rather than simple measures of inflation expectations, for they incorporate a premium component that compensates investors not only for the expected level of inflation over the horizon of the contract but also for the uncertainty and risks surrounding the level of future inflation. Fluctuations in inflation risk premia are also very relevant for monetary policy: the analysis of financial indicators of inflation expectations offers additional insights beyond the level of long-term inflation expectations (Ciccarelli and Garcia (2005)).

Inflation expectations measures

Table 1

Name	Description	Periodicity	Abbreviation
Survey of experts	Applied to analysts of financial sector (credit banks, pension funds, insurance companies, etc.). The relevant question is: What will annual inflation be in the same month of next year?	Monthly 2003–15	SE
Survey of some sectors	Applied to representatives of the financial sector, industry, retailers, transport and communications, labour unions and academics. The relevant question is: What will annual inflation be in the same month of next year?	Quarterly 2000–15	SSQ
One-year breakeven inflation	"Expected inflation" extracted from the prices of Government bonds indexed to inflation (TES UVR) and fixed nominal rate bonds (TES fixed rate).	Monthly 2003–15	BEI1
Forward break-even inflation 1-1	"Expected inflation" one year after one year extracted from the prices of Government bonds indexed to inflation (TES UVR) and fixed nominal rate bonds (TES fixed rate).	Monthly 2003–15	F1BEI1
Forward break-even inflation 2-3	"Expected inflation" on average for three years after two years extracted from the prices of Government bonds indexed to inflation (TES UVR) and fixed nominal rate bonds (TES fixed rate).	Monthly 2003–15	F2BEI3
Forward break-even inflation 2-1	"Expected inflation" one year after two years extracted from the prices of Government bonds indexed to inflation (TES UVR) and fixed nominal rate bonds (TES fixed rate).	Monthly 2003–15	F2BEI1

Table 2

TESTS OF RATIONALITY OF INFLATION EXPECTATIONS

	SE	SSQ	BEI1	F1BEI1	F2BEI3	F2BEI1
Panel A: Is there a long relationship between observed inflation and expecations?						
Johansen Cointegration test						
Ho: r<=1	2,42	2,85	3,25	4,45	8.91*	7,14
H0: r=0	48.07***	36.28***	24.9***	23.14**	36.21***	16,83
Panel B: Testing for bias Ho: $\alpha=0,\ \beta=1;\quad \pi_t = \alpha + \beta\,\pi^e_{t/t\text{-}j} + \mu_t$						
α	0,025	0,016	0,021	0,038	0.019***	0,039
	(0.047)	(0.029)	(0.158)	(0.032)	(0.007)	(0.041)
β	0,425	0.631***	0.471***	0,090	0.353***	0,048
	(0.948)	(0.326)	(0.136)	(0.29)	(0.092)	(0.339)
Adj R^2	0,05	0,40	0,26	0,00	0,27	0,00
test p.value	0,911	0,429	2,977	0,000	0,000	0,000
Reject H0?	NO	NO	NO	YES	YES	YES
Panel C: Are forecasting errors not autocorrelated?						
Box-Ljung test						
Test statistic lag=1	274,18	338,21	261,31	271,85	172,17	251,02
P.value	0,00	0,00	0,00	0,00	0,00	0,00
Test statistic lag=12	816,40	883,18	620,89	889,23	590,03	832,58
P.value	0,00	0,00	0,00	0,00	0,00	0,00
Reject H0?	YES	YES	YES	YES	YES	YES
Panel D: Are the expectations efficient?. Are macroeconomic data fully exploited?						
Ho: $\alpha 0 = \alpha 1 = \alpha 2 = \alpha 3 = 0;\ \mu_t = \alpha 0 + \alpha 1\,(\pi_{t\text{-}j\text{-}1} - \pi^T_{t\text{-}j\text{-}1}) + \alpha 2\ \mathbf{GAP}_{t\text{-}j\text{-}4} + \alpha 3\ \Delta i_{t\text{-}j\text{-}1} + \eta_t$						
α0	0,000	0,001	0,001	0,002	-0,001	0,000
	(0.006)	(0.009)	(0.005)	(0.007)	(0.005)	(0.018)
α1	-0,238	-0,170	-0,249	-0.578*	0,145	-0,021
	(0.802)	(0.751)	(0.484)	(0.267)	(0.322)	(0.486)
α2	1,730	0,337	1,148	0,535	-2.327**	-0,476
	(1.212)	(1.292)	(1.425)	(1.831)	(0.877)	(2.098)
α3	0.092*	0,068	0.083*	0,061	0.124***	-0,046
	(0.042)	(0.087)	(0.039)	(0.048)	(0.038)	(0.05)
Adj R^2	0,23	0,05	0,16	0,15	0,41	0,02
test p.value	0,264	0,921	0,443	0,680	0,116	0,986
Reject H0?	NO	NO	NO	NO	NO	NO
Sample	Sep 2003 - Nov 2015	Mar 2000 - Sep 2015	Jan 2003 - Nov 2015	Jan 2003 - Nov 2015	Jan 2003 - Nov 2015	Jan 2003 - Nov 2015
Periodicity	Monthly	Quarterly	Monthly	Monthly	Monthly	Monthly
T	135	59	143	131	95	119

(Newey-West standard errors in parentesis, correcting for autocorrelation up to one year)

***, ** and * denote statistical signiticance at the 1%, 5% and 10% levels, respectively

Table 3

RMSE with respect to realized future inflation		RMSE with respect to contemporaneous inflation	
Monthly Survey	1,45	Monthlyy Survey	0,92
Quarterly Survey	1,51	Quarterly Survey	0,64
BEI 1y	1,41	BEI 1y	0,84
Tradable/ Non Tradable DSGE	1,41	Tradable/ Non Tradable DSGE	1,33
PATACON	1,29	PATACON	0,98
Small New Keynesian DSGE	1,24	Small New Keynesian DSGE	1,09
Correlation coefficient with realized future inflation		**Correlation coefficient with contemporaneous inflation**	
Monthlyy Survey	0,39	Monthlyy Survey	0,88
Quarterly Survey	0,42	Quarterly Survey	0,96
BEI 1y	0,54	BEI 1y	0,87
Tradable/ Non Tradable DSGE	0,61	Tradable/ Non Tradable DSGE	0,78
PATACON	0,62	PATACON	0,80
Small New Keynesian DSGE	0,58	Small New Keynesian DSGE	0,77

Adaptive Learning

Table 4

Expectation measures	MSE	v	ϕ0	std. Error	ϕ1	std. Error
SE	0,000	0,048	0,028	0,004	0,330	0,081
SSQ	0,001	0,034	0,017	0,004	0,695	0,072
BEI1	0,000	0,000	0,010	0,005	0,701	0,132
F1BEI1	0,001	0,045	0,025	0,005	0,411	0,133
F2BEI3	0,001	0,055	0,034	0,009	0,361	0,176
F2BEI1	0,000	0,000	0,013	0,002	0,610	0,079

Inflation expectations as a combination of rational and adaptive expectations

Table 5

$$\pi^e_{t+s/t} = c_1 \pi_{t+s} + (1 - c_1)\left[\pi^e_{t/t-s} + c_2\left(\pi_t - \pi^e_{t/t-s}\right)\right] + \varepsilon_t$$

Expectation measures	C1	p.value	C2	p.value	R^2	AIC
SE	0,151	0,035	0,434	0,000	0,746	–8,204
SSQ	0,294	0,000	0,647	0,000	0,899	–7,947
BEI1	0,217	0,031	0,602	0,000	0,761	–7,241
F1BEI1	0,526	0,001	1,040	0,001	–0,251	–6,057
F2BEI3	0,306	0,004	0,470	0,014	0,111	–6,390
F2BEI1	0,448	0,000	0,683	0,000	–0,492	–5,724

Inflation expectations as a combination of the inflation target and adaptive expectations

Table 6

$$\pi^e_{t+s/t} = c_1 Target_{t+s} + (1 - c_1)\left[\pi^e_{t/t-s} + c_2\left(\pi_t - \pi^e_{t/t-s}\right)\right] + \varepsilon_t$$

Expectation measures	C1	p.value	C2	p.value	R^2	AIC
SE	0,413	0,000	0,391	0,000	0,939	–9,633
SSQ	0,254	0,000	0,625	0,000	0,977	–9,434
BEI1	0,325	0,005	0,643	0,000	0,790	–7,370
F1BEI1	0,552	0,000	0,516	0,000	0,384	–6,715
F2BEI3	0,207	0,084	0,684	0,000	0,420	–5,918
F2BEI1	0,430	0,000	0,643	0,000	0,061	–6,023

Regressions for the difference between inflation expectations and the inflation target

Table 7

$$\pi^e_{t+s/t} - Target_{t+s} = a_1 + a_2 \Delta Oil\ Price_t + a_3 El\ Niño_t + \varepsilon_t$$

	Inflation Expectations Measure							
	SSE	**SSQ Total**	**SSQ Manufacturing**	**SSQ Financial**	**SSQ Retail**	**SSQ Transportation & Communications**	**SSQ Academics**	**SSQ Labor Unions**
Constant	**0,004**	**0,0068**	**0,0069**	**0,006**	**0,0079**	**0,0068**	**0,0063**	**0,0122**
Std. Error	0,0011	0,0018	0,0019	0,0015	0,0021	0,0019	0,0019	0,0028
Δ Brent Price	**-0,0028**	**-0,0146**	**-0,0153**	**-0,0143**	**-0,014**	**-0,0149**	**-0,0168**	**-0,0174**
Std. Error	0,0027	0,0063	0,0065	0,0058	0,0062	0,0063	0,0066	0,009
Intensity of El Niño	**0,0021**	**0,0105**	**0,0105**	**0,0105**	**0,01**	**0,0098**	**0,01**	...
Std. Error	0,0012	0,0052	0,0052	0,0052	0,0052	0,0053	0,0057	...
Adj. R^2	0,1138	0,3516	0,3593	0,3953	0,3068	0,3341	0,3539	0,1696

Regressions for the difference between inflation expectations and the inflation target

Table 8

$$\pi^e_{t+s/t} - Target_{t+s} = a_1 + a_2\ Supply\ Shock_t + a_3\ Demand\ Shock_t + a_4\ Policy\ Shock_t + a_5\ Food\ Shock_t + \varepsilon_t$$

	Inflation Expectations Measure									
	SSE	**SSQ Total**	**SSQ Manufacturing**	**SSQ Financial**	**SSQ Retail**	**SSQ Transportation & Communications**	**SSQ Academics**	**SSQ Labor Unions**	**BEI 1**	**F2BEI3**
Constant	0,0057	**0,0080**	0,0080	**0,0071**	**0,0094**	**0,0078**	0,0073	0,0099	**0,0046**	**0,0133**
Std. Error	0,0010	0,0013	0,0014	0,0012	0,0014	0,0012	0,0014	0,0015	0,0017	0,0016
Supply Shock	**0,3481**	**0,3807**	**0,3793**	**0,3658**	**0,4351**	**0,4118**	**0,4345**	**0,4459**	0,27082	**0,6745**
Std. Error	0,1519	0,1360	0,1373	0,1414	0,1283	0,1323	0,1474	0,1515	0,1575	0,0825
Demand Shock	**-0,3052**	**-0,1764**	**-0,1710**	**-0,1954**	**-0,2133**	**-0,1839**	**-0,1918**	**-0,0736**	**0,0439**	**-0,6997**
Std. Error	0,1471	0,1205	0,1199	0,1121	0,1284	0,1128	0,1312	0,1274	0,2099	-0,0946
Policy Shock	**-0,1063**	**-0,1042**	**-0,1153**	**-0,1072**	**-0,0929**	**-0,1051**	**-0,0732**	**-0,1668**	**-0,0564**	**0,1311**
Std. Error	0,0763	0,0926	0,0956	0,0776	0,1039	0,0886	0,1004	0,0987	0,170338	0,0631
Food Supply Shock	**0,0056**	**0,0064**	**0,0066**	**0,0052**	**0,0055**	**0,0057**	**0,0078**	**0,0105**	**0,0089**	**0,0047**
Std. Error	0,0068	0,0058	0, 095606	0,0056	0,0060	0,0053	0,0063	0,0060	**0,0101**	0,0059
Adj. R^2	0,3087	0,3079	0,3055	0,3189	0,3451	0,3539	0,3218	0,4047	**0,1303**	**0,5714**

Probability of de-anchoring of inflation expectations

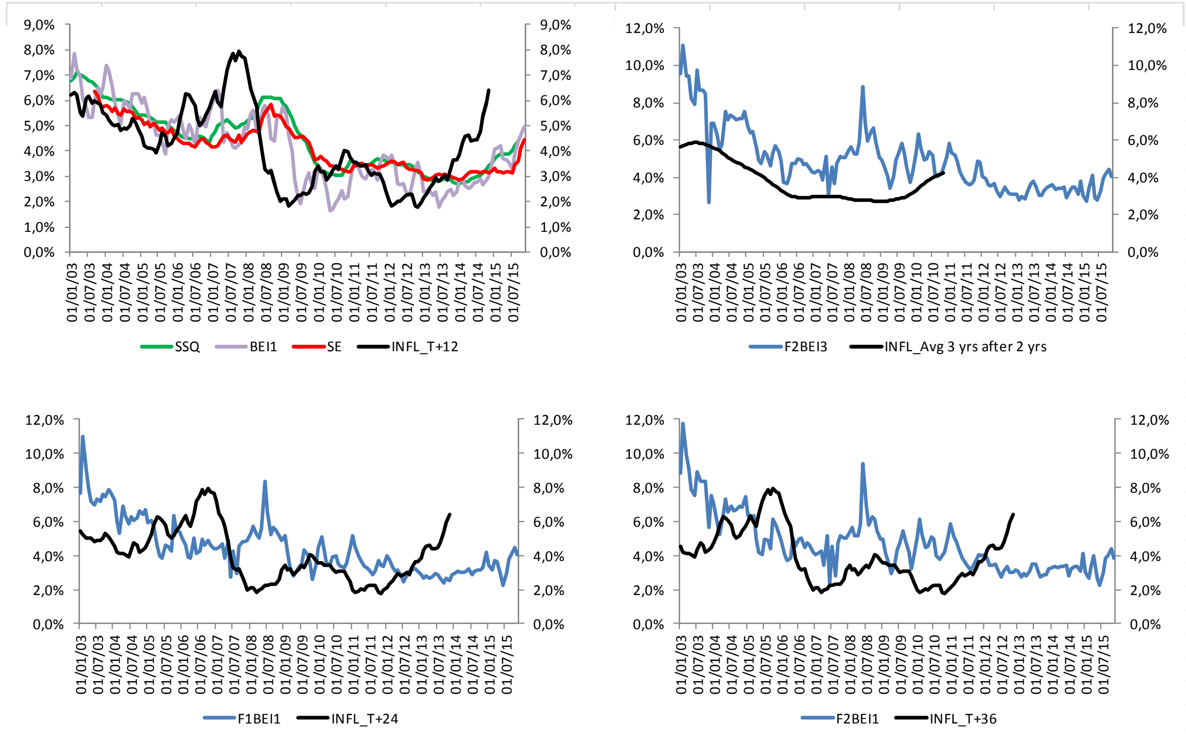
BMA estimation statistics

Table 9

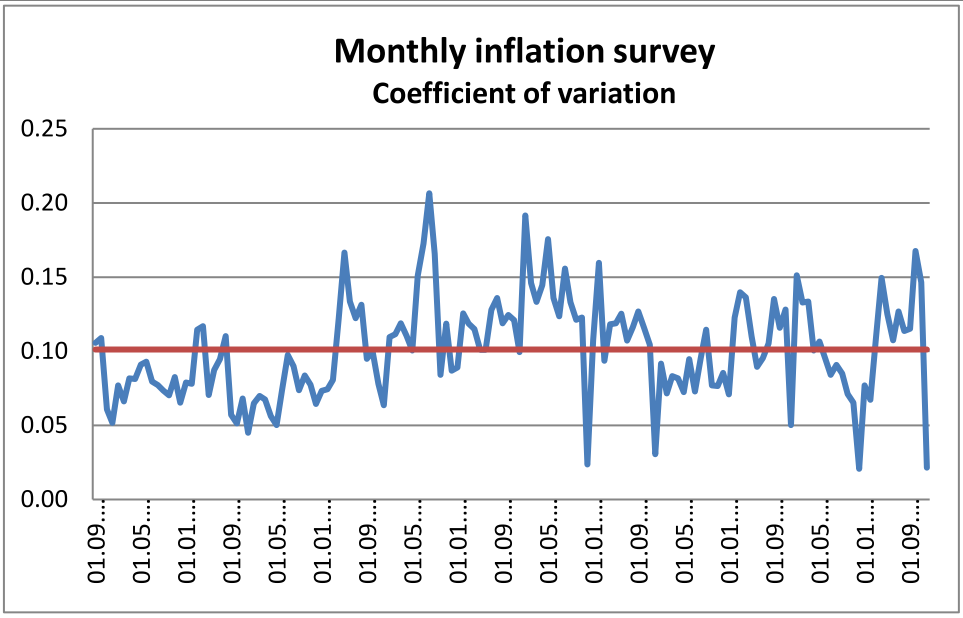
Forecasting horizon to														
h=0 months ahead					h=3 months ahead					h=6 months ahead				
Variable	PIP	Posterior Mean	Posterior SD.	Sign + Prob.	Variable	PIP	Posterior Mean	Posterior SD.	Sign + Prob.	Variable	PIP	Posterior Mean	Posterior SD.	Sign + Prob.
Niña,L2	0,96	7,53	2,72	1,00	SIF,L0	1,00	20,9	5,50	1,00	Niño,L6	1,00	6,72	2,24	1,00
Niño,L6	0,90	6,34	3,36	1,00	Niña,L6	0,95	-6,92	2,70	0,00	SIF,L0	0,99	16,4	6,34	1,00
SIF,L3	0,77	9,92	7,55	1,00	SIF,L5	0,83	11,1	7,58	1,00	Brent,L2	0,94	–8,78	3,56	0,00
SIF,L6	0,69	7,67	6,71	1,00	Brent,L5	0,70	-5,01	4,17	0,00	Brent,L6	0,90	–6,93	3,44	0,00
Brent,L6	0,58	-2,87	2,89	0,00	SIF,L4	0,52	5,45	6,55	1,00	SIF,L2	0,81	12,6	8,54	1,00
SIF,L5	0,54	5,64	6,50	1,00	SIF,L1	0,44	3,85	5,66	1,00	SIF,L1	0,69	8,02	7,37	1,00
Niño,L3	0,54	3,46	3,75	1,00	Dummy,L6	0,38	2,10	3,03	1,00	SIF,L3	0,64	7,17	7,06	1,00
SIF,L2	0,47	4,23	5,70	1,00	Niño,L4	0,38	1,48	2,28	0,98	Niña,L4	0,59	–2,53	2,40	0,00
Niño,L4	0,45	2,98	3,78	1,00	SIF,L6	0,36	2,94	4,87	1,00	Dummy,L6	0,53	4,00	4,19	1,00

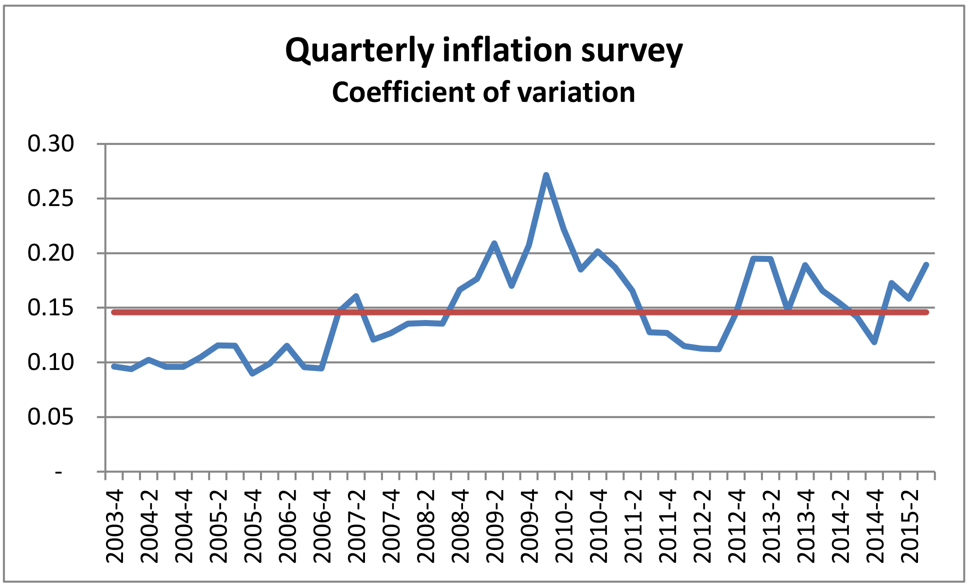
Inflation expectations measures

Graph 1



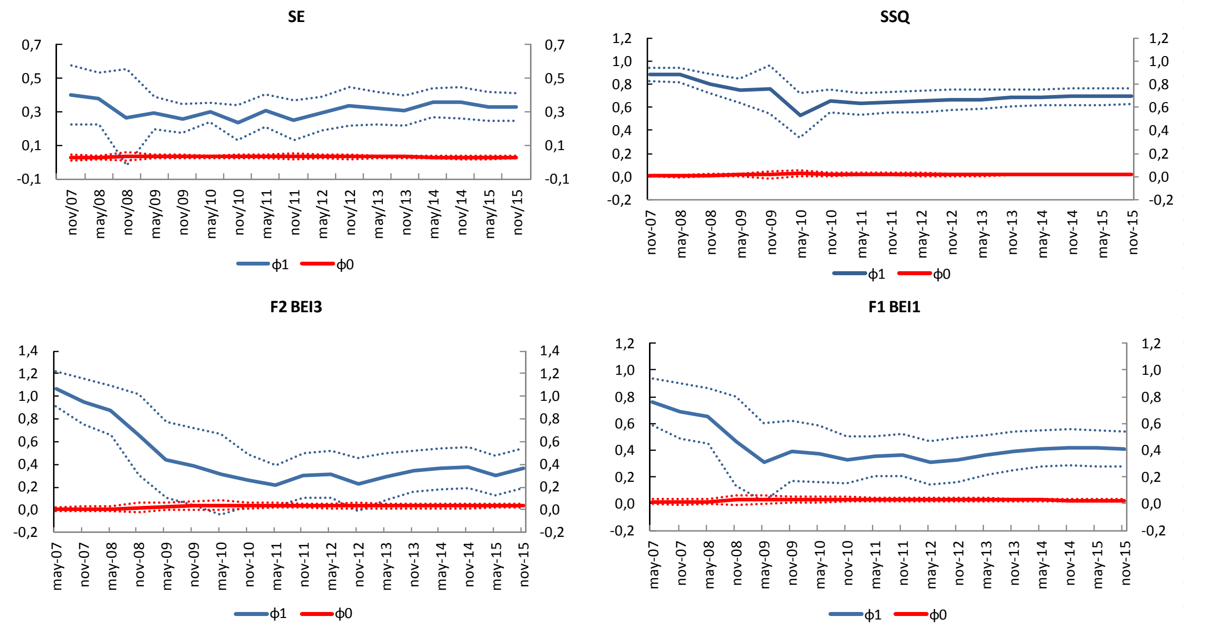
Dispersion of survey inflation expectations Graph 2





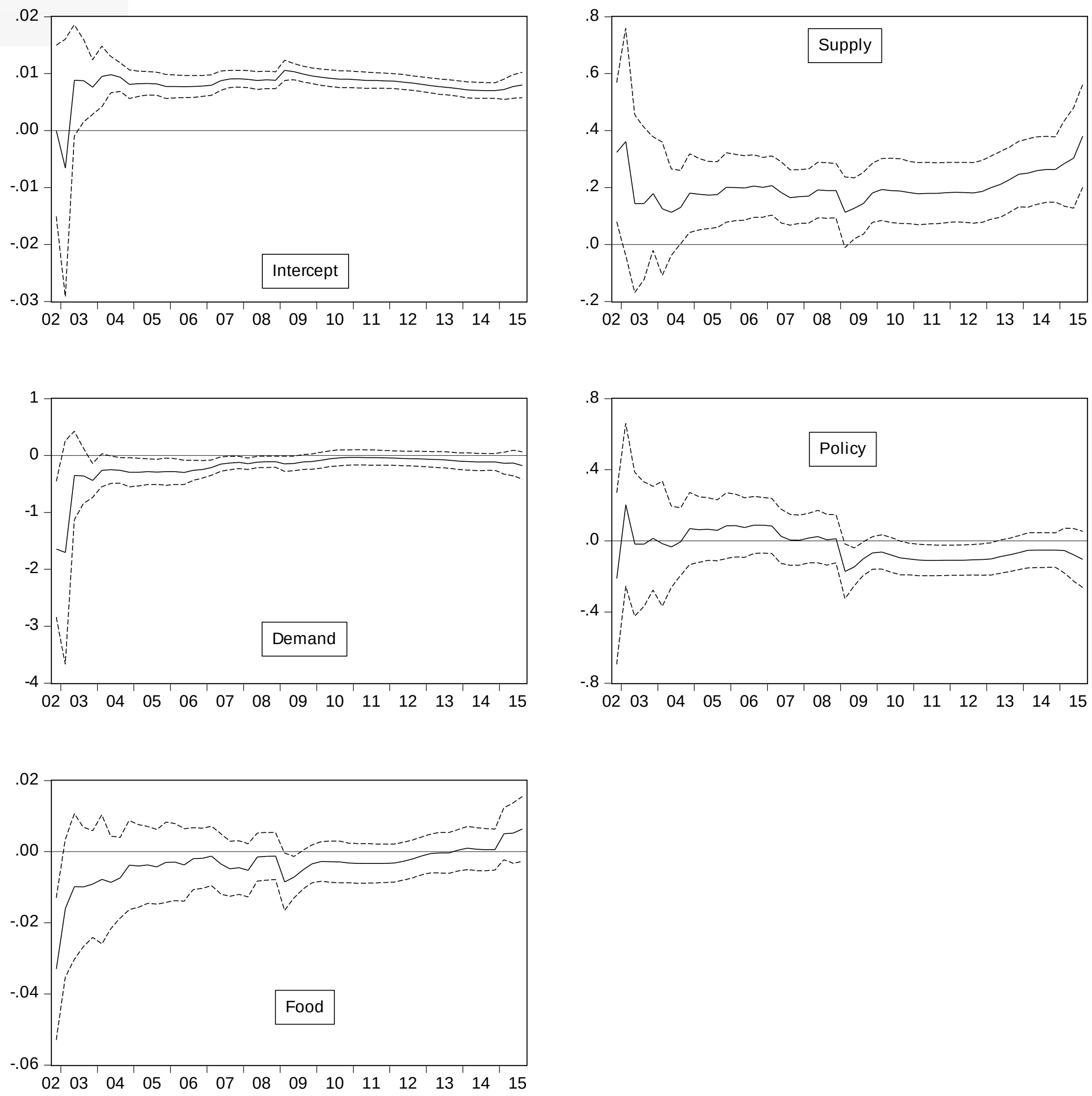
Adaptive learning

Coefficient of observed inflation (ϕ_1) Graph 3



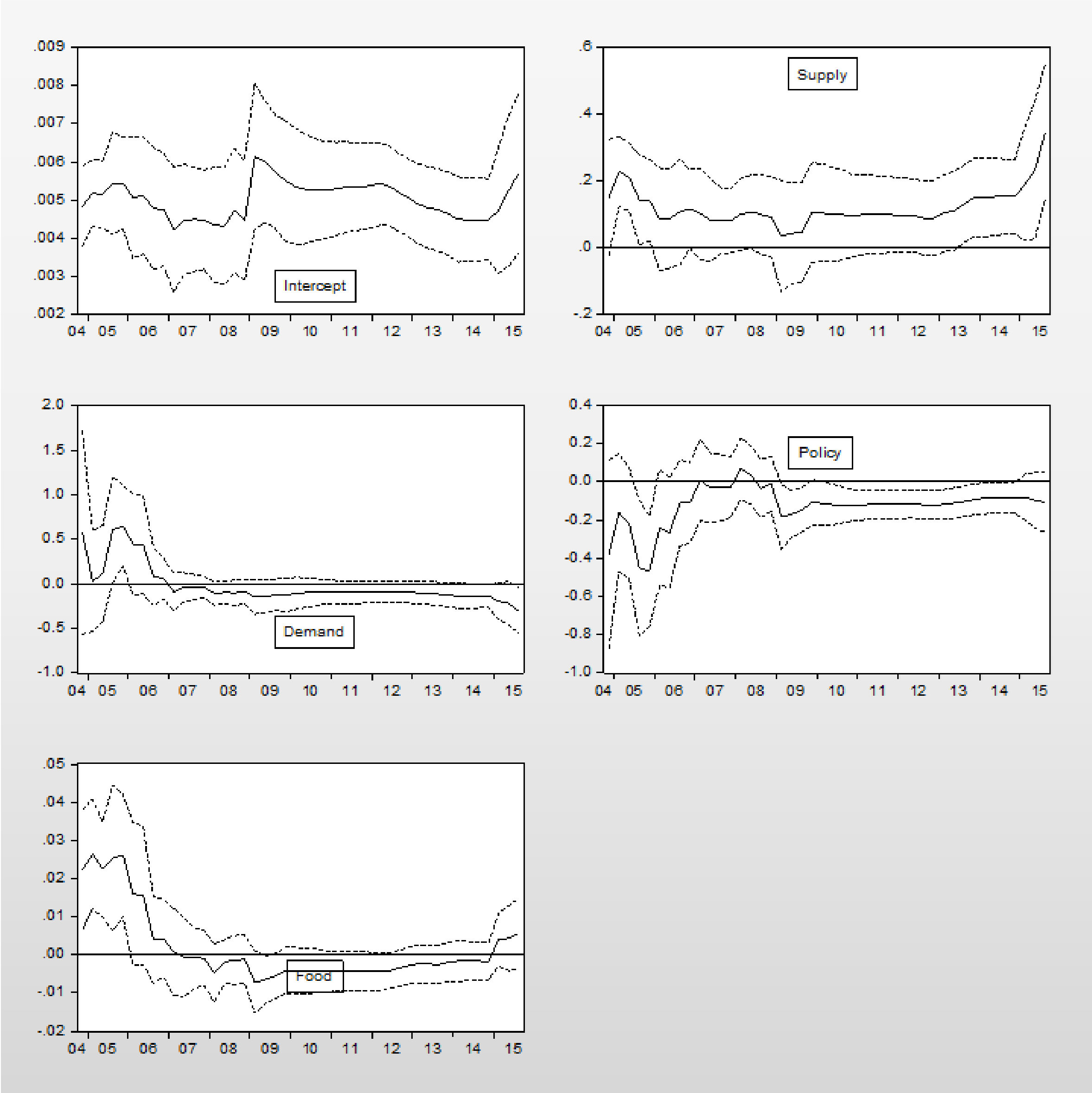
Coefficients of macroeconomic shocks in the regression for the deviation of quarterly survey inflation expectations from target

Graph 4



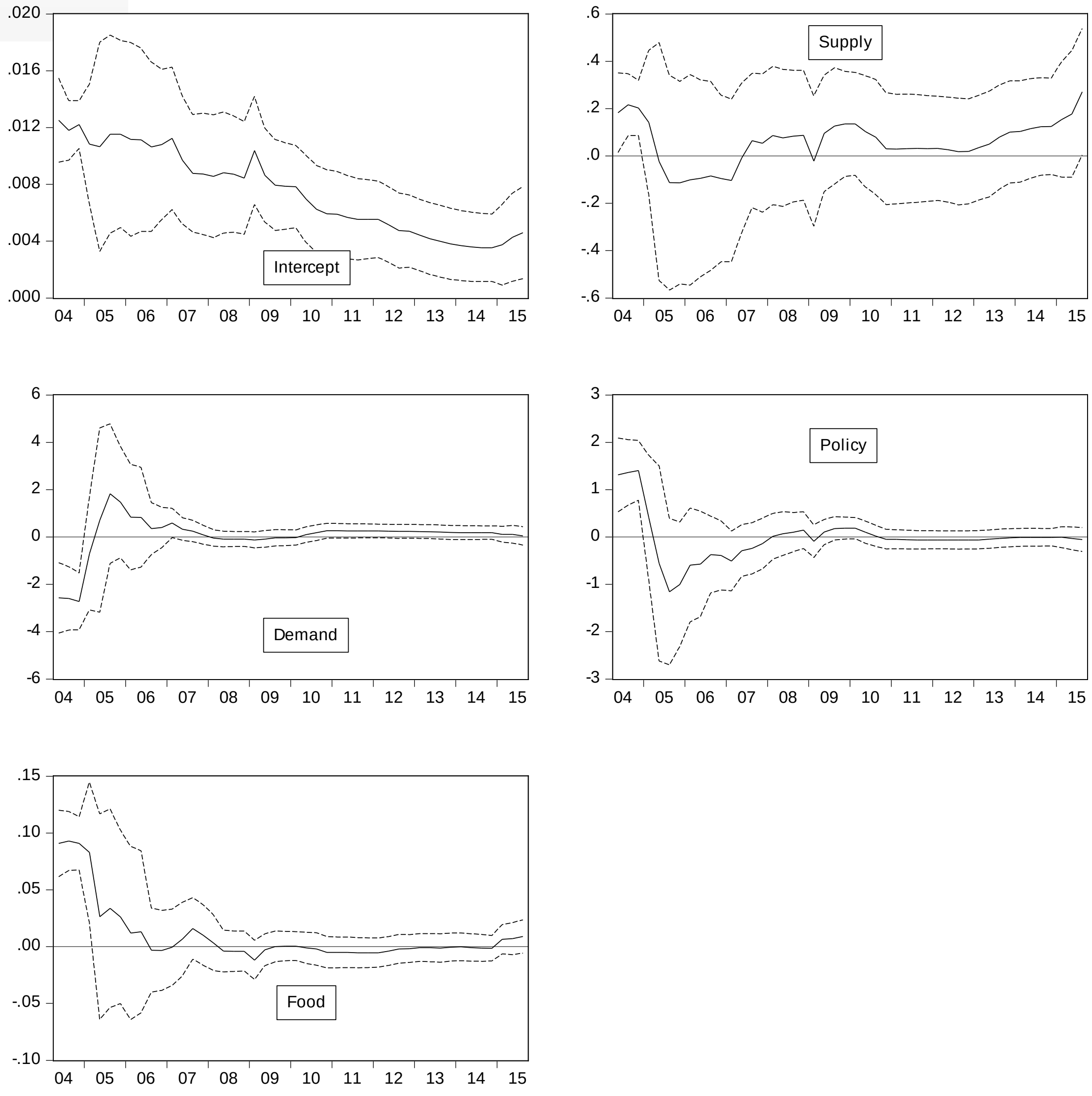
Coefficients of macroeconomic shocks in the regression for the deviation of monthly survey inflation expectations from target

Graph 5



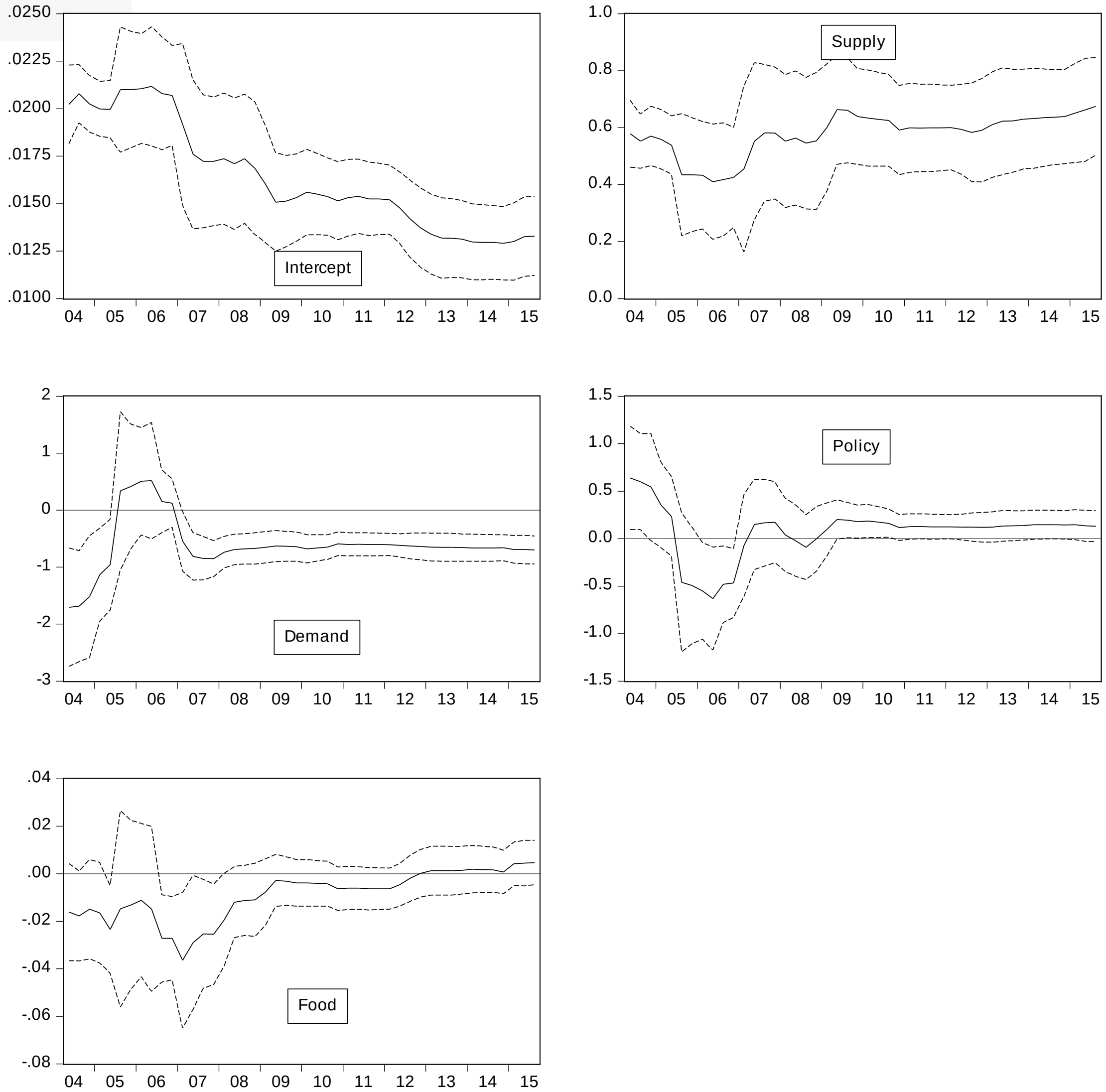
Coefficients of macroeconomic shocks in the regression for the deviation of BEI 1 inflation expectations from target

Graph 6



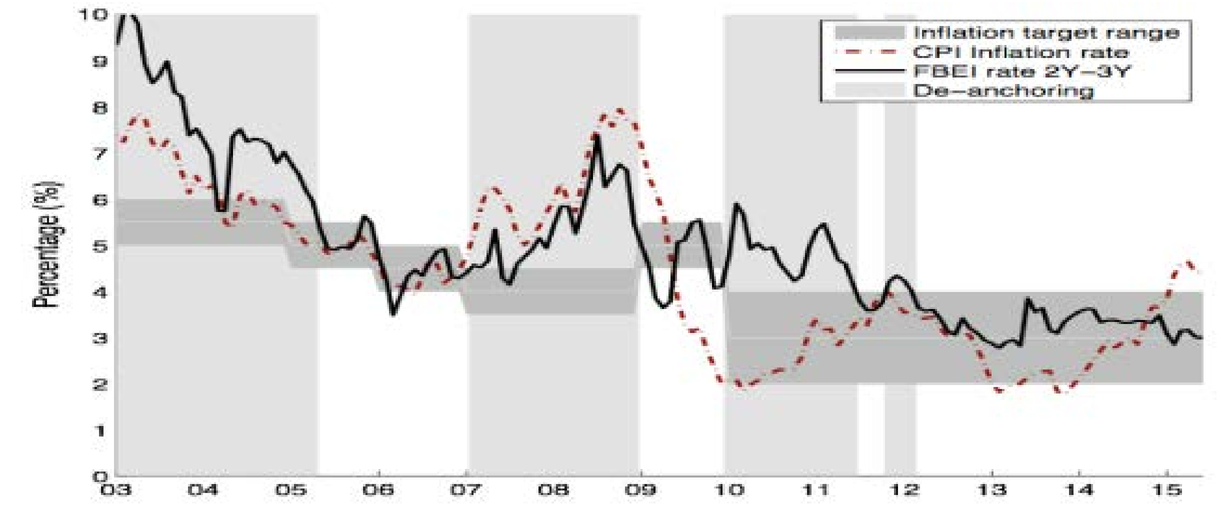
Coefficients of macroeconomic shocks in the regression for the deviation of F2BEI3 inflation expectations from target

Graph 7



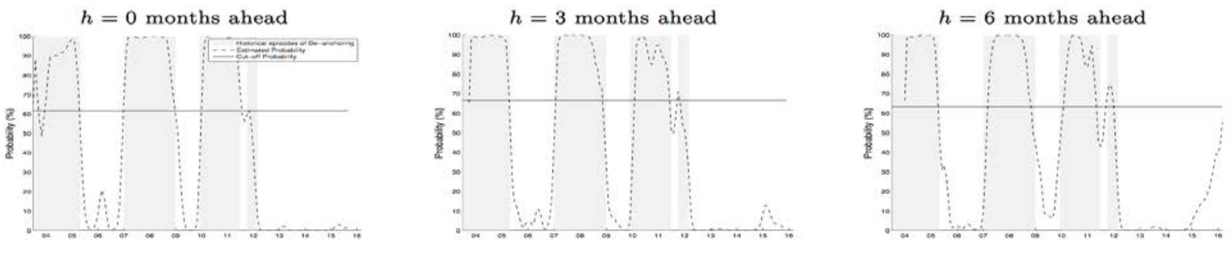
De-anchoring of inflation expectations: Historical events

Graph 8



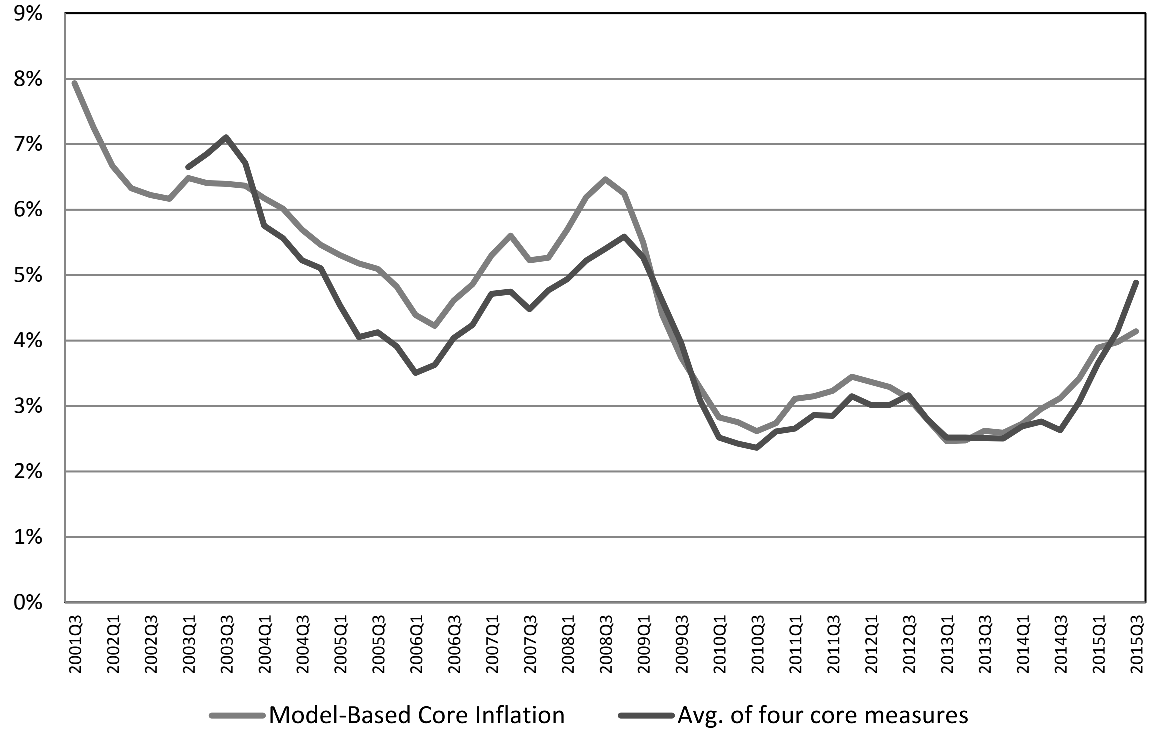
Probability of de-anchoring of inflation expectations: Direct estimation and prediction

Graph 9



Core inflation measures

Graph 10



Appendix 1

The Adaptive Learning Model (Huertas et al 2015)

The adaptive learning hypothesis assumes that agents act as econometricians to produce inflation forecasts. Since they do not know the structure of the economy, they need to establish a forecast rule known as perceived movement law (PML). Based on this law, they estimate the coefficients of the rule and update them when they observe new information and compute the forecast error.

To explore the relevance of this expectation formation mechanism, a test on whether inflation expectations can be estimated by an adaptive learning algorithm with a constant gain coefficient is performed (Pfajfar and Santoro (2010)). Suppose that agents have the following PML:

$$\pi^{g}_{t/t-j} = \phi^{g}_{0,t-1} + \phi^{g}_{1,t-1}\pi_{t-(j+1)} + \varepsilon_t$$

In this equation, agent g forms his forecast of inflation for period t in period $t-j$, $(\pi^{g}_{t/t-j})$, based on the observed inflation in the previous period $(\pi_{t-(j+1)})$. When headline inflation is published in period $t-j$, agent g updates the estimation of $\phi^{g}_{0,t-1}$ and $\phi^{g}_{0,t-1}$ with a constant gain law (CGL).

Let $X_t = (1, \pi_{t-j})$ y $\hat{\phi}_t = (\hat{\phi}_{0,t}, \hat{\phi}_{1,t})'$. Then, if a least square updating method is used, the estimated coefficient will follow this rule:

$$\hat{\phi}^{g}_{t} = \hat{\phi}^{g}_{t-1} + vR^{-1}_{t-1}X'_{t-(2j+1)}\left(\pi_{t-j} - X_{t-(2j-1)}\hat{\phi}^{g}_{t-(j+1)}\right)$$

$$R_t = R_{t-1} + v\left(X_{t-(2j-1)}X'_{t-(2j-1)} - R_{t-1}\right)$$

R_t is the matrix of second moments of X_t and v is the constant gain. When the gain is positive, the parameters are updated with their forecast error and the new available information. If the gain is zero, the coefficients are not updated and there is no learning.

To test for the existence of learning, the methodology used by Pfajfar and Santoro (2010) is followed. They propose this PML:

$$\pi^{s}_{t/t-j} = \phi_{0,t-1} + \phi_{1,t-1}\pi_{t-(j+1)} + \varepsilon_t \qquad j = \{1,12\}$$

Where s represent a simulated series. The method consists of calculating simulated series by combining estimates of v and ϕ. The idea is to find a combination of initial values of the coefficients and a gain parameter to replicate a measure of inflation expectations as close as possible.

Appendix 2

A small semi-structural macroeconomic model for Colombia (Bejarano et al (2015))

A semi-structural model is estimated for Colombia. It is based on the basic closed-economy New Keynesian monetary policy model and includes an IS curve, an ARMA equation for non-processed food (an important source of inflation shocks in Colombia), a "hybrid" Phillips curve for non-food inflation and a Taylor rule. The "hybrid" Phillips curve captures the effects of inflationary inertia. Each one of these equations is subject to shocks. Hence, there are four types of shocks: A food price shock that is associated with the food inflation equation, a "supply" shock that is related to the Phillips Curve, a "demand" shock that is associated with the IS curve and a policy shock that is linked to the Taylor rule. Being a closed economy model, the direct inflationary impact of exchange rate shocks is picked by the "supply" shock.

Phillips curve:

$$\pi_t^{sa} = \phi_1 \pi_{t-1} + (1 - \phi_1) E_t(\pi_{t+1}) + \kappa x_t + z_t^{\pi}$$

π_t is headline inflation, π_t^{sa} is non-food inflation, x_t is the output gap, z_t^{π} is an AR(1) supply shock.

Food Inflation:

$$\pi_t^A = \beta_1 \pi_{t-3}^A + \beta_2 \pi_{t-5}^A + \gamma_1 \varepsilon_{t-2} + \gamma_2 \varepsilon_{t-3} + \gamma_3 \varepsilon_{t-4} + \varepsilon_t$$

π_t^A is food inflation, ε_t is a shock associated with an ARMA(5,4) process that captures the dynamics of non-processed food prices. It includes the possibility of "cobweb-like" price behaviour.

IS Curve:

$$x_t = E_t(x_{t+1}) - \frac{1}{\sigma}[i_t - E_t(\pi_{t+1}^{sa})] + z_t^u$$

z_t^u is an AR(1) demand shock and i_t is the nominal interest rate.

Policy Rule:

$$i_t = \rho^i(i_{t-1}) + \left(1 - \rho^i\right)(\varphi^{\pi}\pi_t + \varphi^x x_t) + z_t^i$$

z_t^i is an iid policy shock, ρ^i is a monetary policy "smoothing" parameter, φ^{π} es represents the strength of the monetary policy response to deviations from the inflation target and φ^x is the degree to which policy reacts to the output gap.

The model is estimated for the period Q4 2000–Q4 2015.[22] The output gap series used in the estimation is the Central Bank Staff measure presented in the quarterly inflation reports. The parameters of the model are estimated with Bayesian methods.

Parameters	
ρ^{z_π}	0.2874
ρ^{z_u}	0.8758
ρ^{i}	0.9100
σ^{z_π}	0.0098
σ^{z_u}	0.0038
σ^{z_i}	0.0069
σ^{ε}	0.1474
φ^{π}	3.8626
φ^{x}	1.4277
ϕ_1	0.2759
σ	2.59
κ	0.0956

22 Central Bank staff short-term forecast were used for the 2015 Q4 data on inflation, GDP gap and the policy interest rate.

Appendix 3

Bayesian model averaging

BMA takes into account model uncertainty by going through all the combinations of models that can arise within a given set of variables (Green (1995); Raftery et al (1997)). Consider a dummy variable y_{t+h} as proxy of de-anchoring of long-term inflation expectations such that

$$y_{t+h} = \begin{cases} 1 \text{ if there is de} - \text{anchoring at time } t+h \\ 0 \text{ otherwise.} \end{cases} \quad (1)$$

for $t = 1, \dots, T$ and $h \geq 0$. The parameter h denotes time horizons for direct estimation.

The BMA methodology assumes that there is a set of possible models $M_1, \dots, M_k$ for estimating a quantity $y_{t+h} = 1$ from the set of variables, D_t. The k^{th} model, M_k, is defined by a subset of covariates of D_t. Instead of using a single model for performing inference on $y_{t+h} = 1$, BMA constructs $P(y_{t+h} = 1 \mid D_t)$, the posterior density of $y_{t+h} = 1$ given the data D_t, not conditional on any particular model. Many possible models are considered, so that model uncertainty is accounted for.

The posterior probability of $y_{t+h} = 1$ given data D_t is

$$P^{BMA}(y_{t+h} = 1 \mid D_t) = \sum_{k=1}^{k} \int P(y_{t+h} = 1 \mid \theta^k, M^k, D_t) \; P(\theta^k, M^k | D_t) d\theta^k \quad (2)$$

$P(y_{t+h} = 1 \mid \theta^k, M^k, D_t) = F(\theta^k, M^k, D_t)$ denotes the probability of being in an episode of de-anchoring of inflation expectations at time $t+h$, θ^k is one of the possible parameter sets of the M^k model and F is the cumulative logistic distribution function. On the other hand, $P(\theta^k, M^k | D_t)$ is the joint posterior probability of θ^k and M^k given data D_t. Therefore, Eq. (2) is a weighted average of probabilities $P(y_{t+h} = 1 \mid \theta^k, M^k, D_t)$ whose weights are given by $P(\theta^k, M^k | D_t)$.

We also compute a cut-off probability $\tau \in [0,1]$ above which the probability $P^{BMA}(y_{t+h} = 1 \mid D_t)$ for $t = 1, \dots, T$ and $h \geq 0$ provides a signal of de-anchoring. The value τ is computed as the solution to the minimisation problem

$$Min \; \varphi(\tau) \; subject \; to \; \gamma(\tau) \leq \bar{\gamma} \quad (3)$$
$$\tau \in [0,1]$$

$\varphi(\tau)$ and $\gamma(\tau)$ are the percentages of de-anchoring's false alarms and undetected events, respectively. The parameter $\bar{\gamma}$ corresponds to the maximum value of γ admitted by the policymaker. Guarín et al (2015) presents technical details of the derivation of the probability $P^{BMA}(y_{t+h} = 1 \mid D_t)$ in Eq. (2) and the minimisation problem in Eq. (3).

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Impact of the CNB's exchange rate commitment: pass-through to inflation[1]

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Abstract

Since 7 November 2013, the Czech National Bank has kept the exchange rate of the Czech koruna above 27 korunas per euro. As the key monetary policy interest rate had already fallen to zero, an exchange rate commitment or "floor" was introduced with the aim of preventing deflation in the Czech economy and restoring inflation to its target rate.

This note presents a simplified analysis of the pass-through of the CNB's exchange rate commitment to inflation and of why the subsequent turnouts of actual inflation need not have matched the CNB's initial expectation. We will not, however, attempt to evaluate the appropriateness of the decision to make the commitment or of the specific exchange rate chosen by the CNB for its floor; such an evaluation would require a detailed comparison between the information and forecasts that the CNB had available in late 2013 and later actual developments.[3]

Keywords: Exchange rate pass-through, exchange rate commitment

JEL classification: F31, E58

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[2] Czech National Bank.

[3] For assessments along these lines, see the CNB's Inflation Reports and, more specifically, the regular sections on "Fulfilment of the inflation target".

1. The CNB's exchange rate commitment as a supplementary tool for reaching the inflation target

1.1 The CNB's motivation for the NER commitment

During 2012, domestic inflation gradually fell below the target level of 2%, for both external and domestic macroeconomic reasons. In response, the Bank Board of the Czech National Bank (CNB) decided to reduce the policy rate to technical zero (0.05%) and committed itself to keeping the rate at that level for an extended period of time, until inflation pressures were seen to increase significantly.

During 2013, newly produced forecasts gradually started to indicate that inflation might actually fall below zero for at least several quarters, with the implied threat of a deflationary spiral. For this reason, on 7 November 2013, the Bank Board decided to immediately initiate FX interventions, a step that it had communicated as a possibility throughout the year. The publicly announced aim was to weaken the exchange rate to at least CZK 27 per euro with a commitment to intervene without time or volume constraints to prevent the koruna from returning below this level (Lízal and Schwarz (2013), Franta et al (2014), Skorepa and Hampl (2014)). In mid-December the CNB for the first time commented specifically on the duration of the commitment, saying that the floor would last "at least until early 2015". Currently the CNB declares it "probable" that the commitment will be discontinued "around the end of 2016".

1.2 The mechanics and transmission channels of the commitment

A temporary use of the nominal exchange rate, once the interest rate has hit the zero lower bound, with the aim of escaping a deflationary trap and achieving the inflation target, is fully consistent with suggestions provided by the theory of inflation targeting (Svensson (2001, 2003)). The general idea is that:

(a) by depreciating the nominal exchange rate (NER), the real exchange rate (RER) depreciates too; and

(b) by not allowing the NER to revert to its previous values, at least for some time, the RER will revert to its previous values (assuming these values were near the equilibrium level) via the inflation differential instead.[4]

Therefore, the logic of the commitment, or NER "floor", was to induce a permanent change in the ratio of the price level in the Czech economy and in the euro area[5] – to induce a certain "price level wedge". Given various rigidities in how price levels tend to react to shocks such as this one, the wedge could be expected to take the form not of an instant jump in the price level ratio but rather a period of elevated values for the inflation differential: the difference between the Czech inflation and its euro area counterpart could be expected to be, for a certain period of time, higher than without the NER floor. The first pro-inflationary impulse would come via the direct exchange rate effect, while the second would emerge through

[4] Needless to say, if the equilibrium RER features a trend, then the actual RER will revert to the previous equilibrium value adjusted by an appreciation trend.

[5] A ratio of price levels in two economies is often called a "purchasing power parity (or PPP) exchange rate" to distinguish it from the market exchange rate (see, for example, Callen (2007)).

higher inflationary expectations which would reduce ex ante real interest rates (while the nominal rate would be still at the technical zero), generating higher domestic demand.

Generally speaking, the nominal exchange rate depreciation of the koruna vis-à-vis the euro can be expected, sooner or later, to manifest itself in domestic prices through several channels, which include, in particular:

(a) a higher price for imported goods for final and intermediate consumption;

(b) a higher price for domestically produced goods due to demand pressures stemming from the substitution of foreign imported goods by cheaper domestic alternatives;

(c) boosted koruna profits for exporting firms as the depreciation raises export prices in korunas.[6] Higher profits then create a room for exporters to raise wages for their employees; this creates an upward pressure on Czech wages generally, which squeezes non-exporting firms' profit margins and ultimately leads to pro-inflationary pressures; and

(d) expected future inflation due to all the above-mentioned reasons, reducing real ex ante interest rates and thus fuelling current domestic demand.

Whatever channels could be expected to be part of the transmission process, we need to keep in mind that the ultimate objective of the NER floor was nominal (to achieve the inflation target); any real economic processes set in motion by the measure were just side effects, whether welcome or not.

1.3 Calibration of the commitment

Various CNB analyses conducted shortly before the floor's introduction indicated that pushing the NER specifically to at least CZK 27 per euro would gradually generate an inflation differential which, assuming a certain trajectory of inflation in the euro area, would make Czech inflation overshoot the CNB's inflation target of 2% in 2015; this would then allow the CNB to raise interest rates and thus escape from the zero lower bound problem.

The impulse to an inflation differential generated by such a one-off NER depreciation was, in itself, bound to disappear over time. But the CNB expected that in the meantime new pro-inflationary demand pressures would emerge on the back of a domestic as well as foreign economic recovery. The CNB's monetary policy would, sooner or later, be able to return back to the standard world of non-zero interest rates set at a level that would keep inflation near the inflation target.

[6] If export prices were to rise less than in step with the extent of the NER depreciation, then foreign demand for Czech exports and thus export volumes might increase. Gopinath (2015), however, concludes that prices in international trade between most countries of the world are set (and sticky) mostly in US dollars or euros. Be this as it may, the possibility that the introduction of the CNB's NER floor led to higher koruna profits for Czech exporters is consistent with the observed and sizeable year-on-year rise in Czech corporate profits in 2014.

1.4 Assessing the commitment

While the Czech National Bank's NER floor manoeuvre is still in progress, it can be assessed from at least three points of view: implementation, communication and macroeconomic impacts. In terms of implementation, the commitment has been a success: the exchange rate reached the CZK 27 level within two days and has remained at or above that level ever since.

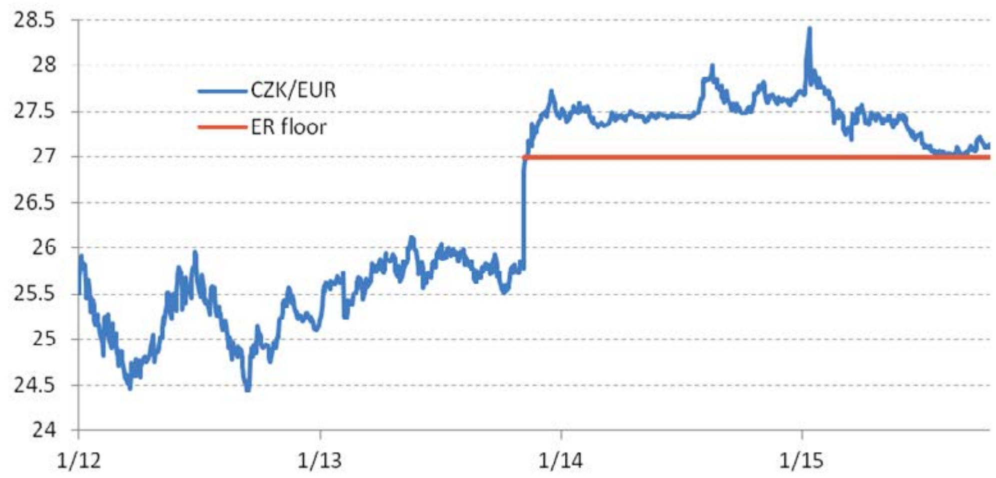
Especially in the first few months after the NER floor was introduced, the decision faced intense criticism from the public, the media and even from some economic analysts. In the light of this backlash, the CNB has intensified its efforts, as described in more detail in Franta et al (2014), to explain why it introduced the NER floor and what effects it expects the floor to have.

As regards actual macroeconomic effects, the jury is still out; the present note is an attempt to shine some light in this particular direction.

2. Evolution of actual exchange rate since introduction of the floor

The NER floor was announced and immediately applied on 7 November 2013. The actual spot exchange rate (see Graph 1) was 25.8 on the previous day; the average for the previous month as well as for the previous 12 months was 25.7. The jump to 27, most of which took place within a few hours on the very first day, thus represented a weakening of some 4.7% on a day-on-day basis and of slightly more than 5% relative to the previous 12 months.

The floor for the nominal CZK/EUR exchange rate and the actual exchange rate Graph 1



Source: CNB.

In its calculations, the CNB had assumed that after the floor's introduction the actual NER would hover at or just slightly above the floor level throughout the originally declared minimum period of commitment, that is, until the end of 2014. In reality, the NER quickly shifted to noticeably weaker levels: the average level for 12 months from 14 November 2013 was almost exactly 27.5, implying a year-on-year depreciation of 7%.

During 2015, however, the nominal exchange rate gradually moved back to the floor level of 27. We can thus say that, compared with what the CNB had planned for the initially considered one year of commitment, the NER has actually had a stronger effect towards inducing the build-up of an inflation wedge.Nevertheless, to keep matters simple, in what follows we will assume that the actual NER has been at 27 ever since the floor was introduced.

3. Observed price level wedge: CPI

From November 2013 to October 2015, that is, over the first 24 months of the existence of the NER floor, the consumer price index (CPI) increased cumulatively by 1.1% in the Czech Republic while it rose 0.6% in the euro area.[7] From this perspective, the actual price level wedge over that time period stood at half a percentage point; during the whole of 2015, this difference oscillated between 0.4 pp and 0.8 pp.[8]

How does this figure compare with the CNB's idea of the effect of a permanent weakening of the CZK/EUR exchange rate by 5%, ceteris paribus? Based on the estimated import content of various components of the consumer basket, CNB (2014) puts this effect at about 1.6 pp or one third of the original NER shock (much less than 5 pp or 100% of the shock because of the low import content of some parts of the CPI such as most services). This incompleteness of the NER pass-through into consumer prices is consistent with or perhaps somewhat higher than the estimates reported by Babecka-Kucharcukova (2009) for the Czech economy and those that Goldberg and Campa (2010) obtained for some other small open economies.[9]

By their construction, these estimates already encompass the important fact that the Czech economy is a very open one where many exporters are, at the same time, importers, so that they have significant "natural hedging" against exchange rate movements.[10]

7 Throughout this note, unless stated otherwise, figures attributed to the euro area will actually be averages of figures for 14 euro area economies weighted by Czech exports to those economies. These "effective euro area" figures are more relevant for our discussion, which is focused on the mutual relationships specifically between the economies of the euro area and the Czech Republic.

8 An alternative way to assess the intensity of the NER pass-through is to use HICP (rather than national CPI) data. For the whole HICP, the cumulative inflation differential over the first two years of the NER floor comes out at 0.6 pp. Focusing on the HICP segment labelled by Eurostat as "Goods" – which can be viewed as a proxy for tradable prices – the differential is 1.5 pp, confirming the intuition that the pass-through is stronger for the tradable parts of the consumer basket.

9 In fact, Goldberg and Campa (2010)'s figures describe the NER pass-through over four quarters. Figures for two-year periods can be expected to be higher, especially if monetary policy does not try to counteract the exchange rate movement. In the long run and assuming a fixed nominal exchange rate, the pass-through should be complete.

10 The fact that economies get more and more involved in global value chains has recently been reiterated by Ahmed et al (2015). The estimates reflect implicitly also the observation (Forbes (2015)) that the extent of exchange rate pass-through depends on the source of the exchange rate shock.

One possibility is to start, for simplicity, with an expositional assumption that the CNB's NER floor was the only factor affecting the Czech price level differently than the euro area's – such that without the floor, the two price levels would evolve in step. Under this assumption, it becomes sensible to directly compare the price level wedge of 0.5 pp, as actually observed at the end of the first two years of the NER floor, with the 1.6 pp wedge that the CNB would expect, and to conclude that the former is just one third or so of the latter.

Does this mean that the exchange rate pass-through in the Czech economy is much weaker than the CNB expected, and that the CNB's NER commitment is not very effective? Not necessarily. We need to realise that, on top of the NER floor, the ratio of price levels may have been hit by other shocks with asymmetric effects – that is, the above-mentioned expositional assumption is grossly incorrect.

3.1 Factors in the Czech economy

Generally speaking, two types of asymmetric shock that are particularly relevant to the ratio of CPI levels are changes in administered prices or indirect taxes – to the extent, of course, that these changes take place "on one side of the border" only.[11]

As for administered prices on the Czech side, we can mention the abolition of some health care fees in January 2014 and of additional health care fees in January 2015. The cumulative contribution to total price level changes over 2014 and 2015 was about –0.3pp (CNB (2015)). An even deeper negative contribution (of about –0.5 pp) came from a fall in the regulated price of electricity at the start of 2014.

As for changes in indirect taxes, a reduction of the Czech VAT rate for selected products from January 2015 had some disinflationary impact on the CPI relative to the euro area. On the other hand, in 2014 the Czech government made two increases to the excise duty on tobacco products. The overall impact of all these measures in the area of indirect taxes was some 0.2 pp, thus offsetting about one quarter of the disinflationary impact of the above-described domestic shocks to administered prices.

3.2 Factors in the euro area

Moving now to the other side of the border, we can find certain local pro-inflationary pressures, that is, pressures which reduce the observed price level wedge and therefore work in the opposite direction to the CNB's ER floor.

Focusing specifically on Germany as the Czech economy's dominant trading partner, in 2014 the German CPI was likely to have still been digesting the repercussions of a hefty increase in the surcharge on retail electricity prices in line with the Renewable Energies Act of 2013 (Destatis (2014)).

As regards indirect taxes, their contribution to the movement of the CPI level can be estimated by comparing Eurostat data on standard HICP versus its data on HICP with constant rates of indirect taxes. This comparison reveals that, while indirect taxes

[11] Asymmetries may emerge also simply due to different weights of individual COICOP categories – such as food or fuels – in the national CPI consumer baskets. The differential importance of various items for the two economies will be tackled in more detail in the following section devoted to PPI developments.

grew in the euro area over 2014 and 2015, their contribution was roughly half of that in the Czech economy.

3.3 PPI more suitable than CPI

Clearly, one might come up with many such larger or smaller non-fundamental asymmetric shocks to the ratio of CPI levels that have emerged since the NER floor was introduced, but which had not been anticipated by the CNB when it selected the floor level. Disentangling the direct and especially the indirect effects of these shocks in each of the two economies separately and then arriving at a ratio of CPI levels net of these shocks would be a daunting task.

Given that these shocks are likely to occur especially in administered prices and indirect taxes, it seems advisable to shift our focus from consumer prices to producer prices. First, at the level of producer prices there tends to be less price regulation (with exceptions such as producer prices for some kinds of energy). Second, changes in indirect taxes are likely to have a weaker impact as they formally apply to consumer prices: for instance, if the VAT rate for books is increased, it will have an impact on wholesale prices only if publishers decide to use this opportunity and lower or raise their margins by raising their prices more or less than proportionately.

4. Observed price level wedge: PPI

In the previous section, we pointed out that the wedge effect of the CNB's NER floor on the price level ratio is hard to determine for the CPI figures as the observed – rather weak – result may have been contaminated by various other asymmetric shocks to one or the other of the two local CPI levels being compared.

Looking at the producer price index (PPI), from November 2013 to October 2015 it fell cumulatively by 2% in the Czech Republic while it fell by 2.8% in the euro area. The actual price level wedge over that time period in terms of producer prices thus reached 0.8 pp. This figure is somewhat higher than that for consumer prices. But it still represents just about one half of what the CNB had expected. Also, the net pass-through of a given exchange rate shock to the PPI can, compared with the CPI, be expected in the current condition of the Czech economy to be significantly higher – by a factor of two or three (Babecka-Kucharcukova et al (2013)).

Even putting aside the potential – probably weak or temporary – effects of changes in administered prices or in indirect taxes, there may have been, besides the NER floor, still other shocks that affected (asymmetrically) producer prices.

4.1 Initial overvaluation of the Czech koruna

At the moment of introduction of the CNB's NER floor, the real exchange rate of the koruna to the euro may have been overvalued, that is, stronger than the equilibrium value.[12] If the koruna really was overvalued, one would expect a subsequent

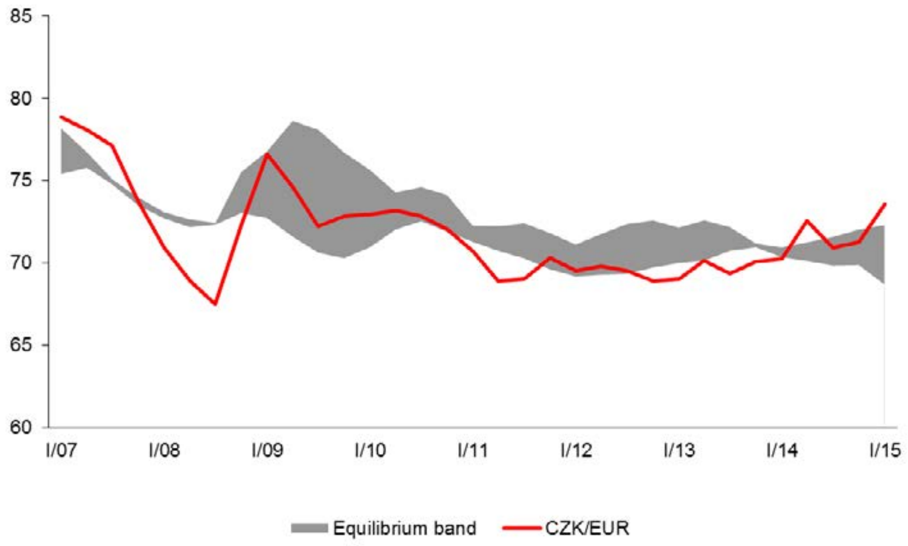
[12] It could just as well have been weaker; however, misalignment in this direction would not, obviously, attenuate the effect of the floor in the way that an overvalued real exchange rate did (as described in the main text).

spontaneous movement of the RER back towards the equilibrium value – whether via a negative CZK-EUR inflation differential or via NER depreciation. But then at least a part of the depreciation brought about by the CNB's NER floor could be "used up" by this re-alignment and so the desired price level wedge effect of the NER floor would be attenuated.

Recent estimates published both by the CNB and by the IMF suggest that in late 2013 the RER indeed was overvalued. The estimates in CNB (2015) point to an overvaluation of around 1–3% on average in late 2013 (Graph 2). The estimate relies on the BEER (Behavioural Equilibrium Exchange Rate) and FEER (Fundamental Equilibrium Exchange Rate) concepts. The BEER approach takes into account a set of key variables affecting the long-run real exchange rate, as the productivity differential and inflows of foreign investment. The FEER identifies the real exchange rate consistent with an external balance, approximated by the current account, and an internal balance approximated by full employment.

CZK/EUR real equilibrium exchange rate

Q1 2000 = 100; CNB calculations Graph 2



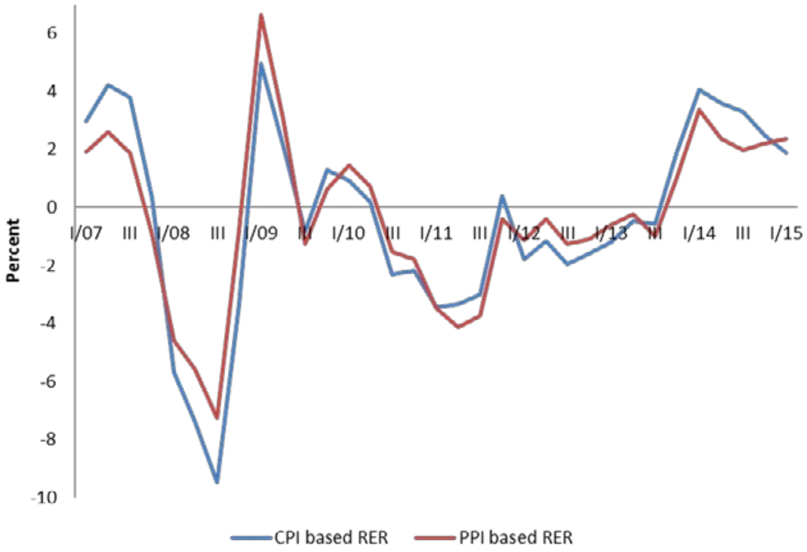
Note: Equilibrium estimates according to the BEER and FEER models deflated by the index of producer prices in manufacturing.

Source: CNB Inflation Report III/2015.

IMF (2014), building on the External Balance Methodology (IMF (2013)), finds the RER to be overvalued by about 5% in 2013. Finally, applying the HP filter to the RER suggests an overvaluation of about 1% in Q1–Q3 2013 (Graph 3).

Real exchange rate gaps – HP filter

Percent | Graph 3



Note: A negative real exchange rate gap suggests over-appreciation.

Source: Authors' calculation.

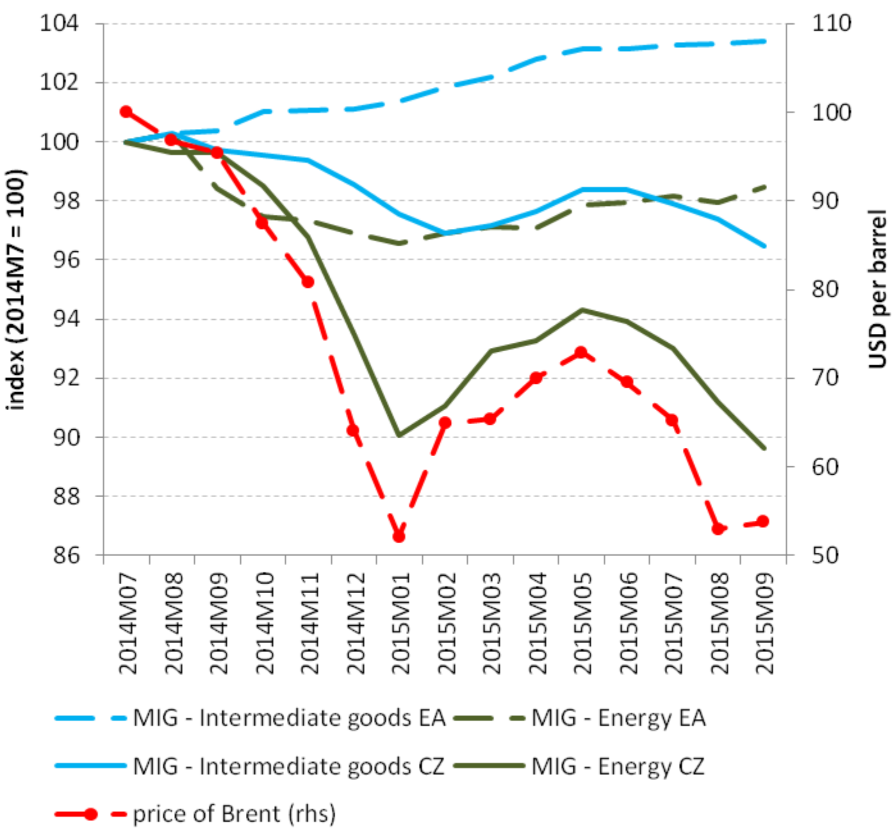
4.2 Fall in the world price of oil

As a shock able to provide at least a partial explanation for the disappointing size of the price level wedge, perhaps the most promising is the dramatic fall in the world price of oil between August 2014 and January 2015. By definition, the world price is (roughly) the price at which oil is bought by any importer, the price being set in the relevant currency – in the case of oil, this currency is the US dollar. So any given change in this price is, in itself, a *symmetrical* shock for all economies; for various reasons, the implications for different economies can, however, be very different so that the ultimate result is an *asymmetrical* shock.

Graph 4 focuses on what Eurostat calls the main industrial groupings (MIG) "Energy" and "Intermediate goods" – that is, those two parts of industrial producer prices which are most likely to react fairly quickly and strongly to oil price developments. As the graph indicates, the fall in the price of oil in the second half of 2014 does seem to have had an asymmetric impact: in late 2014 a sizeable gap between producer prices in the euro area and the Czech economy opened and kept growing in both industrial groupings.

Producer prices in the areas of energy and intermediate goods in the euro area and the Czech Republic

Graph 4



Sources: Eurostat, US Energy Information Administration.

4.3 Downward price pressures in the manufacture of food products

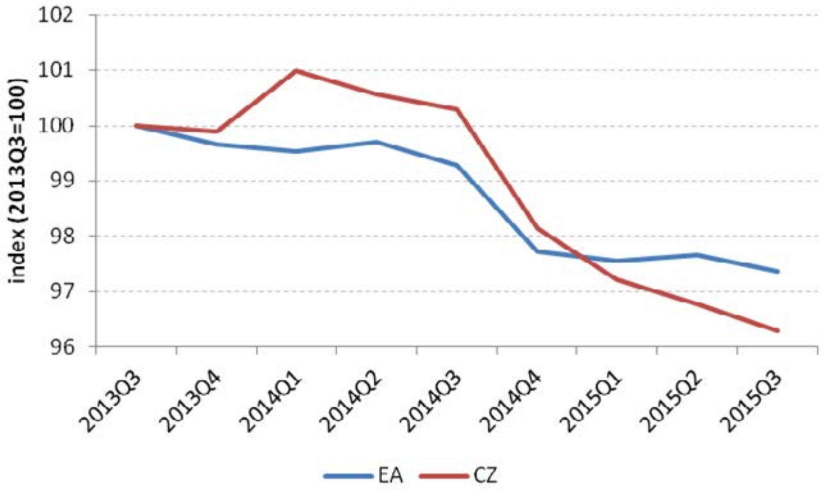
After sanctions were imposed on Russia in the spring of 2014 in response to developments in Crimea, Russia retaliated with, among other measures, a ban on food imports to Russia from Australia, Canada, the EU, Norway and the United States. This ban is likely to have caused an increase in the supply of food products in many economies in the EU (and elsewhere), including the Czech Republic.

As Graph 5 suggests, however, while prices in the NACE branch "Manufacture of food products and beverages" have fallen since the third quarter of 2013 in both economies under study, the fall in the level of Czech prices during 2014 was less pronounced than that in their euro area counterparts. This need not be a surprise, given that the share of fruit and vegetables exports to Russia in the GDP is actually about twice as high in the euro area than in the Czech Republic.

Czech food prices started to fall faster than those in the euro area only towards the end of 2014 and in 2015. This indicates that perhaps the generally good European harvest in 2014 was particularly good in the Czech Republic (see eg USDA FAS (2015)) or there may have been a particularly strong reaction of Czech producer prices to the abolition of the EU milk quota at the end of March 2015.

Producer prices in "Manufacture of food products and beverages" in the euro area and in the Czech Republic

Graph 5



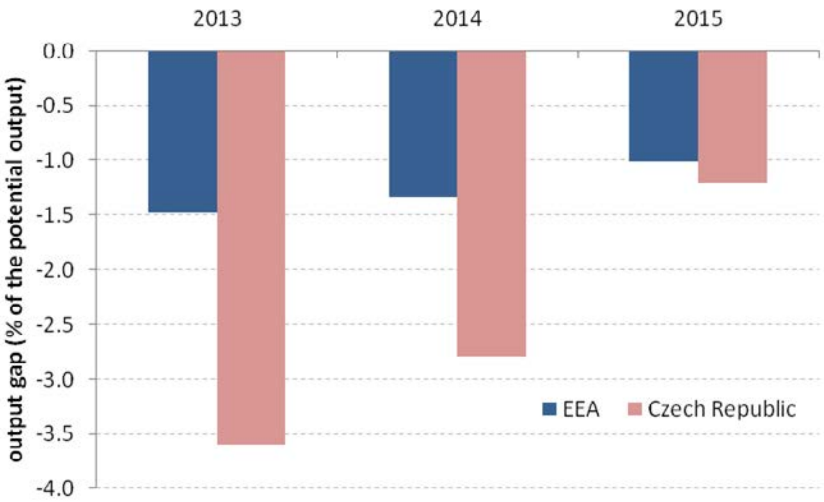
Source: Eurostat.

4.4 Cyclical position of the economy

Another cross-border asymmetry between factors of price evolution in the economy of the Czech Republic and those of the euro area, this time from the demand side, would arise if the time period during which the CNB was applying its NER floor were characterised by the different cyclical positions of the two economies. Graph 6 shows that, while in 2014 and 2015 both economies suffered a negative output gap, the Czech recession was markedly deeper. Needless to say, the output gap recorded in the Czech economy in 2014 and even more in 2015 is likely to have been already influenced – via the transmission mechanisms described above – by the introduction of the CNB's NER floor in November 2013.

Estimated output gap

Graph 6



Source: IMF, *World Economic Outlook* database.

5. Pass-through dynamics

In Section 3 above, it was stated that the CNB's ex ante estimate of the price level wedge generated ceteris paribus by the NER floor, if applied permanently, was 1.6 pp. This estimate was based on the analysis of nominal flows among economic sectors, the structure of value added and the components of final use during a single year (accessible in the input-output tables of the Czech Statistical office).[13] Estimates based on the CNB's structural forecasting model were even slightly higher. Even if there were no asymmetric shocks pushing on the ratio of Czech and euro area price levels in the opposite direction than the direction intended by the floor the currently observed wedge might also be smaller than 1.6 pp for the simple reason that two years have not been enough for the whole effect to play out.

More specifically, various rigidities within the Czech economy which cause a delay before the price signal from the exchange rate reaches domestic price indices may drag on the process more severely than the CNB estimated.[14] But there seems to be little reason for these rigidities to have grown stronger in recent years compared to the previous time period on which the CNB based its assessment of the likely speed of the pass-through.

A related possibility is that, at the first stage, exporting companies' owners may have chosen not to offer wage rises to their workers, so that one of the transmission channels may have been weakened. Instead, the owners may have decided to cash out the higher profits via dividend payouts (a large part flowing abroad, given the high share of foreign ownership in the Czech economy) or to raise investment (Levy-Yeyati and Sturzenegger (2007)).

6. Expectations

A different possibility is that the pass-through has been hindered by firms' doubts about the actual duration of the floor. Imagine a typical Czech exporting company, as mentioned above in Section 1.2, when considering the transmission channels for the NER floor. Regarding assumptions about the future, the company had two basic options. First, it could conclude that the exchange rate would stay near 27 for a "fairly long" period of time, allowing the company – in line with the logic of the floor – to raise output prices or to expand productive capacities and to attract more workers by raising wages. The exporter's second option was to expect the exchange rate to revert to much stronger levels sooner rather than later, in which case making new investments and raising wages would not be wise.

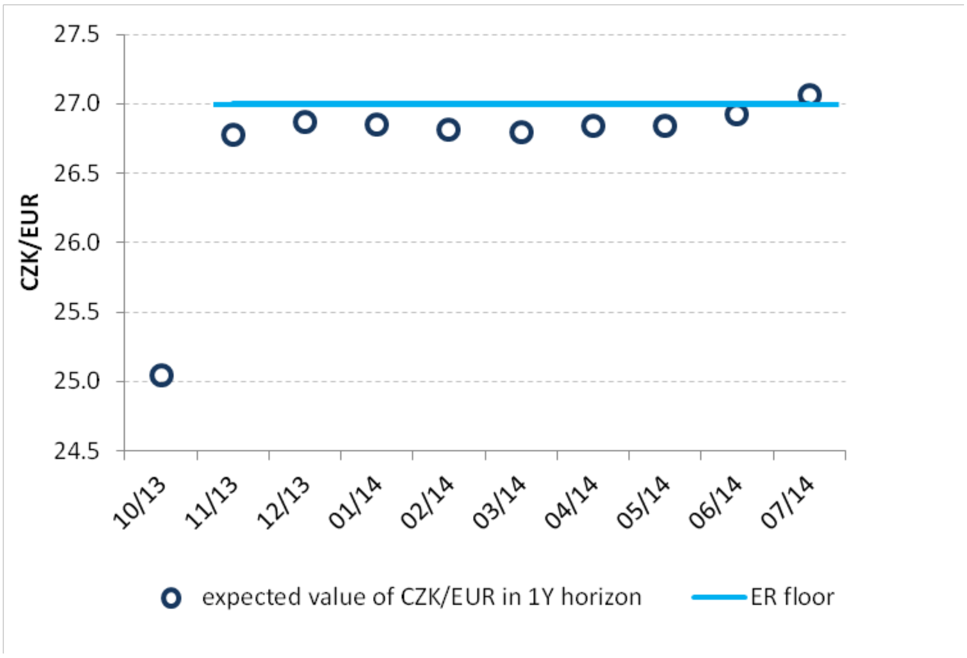
Graph 7 shows the extent to which Czech financial sector analysts participating in a regular CNB survey changed their expectations of the exchange rate immediately before and several months after the introduction of the floor. The expected level of the exchange rate on a one-year horizon did rise markedly in November 2013 relative to the level expected one month earlier. But the one-year exchange rate expectation actually reached the floor level only in July 2014.

[13] For more details see CNB (2014).

[14] See, for example, CNB (2011).

Analysts' exchange rate expectations versus the CNB's NER floor

Graph 7



Source: CNB.

The first time that the CNB commented on a specific time horizon for the potential discontinuation of the commitment was in mid-December 2013, when it was announced that the floor would be in place "at least until early 2015". Given this, the message of Graph 7 is that, at least in the first one or two months after November 2013 (in which the actual exchange rate had already reached levels well above 27 korunas per euro), the analytical community may have had certain doubts about whether the CNB would (be able to) honour the commitment up to the stated horizon of early 2015. Since the initial horizon-specifying statement made in December 2013, the declared horizon has been changed several times. At the end of July 2014, it was amended to "not before 2016". At the beginning of February 2015, it was further updated to "not before the second half of 2016". In November 2015, it was reformulated to "probably around the end of 2016". So the residual minimum duration of the commitment has never been longer than about six quarters. So one possibility is that at least some companies may have understood "six quarters (or more)" as not "fairly long" enough in the above sense to make critical changes such as boosting production or raising wages.

The same CNB survey showed that the floor's introduction in November 2013 caused no perceptible change in analysts' expectations regarding wages and GDP growth GDP for 2014.[15] This lack of impact indicates that the private sector initially doubted that the floor would endure for a "fairly long" enough time to produce the macroeconomic effects intended by the CNB.

If typical Czech exporters shared the analysts' views, it may well have continued to doubt for some months after November 2013 that the floor's profit-enhancing

15 The time series of these expectations can be accessed at www.cnb.cz/en/financial_markets/inflation_expectations_ft/.

effects would persist at the same level as in these first few months. Of course, the same kind of initial uncertainty may have, at least temporarily, inhibited the pass-through via importers' behaviour. The reluctance of importers to raise their output prices for the domestic market may have been amplified by a fear of first-mover disadvantage, at least in competitive sectors.

6. Summary

In November 2013, the CNB introduced an exchange rate commitment with the aim of driving a positive wedge between the future path of the Czech price level and that of the euro area price level. We find that the actual price level wedge, that is, the actual change in the ratio of the two price levels, after two years of the commitment to be about 0.5 and 0.8 percentage points for CPI and PPI, respectively. We explain that the PPI might be a more suitable price index when assessing the pass-through than the CPI since the latter tends to suffer more from often non-fundamental shocks in indirect tax changes and regulated prices. But even the 0.8 pp value for the PPI is only about half of the net long-term effect that was forecast by the CNB. In addition, existing empirical estimates for the Czech economy indicate that, for the PPI, the pass-through should be up to three times stronger than for the CPI.

We then identify – albeit very briefly and often just qualitatively – some of the major factors that may have worked against the intended effect of the NER floor, ie that may have pushed the Czech price level lower than that of the euro area. The paper suggests that several types of factor underlie the lower than expected net pass-through of the NER floor. First, various ex post estimates point to a real exchange rate overvaluation at the end of 2013. In this case, at least part of the nominal exchange rate depreciation generated by the commitment would simply offset the initial overvaluation, reducing the effect on the price level wedge.

Second, some shocks might have had asymmetrical effects in the Czech Republic and the euro area, such as the drop of world oil prices in late 2014 along with a deeper recession in the Czech Republic than in the euro area in 2014. Using energy and intermediate goods in the PPI sub-index, the paper shows that the prices of these items fell more sharply in the Czech Republic than in the euro area, probably due to different structural characteristics. As a result, the world oil price shock and its asymmetric effects have partially offset the price level wedge that the CNB's exchange rate commitment was intended to generate. Similar effects may have come from foodstuffs. A deeper recession and thus higher disinflationary pressures in the Czech Republic have likely also mitigated the actual size of the wedge.

Finally, the pass-through of the commitment may have been weakened if the market had expected the exchange rate commitment would not persist.

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Inflation mechanism and monetary policy: perspectives from Hong Kong

Lillian Cheung, Kevin Chow, Michael Cheng and Philip Ng

Abstract

Hong Kong's inflation is heavily influenced by the development in the property market, as property prices can affect the CPI through the CPI rental component, rental cost effect on service fees and charges, and the wealth effect on aggregate demand. Therefore, the deployment of countercyclical and other prudential measures by Hong Kong SAR's policymakers not only enhances the banking sector's resilience to property market shocks, but also helps to mitigate big swings in consumer prices resulting from property market booms and busts.

Keywords: Inflation, monetary policy, property market

JEL classification: E31, E50, R30

1. Inflation dynamics in Hong Kong SAR

Hong Kong's inflation dynamics are quite different from those of its Asian peers. Unlike in many other Asian economies, where the tradables make the largest contribution to inflation, Hong Kong's inflation is largely influenced by non-tradables, with the food component accounting for only a small share. In particular, inflation in Hong Kong SAR is heavily influenced by changes in the rental component, which in turn is affected by the boom-bust cycle in property prices. At the same time, higher property prices also drive up the rents of commercial premises, exerting upward pressure on service fees and charges. The positive wealth effect stemming from the property market up-cycle may also increase domestic price pressure through the consumption channel. All these point to the significant role of property prices in driving Hong Kong's inflation cycle.

In Hong Kong, the most commonly used indicator of headline inflation is the government-compiled Composite Consumer Price Index (CCPI). But to ease the domestic price pressures faced by different income groups, the government from time to time rolls out one-off relief measures (eg waivers of public housing rent, rate concessions and electricity charge subsidies) to mitigate the impact of inflation on citizens' well-being, particularly for the underprivileged.[1] As these relief measures understate the actual price movements in the rental and other components in the CPI basket, the government has also published the underlying inflation rate with these one-off effects removed, which is more useful for gauging domestic price pressure (Graph 1). But unlike in some other economies, there is no officially defined "core" inflation in Hong Kong.[2]

Non-tradables account for the bulk of the CPI basket, reflecting the service-oriented nature of the Hong Kong economy. The service component accounts for 76% of the consumption basket, with the housing rent component amounting to about one third of the CPI basket. Tradables such as primary food, beverage and consumer durables contribute to the remaining portion of the CPI basket, with primary food taking up about 10% of the basket (Table 1). This is quite different from other Asian peers, where CPI inflation is more sensitive to changes in the prices of basic food and agricultural products, given that food is a major household consumption item.

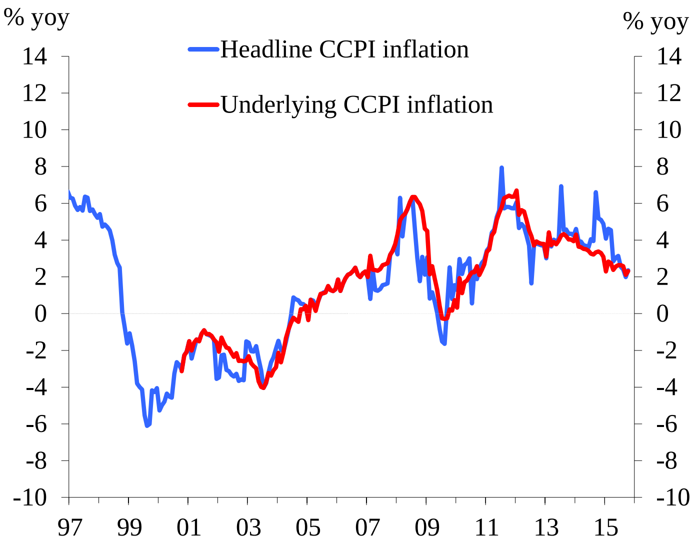
The heavy weighting of the rental component suggests that large swings in property prices could have a significant effect on Hong Kong's CPI inflation. Past developments show that movements in housing rent explain almost half of the fluctuation in headline CPI inflation over most of the past decade (Graph 2). In particular, the marked decline in the rental component played an important role in the 1999–2004 deflation episode, when house prices dropped by close to 70% from peak to trough in the aftermath of the Asian financial crisis. The strong influence of the rental component on CPI inflation in part reflected the relatively large movement

1 These one-off relief measures aim to ease the burden of inflation on people's livelihoods. As the relief measures reduce the final costs people pay for various goods and services, they lower the CCPI in the months of implementation, thereby causing swings in CPI inflation.

2 That said, see F Leung, K Chow and S Chan, "Measures of Trend Inflation in Hong Kong", *HKMA Working Papers*, no 07/2009, April 2009, who found that the "trend" inflation estimated by the exclusion method (by excluding basic food, energy and other volatile items) and the principal component technique had strong predictive power on future changes in the headline CCPI inflation.

in housing rent in line with the up and down cycle of property prices. Meanwhile, as higher property prices also tend to drive up the commercial rents that constitute a significant part in the operating expenses of service providers, any significant change in rents of commercial premises will prompt business owners to pass this increment through to their service fees and charges. This also helps explain the stronger co-movement between the components of rentals and other services in the CPI basket.

Headline and underlying inflation in Hong Kong Graph 1



Note: Underlying inflation data only start from around year 2000.

Source: Census and Statistics Department (C&SD).

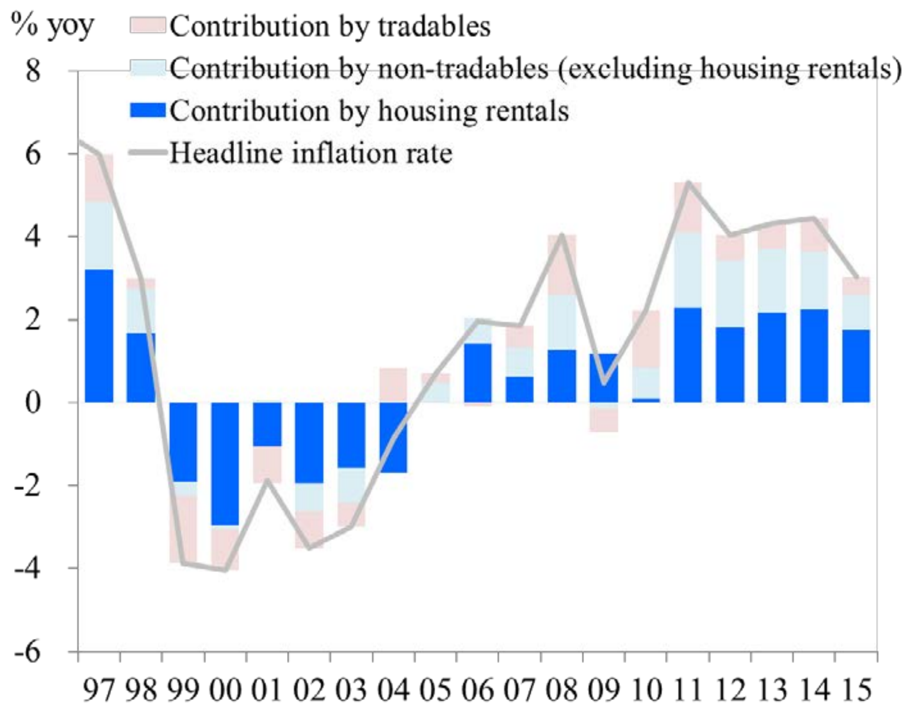
Expenditure weights of consumer goods and services used in the CCPI Table 1

Year 2009–10	%	%	%
1. Services			**76.14**
Housing			31.66
Rent, including rates and government rent		29.19	
Housing: private housing rent	27.14		
Housing: public housing rent	2.05		
Food: meals bought away from home			17.07
Transport			8.44
Motor fuel		0.59	
Electricity, gas and water			3.10
Liquefied petroleum gas and other fuel		0.18	
Miscellaneous services			15.87
2. Goods			**23.86**
Food: basic food that excludes meals bought away from home			10.38
Durable goods			5.27
Clothing and footwear			3.45
Alcoholic drinks and tobacco			0.59
Miscellaneous goods			4.17
3. Goods and services			**100.00**

Source: C&SD.

Headline inflation and its major components

Graph 2



Source: C&SD and HKMA staff calculation.

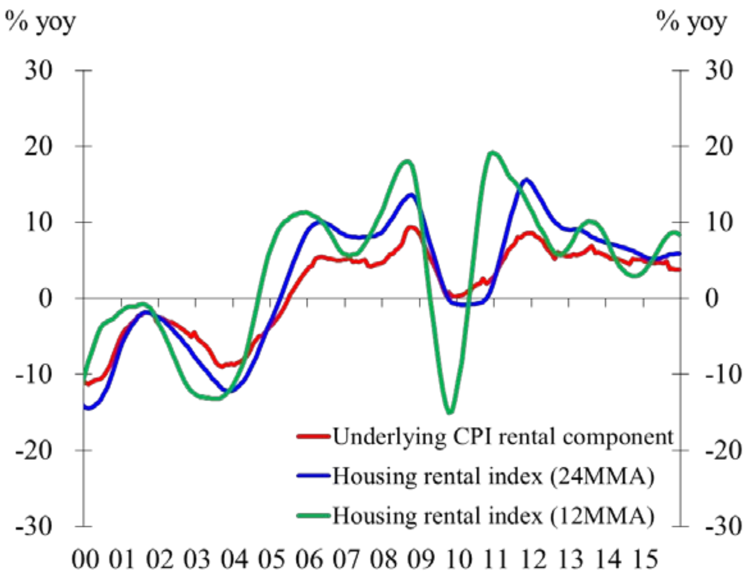
Understanding the dynamics between the housing rental component and market rentals, between housing rents and prices, as well as between the rental and non-rental component of the CPI basket is therefore important for gauging and assessing consumer price trends in Hong Kong.

Technically, **there is a significant time lag before a change in housing prices feeds through to housing rents**, as the tenancy of private dwellings usually lasts for one to two years depending on contractual agreements. Reflecting these factors, changes in house prices only gradually pass into CPI inflation through the rental component, with a degree of pass-through that is rather less than one-to-one. Past experience suggests that the housing rental component of the CPI very closely tracks the 12-month and 24-month moving average of market rentals (Graph 3). Given the important role that the rental component plays in Hong Kong's overall CPI inflation, one can therefore get a good sense of where inflation is heading by tracking movements in market rentals.

Historically, **there has been a strong co-movement between housing rents and house prices**, but the former tends to be less volatile than the latter (Graph 4). This is because housing rent is largely determined by end user demand, while the price of a residential property could be affected by both end user and investment demand, with the latter driven by a host of factors such as interest rates and price expectations.

CPI rental components and housing rentals

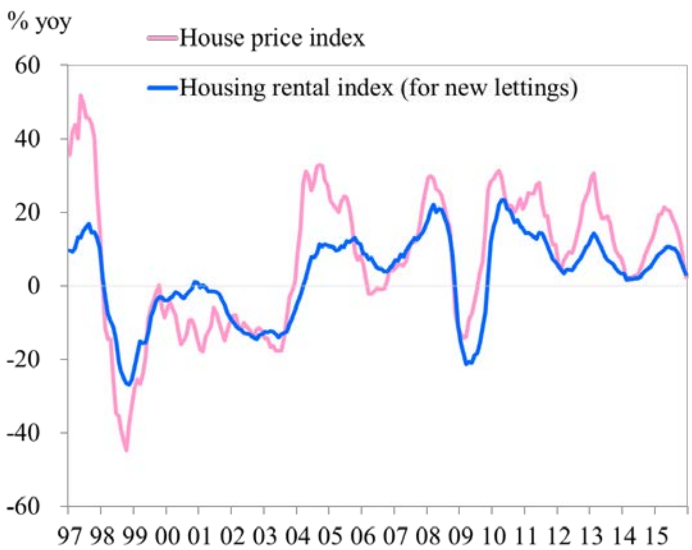
Graph 3



Sources: C&SD; Rating and Valuation Department (R&VD); HKMA staff calculations.

Growth in market rentals and house prices

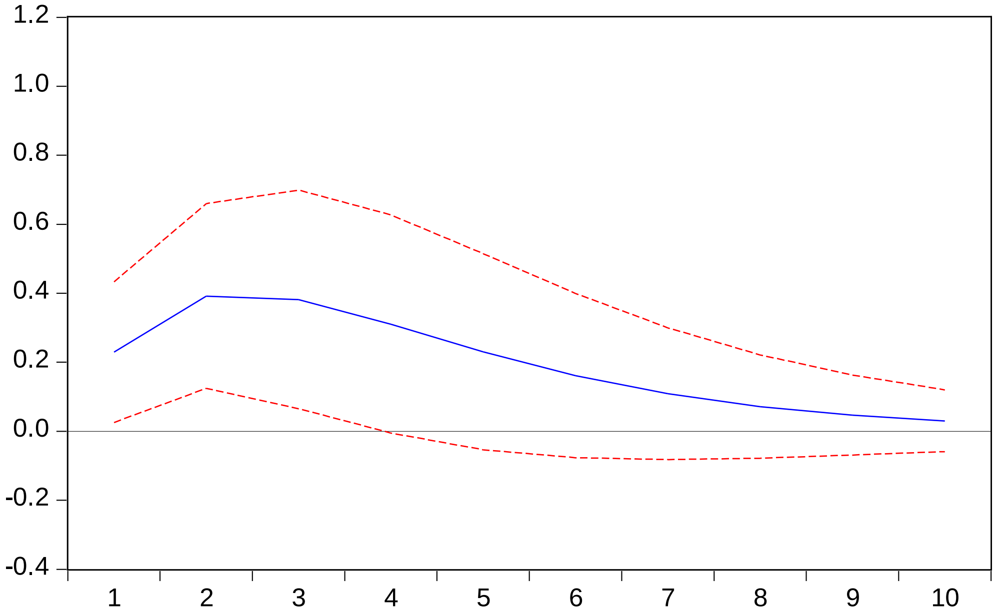
Graph 4



Source: R&VD.

Response of output gap to a positive house price shock

Graph 5

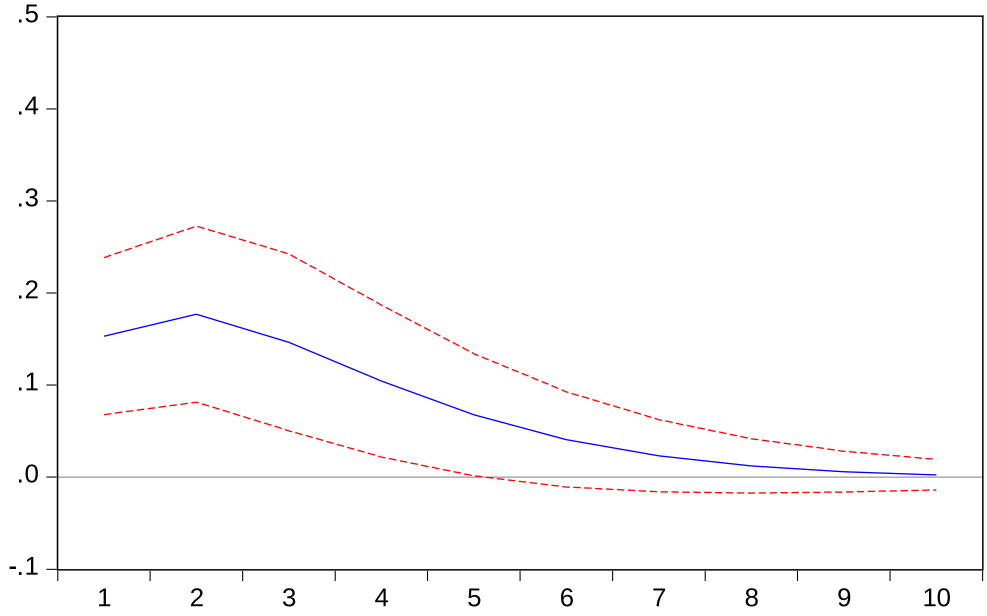


Sources: C&SD; HKMA staff calculations.

House prices can also affect CPI inflation through a number of indirect channels such as their impact on the wealth effect and prices of property-related services and items. In a simple vector auto-regression (VAR) model with CPI non-rental component inflation, the output gap and house price inflation as endogenous variables, and retained import price inflation as exogenous variables, a positive shock to house price inflation is estimated to increase both the output gap and CPI non-rental component inflation (Graphs 5 and 6), reflecting house prices' wealth effect on aggregate demand as well as the rental cost pressure on service fees and charges.[3]

[3] The VAR model is estimated with quarterly data from Q2 2000 to Q3 2015, and one lag of each variable is included in the VAR, based on lag length selection criteria. The output gap is expressed as a percentage difference from the potential GDP, while house prices and the CPI non-rental component are expressed in log-difference. For details of the estimation of Hong Kong's output gap, please refer to M Cheng, L Chung and I Yu (2011), "On the Estimation of the Output Gap of Hong Kong", *HKMA Occasional Paper*, no 03/2011, 28 October 2011. The impulse responses are estimated using the generalised impulse response technique, which is robust to the ordering of variables in the VAR.

Response of CPI non-rental component to a positive house price shock Graph 6



Sources: C&SD; R&VD; HKMA staff calculations..

2. Interlinkages between financial stability and price stability and implications for monetary policy

Owing to the strong influence of property prices on domestic inflation, large swings in house prices will not only have significant implications for financial stability, but will also undermine price stability. For example, during the up-cycle in the property market, overheating pressures will increase the banking sector's vulnerability to property price shocks, while the positive wealth effect and buoyant real estate sector will strongly boost domestic demand, thus exerting upward pressure on overall consumer prices. During the down-cycle in the property market, the decline in house prices and rising defaults by mortgage borrowers could result in a tightening of lending that will weigh on business activities. This, together with the negative wealth effect associated with the correction in house prices, will weaken domestic demand and exert downward pressure on inflation. This suggests that the property price cycle can significantly amplify the boom-bust tendency of other economic activities, in turn leading to increased volatility in consumer prices.

Given the heavy weighting of the rental component in the CPI basket and the significant role of the property price channel in affecting domestic demand, the use of macroprudential measures could be effective both to safeguard financial stability in the face of big swings in property prices and, indirectly, to help mitigate big swings in consumer prices resulting from property market boom and busts. By reducing the leverage of borrowers and building a buffer in the banking sector against property price shocks, the potential fallout from any sharp swings in property prices on economic activity and hence price stability is reduced. This is particularly important in the case of Hong Kong given that there is no discretionary monetary policy to directly manage price stability under the Linked Exchange Rate System (LERS).[4]

The boom-bust cycle in property prices during the Asian financial crisis has shown that sharp declines in house prices not only affect asset quality in the banking sector, but also put substantial downward pressure on Hong Kong's consumer prices, reflecting the significant influence of the property price channel on domestic demand (see Graph 5). The lesson learnt is that it is important for banks to build up buffers to withstand property market shocks.

In this regard, since 2009, the HKMA has implemented seven rounds of countercyclical measures on the mortgage lending business, by lowering the caps on the loan-to-value (LTV) ratio and the debt servicing ratio (DSR) for mortgage borrowers. The coverage of these measures was also extended from luxury homes to investment properties and later to those where borrowers are repaying their debt with foreign income or have multiple mortgages. A risk-weighted floor of 15% was also applied to all outstanding mortgages. With these countercyclical measures in place, the LTV ratio of new mortgages has trended down to around 50% from 64% in 2009. Meanwhile, the DSR of mortgage applicants has come down to below 35% from 38% in 2010.

Apart from countercyclical measures, the Hong Kong government has also implemented demand management measures to discourage speculative activities and dampen investment demand in the property market. Key policy measures include special stamp duty (SSD) of as much as 20% for properties resold within two years, buyer's stamp duty (BSD) of 15% for residential properties acquired by companies and non-residents, and double stamp duty (DSD) for transactions in all types of properties, except for those residential units purchased by residents who are first-time home buyers. Preliminary findings show that higher transaction taxes in the form of additional stamp duties help restrain house price appreciation.[5] Over the longer term, the government will increase land supply to redress demand supply imbalances in the housing market.

3. Concluding remarks

In the case of Hong Kong, which is a highly services-oriented economy, dampening swings in house prices not only helps reduce risks to financial stability, but is also important for price stability. Past experience suggests that the bursting of a property price bubble could have dire consequences on price stability, which can be seen from the prolonged deflation in consumer prices period during 1999–2004 in the aftermath of the Asian financial crisis.

[4] It is useful to note that the LERS is not the root cause of property price bubbles and a flexible exchange rate would not preclude such bubbles. Even economies with well established flexible exchange rate regimes are not immune from the problem of asset bubbles. The United States is a case in point, as evidenced by the housing bubble in 2006.

[5] For details please refer to "Box 5: The impact of counter-cyclical prudential and demand management measures on Hong Kong's housing market", Hong Kong Monetary Authority, *Half-yearly Monetary and Financial Stability Report*, September 2014.

In Hong Kong, while there is no discretionary monetary policy under the LERS, policymakers can deploy countercyclical and other prudential measures to restrict the leverage of home buyers during the property price upswing, thereby enhancing the resilience of the banking sector to property market shocks. Meanwhile, reduced volatility in house prices would also help maintain price stability, given the heavy weight of the rental component in the CPI basket and the significant role of the property price channel in affecting domestic demand.

Fixing an impaired monetary transmission mechanism: the Hungarian experience

Péter Gábriel, György Molnár[1] and Judit Várhegyi[2]

Abstract

In the 2000s, after the introduction of inflation targeting, most monetary transmission channels were weak in Hungary, making monetary policy less effective. Inflation expectations were unanchored and fiscal policy was unsustainable. Households and the government built up high debt levels mainly denominated in foreign currency. The financial crisis exacerbated earlier problems related to the transmission mechanism. In addition to regular monetary policy tools, the central bank also reacted to the crisis with targeted measures to reduce vulnerability and improve the effectiveness of the transmission mechanism. Recently, transmission channels have strengthened, giving monetary policy more room for manoeuvre. This paper presents the rationale for the policy measures taken after the outbreak of the crisis and their results.

Keywords: Transmission mechanism, central banking, monetary policy, Hungary

JEL classification: E50, E52, E58

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1. Introduction

In an inflation targeting regime, the monetary transmission mechanism needs to function properly if the primary objective of price stability is to be achieved. An effective transmission mechanism can provide sufficient room for manoeuvre in the implementation of monetary policy.

In the 2000s, after the introduction of inflation targeting, most monetary transmission channels were weak in Hungary, making monetary policy less effective. Inflation expectations were unanchored and fiscal policy was unsustainable. Households and the government built up high debt levels denominated mainly in foreign currency. Due to the economy's increasing vulnerability, monetary policy had to attenuate the impact of renewed increases in risk premia again and again, instead of focusing on its primary objective. The financial crisis exacerbated earlier problems related to the transmission mechanism. As transmission channels were impaired, monetary policy was unable to mitigate the impact of the crisis, further increasing an already enormous output loss.

The gradual improvement in international risk perceptions, the adjustment of foreign currency debt and the change in fiscal policy widened the room for manoeuvre in monetary policy and facilitated the easing cycle starting from 2012. In parallel with regular monetary policy tools, the central bank explored targeted measures to reduce vulnerability and improve the effectiveness of the transmission mechanism. Several measures were implemented to reduce indebtedness and bring down foreign currency debt. For example, the Self-financing Programme and the conversion of FX loans helped reduce outstanding foreign debt and the balance sheet exposure of economic agents, reducing the economy's vulnerability. Recently, the effectiveness of the transmission mechanism has increased and monetary policy has gained additional room for manoeuvre. This paper presents the rationale for the policy measures taken after the outbreak of the crisis and their results.

The rest of the paper is structured as a follows. Section 2 describes the problems of the monetary transmission mechanism before the crisis. Section 3 provides an overview of the main processes during the crisis. Section 4 presents the measures to reduce vulnerability and improve the effectiveness of the transmission mechanism. Section 5 concludes.

2. The transmission mechanism before the crises

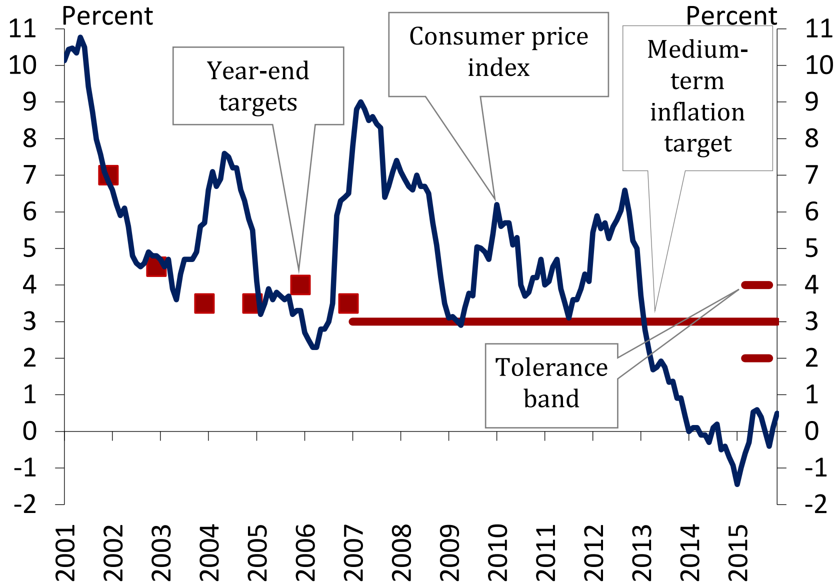
From June 2001 until early 2008, the Magyar Nemzeti Bank (MNB) employed an inflation targeting regime in conjunction with an exchange rate band. Since early 2008, a freely floating exchange rate regime has been in operation. From the time inflation targeting was introduced, monetary policy relied mostly on the exchange rate channel to influence economic growth and inflation. After 2001, a large fiscal deficit combined with insufficient internal savings increased the economy's vulnerability and constrained monetary policy. From the mid-2000s, the exchange rate channel became increasingly impaired as households had accumulated a large amount of foreign currency-denominated debt. This made them sensitive to exchange rate movements, so that the depreciation of the home currency weighed on consumption. As other transmission channels – the expectations, interest rate channels etc – were also weak, room for manoeuvre in monetary policy was limited.

2.1 High inflation expectations

From a policymaker's point of view, anchored inflation expectations help to make monetary policy more effective and flexible. In the case of an inflation shock, a smaller monetary policy reaction is needed to push inflation toward the medium-term inflation target. As a result, the output cost of disinflation, as measured by the sacrifice ratio, is lower.

The expectations channel is highly relevant for Hungary because disinflation has been one of the key challenges since the transition to a market economy. After the introduction of inflation targeting, inflation overshot the official inflation target for several years (Graph 1). In the pre-crisis period, the difference between actual inflation and the central bank's inflation target was attributable mainly to shocks (oil and food price shocks, indirect tax hikes and increases in administered prices) that were beyond the control of monetary policy. However, other factors also contributed to the overshooting of the inflation target, especially high inflation expectations.

Developments in inflation and the inflation target | Graph 1



Sources: Hungarian Central Statistical Office and MNB.

The fact that inflation regularly exceeded the inflation target made it challenging to anchor expectations. The inflation expectations of Hungarian households co-moved closely with the actual inflation figures and were backward-looking. Between 2001 and 2008, average one-year-ahead inflation expectations were around 7%, which was significantly higher than the inflation target in the 2000s, and expectations were also highly volatile in international comparison (Table 1). As expectations were unanchored, inflation expectations reacted strongly to increases in the prices of energy and food products (Gábriel et al (2014)). The gap between the expected inflation rate and the inflation target, coupled with the high volatility of expectations, showed that, compared with other inflation targeting economies, in Hungary the inflation target did not sufficiently coordinate the expectations of economic agents (Table 1).

Developments in inflation expectations in the 2001–08 period — Table 1

	Average difference between inflation expectations and target	Average difference between actual HICP and target	Volatility of inflation expectations	Volatility of actual HICP
Hungary	**2.8**	**1.5**	**5.7**	**4.4**
Czech Republic	–0.4	0.8	1.3	4.2
Sweden	–0.8	–0.1	0.3	0.9
United Kingdom	–0.6	–0.1	0.5	0.8

Note: Quantified inflation expectations can be derived from qualitative survey data of European Commission by using the extended Carlson–Parkin method. For more details about the methodology, see Gábriel (2010).

Sources: Eurostat, MNB calculations based on European Commission data.

2.2 Premium shocks

Shifts in the perceived riskiness of a country may have a significant impact on the exchange rate. In a small open economy, changes in the nominal exchange rate have a direct and significant effect on both inflation and the real economy. Financial stability concerns may also come to the fore if exchange rate movements become highly volatile. If there is a transitory upward movement in the risk premium on financial assets, and a resulting flight from the currency, monetary policymakers may have to respond by raising interest rates.

Between 2001 and 2008, the risk premium on Hungarian assets was higher and more volatile than in other European inflation targeting countries (Table 2). Despite the high global appetite for risk, there were several episodes of increased pressure on sovereign bond yields even in this period. Interest rates jumped in 2003 following speculation against the forint and also after a surprise shift of the exchange rate band. Temporary political uncertainties also led to a sharp increase in government bond yields. The fiscal deficit was considerably above 3% of GDP prior to the crisis. Furthermore, the private and the public sectors had accumulated a large stock of foreign currency-denominated debt, making the economy vulnerable. Abrupt temporary increases in the risk premium led to extra incentives to raise the policy rate. Estimates for 2001–08 show that, compared with other countries in the region, the MNB put more emphasis on smoothing out exchange rate fluctuations due to premium shocks (Vonnák (2010)). Thus, when international risk appetite suddenly reversed, the MNB had to signal its commitment to maintaining nominal stability more clearly than the central banks of other countries. These constraints became increasingly binding after the outbreak of the Global Financial Crisis.

Bond yields in the 2001–08 period

Table 2

	5Y bond		10Y bond	
	Mean	Variance	Mean	Variance
Hungary	**8.0**	**1.3**	**7.4**	**0.6**
Czech Republic	3.8	0.6	4.4	0.5
Sweden	3.9	0.6	4.3	0.5
United Kingdom	4.6	0.3	4.7	0.1

Source: Bloomberg.

2.3 The spread of foreign currency lending

Monetary policy decisions influence supply and demand conditions in the credit market. A change in the base rate affects lending activity through the lending and balance sheet channels.

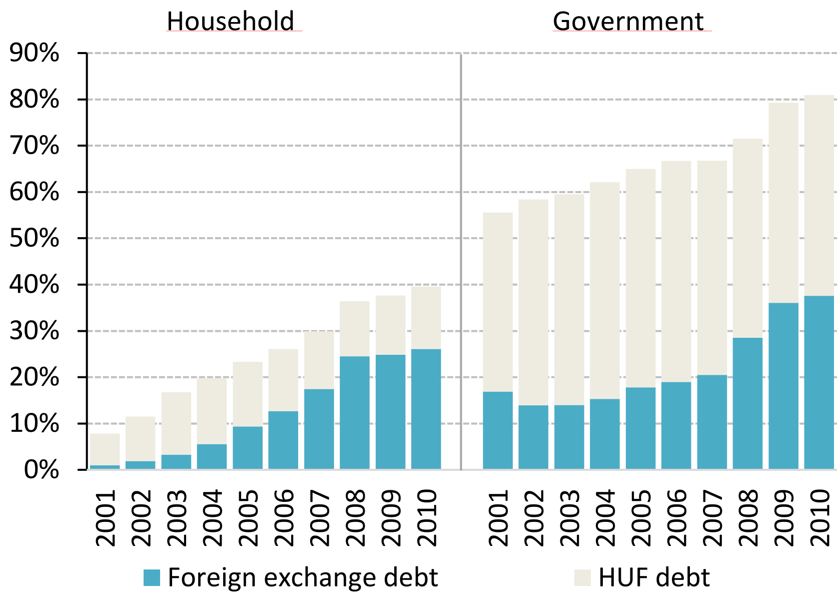
When inflation targeting was introduced, the depth of Hungarian financial intermediation was limited, weakening the lending and balance sheet channels. In the following years, the depth of intermediation increased in parallel with the pickup in borrowing. However, increased lending activity was accompanied by increasing vulnerability. Foreign currency loans gained ground in both the private and the public sectors (Graph 2). Hungarian households increasingly took on debt in Swiss francs and in euros, and to a smaller extent in Japanese yen as well.

Household FX debt increased dramatically after Hungary's accession to the European Union and accounted for nearly 70% of total household liabilities during the crisis. Both demand and supply factors had contributed to the spread of foreign currency loans. The credit demand of households was fuelled by their rising income and favourable income expectations. Increasing optimism was linked to the European Union accession and a stable macroeconomic environment. On the supply side, the banks turned to riskier but profitable household lending. There was also a significant interest rate differential between the Hungarian forint and foreign currency-denominated borrowing, which contributed to the spread of FX lending. These developments led to a significant unhedged FX position, given that the incomes and the wealth of households are principally denominated in forints.

The spread of foreign currency-denominated loans weakened the monetary transmission mechanism. Interest rates relevant for households with foreign currency-denominated loans were not linked to the central bank base rate. The build-up of household debt had also affected the traditional exchange rate channel of the transmission mechanism. Episodes of depreciation had important consequences for indebted households. When the Hungarian forint depreciated, households with a high FX debt burden reduced their consumption spending because of higher loan instalments and negative wealth effects. This decline in household consumption partly offset the positive effect of the depreciation on exports.

Household and government debt as a percentage of GDP

Graph 2



Source: MNB.

3. The crisis period

Unsustainable financing at the outbreak of the financial crisis led to a sharp rise in the Hungarian risk premium. The Hungarian economy was particularly affected by the decline in risk appetite, as the economy was deemed highly vulnerable due to its large sovereign foreign debt and balance sheet exposures. The rise in the risk premium was combined with a significant exchange rate depreciation, resulting in large capital outflows and financial stability problems in the banking sector. As a result, financial stability considerations started to play an ever greater role in shaping interest rate decisions. Monetary policy had less room to manoeuvre during a period when the state of the real economy would have called for looser monetary conditions.

3.1 Monetary policy

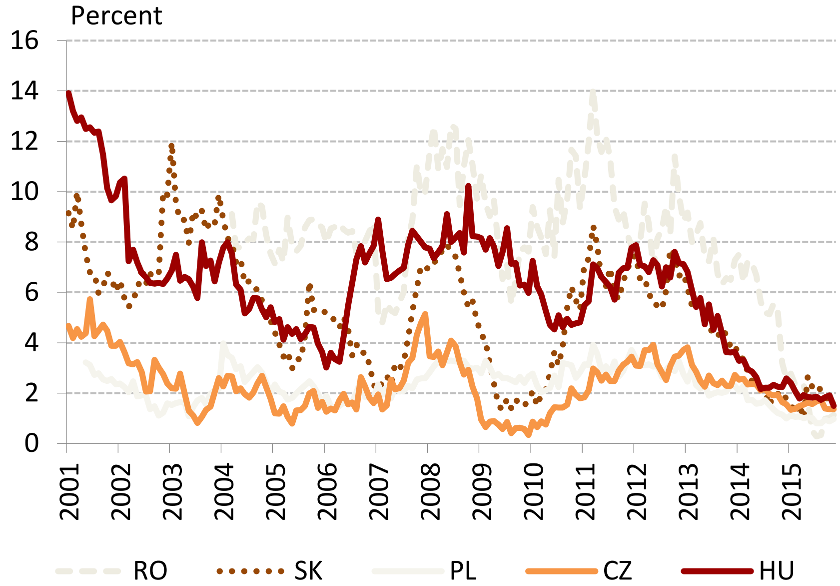
The financial crisis exacerbated earlier problems related to the transmission mechanism. The unhedged FX position of Hungarian households posed a significant risk to the stability of the balance sheets of both households and banks. Some households tightened their belts, so that they could continue to pay their instalments. The decline in household consumption offset any growth effects that would have stemmed from increased competitiveness due to the depreciation.

At the end of 2008, the exchange rate was under significant depreciation pressure. Bearing in mind financial stability concerns, the MNB increased the base rate significantly. As both monetary and fiscal policy were constrained, output contracted sharply. Banks were required to write down losses, and their profitability declined. A sizeable and prolonged balance sheet adjustment started, which led to a significant contraction in lending. In addition to supply side constraints, demand constraints also contributed to the decline in credit growth, as households became more cautious.

The weakness of the economy started to ease in 2010 following the gradual normalisation of the global economic situation. Besides external developments, domestic factors (the implementation of a more disciplined fiscal framework, increasing domestic savings, structural reforms etc) also contributed to the improvement. From the end of 2012, inflation gradually slowed and has remained at near-zero levels since the beginning of 2014. Favourable cost-side pressure, restrained demand, the gradual adjustment of expectations and the cuts in regulated energy prices all contributed to the moderation in inflation.

From late 2012, households' inflation expectations declined in line with actual inflation and in accordance with the backward-looking nature of expectations. The main contributing factors were a reduction in fuel and regulated energy prices in parallel with low commodity price developments. The expectations of Hungarian households have fallen to levels similar to those of countries with histories of sustained low inflation (eg the Czech Republic and Poland) (Graph 3).

Households' inflation expectations — Graph 3



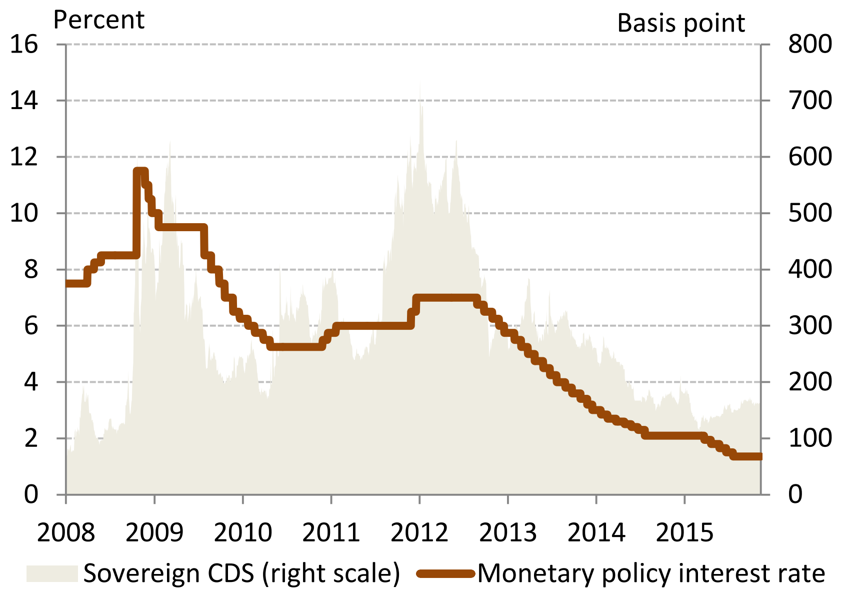
Sources: Hungarian Central Statistical Office, MNB calculations based on European Commission data.

Inflation expectations have now been low and stable for some time. If the MNB continues to keep inflation in line with the medium-term target, household inflation expectations may become more forward-looking. As a result, in the case of an inflationary shock hitting the economy, inflation expectations should continue to remain close to the target, which should also lead to a quicker easing of the price shock. If expectations remain anchored in the long run, this may contribute to the sustainability of the low inflation environment and make monetary policy more effective.

The adjustment of outstanding foreign currency debt, combined with the low underlying inflation dynamics and more anchored inflation expectations brought about by the global financial crisis, gradually gave monetary policy more room for manoeuvre. As a result, monetary policy was able to respond to the low inflation environment and weak economic demand. These developments allowed the MNB to implement a rate-cutting cycle which ended in June 2015. In the course of the easing cycle started in August 2012, the interest rate was reduced by a total of 565 basis points from 7% (Graph 4). According to estimates, the rate-cutting cycle increased inflation on average by 1 percentage point each year between 2013 and 2015, thus avoiding deflation. In addition, lower rates stimulated economic activity; the easing cycle also increased GDP by around 1 percentage point in the same period (Felcser et al (2015)).

The rate-cutting cycle was supported by a steady decline in the risk premium. As a result of decreasing vulnerability, monetary policy was able to react to the negative output gap in line with the framework of the flexible inflation targeting regime.

Central bank base rate and CDS Graph 4



Sources: MNB, Bloomberg.

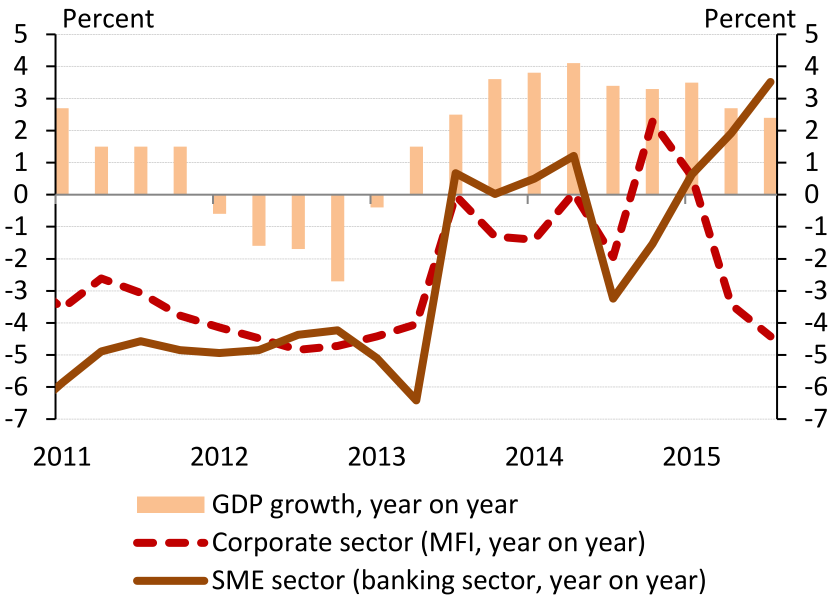
3.2 New measure to stimulate lending: the Funding for Growth Scheme

Credit conditions tightened significantly after the outbreak of the financial crisis, resulting in a decline in corporate lending. Small and medium-sized enterprises found it particularly difficult to find financing. As banks' risk tolerance weakened, longer-term loans declined within the SME sector, which could have led to long-term negative growth effects. Monetary policy was unable to tackle the problem using the traditional channels of the monetary transmission mechanism. Therefore, the MNB started to look for alternative instruments to ease monetary conditions.

To alleviate the disruptions observed in lending to SMEs, the MNB launched the Funding for Growth Scheme in June 2013 and then its extension (FGS+) as a temporary monetary policy tool. Its aim was to support the economic recovery, and encourage lending to this segment of the economy. The FGS considerably improved SME's access to credit on favourable terms. Overall, around 31,000 enterprises received financing and utilisation of the FGS was HUF 2,126 billion (6.6% of GDP) until the end of 2015. As a result, the decline in corporate lending has stopped and the programme has had a positive impact on GDP growth as well (Graph 5). Based on our empirical investigations, in 2013 the programme generated significant new investment in the SME sector that would not have happened otherwise. Some 30% of investment undertaken by participating firms is attributed to the FGS, but this result is heterogeneous with respect to firm size. This ratio is higher for micro firms, namely 60% (Endrész et al (2015)). As a result, the growth effect of the two phases of the FGS has been around 1% in both 2013–14 and 2014–15 (MNB (2015a)).

In the long run, as market-based lending is preferable, the schemes will be gradually phased out as lending conditions improve. The MNB introduced an exit phase of the programme from the beginning of 2016 with stricter conditions in terms of both amount and loan purpose. The one-year additional availability of FGS loans may ensure the smooth return to market-based lending both by credit institutions and SMEs.

Growth rate of loans outstanding to the entire corporate sector and SMEs | Graph 5



Note: In the case of the corporate sector, the time series is based on transactions, while the SME data are based on estimated transactions from Q4 2013.

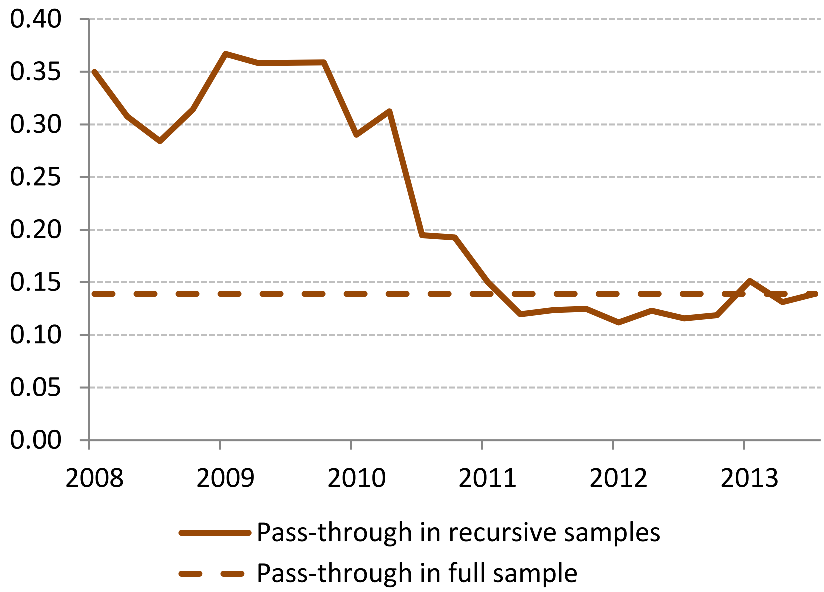
Sources: MNB and Hungarian Central Statistical Office

3.3 Further decline in the effectiveness of the exchange rate pass-through

As previously discussed, foreign currency-denominated lending changed the impact of exchange rate depreciation on output even before the crisis. During the crisis, the pass-through of cost shocks to prices has also changed. While the exchange rate was one of the strongest factors influencing inflation developments before the crisis, recent analysis suggests that persistently weak demand may have moderated the exchange rate pass-through. The smaller inflationary impact was particularly noticeable in the case of traded goods. Before the crisis, the prices of imported goods calculated in forints co-moved tightly with domestic industrial goods prices. By contrast, in recent years there has been a break in this relationship.

Based on empirical estimations, prior to the crisis 30–40% of exchange rate depreciation appeared in consumer prices on a two-year horizon (Vonnák (2010)). In recent years, however, prices responded less to a depreciation of the exchange rate (Graph 6). The decrease in pass-through can be attributed to cyclical factors, namely the weak demand environment. Furthermore, structural factors (eg falling inflation) have also contributed to the weakening of the relationship. A 1 percentage point shift in the exchange rate over a two-year time horizon changed consumer prices by only half as much as it did pre-crisis (Hajnal et al (2015)).

Response of prices to a 1% depreciation after 2 years — Graph 6



Source: MNB.

4. Policy measures to improve monetary transmission

Overall, at the beginning of the crisis the Hungarian risk premium increased significantly, while economic activity fell sharply. The effectiveness of the transmission mechanism decreased further and monetary policy had little room for manoeuvre. It became increasingly clear that monetary policy had to implement new measures to reduce vulnerability and improve transmission effectiveness.

4.1 Measures to improve monetary transmission

After the outbreak of the crisis, the financial position of economic agents deteriorated considerably and deleveraging started. Although net external debt declined considerably, the prolonged adjustment became a drag on economic recovery and led to a sustained reduction in monetary policy effectiveness. The central bank started to explore new measures to speed up the adjustment, with the goal of making it less costly.

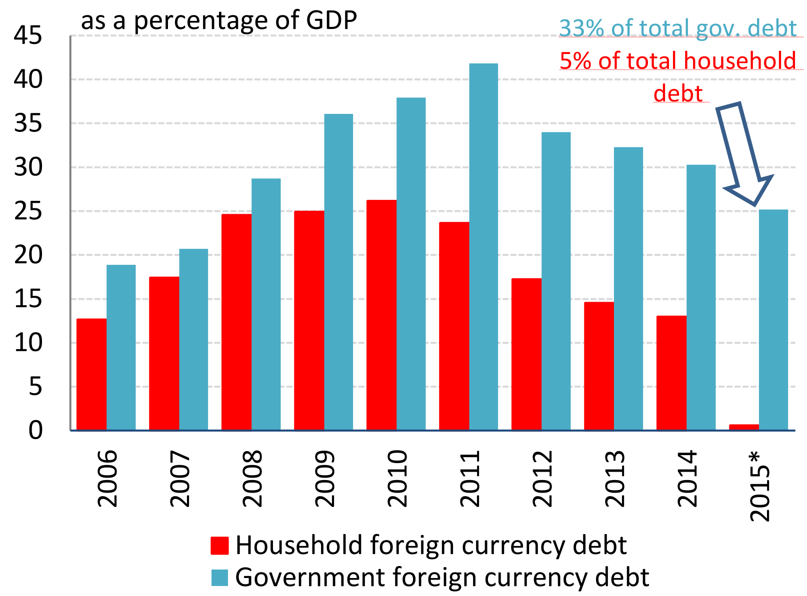
To reduce external vulnerability, the MNB introduced the Self-financing Programme in April 2014. According to the concept of self-financing, external vulnerability is mitigated by reducing gross external debt and moving in the direction of forint financing of the government. Based on data for the period up to March 2015, the ratio of FX debt to gross government debt declined to below 34% from 40% before the programme was launched. At the same time, the banks' share went up from 15% to nearly 19% (MNB (2015b)). The higher share of forint-denominated debt strengthens the interest rate channel.

To strengthen the effectiveness of the interest rate and the exchange rate channels, policymakers also implemented measures to reduce the FX exposure of households. An early repayment scheme in 2011 lowered the stock of households' foreign currency loans, which was then followed by the introduction of an exchange rate cap system. Despite continuous deleveraging and the measures discussed above, the financial strain on households and supply side constraints on lending continued to weaken the lending channel of the transmission mechanism. Even though the exchange rate risk of FX loans was borne primarily by households, the losses arising from loans becoming non-performing due to unfavourable exchange rate movements weakened banks' profitability.

The latest measure to free households of their exchange rate exposure was the conversion of FX loans into forint loans. In the autumn of 2014, the adoption of new laws paved the way for a final solution to foreign currency loans. A great majority of the foreign currency and foreign currency-based mortgage loans of households were converted into forints in 2015.

As a result, the current outstanding net amount of foreign currency liabilities of households and government has significantly declined in recent years (Graph 7). In the case of households, foreign debt is now negligible, it was around 5% of total debt in 2015 compared to the pre-crisis 70% level. Regarding the government sector, the share of foreign debt fell from around 45% in 2009 to 33% in 2015. Accordingly, monetary policy is less constrained by concerns about financial stability.

Foreign currency debt of households and government as a percentage of GDP Graph 7



Note: *MNB estimation

Source: MNB

A new regulatory environment for the pricing of household lending was also needed, since the existing regulation allowed banks to change interest rates unilaterally in a non-transparent way. Other country experiences (eg that of Poland) showed that transparent pricing (such as lending rates based on a reference rate) may dampen the negative effects of financial distress on households. According to the "fair banking" law, enacted in November 2014, lenders may grant loans with interest rates fixed for interest periods of at least three years, or with variable interest rates tied to a reference rate plus an interest rate spread fixed for the entire maturity, or at least for three-year interest periods. As an additional condition, upon expiry of the interest periods, lenders may only modify the interest rate or the interest rate spread in line with any MNB-approved and published change in the objective interest rate or interest rate spread change indices. The interest rate change indices protect consumers from unilateral interest rate hikes, while they are symmetrical in the sense that banks may raise interest rates when it is justified by objective circumstances. In the future, developments in the central bank base rate should have a more direct influence on lending rates and as result on aggregate consumption and inflation.

An important obstacle to improving the credit channel further is the large amount of non-performing loans on the balance sheets of commercial banks. At the end of 2014, the central bank established an asset management company (MARK Ltd, a private company established for the purpose of debt restructuring and management) to reduce the amount of non-performing commercial real estate loans. The aim is to remove distressed or non-performing loans from the whole Hungarian banking system, helping to strengthen the financial system by easing credit supply constraints. The company can also support monetary policy by improving the effectiveness of the credit channel.

The benefits of efforts to decrease vulnerability and improve monetary transmission are visible. While several emerging markets have recently been hit hard by the Federal Reserve's pullback from quantitative easing, and by uncertainty with respect to the timing of the Fed's rate hike, the Hungarian economy has remained resilient and the policy interest rate continues to be set in accordance with the domestic economic conditions.

5. Conclusion

In the 2000s, most monetary transmission channels were weak in Hungary, making monetary policy less effective. The exchange rate channel had functioned as the strongest channel within the monetary transmission mechanism; however, it also became impaired following the spread of FX loans. Due to the economy's increasing vulnerability, monetary policy also repeatedly had to counter the impact of renewed increases in risk premia. The financial crisis exacerbated problems related to the transmission mechanism.

The gradual improvement in international risk perceptions and the economic environment widened the room for manoeuvre in monetary policy and facilitated the interest rate-cutting cycle starting from 2012. To strengthen the effectiveness of the interest rate channel and the exchange rate channel, policymakers implemented targeted new measures. As a result of these measures and the deleveraging by households, the vulnerability of the economy has declined, the effectiveness of the transmission mechanism has improved considerably and monetary policy became more efficient. The stricter inflation targeting regime is expected to be more successful in smoothing business cycles and keeping inflation in line with the target over the medium term.

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Inflation mechanisms, expectations and monetary policy in Indonesia[1]

Hendar[2]

Abstract

Indonesia has been experiencing relatively low and stable inflation for the last five years. Currently, inflation has switched to a low inflation regime, thanks mainly to better anchored inflation expectations owing to the more credible inflation targeting framework (ITF) adopted in July 2005. Nevertheless, building and maintaining credibility remain the key challenge, as credibility affects the behaviour of economic agents and anchors expectations. Further, the post-Global Financial Crisis monetary policy framework in Indonesia is characterised by the flexible ITF.

Keywords: Inflation, monetary policy, flexible ITF

JEL classification: E31, E52

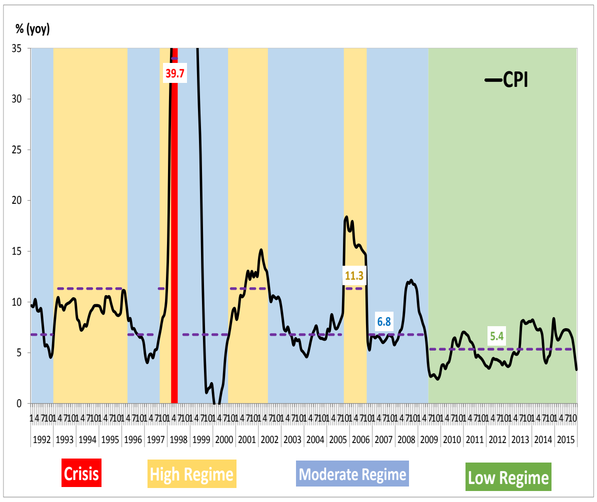
[1] The views expressed in this note do not necessarily represent those of Bank Indonesia. I am grateful to Ferry Kurniawan for help in preparing this note.

[2] Deputy Governor, Bank Indonesia.

1. Introduction

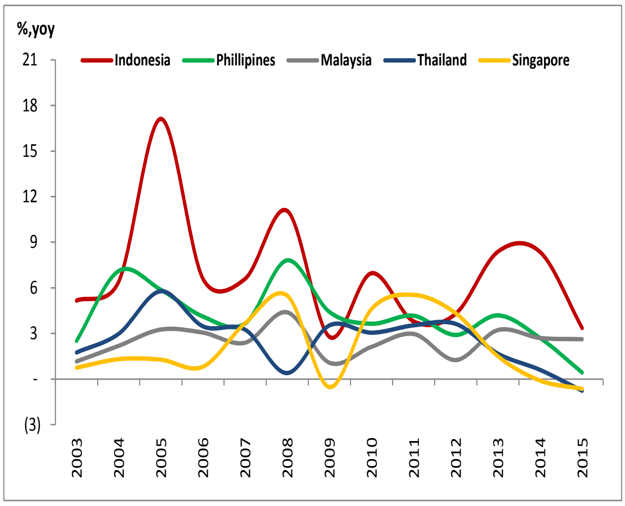
Two major issues in modern central banking are the role of inflation expectations and the conduct of the monetary policy in the aftermath of global financial crisis (GFC). Keeping inflation expectations low and stable makes the economy more resilient in the face of adverse shocks and allows the economy's pricing mechanism to function more efficiently, for example as reflected in the dynamics of exchange rate pass-through. Anchoring inflation expectations requires that the central bank be regarded as credible. However, the challenges for building credibility in the aftermath of the GFC are greater, and there is an ongoing debate on whether monetary policy should incorporate financial stability as macroeconomic stability frequently stems from instability in the financial sector.

Inflation trend — Graph 1



Sources: Statistics Indonesia; Bank Indonesia calculations.

Peer country inflation — Graph 2



Source: CEIC.

This paper briefly discusses the two issues mentioned above for the case of Indonesia. Indonesia has been experiencing relatively low and stable inflation for the last five years. Recently, inflation has switched to a low inflation regime, averaging around 5.4% year over year (Graph 1). One key factor has been better anchored inflation expectations owing to the more credible inflation targeting framework (ITF) adopted in July 2005. Despite several significant improvements since the adoption of the ITF, there are still some challenges. For instance, average inflation is still high relative to peer countries (Graph 2) and compared to the official inflation target.[3] Hence, the key challenge remains how to build and maintain credibility, as credibility affects the behaviour of economic agents and anchors expectations. The post-GFC monetary policy framework in Indonesia is characterised by the Flexible ITF (see eg Juhro and Goeltom (2015)). The ITF is implemented in a more flexible manner, in the sense that Bank Indonesia must not only look at the inflation target merely in terms of policy formulation but also consider a number of other factors, including

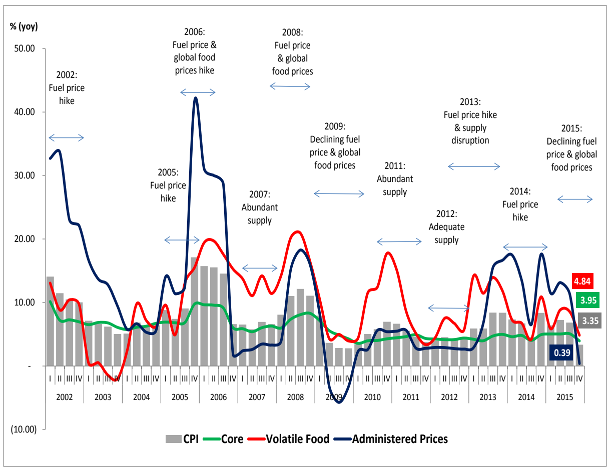
[3] The official inflation targets are 4±1% for 2016–17 and 3.5±1% for 2018.

financial sector stability as well as the dynamics of capital flows and exchange rate. The paper proceeds as follows. Section 2 offers a brief summary of the main characteristics of inflation in Indonesia. Sections 3 and 4 discuss inflation expectations and the dynamics of exchange rate pass-through. The recent development of monetary policy in Indonesia will be presented in the final section.

2. Characteristics of inflation in Indonesia

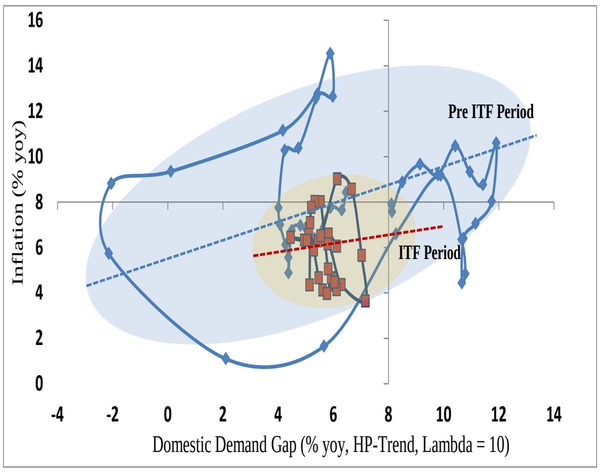
In Indonesia, inflation is measured as changes in the consumer price index (CPI) published by the Central Agency on Statistics (Statistics Indonesia). Further, headline CPI inflation is disaggregated into three components (Graph 3): core inflation, volatile food and administered prices. Core inflation is the persistent component within inflation movement, influenced by fundamentals such as supply and demand interaction, whereas the volatile food component is inflation predominantly influenced by shocks in the foodstuffs category, such as harvests, disruptions from natural events or movements in domestic food commodity prices and international food commodity prices. The administered prices component is inflation predominantly influenced by shocks from government-announced prices, such as for subsidised fuels, electricity billing rates and transport fares. In particular, core inflation (which consists of 751 commodities) accounts for 65% of headline inflation, whereas volatile food (85 commodities) and administered prices (23 commodities) account for 17% and 18% of headline inflation, respectively. In general, inflation in Indonesia arises from demand and supply shocks and inflation expectations. The pressure from the demand side has been relatively moderate recently, especially as economic growth slowed to around 5% in 2015 from 6% in 2011. Several indicators confirm the relatively weak demand pressure, such as the negative output gap, the declining credit growth rate and stagnant retail sales. Further, there is an indication that inflation is less responsive to domestic demand. It appears that the stability-growth nexus during the ITF period has weakened, reflected by an apparent flattening of the Philips curve, as can be seen in Graph 4 (Juhro (2015)).

Inflation disaggregation — Graph 3



Source: Statistics Indonesia.

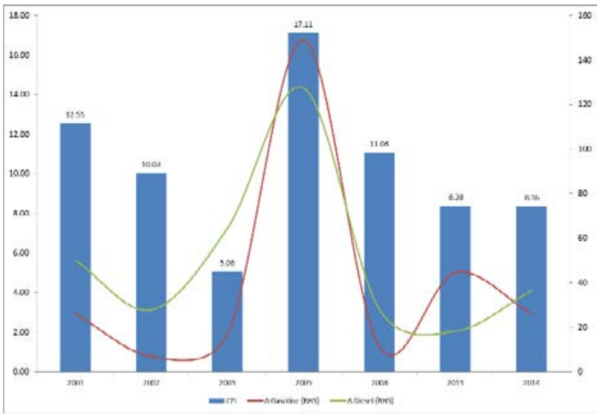
Inflation-GDP growth nexus — Graph 4



Source: Juhro (2015).

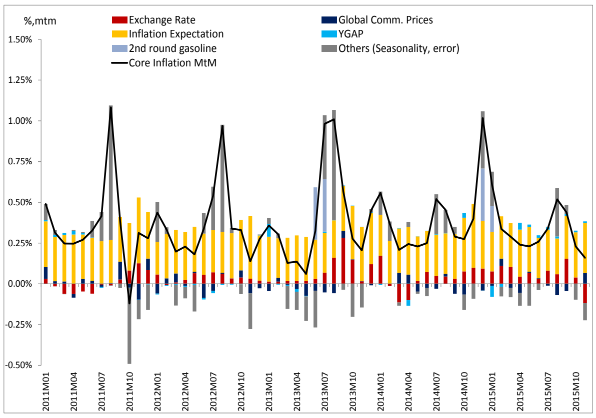
Inflation is under pressure from supply side shocks such as changes in administered prices, negative supply shocks to food production due to natural disasters and disruptions in distribution networks, and the sharp depreciation of the exchange rate. As can be seen in Graph 3, the peaks in Indonesia's inflation are often associated with administered prices and volatile food dynamics. The high pressure from administered prices is related to the energy subsidy reforms covering fuel prices, electricity tariffs and liquefied petroleum gas (LGP). The rise in administered prices had a marginal impact on inflation in 2013 and 2014 that was kept to single digits in the context of a tight bias in monetary policy and productive policy coordination between the central bank and the government. Bank Indonesia's bias towards a tight monetary policy proved able to rein in inflation expectations (see below) following the hike in subsidised fuel prices. On the government side, the policies for curbing the second-round effects of the fuel price hike involved restrictions on fare increases for land-based transportation and preparation of social safety nets. Looking forward, the energy subsidy reforms adopted by the government are expected to lay the foundation for more robust control of inflation.

Inflation in periods of fuel price hikes — Graph 5



Sources: Statistics Indonesia; Bank Indonesia calculations.

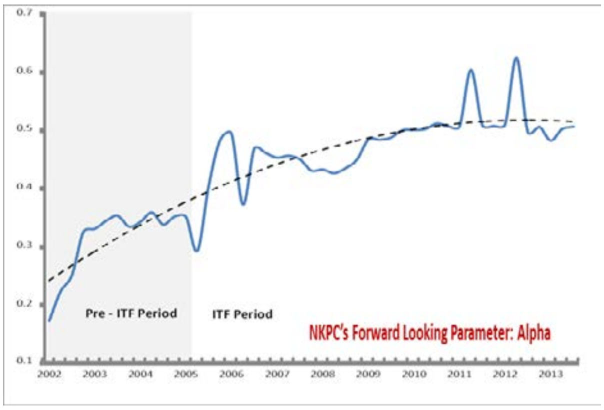
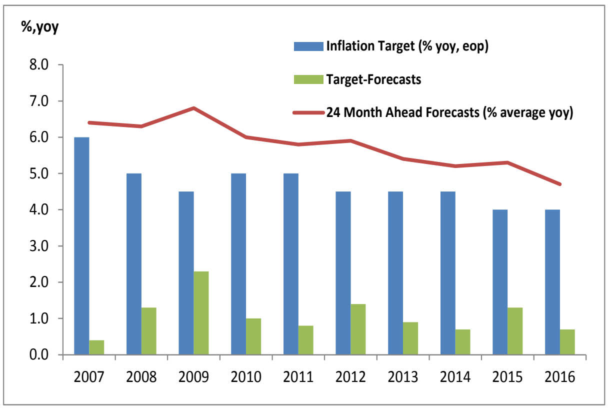
The determinants of core inflation — Graph 6



Source: Bank Indonesia.

3. Inflation expectations

Inflation expectations play an important role in the conduct of monetary policy. For example, price adjustments made by economic agents in each period mainly depend on the inflation that is expected in future periods. In particular, the New Keynesian Phillips curve emphasises the importance of inflation expectations for the rate of actual inflation. Hence, central banks' ability to achieve price stability is often directly linked to their ability to anchor inflation expectations at their target. In a situation where inflation expectations are well anchored, the higher the forward-looking component the smaller the costs of disinflation. Therefore, understanding whether inflation expectations are anchored is important. Investigating movements in longer-term measures of inflation expectations – beyond the horizon where persistent shocks might have a measureable effect – may be more informative when assessing the degree of anchoring of inflation expectations. In practice, inflation expectations are well anchored if the distance between the expectations and the inflation target is sufficiently small.

Forward-looking inflation expectation parameter — Graph 7	Inflation expectations (24-month-ahead forecasts) — Graph 8
	
Source: Juhro (2015).	Sources: Consensus Economics; Bank Indonesia calculations.

Inflation expectations contribute significantly to the dynamics of core inflation in Indonesia (Graph 6).[4] Further, as argued by Juhro (2015), there is an indication that the weight of the forward-looking component of inflation expectations increases over time (Graph 7). However, the empirical evidence of the anchoring of inflation expectations for Indonesia is still limited. In order to gauge whether inflation expectations are anchored, Bank Indonesia monitors both short-term (three- and six-month) and longer-term (one- and two-year) indicators across different economic agents (such as professional forecasters, consumers and producers). From the longer-term perspective, as can be seen in Graph 8, inflation expectations – as measured by two-year-ahead inflation forecasts published by Consensus Economics – have been trending downwards over time (from 6.4% (average year over year) for 2007 to 4.7% (average year over year) for 2016). Even though there are still discrepancies between long-term inflation two years ahead forecasts and the official inflation target, in general there is a co-movement between them. This suggests that the presence of a formal inflation target has helped to anchor inflation expectations. The lower inflation expectations anchor in recent years is also observed in other countries and is not limited to inflation targeting economies; however, the level at which inflation has been anchored has declined by more over time for inflation targeting economies than for others (Mehrotra and Yetman (2014); Mishkin and Schmidt-Hebbel (2007)). Further, when the public has better information about the true intentions and inflation fighting goals of the central bank they are less likely to change their expectations about future inflation following a transitory shock to observed inflation (Davis

[4] The decompositions are based on the following equation:

$$\pi\_core_t = C + \sum_{i=1}^{n} \alpha_i . \pi\_core_{t-i} + \omega . \pi^e + \sum_{i=0}^{n} \beta_i . (demand)_{t-i} + \sum_{i=0}^{n} \gamma_i . (Exchange\ Rate)_{t-i} + \sum_{i=1}^{n} \theta_i . (Import\ Price)_{t-i} + \sum_{i=1}^{n} \rho_i . Dummy_i + \varepsilon_t$$

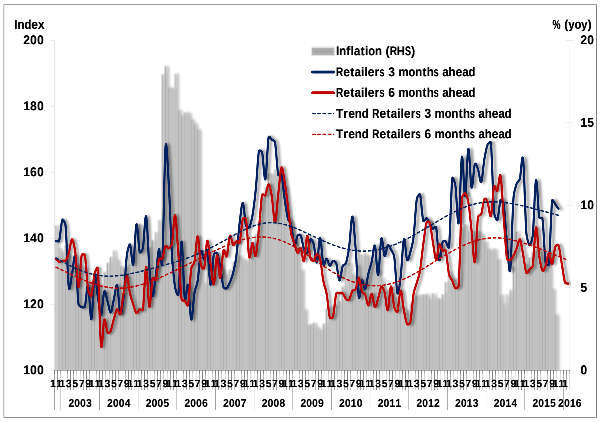
(2014b)). Hence, the subdued longer-term inflation expectations in Indonesia, to some extent, are due to the adoption of the ITF since July 2005.

In terms of short-term inflation expectations, we can also see similar results that expectations are trending down. The survey at the retailer level – both three and six months ahead – shows that inflation expectations have been declining recently (Graph 9). Specifically, there is an indication that the sensitivity of inflation expectations to the latest (November 2014) fuel prices increase has declined. Furthermore, the shorter the forecast horizon, the more inflation expectations are affected by actual inflation and current shocks (Graph 10).[5]

In order to better understand and monitor inflation expectations, Bank Indonesia has been conducting a pilot project to measure inflation expectations based on surveys of different economic agents (producers, consumers, firms and economists) which also cover various horizons (both fixed event and fixed horizon forecasts). For example, the consumer expectations are the highest among economic agents (10.9%), whereas retailers', firms' and economists' expectations are 5.6%, 7.3% and 5.5%, respectively. Economists' expectations are the lowest and closer to inflation target as they have more information relative to the other economic agents, whereas awareness of consumer respondents to the inflation target is relatively low and they tend to monitor the prices of basic needs which are closely related to the dynamics of volatile food inflation.

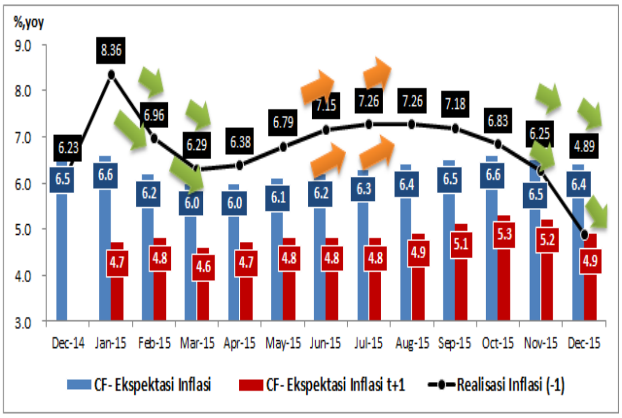
Overall, better anchored inflation expectations, to some extent, minimise the impact of supply shocks (Graph 5) and allows the economy's pricing system to function more efficiently. This is reflected, for example, in the lower pass-through of the exchange rate.

Inflation expectations – retailers Graph 9



Source: Bank Indonesia - DSta.

Inflation expectations and realisation Graph 10



Sources: Consensus Economics; Bank Indonesia calculations.

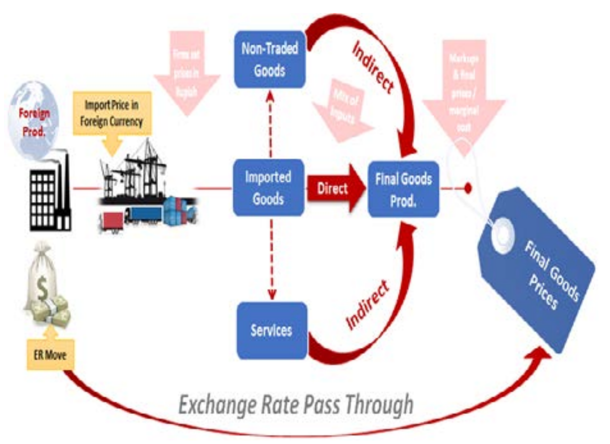
[5] Mehrotra and Yetman (2014) argue that as the horizon shortens, there is greater weight on realised outcomes and less on the lung-run anchor. When the horizon becomes very short, inflation expectations are driven almost entirely by actual inflation.

4. Exchange rate pass-through

The exchange rate is an essential component of the transmission mechanism of monetary policy in a small open economy adopting a flexible exchange rate system, like Indonesia. The dynamic of the exchange rate affects the target variables of monetary policy, such as inflation and the output gap, through a variety of channels. Economists use the term exchange rate pass-through (ERPT) to capture how exchange rate movements affect prices. Initially, changes in the exchange rate affect import prices (often called first-stage ERPT), which feed through into the overall price level and inflation (second-stage ERPT) (Graph 11). First-stage ERPT is believed to be quite large and to occur fairly fast relative to second-stage ERPT. Knowing the degree of ERPT is crucial for conducting appropriate monetary and exchange rate policy. For example, the lower the degree of ERPT, the smaller the interest rate adjustment required to maintain the inflation target; hence monetary policy becomes more effective. In contrast, if ERPT is high, the central bank may be tempted to intervene in the foreign exchange market to limit currency fluctuations. The fear of floating is partly linked to concern about high ERPT and its consequences for the trade balance (see eg Brun-Aguerre et al (2012)).

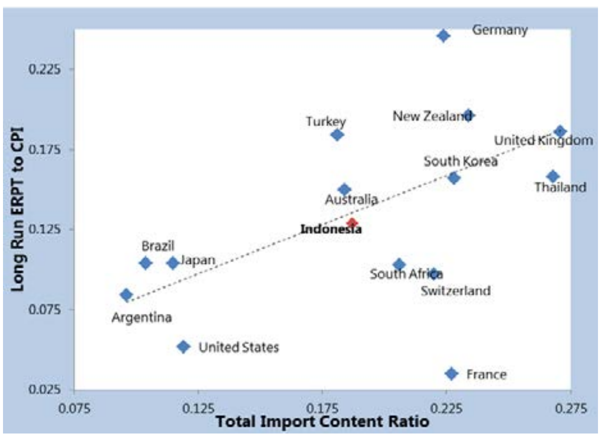
Many factors may influence ERPT, thus the empirical estimates of the magnitude have varied widely across countries and time periods. One important factor for overall pass-through rates are changes in the composition of industries in each country's import basket (see eg Campa and Goldberg (2005)). The degree of competition may affect the magnitude of ERPT; for example, in a competitive market, margins tend to be much tighter, so firms do not have the ability to absorb the effects of exchange rate movements and they may adjust prices more quickly. Over time, ERPT may also change due to macroeconomic conditions, such as inflation or the business cycle. Among others, Taylor (2000) puts forward the hypothesis that the responsiveness of prices to exchange rate dynamics depends positively on inflation. In a low and stable inflation environment, economic agents perceive shocks as temporary, which may happen when monetary credibility is established. The state of the economy may also affect ERPT; for example, when the economy is strong, economic agents – especially retailers in second-stage ERPT – tend to be more aggressive in passing on import cost increases, and vice versa (Chew et al (2011)).

Exchange rate pass-through — Graph 11



Source: Forbes (2015), updated.

ERPT and import content — Graph 12

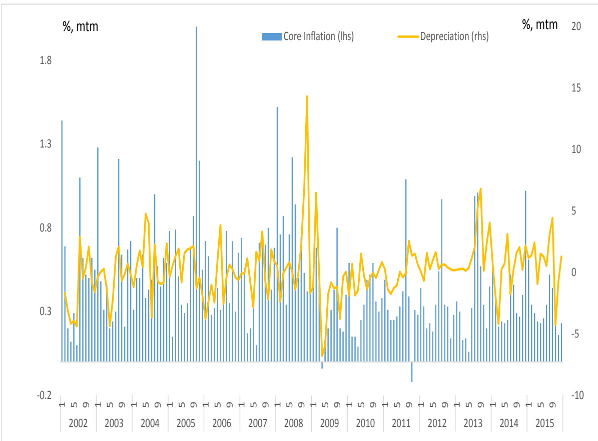


Source: Gopinath (2015), updated for Indonesia.

Overall, in line with the trend of inflation and expectations, ERPT in Indonesia has been declining as well.[6] However, as also commonly observed in other countries, the magnitude of ERPT is sensitive to model specifications. Based on various approaches, recent ERPT estimates for Indonesia are in the range of 0.07–0.13. One way to measure ERPT is to use input-output tables to arrive at a measure of the import content of households and combine this with the estimates of import pass-through (Gopinath (2015)). As can be seen in Graph 12, relative to other countries, Indonesia's ERPT magnitude and import content are both moderate, around 0.13. Hence, a 1% depreciation of the rupiah will increase inflation by approximately 0.13%. Among others, Kurniati (2007) has found that post-Asian crisis ERPT is lower than in the pre-crisis period. Recent research by Bank Indonesia (2015) using sample period 2002–14 obtained similar results, showing that the second-half period ERPT is lower than the first-half period ERPT.

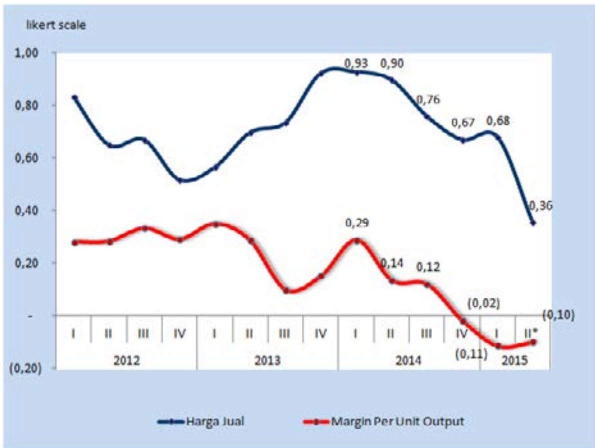
Over time, ERPT may change due to economic conditions, such as inflation or the business cycle. In particular, during the recent period of growth deceleration, there are indications that ERPT has been subdued (Graph 13). When demand is weak, firms are reluctant to pass the depreciation on to prices and risk a loss in market share, preferring instead to reduce their profit margin (Graph 14). Another factor that makes firms reluctant to pass on depreciation to prices is that they perceive depreciations as temporary fluctuations and thus do not change their inflation expectations. During the latest episode of significant depreciation (August 2015), inflation expectations were relatively stable (Graphs 9 and 10) and hence the ERPT was relatively muted.

Exchange rate and inflation Graph 13



Source: Bank Indonesia.

Price and margin Graph 14



Source: Bank Indonesia.

[6] Evidence of lower ERPT has also been observed in other countries; see Taylor (2000), Campa and Goldberg (2005), Mihaljek and Klau (2008) and Frankel et al (2012).

5. Implications for monetary policy

Despite several significant improvements since the adoption of an ITF in Indonesia in July 2005, inflation targeting still faces challenges, especially in the aftermath of GFC. A key challenge remains how to build and maintain credibility. Credibility and expectations are closely related. In the US case, Davis (2014a) argues that inflation expectations, particularly long-rung expectations in the post-Volcker era, can best be explained in a model where the Federal Reserve's monetary reaction function is unchanged but the central bank gradually regains credibility and with time is able to anchor inflation expectations by convincing the public of its commitment to a low and stable inflation rate.

In the case of Indonesia, building credibility is more challenging as inflation is strongly influenced by supply shocks such as volatile food and administered prices. Hitherto, inflation targets have been achieved only occasionally and never consecutively. The main priority for Bank Indonesia is to build credibility through the following actions (see eg Goeltom (2008)):

i. Taking extensive steps to communicate the policy framework to the public through seminars and roundtable discussions with bankers, academics, government officials, Bank Indonesia regional office officials and the media.

ii. Reinforcing communication with monthly and quarterly policy announcements in order to establish consistency, a key prerequisite in communicating inflation targeting policy. Success in building credibility will ensue only if the policy is clearly and consistently implemented in line with deviations of expected inflation from the target.

iii. Strengthening decision-making process within Bank Indonesia as required by forward-looking strategy to determine monetary policy responses for achieving the inflation target. Overall macroeconomic conditions, the inflation forecast and monetary policy responses are assessed at each quarterly board meeting as the basis for deciding the BI Rate to attain the inflation target.

iv. Publishing regular press releases and holding press conferences to announce the decisions of the board meeting. These are supplemented with a quarterly Monetary Policy Report (presenting an overall assessment of macroeconomic, inflation and monetary conditions), the inflation forecast and the monetary policy responses necessary to keep inflation on track with the target.

v. Strengthening policy coordination with the fiscal authorities. The effect of increases in administered prices on inflation means that inflationary pressures can potentially be mitigated through regular consultation on proper timing for adjustments in administered prices.

In addition, the GFC provided clearer evidence that financial systems are affected by the economic conditions prevailing in advanced economies and that some external disturbances are beyond the control of the monetary authority and may cause inflation to deviate from its target, thus affecting the credibility of inflation targeting (see eg Agénor and da Silva (2013)). In the aftermath of the GFC, there has been an ongoing debate on whether monetary policy (including inflation targeting) should incorporate financial stability. A consensus has been emerging that achieving price stability is insufficient to guarantee macroeconomic stability overall because macroeconomic instability frequently stems from instability in the financial sector, even when inflation is maintained at a low level (Bean et al (2010)).

In line with this consensus, the post-GFC monetary policy framework in Indonesia is characterised by the Flexible ITF. Inflation targeting is implemented in a more flexible manner, in the sense that Bank Indonesia must not only look at the inflation target merely in terms of policy formulation but also consider a number of other factors, including financial sector stability as well as the dynamics of capital flows and the exchange rate. Given the dynamics and complexity of the challenges faced, there are five principles for enhancing Flexible ITF (Juhro and Goeltom (2015)):

i. Continuing the adherence of policy framework to an inflation target as the overriding objective of monetary policy. The main characteristics of ITF will remain (ie pre-emptive, independent, transparent and accountable policy implementation).

ii. Integrating monetary and macroprudential policy. Appropriate monetary and macroprudential policy integration is required in order to buttress monetary and financial system stability.

iii. Managing the dynamics of capital flows and exchange rates. In supporting macroeconomic stability, coordinated implementation of a policy instrument mix must ultimately be part of an important strategy for optimally managing the monetary policy trilemma.

iv. Strengthening policy communication strategy as part of the tool chest of policy instruments. Policy communication is no longer practiced purely for the sake of transparency and accountability; it is now regarded as a valuable monetary policy instrument.

v. Strengthening Bank Indonesia and government policy coordination. Policy coordination is crucial, given that inflation stemming from the supply side creates most inflation volatility.

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Inflation measurement and inflation expectations: the case of Israel

Nadine Baudot-Trajtenberg and Edward (Akiva) Offenbacher[1]

Abstract

Inflation in Israel has been below the inflation target for over two years now and inflation expectations at short horizons have followed actual inflation to below the target. The low inflation outturns are the result of sharp, negative external and domestic price level shocks, including the global declines in oil and other commodity prices along with some domestic policy mandated price declines. A number of other countries are also experiencing below-target inflation. This paper discusses issues and challenges for monetary policy in Israel that have arisen as a result of the prolonged effects of the negative price shocks against the background of an already highly expansionary monetary policy and relatively solid real economic developments.

Keywords: Inflation measurement, inflation expectations, price stability

JEL classification: E42, E31, E58

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The Bank of Israel's mandate is threefold: (i) to maintain price stability – its central goal – which is defined as annual headline inflation between 1 and 3%; (ii) to support other objectives of the government's economic policy, particularly growth, employment and the reduction of social gaps; and (iii) to support the stability and proper functioning of the financial system.

The Bank of Israel Law (2010) and the Monetary Policy Committee (MPC) have translated these multiple goals into a "flexible inflation target", whereby short-term deviations from the inflation target are accommodated so long as the MPC can foresee a return of the annual inflation rate to within the target range within 24 months (as stipulated in the Bank of Israel Law), thus allowing the Bank to pursue its other goals in parallel to maintaining price stability over the intermediate and longer term.

Note that inflation is defined, by law, in terms of the CPI and not on the basis of a perhaps more stable "core inflation" measure. This poses special challenges at times of unusually large (and persistent) external shocks. The past two years presented such a challenge, and indeed despite expansionary monetary policy, inflation was not only below target but, in fact, negative during both 2014 and 2015. Clearly, disentangling pressure on prices from transitory shocks that affect the headline figure is crucial in order to devise the appropriate policy response, particularly since monetary policy must be forward-looking and should not respond to past inflation shocks unless they provide solid indication of future deviations of inflation from target. Extricating the right signal from an array of prices requires two things: first, understanding how the various components affect headline inflation and the extent to which it is affected by external[2] shocks; and second, understanding how inflation expectations are formed, and particularly how, when and to what extent those expectations are affected by seemingly temporary, external shocks.

1. Measuring inflation

The focus of monetary policy is on the percentage change in headline CPI over the previous 12 months, in part due to substantial monthly fluctuations even when the overall inflation level is low. For instance, April is known for an unusually high increase of CPI in part due to annual holidays (Passover and Easter) associated with high spending and sometimes due to weather-induced price hikes in fruits and vegetables. In Israel, imports of fruits and vegetables are strictly limited, which causes high monthly inflation volatility despite it being a relatively minor item in the CPI basket (2.7% of the CPI basket), and despite the low inflation level (the rolling 12-month inflation rate has averaged 1.8% since 2000). While fruits and vegetables can easily be isolated from the CPI, the seasonality of other prices is difficult to assess as the calendar month in which so-called "seasonal" affects occur may vary, eg the

[2] Even the word "external" requires interpretation – in some cases, shocks are clearly external, such as an episode of unusually bad weather which affects the prices of locally grown fruits and vegetables. But sometimes shocks are policy-induced, such as a reduction of local taxes or a statutory reduction of state controlled prices on goods like water and electricity – a policy which itself may very well reflect a reduction in inflation expectations – in which case such shocks are not entirely "external" to the inflation environment.

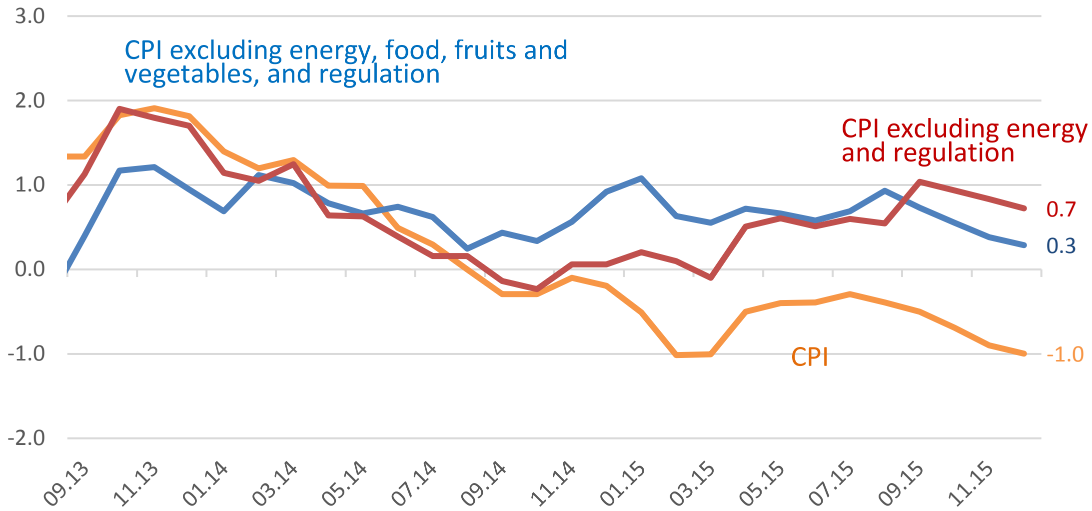
seasonality of weather patterns is not regular and Jewish holiday periods[3] are not fixed according to the Gregorian calendar. Examining inflation over the past 12 months nets out this seasonality.

Although we do not define a specific core inflation measure, we attempt to isolate elements that are considered to be external and temporary shocks to domestically generated price movements, understanding that it is not always clear how external or how temporary these elements are. Lately, the dramatically falling oil prices and consequent impact on energy prices in Israel (which are determined by an administrative process, partly in response to world prices) have had a significant impact on headline inflation, so we attempt to isolate this component, attributing it to external factors.[4] Other external shocks such as VAT rate changes (eg the 2015 reduction) or adjustments of administrative fees (television fees, water prices etc) have also been segregated. Thus when looking at Graph 1, we can see that these shocks all pushed annual inflation downward in 2015, with headline annual CPI at –1%, while CPI excluding food, fruits and vegetables and "administrative measures" stood at 0.3% – still below the 1–3% inflation target.

Headline vs underlying inflation

Twelve-month inflation, 2013–15

Factors of a one-off nature and energy prices contribute to low inflation Graph 1



In general, in a further attempt to disentangle external from domestically generated price movements, we also consider two CPI indices: one of tradable goods and services (36% of CPI) and one of non-tradable goods and services (64% of CPI). As can be seen in Graph 2, these have also exhibited considerably different inflation rates over the past few years. The interpretation of these price movements must of

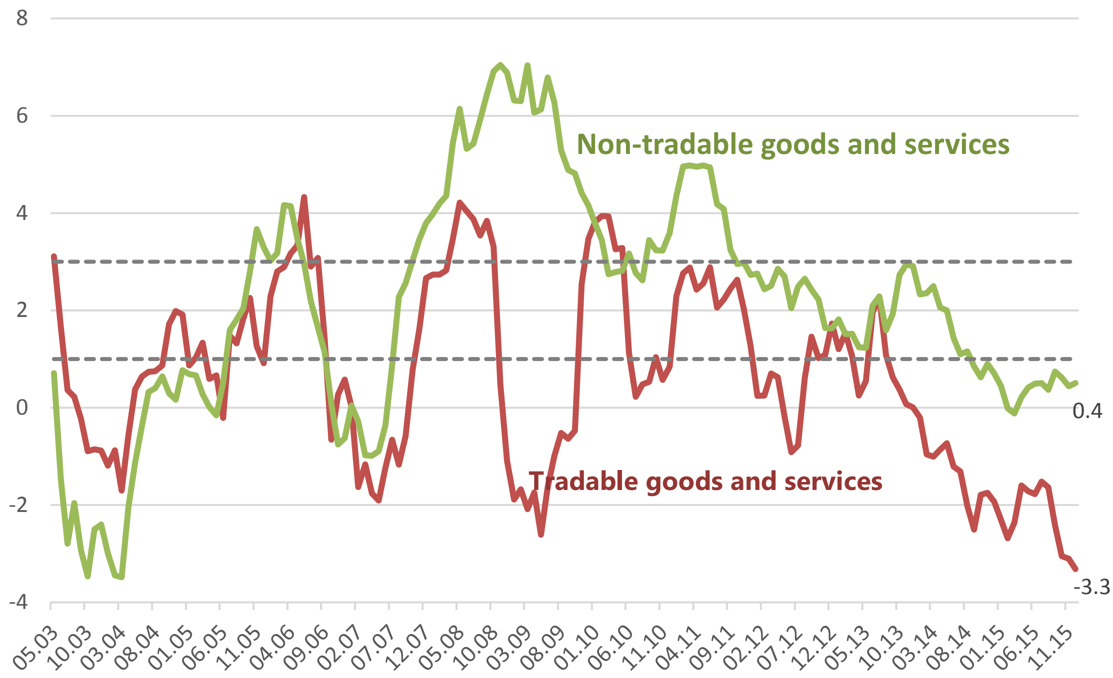
3 Typical items subject to "holiday" pricing are holiday packages, flights and hotels etc.

4 See below the discussion of inflation expectations which quotes from Sussman and Zohar (2016) on the impact of oil prices on inflation expectations.

course take into account effective exchange rate movements, although this impact appears to be quite moderate. As we will see later, the most recent estimates of exchange rate pass-through are now quite low in Israel, amounting to about 10% overall (ie a 10% devaluation of the currency would lead to a 1% CPI increase) and to half that amount when excluding the housing component of CPI (rental prices).[5]

Non-tradable and tradable goods and services

12-month inflation, 2003–15 Graph 2

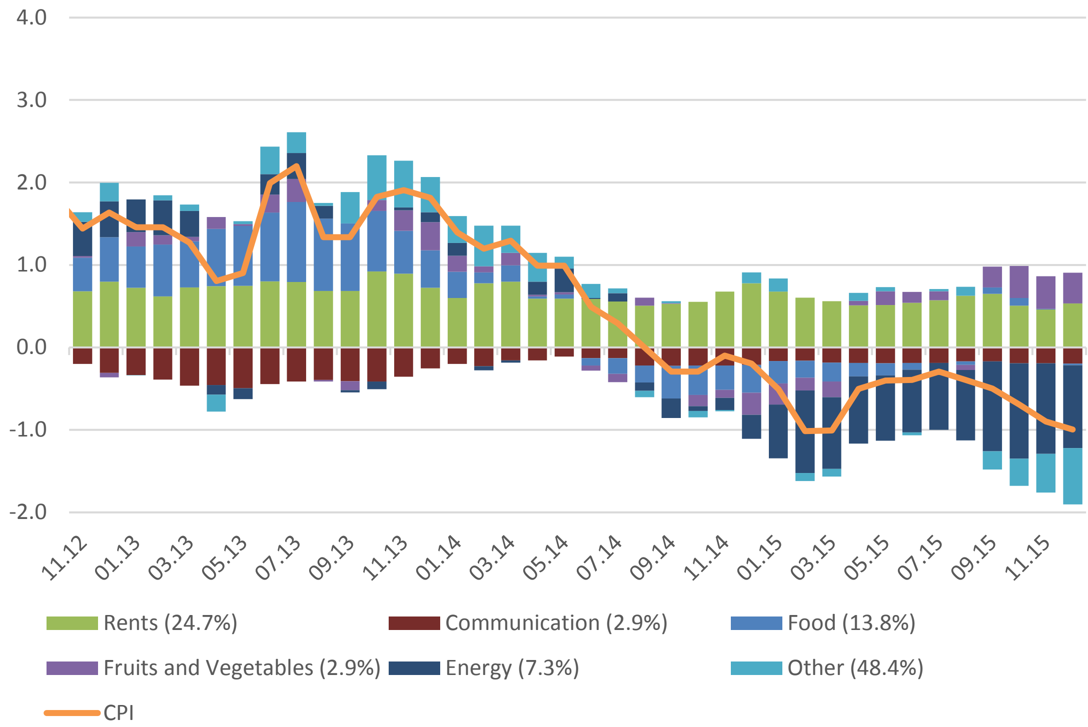


Structural changes can impact relative prices and the overall price level, and though these are often difficult to identify and quantify, some sectors have undergone major reforms specifically in order to enhance competition; the ensuing effects on prices have stood out in the past few years. One example is the telecommunications sector, which underwent a major reform in 2011 and which has since seen continual price reductions, as can be seen in Graph 3.

5 See Ribon (2015b).

Selected sector contribution to CPI

12-month % change, 2012–15 Graph 3



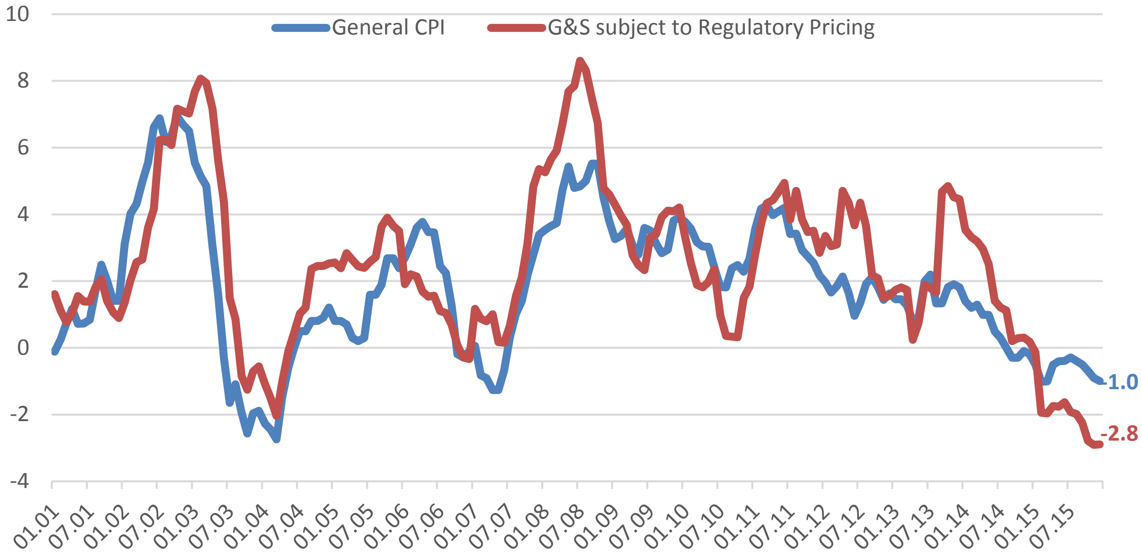
Administrative or regulated prices amount to approximately 15% of the CPI, although one should be careful in inferring that price movements in this category are due entirely to exogenous factors – clearly some of the adjustments are made in response to the general inflationary environment. So they may be considered "one-off" for the specific month or quarter in which they occur, but one should be more careful about excluding them from the general inflation undercurrent. As can be seen in Graph 4, regulated or administratively set prices tend to move in tandem with the rest of the CPI basket, although, as noted, lately it has tended to pull the inflation rate down further.

A few years back, a more thorough investigation in search of a better core inflation measure was undertaken by Ribon[6] in which 20 different indices were scrutinised, and none were found to clearly dominate headline CPI, though each contributed to our understanding of current inflationary trends.

6 See Ribon (2009).

Changes in administrative prices vs headline CPI

12-month annual % change, 2001–15 Graph 4



We have not assessed how the distribution of income may have affected the general inflation rate, though a recent paper by Ribon has attempted to evaluate some aspects of the reverse relationship: to what extent have different socioeconomic groups experienced different inflation rates given the wide variance in the composition of the consumption basket? By carefully looking at the residential area of various income groups, at a time when housing costs have increased rapidly nationwide but at different paces in different regions of Israel, Ribon found that "… there is wide variance in the rate of price changes of consumption baskets among different households, but there is no strong persistence over time in the relative inflation for a large part of the population groups".[7]

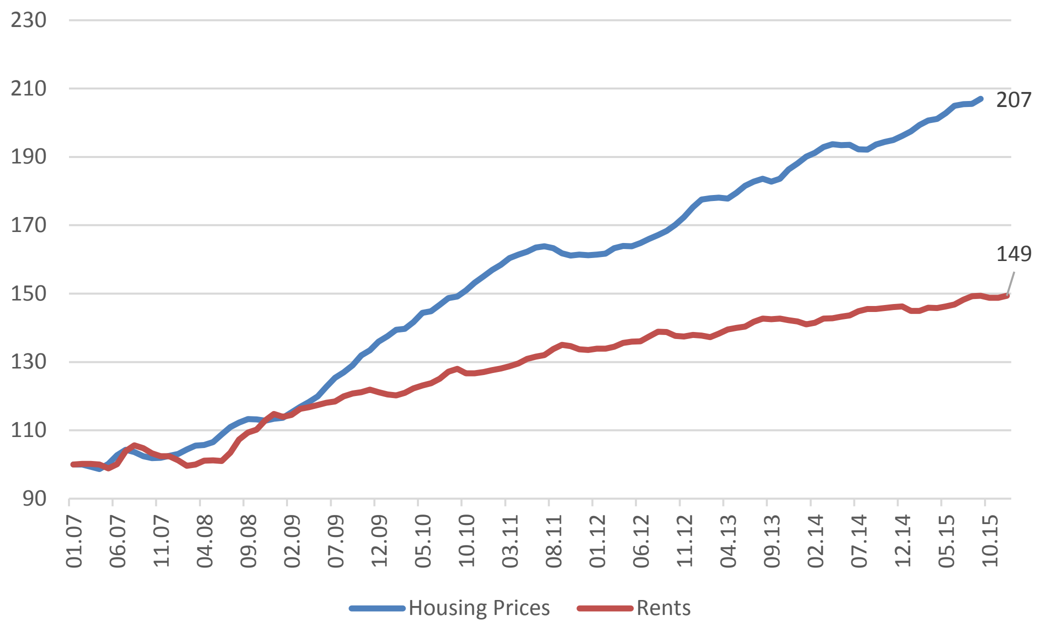
The housing component of the Israeli CPI is not only a significant part of the basket (24.7%), but it has also been the only consistent positive contributor to inflation in recent years, as can be seen in Graph 3. Its measurement in the CPI, even for owner-occupied housing, is based on rental prices (both continuing contracts and new rental contracts), though the rental market is not as developed in Israel as in most other advanced economies. This is the case not only because the share of owner-occupied housing is relatively high (68%) but mainly due to the fact that there exist few long-term rental properties (that is, apartment buildings or other residential properties built for the specific purpose of long term rental). Note, however, that the rental price increases over the past eight years pale in comparison to those of (directly measured) owner-occupied housing prices, as can be seen in Graph 5[8].

[7] See Ribon (2015a).

[8] We will not address here the thorny issue of financial stability that arises in the wake of sharp and sustained increases in housing prices, but note that the Supervisor of Banks has repeatedly introduced macroprudential measures, such as limiting LTV and payment-to-income ratios and the

Housing prices and rents

2007 = 100 Graph 5



2. The inflation process: attaining price stability (and beyond?)

From hyperinflation in the late 1970s and early 1980s to low double-digit inflation in the 1990s, the Israeli economy has now enjoyed the longest period of price and financial stability in its history. In spite of an environment characterised by severe international crises and significant domestic stress, Israel finally attained price stability near the beginning of the current millennium and has maintained low single-digit inflation for 15 years.

The notion of price stability includes stability of both actual and expected inflation. That is, it is not sufficient for actual inflation to be low and stable; in addition, the monetary regime must be credible in the public's perception, as evidenced by measures of expected inflation for the medium and long terms. This definition is in the spirit of former Fed Chairman Greenspan's intuitive definition of price stability (Greenspan (2002), p 6): "… price stability is best thought of as an environment where inflation is so low and stable over time that it does not enter materially in the economic decisions of households and firms".

Although this definition does not explicitly mention expectations, it clearly implies that inflation expectations must also be low and stable for economic agents to be able to ignore inflation in their decisions. In the context of an inflation targeting

share of the variable interest rate component of each mortgage, as well as increasing capital charges for mortgage lenders.

regime, this means that observable measures of actual and expected inflation are consistent with the inflation target, in terms of both the level and the time horizon defined by the target.

In Israel's case, Cukierman and Melnick (2015) (both former members of the MPC) make the case that the period of price stability begins at the end of 2003, when inflation expectations became well anchored by the inflation target (see Graph 6). This in spite of the fact that Israel's monetary regime met the IMF definition of "full-fledged inflation targeting" already in mid-1997 (see Stone and Bhundia (2004)) and, as shown econometrically by Melnick and Stroshal (2015), actual inflation was generally within the target zone already by late 1998. But given Israel's history of volatile inflation, it is not surprising that inflation expectations lagged both institutional developments and actual price movements. Perhaps surprisingly, the dating of price stability in Israel is nearly the same as Greenspan's dating of the achievement of price stability in the United States (see Greenspan (2002) and Orphanides (2006)). It is interesting to note that for the period January 1999–August 2015, average 12-month inflation in the US and Israel were nearly equal, 2.14% and 2.27%, respectively, but the standard deviation was 1.9% in Israel while it was only 1.3% in the US.

Inflation expectations – one-year- and 10-year-ahead

1994–2015 Graph 6

Institutional changes

Three major institutional developments in the "lead-up" period were of key importance in establishing the credibility required for sustained price stability. First, in September 1994, in the wake of the realisation that an ambitious inflation target would be missed by a wide margin for that year, the government approved the active use of domestic interest rate policy to attempt to attain the target (see Cukierman and Melnick (2015)). This was the first clear message sent by the authorities that a target is not just a forecast but a metric to be attained through explicit policy measures.

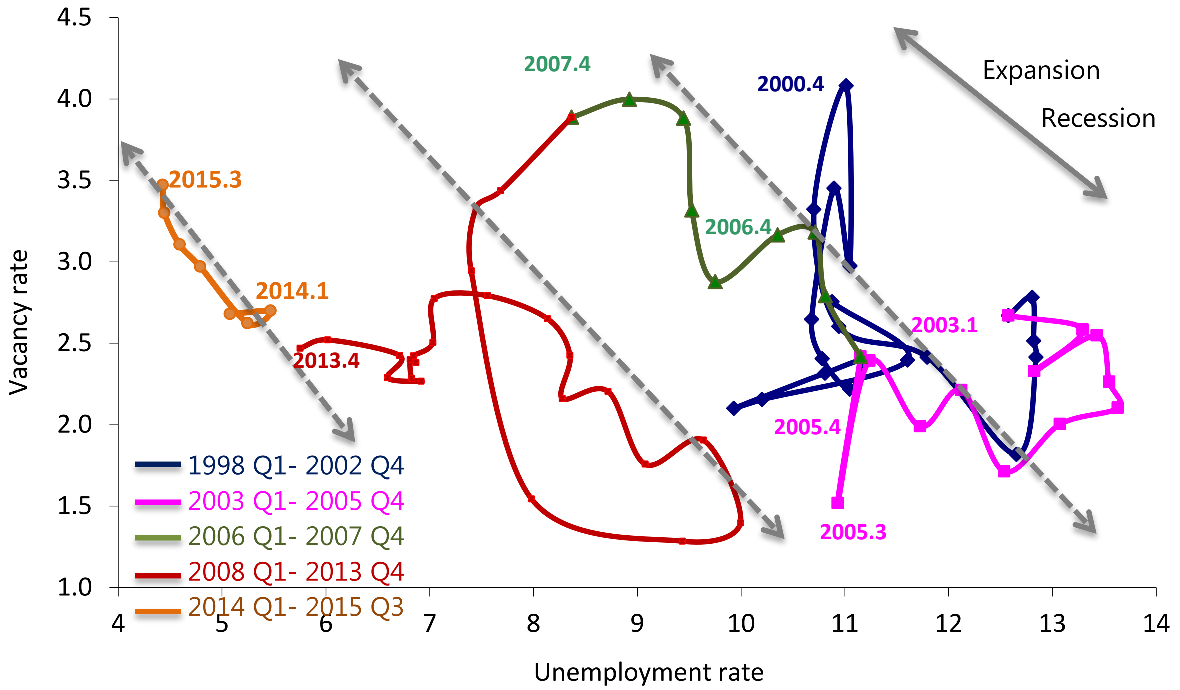
However, the government's reluctance to take the important complementary step of enabling exchange rate flexibility in combination with high interest rates relative to abroad led to a surge of capital inflows and massive forex intervention by the Bank of Israel. By June 1997, the Bank was able to convince the government that this situation was untenable, and the government approved the second key policy measure leading to price stability – a significant widening of the exchange target zone (ERTZ), creating a de facto fully flexible exchange rate policy regime. In addition to widening the ERTZ, the Bank of Israel and the government continued to pursue a gradual liberalisation of foreign exchange controls, first on the side of credit and then on the side of the public's assets. The disinflation process was temporarily interrupted in the fourth quarter of 1998 by a brief inflationary shock due to the Russian bond/LTCM crisis; the shock was offset by a large, immediate interest rate hike. This episode was important in establishing the credibility of the inflation targeting policy.

Stable conditions resumed and by mid-1999 the time was ripe for the third and final key policy measure leading to price stability: declaration by the government of a formal, long-term inflation target at the level that had been adopted as best practice by a significant number of advanced economies – an annual rate of approximately 2%. This announcement came in August 2000 as part of a government decision to adopt the European standard for macroeconomic management (see Bank of Israel (2001)), stipulating a gradual reduction of the inflation target over three years and setting by 2003 a target range of 1–3% for an indefinite horizon (see discussion in Cukierman and Melnick (2015), Section 5.)

Structural changes – flexible labour markets

Israel's strong economic performance from mid-2003 to mid-2011 far outstripped the rate of growth in other advanced economies and was affected acutely by the global financial crisis during only the fourth quarter of 2008 and the first quarter of 2009. During this period, inflation fluctuated within and somewhat outside the target range, with misses attributable primarily to worldwide commodity price fluctuations. Labour markets since 2004 became more efficient as labour participation of the core age group (25–64) increased from 75.4% in Q1 2004 to 80% in Q3 2015 while unemployment fell from 11.7% to 4.5% in those quarters. These changes occurred with little increase in gross real wages, though the drop in personal income tax rates during the period generated higher net wages. In fact, the Beveridge curve relating the unemployment rate to the job vacancy rate seems to have shifted twice during the past decade, as can be seen in Graph 7, pointing to a more efficient labour market.

Beveridge curve, 1998–2015 Graph 7



Falling exchange rate pass-through

In a small open economy such as Israel's, the inflation rate can be expected to be affected by exchange rate movements in the short run, but in addition its history of high inflation gave rise to "Institutional arrangements designed to safeguard the real value of a unit of account...however, once established, dollarisation in the real estate market tended to persist long after stability made it no longer necessary", in the words of Cukierman and Melnick (2015). As can be seen in Graph 8, taken from the same authors, the percentage of dollar-denominated rental contracts fell from around 90% in 2005 to approximately zero today, with the steep fall occurring within one year between 2007 and 2008, roughly four years after Israel attained price stability.[9]

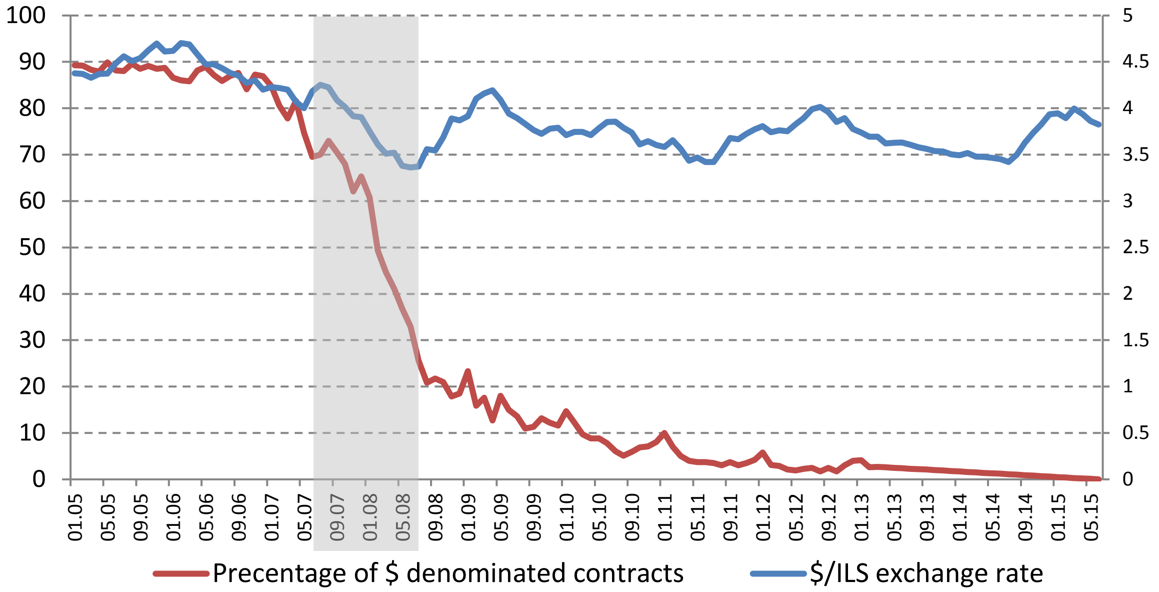
In the same article, Cukierman and Melnick estimate that the pass-through coefficient went from close to 1 between 1980 and 1998 to 0.09 in the period 2003–15. These results are consistent with estimates by Ribon (2015b) which find that the short-term pass-through of exchange rate movements to inflation has dropped from close to 80% 20 years ago to approximately 10% today. The pass-through from the exchange rate to the CPI excluding the housing component has dropped from about 47% to 5% over the same period, as can be seen in Graph 9. Note that this highlights the role of institutional elements enhancing the pass-

[9] Note that the fall also occurred roughly at the same time as the global financial crisis was developing in the US, with the shekel initially strengthening vis-à-vis the dollar, which may have accelerated the switch from dollar denominated contracts to shekel contracts.

through effect, which accounts here for half of the total effect in both the strong and weak pass-through effect periods.

Percentage of new dollar-denominated rental contracts (lhs) and USD/ILS exchange rate (rhs)

Graph 8

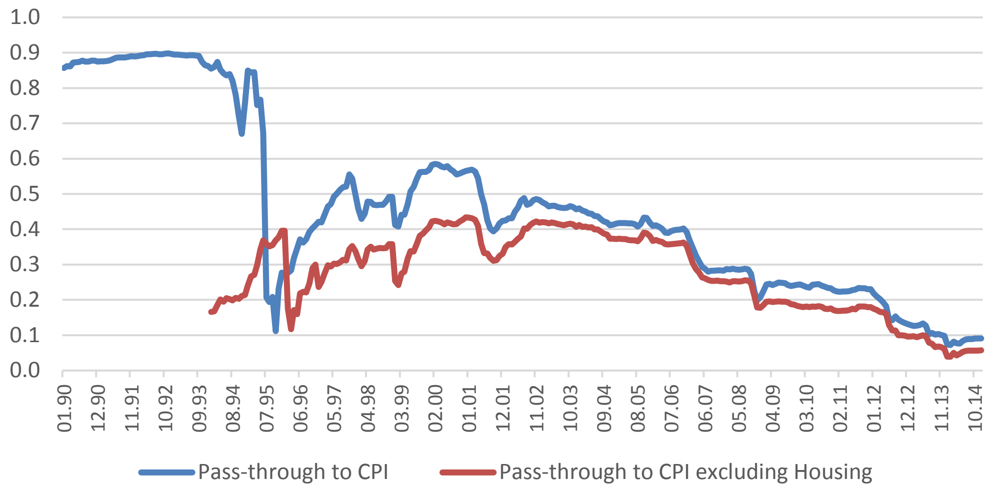


Source: Cukierman and Melnick (2015).

Pass-through coefficient from exchange rate to CPI and CPI excluding housing

1990–2014

Graph 9



Source: Ribon (2015b).

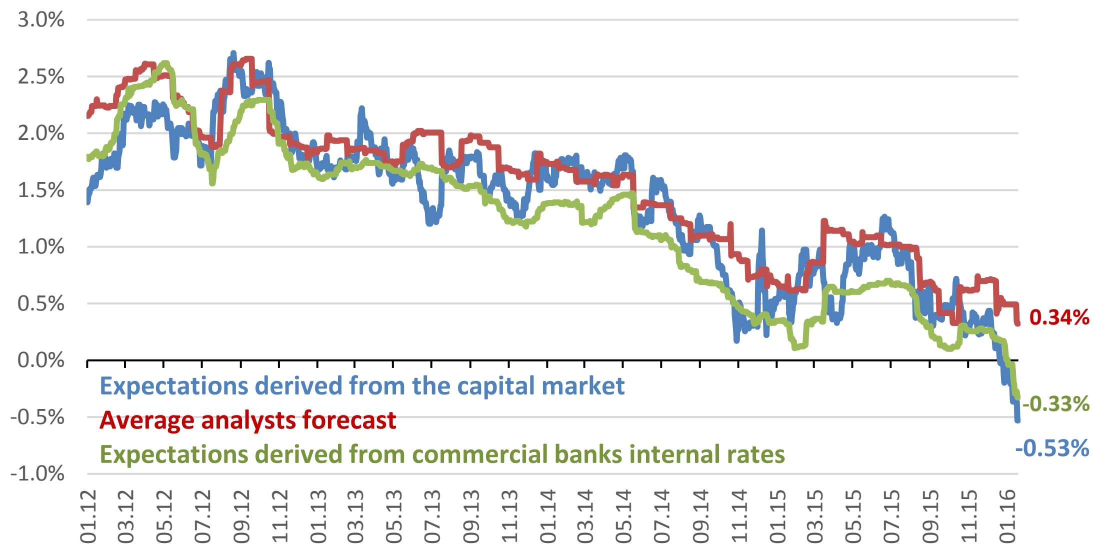
3. Inflation expectations and monetary policy

Another lingering effect of Israel's past history of high inflation lies in the still active CPI indexed bond market, which still accounts for about a third of the government's newly issued tradable debt, and approximately 70% of the corporate bond market. This has made it relatively easy to measure and interpret break-even inflation expectations, both short- and long-term, using indexed and unindexed bonds of various maturities. However, since fiscal responsibility and price stability have been achieved, the number of bond series issued by the government has declined, so measurement of inflation expectations increasingly relies on synthetically built yield curves, as in most other advanced countries. In addition, we look at forecasters' published figures for one-year inflation expectations, as well as break-even inflation calculated from commercial banks' internal interest rates, indexed and unindexed, that they calculate and use internally to price products to customers.

Graph 10 shows that a recent development has been a gradual but persistent drop in short-term inflation expectations, from all sources: professional forecasters, financial market-based and commercial banks' internal pricing. This has occurred while the economic environment has not changed markedly over the past year, though the most recent forecasts continue to point to an increasingly lacklustre level of economic growth – about 2.5%. The labour market, on the other hand, continues to show resilience, both on the job creation front and in the pace of nominal wage growth, which continues to increase at about 2–3% annually.

One-year inflation expectations

Various sources, daily 2012–15 Graph 10

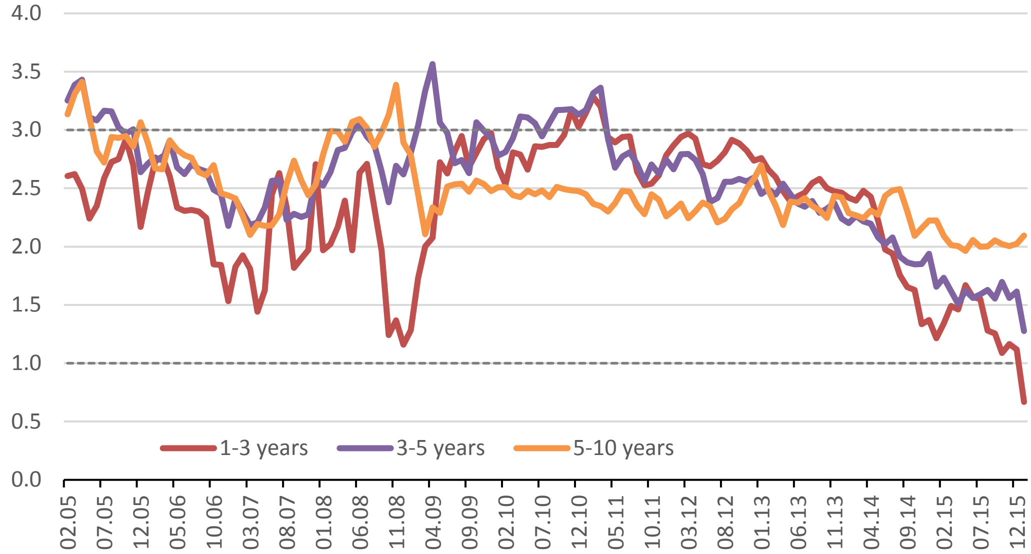


Note that due to the large one-off external shocks which have occurred recently, such as the reduction in VAT and the drop in water prices and other administrative measures, and given that these are announced ahead of time, Israel has increasingly been relying on forward inflation expectations, such as the one-year expectation one year ahead, in order to attempt to net out the effects of these shocks.

Graph 11 shows that long-term inflation expectations are well anchored around the middle of the inflation target (2%), the medium-term expectations have stabilised at a lower level (about 1.5%) but are still within the target range, and the short-term forward expectations have now dropped below the band for the first time ever, and stood at 0.7% in mid-January 2016. Clearly the market expects the very low inflation environment to remain so for a number of years ahead, which can no longer be explained by the one-off shocks mentioned above.

Forward inflation expectations: short-, medium- and long term

2005–15 Graph 11



The accuracy of these various measures of short-term inflation expectations and forecasts over the past few years can be seen in Graph 12 and perhaps indicates their usefulness for monetary policy.

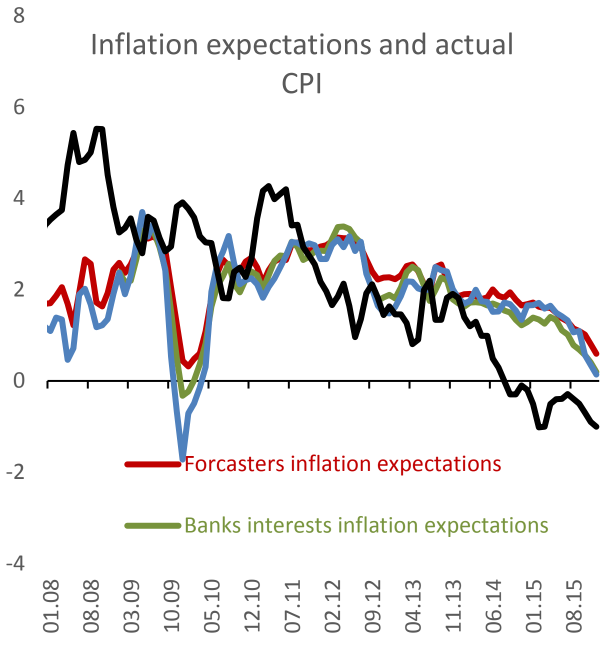
The various sources of expectations and forecasts move closely together and show some persistence in their deviation, which for the past few years has manifested itself as a systematic overestimation of future inflation.

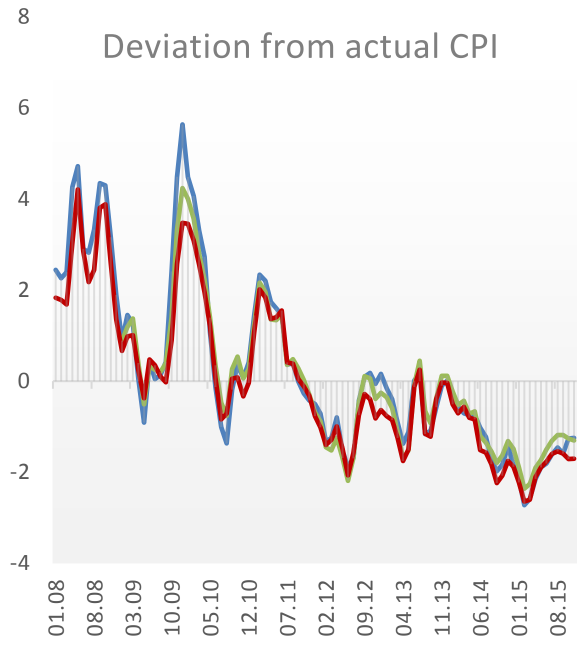
An interesting insight as to the source of these deviations has been suggested by Sussman and Zohar (2015), who investigate the changing role of oil prices in the formation of inflation expectations, both in Israel and other oil-importing countries. They note that oil prices have become more strongly correlated with five-year break-even inflation, as can be seen in Graph 13, despite the fact that oil is a relatively minor component of the CPI.[10]

[10] In Israel it is reflected mostly in the price of gas, which is heavily taxed and thus mitigates substantially the oil price movement.

One-year inflation expectations and forecasts and actual CPI

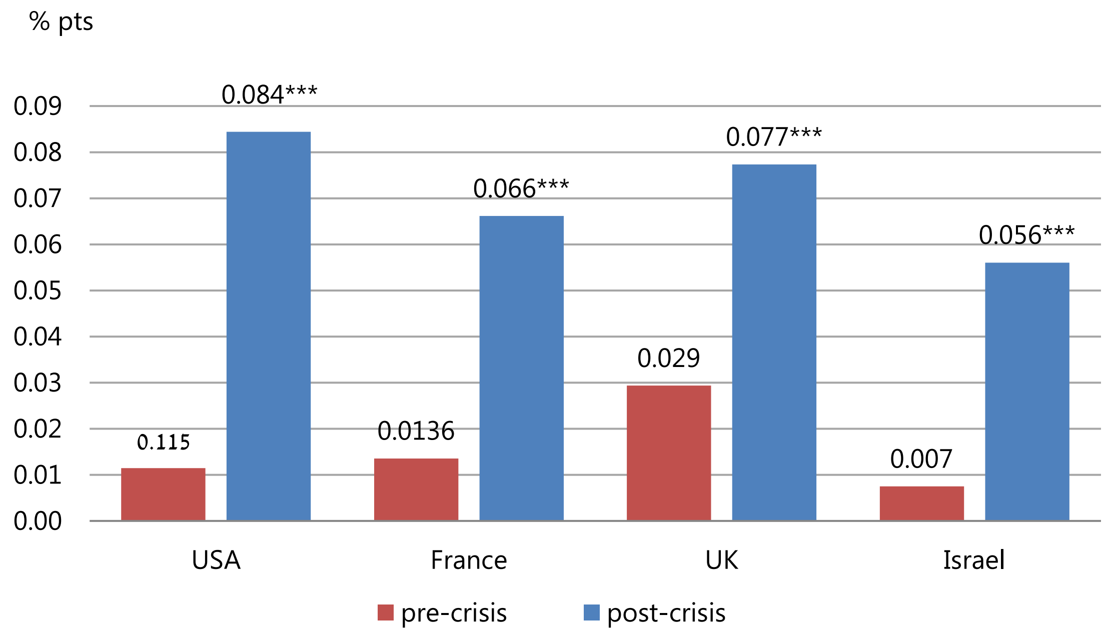
Monthly, 2008–15 Graph 12





Percentage point change in five-year break-even inflation rates caused by a 10% increase in oil prices

Monthly, January 2004–June 2015 Graph 13



Using principal component analysis on other commodity price movements (as well as weather patterns in the area of production), they decompose oil price movements into demand and supply shocks, in order to eliminate possible spurious correlation between oil prices and inflation expectations due to a global aggregate demand shock. They find: "During the crisis, we saw that global demand and supply conditions reflected in oil prices became strongly correlated with inflation expectations. Examining the contribution of these factors … reveals that while both factors contribute more to the developments in inflation expectations since the onset of the crisis, global demand has a more dominant effect. In fact, it seems that in the post-crisis period global demand explains a substantial part of the development in global expected inflation."

4. Conclusion

Like many countries, Israel has been experiencing low and declining inflation and inflation expectations in the past few years, generally well below inflation target ranges considered consistent with price stability, while at the same time real economic activity has been relatively resilient. The main sources of this continuing low inflation environment include the very long and sluggish economic recovery from the global financial crisis and the sharp global declines in oil and other commodity prices since end-2013, though in Israel the real economy has been relatively resilient. Year-over-year monthly inflation has been negative for a year and a half, while inflation expectations have remained anchored within or near the inflation target range until recently. Having pursued highly expansionary monetary policies since the beginning of the crisis, monetary authorities in Israel and many other constituencies are somewhat hard-pressed to take further aggressive measures to reinflate. The Bank of Israel bases this policy stance on a number of considerations: (i) primarily the assessment that the negative price shocks are due mainly to temporary, positive supply shocks, so inflation is likely to gradually return to a path consistent with the inflation target within the two-year horizon provided for in the Bank of Israel Law; (ii) uncertainty about the effectiveness and possible unintended side effects of further unconventional monetary policy measures, such as negative policy rates or significant local currency bond purchases; and (iii) concern about continuing house price increases. Looking ahead, the Bank will have to weigh the possible emergence of further indications of second-order deflationary expectations against the likely costs of yet more monetary expansion.

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Inflation dynamics in the post-crisis period: Korea's experience

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Abstract

This note presents preliminary evidence of recent structural changes to inflation dynamics in Korea, and sets out some possible causes and policy implications. First, the estimated Phillips curve changed significantly during 2011–12, which helps to better explain the prolonged low inflation in the post-2012 period. Second, various measures of trend inflation are estimated to have fallen to about 2% in the post-2012 period from about 3% before 2011, which provides further evidence of changes in the inflation process during the recent past. Third, we focus on the role of changes in economic structures following the global financial crisis in driving changes in the inflation dynamics in the post-2012 period, and discuss some implications for monetary policy.

Keywords: Inflation dynamics, Phillips curve, trend inflation, changes in economic structures, monetary policy

JEL classification: E31, E52

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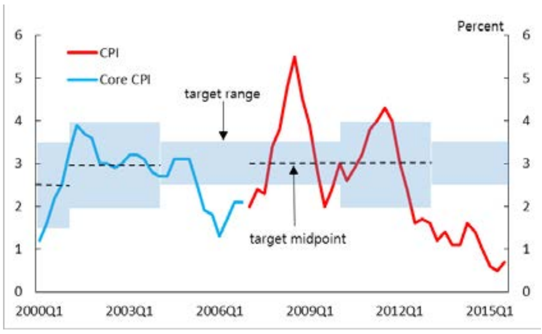
1. Motivation

Inflation dynamics in Korea appear to have undergone substantial changes during the recent past. While inflation rates fluctuated during and immediately after the global financial crisis, as one would expect, their subsequent post-crisis evolution is much less compatible with standard models of the inflation process. In fact, inflation rates in Korea have weakened more rapidly and persistently since 2012 than can be explained by variations in economic slack and other inflation determinants.

The low inflation that has emerged from 2012 onward is unprecedented in terms of its duration and severity: inflation has been running below the target range or the tolerance interval for 37 consecutive months from, November 2012 to November 2015, with the average deviation amounting to –1.4 percentage point.[4] This marks the longest period over which inflation has remained below target since the adoption of inflation targeting in 1998.[5] Indeed, the recent decline in Korea's inflation is twice the OECD average. While this low inflation is in large part due to supply shocks, especially from the second half of 2014, its timing and severity raise the question of whether structural changes may have influenced the inflation process in Korea in the post-crisis period.

Inflation rates[1] in Korea — Graph 1



Notes

[1] Year-on-year. [2] The shaded blue area represents either the target range or the tolerance interval.

Recent changes in inflation[1] — Table 1

	2001–07 (A)	2012–14 (B)	B–A
Korea	3.1	1.6	–1.5
OECD average	2.7	1.9	–0.8

Note

[1] Average CPI inflation rates over the specified period.

Our purpose in this note is to provide a preliminary assessment of potential changes in inflation dynamics during the recent past in order to better understand the prolonged low inflation since 2012, and to present some possible causes and policy implications of these changes. To this end, Section 2 sets up the analysis of whether inflation dynamics have changed during the recent past using Phillips curves. Section 3 presents three measures of trend inflation, and tests for structural breaks in their level. Section 4 discusses possible causes of recent changes in inflation

[4] The inflation target was the 3% midpoint of the tolerance interval of 2–4% during 2010–12, while the target range was 2.5–3.5% during 2013–15.

[5] The second longest period of the deviation below the target range or the interval is 27 months, from July 2005 to September 2007, with the average deviation being only –0.5 percentage point.

dynamics. Finally, Section 5 summarises the main findings, and considers potential policy challenges.

2. Analysis of changes in inflation dynamics using Phillips curves

This section examines potential changes in the Phillips curve relationship so as to better understand the prolonged low inflation from 2012 onward. The first subsection estimates a standard Phillips curve to document how the model fares with actual inflation rates. The second subsection then estimates an augmented Phillips curve allowing for parameter change, to analyse the curve's ability to improve the empirical fit of the model, particularly during the recent past.

2.1. Standard Phillips curve

Following the specifications in Friedrich (2014), we estimate a standard Phillips curve for the headline inflation rates:

$$\pi_t = \alpha + \beta\pi_t^e + \gamma y_t + \delta imp_t + \varepsilon_t,$$

π : CPI inflation, π^e : Household inflation expectations (one year)

y : GDP gap, imp: Import price inflation (in KRW)

where current inflation is explained by inflation expectations, the GDP gap, import price inflation, and other residual factors. The use of household inflation expectations is in line with Coibion and Gorodnichenko (2015), who find that household inflation expectations help to explain missing disinflation in the United States during the Great Recession. Due to the availability of data, the sample used for the estimation is in quarterly frequency, and spans the period from Q1 2003 to Q4 2014.

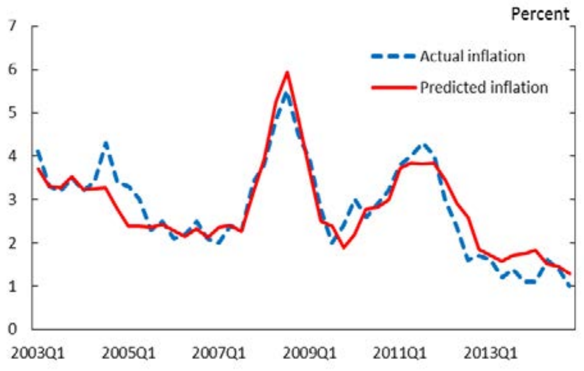
Table 2 shows the estimated coefficients of the standard specification, and Graph 2 illustrates the resulting in-sample fit. As shown in Table 2, the coefficients of inflation expectations, the GDP gap, and import price inflation are statistically significant, and their signs are consistent with economic theory. However, as depicted in Graph 2, while the standard Phillips curve relationship generally does a good job in predicting inflation rates in the period before 2011, it does not do well in predicting inflation rates from 2012 onward. A closer examination reveals that the in-sample prediction is consistently higher than actual outturns in the post-2012 period, suggesting that some aspects of inflation dynamics are likely to have changed around the period 2011–12.

Estimated coefficients using the standard Phillips curve	Table 2

Variable	Coefficient
Constant (α)	–0.39
Inflation expectations (β)	0.87***
GDP gap (γ)	0.13**
Import price inflation (δ)	0.05***

Note
[1] *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

In-sample fit[1] using the standard Phillips curve — Graph 2



Note
[1] Year-on-year.

2.2. Augmented Phillips curve

In order to account for potential changes in inflation dynamics parsimoniously, we estimate an augmented Phillips curve which adds a post-2012 dummy and interacts it with the other explanatory variables:

$$\pi_t = \alpha_1 + \beta_1\pi_t^e + \gamma_1 y_t + \delta_1 imp_t + \alpha_2 D_t + \beta_2\pi_t^e D_t + \gamma_2 y_t D_t + \delta_2 imp_t D_t + \varepsilon_t,$$

π : CPI inflation, π^e : Household inflation expectations (one year), y : GDP gap,

imp: Import price inflation (in KRW), D : Post-2012 dummy variable (1 from Q1 2012 onward)

where the dummy takes on the value of 1 from Q1 2012 onward, and 0 otherwise. Interacting the post-crisis dummy with other explanatory variables in the equation allows the effects of the constant term, inflation expectations, the GDP gap and import price inflation to differ between the pre-2011 and post-2012 periods. The definition of the remaining variables and the sample period are the same as those with the standard Phillips curve.

Table 3 indicates that inflation is more sensitive to inflation expectations but less sensitive to import price inflation during the post-2012 period. Further, the constant term in the inflation process is much smaller, implying that the Phillips curve may have shifted downward in the post-2012 period. However, unlike the coefficients of the other variables, there is no significant change in the sensitivity to the output gap during the post-2012 period.

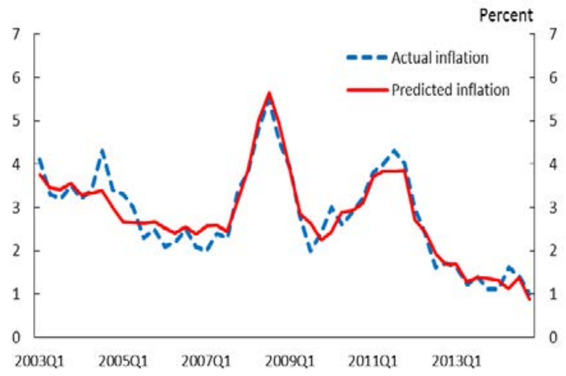
Estimated coefficients using the augmented Phillips curve — Table 3

Variables		Coefficient
Constant (α_1)		0.19
Inflation expectations (β_1)		0.76***
GDP gap (γ_1)		0.06
Import price inflation (δ_1)		0.05***
Dummy variable	(α_2)	–2.25**
	(β_2)	0.53*
	(γ_2)	0.68
	(δ_2)	–0.11**

Note

[1] *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

In-sample fit[1] using the augmented Phillips curve — Graph 3



Note

[1] Year-on-year.

Graph 3 depicts the resulting in-sample fit based on the augmented Phillips curve specification. It shows that adding the post-2012 dummy and interacting it with standard determinants substantially improves the explanatory power of the model, especially during the recent past.

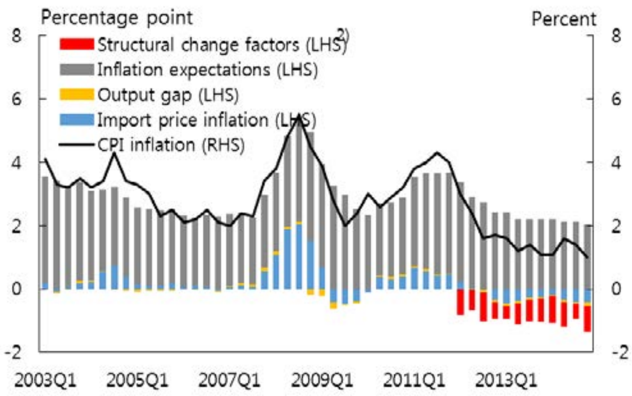
Viewed as a whole, the estimation results suggest that inflation dynamics in Korea are likely to have undergone substantial changes around the period 2011–12, and accounting for this change helps to better explain the prolonged low inflation during the post-2012 period. Further, the downward shift in the Phillips curve may have played a prominent role in driving changes in the inflation process.

Before scrutinizing the lower-frequency inflation process further, it is helpful to quantify the contribution of structural change factors in explaining the inflation fluctuations during the post-2012 period. To this end, we conduct a historical decomposition of the determinants contained in the augmented Phillips curve, and define structural change factors as the sum of the terms associated with the post-2012 dummy interacted with a constant term and other explanatory variables.

Graph 4 shows that inflation expectations explain a large part of the inflation process over the entire period, which is similar to Friedrich (2014). Meanwhile, the GDP gap and import price inflation generally played a role in boosting inflation rates in the pre-2011 period, whereas they have played a role in reducing inflation rates since 2012, albeit by a smaller magnitude relative to inflation expectations. Further, since 2012, structural change factors have played a role in lowering inflation rates by 0.4–0.9 percentage point, a magnitude that is greater than those of the GDP gap and import price inflation calculated based on the pre-2011 coefficients.

Contributions of individual inflation determinants[1]

Graph 4



Notes

[1] Results are based on the augmented Phillips curve. [2] Structural change factors consist of the post-2012 dummy interacted with a constant term and other explanatory variables.

3. Analysis of changes in inflation dynamics using trend inflation

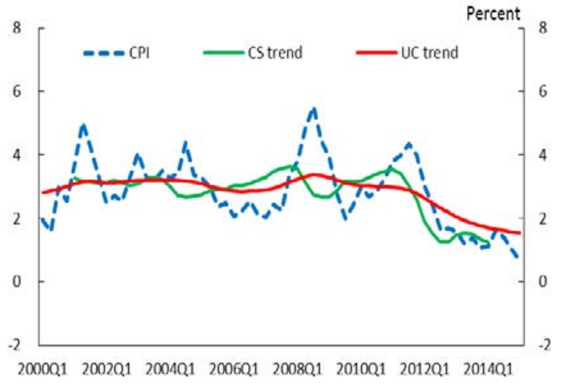
This section investigates potential changes in the evolution of trend inflation in order to further our understanding of the protracted low inflation during the post-2012 period. Trend inflation measures the underlying trend in inflation after removing transitory price movements due to short-run disturbances. Thus, it is reasonable to attribute its persistent shift to structural changes in the inflation process.

We start by estimating trend inflation using three econometric methods: vector autoregressions by Cogley and Sbordone (2008) (henceforth CS), an unobserved component model by Harvey and Koopman (2009) (henceforth UC), and a dynamic factor model by Giannone and Matheson (2006) (henceforth DFM). The use of multiple methods is to check for the robustness of our results to alternative methods for estimating trend inflation.

Specifically, the CS model constructs four-variable vector autoregressions consisting of inflation, the GDP gap, the short-term interest rate and unit labour costs, and then defines trend inflation as the level to which inflation is expected to settle after short-run fluctuations die out. Next, the UC model decomposes inflation into trend and cyclical components using a state-space model, and then takes the trend component as trend inflation. Finally, the DFM model extracts common factors from various disaggregated price inflation rates, and derives trend inflation by removing any short-term fluctuations from common factors. Meanwhile, in line with the availability of data, the sample used for the estimation is at a quarterly frequency from Q1 2000 to Q1 2015 for the CS and UC models, and is at a monthly frequency from January 2000 to March 2015 for the DFM model.

Graph 5 shows the evolution of trend inflation since 2000 estimated using the CS and UC models, while Graph 6 shows the evolution of trend inflation estimated using the DFM model. In the period before 2011, the three measures of trend inflation are estimated to have been hovering around 3%, which is the midpoint of the inflation target over this period. However, they are estimated to have undergone persistent decline over the years 2011–12, descending to about the 2% level on average during the recent past. This evidence echoes the finding in the Phillips curve analysis that structural changes in the inflation process seem to have occurred around the period 2011–12. Compared across different estimation methods, trend inflation estimated using the DFM model shows a relatively smaller decline recently, while showing more fluctuations in the pre-2011 period.

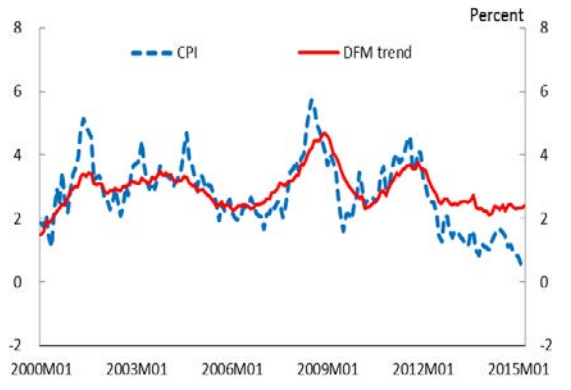
Trend inflation from CS and UC models[1, 2] Graph 5



Notes

[1] CS indicates a model by Cogley and Sbordone (2008), while UC indicates an unobserved component model by Harvey and Koopman (2009). [2] The CS and UC trend inflations are estimated using quarterly data for the period from Q1 2000 to Q1 2015.

Trend inflation from DFM Model[1, 2] Graph 6



Notes

[1] DFM indicates a dynamic factor model by Giannone and Matheson (2006). [2] The DFM trend inflation is estimated using monthly data for the period from January 2000 to March 2015.

As the next step, we test for structural breaks in the level of trend inflation as developed in Bai and Perron (2003) to investigate whether the trend inflation process underwent structural changes since 2000. Table 4 shows the resulting timing of significant structural breaks occurring for each measure of trend inflation. The estimation results show that the three measures of trend inflation experienced structural breaks during the period 2011–12. Specifically, the CS and UC trend inflation show structural breaks in Q3 2011 and Q3 2012, respectively, while the DFM trend inflation shows structural changes in June 2012 as well as in April 2005, July 2007 and October 2009.

Test for structural breaks in trend inflation Table 4

	Timing of structural changes[1]
CS trend inflation	Q3 2011
UC trend inflation	Q3 2012
DFM trend inflation	April 2005, July 2007, October 2009, June 2012

Note

[1] The timing of structural breaks is determined based upon values minimising the Schwarz test statistic modified by Liu, Wu and Zidek (1997).

4. Possible causes of changes in inflation dynamics

In the light of our findings that the inflation process may have changed during the recent past, this section considers possible causes of the decline in trend inflation, and discusses some policy implications.

A traditional macroeconomic view states that long-run inflation is fundamentally a monetary phenomenon, and is determined by monetary policy and its effects on long-term inflation expectations.[6] However, given that economic stagnation has persisted despite exceptional monetary policy stimulus following the financial crisis, an alternative view has gained traction, namely that economic structures other than monetary factors may influence inflation over a longer period of time.

For example, BIS (2015) decomposes inflation drivers into short-run, cyclical, and secular factors, and shows that secular drivers, such as globalisation, wage structure, and technology, have significant impacts on the low-frequency component of inflation. Faust and Leeper (2015) argue that most of the unusual inflation dynamics, known as disparate confounding dynamics, could be explained by taking proper account of structural economic factors, such as debt structure, demographics, etc. Our main focus in this section is the role of economic structures in explaining long-run inflation in Korea.

One fundamental background fact is that the Korean economy has been in the course of gradual transition from a fast- to a slow-growth model starting since the mid-2000s, a transition that accelerated in the aftermath of the global financial crisis. In terms of growth accounting, the increase in the labour force is constrained by rapid population ageing, and capital accumulation has slowed due to weak domestic investment opportunities. A slowdown in productivity growth further reinforces the deceleration in growth potential.

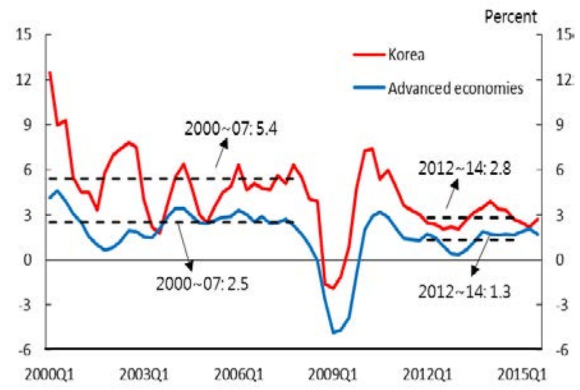
In principle, these factors could have both inflationary and disinflationary consequences: they reduce underlying inflation by weakening domestic demand, but they also tend to increase inflation by limiting production capacity. However, the overall impact seems to be disinflationary, especially because the growth deceleration interacts with other structural vulnerabilities, such as the labour market duality and the inadequacy of the social insurance system.

The other important factor is the rapid increase in economic integration following the global financial crisis. Increased economic integration could put downward pressure on aggregate inflation by intensifying competition between domestic and foreign markets (see Rogoff (2003), and Guerrieri et al (2010) for more detail). Further, higher trade openness is likely to magnify and prolong the transmission of external shocks into domestic inflation.[7] Thus, small open economies such as Korea's are more likely to experience prolonged low inflation in times of lacklustre global growth in the wake of the financial crisis.

[6] See Friedman (1963) among others.

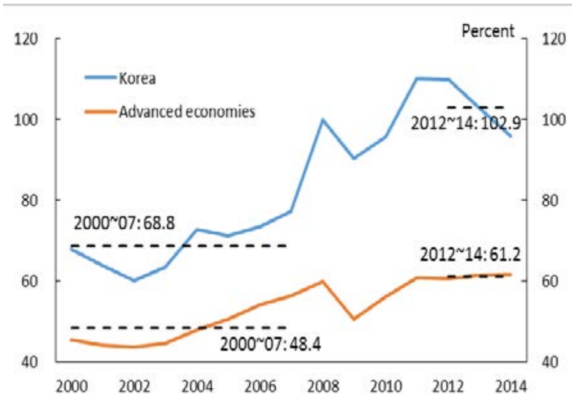
[7] See Milani and Park (2014) for more detail.

Output growth rates Graph 7



Sources: Bank of Korea, IMF.

Trade openness[1] Graph 8



Note

[1] Trade openness is measured as the ratio of the sum of exports and imports over GDP multiplied by 100.

Source: IMF.

Despite our focus on economic structures, monetary policy may have played a part in prolonging low inflation during the recent past. For example, monetary authorities in small open economies may find it desirable not to respond to persistently negative inflation shocks from abroad as aggressively as they have to other types of shock.[8] Obviously, further study is necessary so as to better understand the precise role of monetary policy in explaining low inflation.

5. Summary and policy challenges

This note makes a preliminary assessment of recent changes in inflation dynamics in order to better understand the prolonged low inflation from 2012 onwards, and to set out its possible causes. The analysis yields three main findings. First, the Phillips curve is estimated to have changed significantly during the period 2011–12, and taking into account this change better explains the low inflation in the post-2012 period. Second, various measures of trend inflation are estimated to have fallen to about 2% in the post-2012 period from about 3% before 2011, which provides further evidence of recent changes in the inflation process. Third, we focus on the role of changes in economic structures in driving changes in the inflation dynamics in the post-2012 period, highlighting that both structural transition and high economic integration may act as persistent disinflationary forces, particularly in times of lacklustre global growth in the aftermath of the global financial crisis.

Given that trend inflation appears persistently lower, two further issues arise with regard to the conduct of monetary policy. One issue is the need to provide better measures of potential output and underlying inflation in real time. The other issue is to analyse how the decline in trend inflation affects the relationship between real activity and inflation, namely the slope of Phillips curve. Clarification of these issues

[8] See Kim et al (2015) for more detail.

would seem to be important for the better calibration of monetary policy in an environment of changing trend inflation.

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Economic changes, inflation dynamics and policy responses: the Malaysian experience

Sukudhew (Sukhdave) Singh[1]

Abstract

This note examines Malaysia's inflation dynamics as influenced by changes in the policy environment and economic structure. In particular, it highlights the growing role of domestic demand, increased integration with the global economy, and the policy reforms that are shifting the economy towards more market-based prices and greater competition. As a result, Malaysia's inflation dynamics are expected to change, and this will have implications for the central bank's policies.

Keywords: Inflation dynamics, market-based prices, reforms, integration, monetary policy

JEL classification: E31, E52, E58, F60

[1] Deputy Governor, Central Bank of Malaysia.

The views expressed in this paper are those of the author and do not necessarily reflect the official views of the Central Bank of Malaysia or its Monetary Policy Committee.

1. Introduction

Malaysia has generally experienced low and stable inflation over the last two decades. This period coincided with domestic macroeconomic stability and lower global inflation. However, these inflation dynamics are expected to change, following four fundamental changes in the domestic economy. These are the move towards a more market-based pricing of goods and services; changes in the labour markets; the growing role of domestic demand as a driver of growth; and greater integration with the world economy through trade and global value chains. This note discusses these changes and how they will affect Malaysia's inflation dynamics, and the implications for monetary policy.

2. Key changes in the Malaysian policy environment and economy

2.1 Shifting towards more market-based prices and greater competition

In the past decade, policy reforms in Malaysia have focused on shifting the economy towards more market-determined prices by removing subsidies and promoting greater competition in the goods and services markets, as well as through reforms in the labour markets.

As part of the fiscal reforms undertaken since 2010, subsidies on selected food items (such as cooking oil and sugar), fuel and utilities have been gradually removed. One important adjustment that has changed the country's inflation dynamics is the implementation of the managed-float pricing mechanism for fuel in December 2014.[2] Under this mechanism, fuel prices are adjusted monthly in response to changes in market prices. Aside from the removal of subsidies, the other element of the fiscal reforms that have an implication for inflation dynamics is the implementation of the Goods and Services Tax (GST) in 2015. Potential future changes to the GST rate would have broad-based effects on prices. The Government has also introduced measures such as the introduction of the Competition Act (2010) and establishment of the Malaysian Competition Commission to enforce the Competition Act. This is to ensure well functioning and competitive markets.

The other factor that is likely to affect inflation dynamics is ongoing reform in the labour market. These measures include the implementation of the minimum wage policy in 2013; the introduction of a productivity-linked wage system; a gradual reduction in reliance on low-cost and low-skilled foreign workers; and measures to address labour market rigidities such as restrictive regulations on the hiring and firing of workers.

2 Prices of petrol and diesel are determined through the managed-float pricing mechanism, which incorporates changes to global oil prices, the USDMYR exchange rate, profit margins for dealers, and marketing costs. The government announces domestic fuel prices at the start of the month based on developments in global oil prices and the exchange rate in the previous month. Previously, prices of petrol and diesel were adjusted irregularly and were heavily subsidised.

Finally, following the unpegging of the ringgit in 2005,[3] the ringgit exchange rate under the managed float system has moved actively in response not only to fundamental economic shocks but also to the volatile capital flows arising from the unconventional monetary policies of the major developed economies.

2.2 Growing role of domestic demand

There has been a shift towards domestic demand as a key driver of growth over the recent years. This change reflects stronger growth in private consumption and domestic investment amid the slowdown in external demand following the financial crises in the United States and Europe (Table 1). On the supply side, the shift towards a more domestic-demand driven economy is also reflected in the larger share of the services sector, which is closely correlated with private consumption, and the higher share of the construction sector that is closely related to domestic investment (Graph 1).

Growth in components of GDP in Malaysia

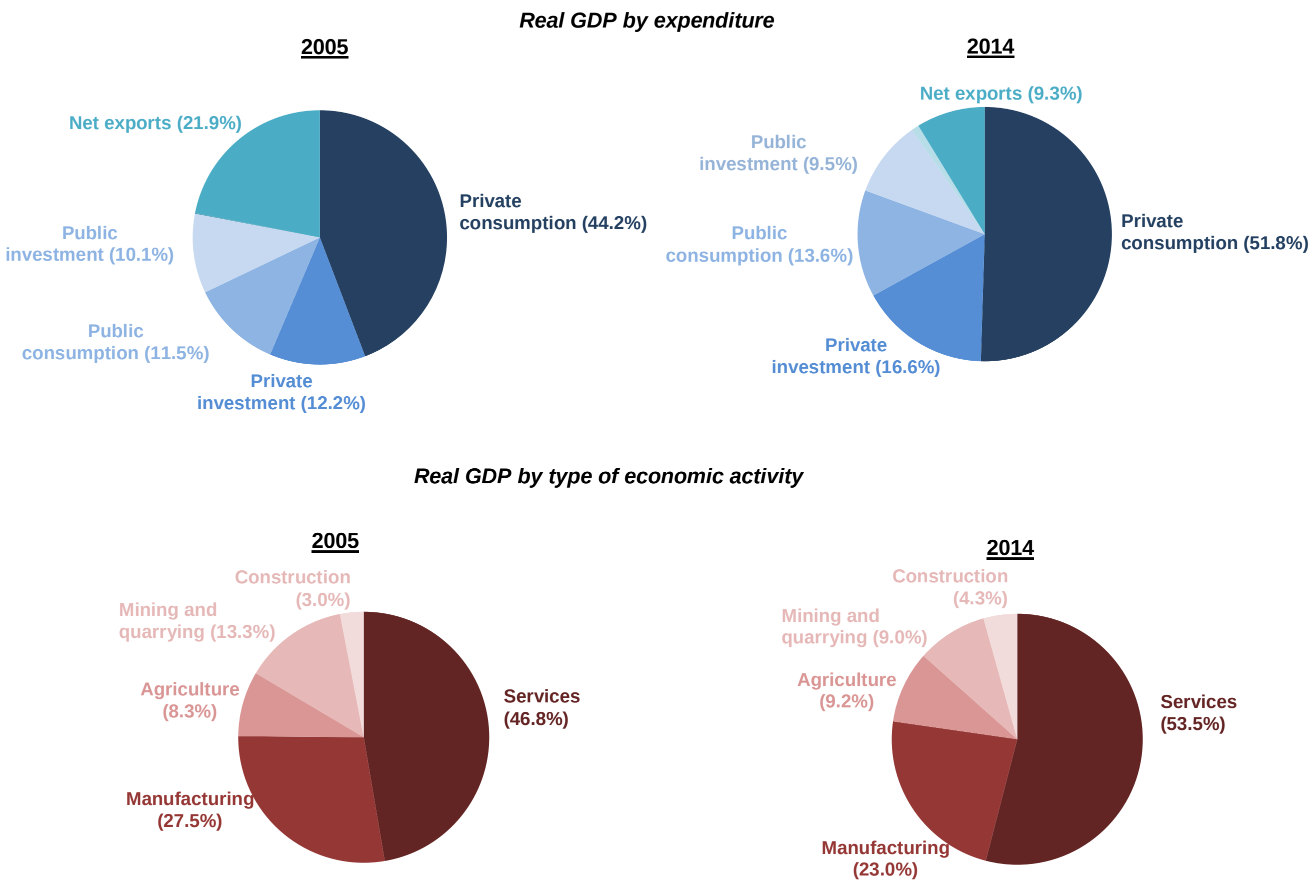
Table 1

CAGR, %	2005–06	2007–08	2009–10	2011–12	2013–14
Domestic demand	**6.9**	**8.2**	**3.9**	**9.3**	**6.6**
External demand	7.5	2.7	–0.5	1.2	2.7

Source: Central Bank of Malaysia.

3 The ringgit was pegged to the US dollar in 1998 during the Asian Financial Crisis. This was one of a host of measures introduced to stabilise economic and financial conditions.

Components of the GDP of Malaysia: 2005 vs 2014 Graph 1



Source: Central Bank of Malaysia.

Stronger growth in household consumption and increased investment in properties and financial assets reflected primarily the increase in household incomes, although access to financing also played a role.[4] Average monthly household income rose threefold from MYR 2,020 in 1995 to MYR 6,141 in 2014 and it is expected to increase further to MYR 10,540 by 2020.[5] As income grows, there is also a shift in consumption patterns. For example, a larger proportion of expenditure is now spent on services such as housing, transport and communication, while the share spent on food has declined.[6] Rising household income also corresponds with a significant expansion of the household balance sheet, such that the ratio of household assets to

4 Household debt-to-GDP ratio increased from 65.9% at end-2006 to 88.4% at end-September 2015.

5 Source: Department of Statistics, Malaysia and Economic Planning Unit, www.epu.gov.my/en/household-income-poverty.

6 The share of housing, transport, communication, recreational services and culture, restaurants and hotels and education in the CPI basket increased to 52.4% in 2010 from 44.8% in 1995. Conversely, the share of food and non-alcoholic beverages declined to 30.3% in 2010 from 34.9% in 1995.

GDP has risen from 267% in 2002 to 322% in 2013.[7] This in turn has increased the relative importance of housing and financial wealth, leading to a greater role of asset price movements in influencing private consumption.[8]

2.3 Greater economic integration

Malaysia's economy is highly integrated with the global economy and is now among the top 20 most open economies in the world.[9] However, there has been an evolution in the nature of that integration. First, as noted earlier, growing incomes have led to increased consumption of imported goods and services. Second, Malaysia has had a very open policy towards international trade and investment and has actively sought to diversify both its exports and its trade partners. Some of the market diversification has occurred due to growing regional integration and the deepening of regional value chains. In particular, Malaysia is exporting more to, and importing more from, the Asian region, with a significant increase in trade with China.[10] Malaysia has also become highly integrated through linkages formed with the global and regional value chains, which has increased competition both internationally and locally, and affected the way firms set prices and wages.

Economic integration will be further enhanced in the coming years by Malaysia's participation in the ASEAN Economic Community (AEC) and the Trans-Pacific Partnership Agreement (TPPA). These will further reinforce the domestic trends toward more market-based prices, more competition, and greater market liberalisation.

The implication of this increasing economic integration is that domestic price dynamics are increasingly determined by what happens outside the economy and that inflation is increasingly sensitive to external price shocks. A recent example has been the impact of lower global oil and commodity prices.

3. Inflation dynamics in Malaysia

Historically, headline and core inflation have been low and generally stable around their long-run values (Graph 2 and Appendix I).[11] Of significance, inflation dynamics in the past two decades have been dominated by supply-side shocks.[12] These

[7] Household assets include housing wealth, deposits and equity. Source: Box article "Evolving household balance sheets and implications for private consumption" in BNM, *Annual Report 2013*.

[8] In Malaysia, housing wealth is the largest contributor to private consumption growth after income, contributing on average 14.5% between 2005 to 2Q 2013. Source: Box article "Evolving household balance sheets and implications for private consumption" in BNM, *Annual Report 2013*.

[9] Total trade as a share of GDP rose from 105% in 2000 to 131% in 2014.

[10] Close to 70% of Malaysia's total trade is now with the Asia region and trade with China rose from 4% of total trade in 2000 to reach 14% in 2014.

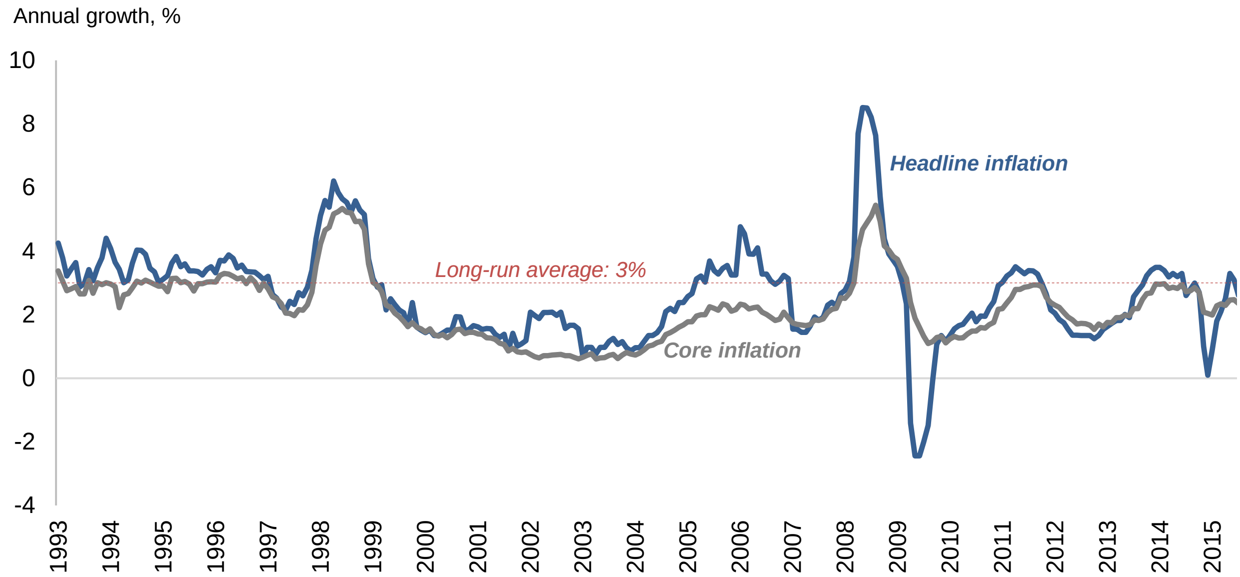
[11] Headline inflation and core inflation averaged close to 3% and 2% respectively in the last two decades (standard deviation of 1.5 and 1.0 respectively).

[12] Terms of trade shocks can drive inflation dynamics in small open economies that are heavily dependent on commodity exports. To this end, continued diversification of the Malaysian economy

domestic supply shocks have been primarily driven by disruptions in supplies and by periodic changes to the administered prices of certain goods (which account for 17% of the CPI basket). To some extent, the existence of subsidies and controlled prices for administered goods had limited the impact of external shocks on domestic inflation. These shocks were transmitted mainly through changes in the prices of fuel and food, which together account for close to 40% of the CPI basket. It also helped that most of the supply shocks were exogenous and transitory in nature and therefore facilitated the convergence of headline inflation to core inflation relatively quickly.[13] This, in part, explains why second-round effects were largely absent in Malaysia.[14] Finally, inflation persistence in Malaysia has declined in the recent years, a common empirical finding across many countries.

Headline and core inflation in Malaysia

Monthly: 1993–2015 Graph 2



Source: Department of Statistics, Malaysia; Central Bank of Malaysia.

towards manufactured exports implies that shocks to commodity terms of trade play a less prominent role in shaping inflation dynamics in Malaysia, unlike in the 1970s and 1980s. In fact, more than two thirds of the fluctuations in the overall terms of trade are driven by the manufacturing sector, with about half due to terms of trade in electric and electronic goods (E&E) given Malaysia's prominent role in E&E value chains.

13 See Chuah, Chong and Tan (2015).

14 This is also supported by the supply of foreign workers and the structure of trade unions in Malaysia. Trade union members are less than 10% of the labour force and the collective wage bargaining process covers 2% of the labour force. There is also no wage indexation and there is a lack of wage setting coordination across industries.

3.1 Larger and quicker pass-through of shocks resulting in greater inflation variability

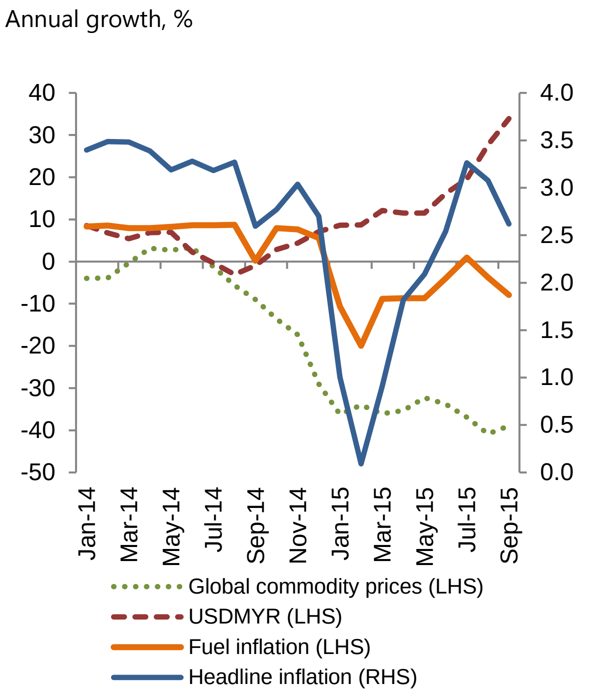
The shift towards more market-based prices means that the pass-through to inflation is expected to change in terms of size, persistence and pervasiveness. There is likely to be larger and quicker pass-through of shocks that could lead to higher inflation variability. For example, under the managed-float pricing mechanism for fuel, changes in global oil prices will have a larger and quicker pass-through to domestic inflation. The greater volatility of the exchange rate is also expected to make it a more important consideration in domestic price-setting. Hence, the expected higher volatility and uncertainty of global oil prices and exchange rates over the near to medium term is likely to make inflation and inflation projections more variable and uncertain. Moreover, as fuel is an important cost component for firms, more variable fuel prices could lead to increased variability of other prices in the CPI, especially food. As such, global oil prices and the exchange rate are now likely to play a more important role in the inflation expectations of households and firms.[15]

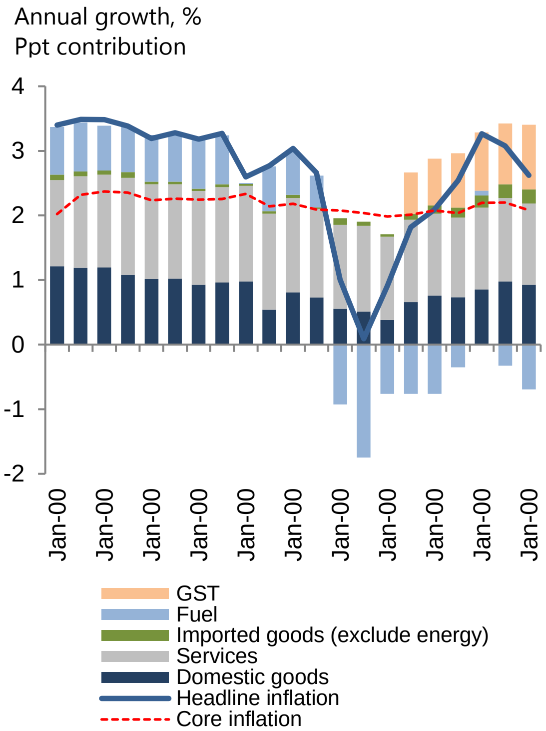
Assessing inflation dynamics in Malaysia is also more challenging when shocks move in opposite directions (Graph 3). Specifically, the recent marked downtrend in global commodity and energy prices has helped mitigate the inflationary impact from the persistent ringgit depreciation and the implementation of the GST (Graph 4). Thus far, the inflationary impact from the exchange rate depreciation has been contained despite the continued ringgit weakness since September 2014.[16]

15 Factors that influence the formation of inflation expectations include prices of items frequently purchased by households, notably food and petrol; and items regularly captured by media coverage. See Georganas, Healy and Li (2014), and Cavallo, Cruces, and Perez-Truglia (2014).

16 The ringgit's current weakness represents the most persistent depreciation episode in the last two decades. The ringgit has cumulatively depreciated against the USD by over 26% since September 2014 and against the currencies of Malaysia's main import partners, the ringgit has depreciated by 16.0%. In Graph 3, a positive growth represents depreciation.

Global commodity prices, exchange rate and inflation 2014–15	Graph 3	Contributions to headline inflation in Malaysia 2014–15	Graph 4





Source: Department of Statistics, Malaysia , Bloomberg, IMF and Central Bank of Malaysia.

3.2 Demand-side shocks and wage dynamics to feature more prominently in inflation dynamics

Given the increased role of domestic demand in the economy, its strength has become a fundamental force in determining inflationary conditions. First, the shift in consumption patterns – as shown by the change in the CPI's composition towards more non-tradable goods and housing – means that the key drivers of inflation will be domestic factors such as the prices of services and rentals. Second, strong growth in domestic investment activity could also lead to higher inflation given the competition for resources, although the ability to import may reduce some of those inflationary pressures – but at the expense of a deterioration in the current account of the balance of payments. Third, as private consumption is increasingly supported by housing and financial wealth, asset price shocks could have larger implications on consumption, and consequently, on inflation.

In future, a more competitive and flexible labour market is also expected to make the inflation process more interlinked with wage dynamics. A tighter labour market amid a less elastic supply of foreign labour would mean that rising inflation expectations could trigger wage inflation as workers demand higher wages to compensate for the decline in purchasing power. This wage inflation could give rise to second-round effects that lead to greater inflation persistence.[17]

3.3 Higher sensitivity to external factors

Even though domestic demand is a key economic driver, increasing global integration implies that domestic prices are increasingly linked to global prices and global developments can now have a more significant impact on domestic prices than before. Generally, greater integration has contributed to lower inflation in Malaysia. First, lower production costs in EMEs amid increasing competition in goods, services and labour markets, together with advances in productivity, have contributed to lower and more flexible prices. A more competitive landscape, both domestically and globally, is expected to reduce price stickiness and lead to lower persistence in the inflation process.

Second, complex global and regional value chains have increased competition and price flexibility, and this has dampened domestic inflation.[18] International firms that are exposed to multiple stages of production, currencies and markets have greater flexibility to make the necessary adjustments – whether it is to establish natural hedges for the cost of their inputs or to allocate resources along the value chain. This allows them to better manage the pricing of their products. For local firms that have to compete directly and indirectly with international firms, they need to behave strategically and manage their costs and product pricing in order to retain market share.

Overall, it is evident that increasing global integration has led to domestic prices co-moving to a greater extent with international prices. Global developments are transmitted to Malaysia more quickly and pervasively through the trade, commodities and financial channels. Such co-movement of prices has been observed over the last decade with respect to the impact of changes in global commodity prices.

Since the fourth quarter of 2014, the ringgit exchange rate against the US dollar has depreciated significantly. This has been the outcome of unfavourable domestic developments, large capital outflows, a drop in export earnings due to lower oil and commodity prices, and the strong US dollar. As noted earlier, a combination of lower global inflation, weak global fuel and commodity prices, and more moderate domestic demand has helped to offset some of the pass-through of the weaker exchange rate. In other circumstances, the impact of changes in the exchange rate have not been favourable in terms of domestic inflation, leading to asymmetrical adjustments with prices often increasing when the exchange rate depreciates but rarely coming down when the exchange rate appreciates.

[17] Nevertheless, the risk of wage inflation in Malaysia's case is limited, given the absence of some preconditions such as wage indexation to inflation, high labour unionisation, coordinated wage bargaining across industries, and centralised wage bargaining (control of aggregate and relative wage movements).

[18] See Aron, Macdonald and Muellbauer (2014).

4. Policy implications

First and foremost, it is important to highlight that monetary policy in Malaysia has not been determined solely by the level of inflation. The impact of monetary policy on financial conditions has also been a key consideration. Therefore, the setting of monetary policy has required a balance between the need to support the economy, maintain a low inflation rate and avoid creating incentives for excessive financial risk-taking. The outcome has been a monetary policy that has avoided setting very low interest rates for extended periods. In particular, monetary policy has avoided negative real interest rates for sustained periods, although temporary negative real interest rates were tolerated when the inflation rate increased due to the transitory effect of various shocks. Low interest rates have a propensity to create various financial imbalances, particularly in a high savings society like Malaysia, where the risk is not only of imprudent increases in leverage but also that the search for yield will cause savings to be disintermediated into the informal sector and into potentially risky ventures. When it comes to the economy, our experience has been that, more than just low interest rates, an economy needs supportive credit conditions and a prudent credit culture to grow in a healthy sustainable manner. The aversion to long periods of negative interest rates, combined with other policy tools such as micro- and macroprudential measures are, in the Monetary Policy Committee's view, the best way to ensure that monetary policy supports both macroeconomic and financial stability.

Turning specifically to the issue of structural developments in the economy affecting the inflation process and their implications for monetary policy, the outcome has been that these structural developments have made the conduct of policy both easier and at the same time more complex. First, the fact that the price movements are now less distorted by arbitrary adjustments to subsidies and administered prices, means that changes in the inflation rate are more reflective of actual changes in macroeconomic conditions in the domestic and global economies. This makes it easier to analyse the underlying causes of changes in inflation and assess the need for a monetary policy response.

However, the structural changes also make it more difficult to interpret various price series and other indicators used by the central bank. This makes existing analytical models based on historical data less reliable when assessing the inflation outlook. As a result, industry and household surveys have become more important for an understanding of how behaviours are changing and the likely impact on inflation dynamics. The new understanding can also be useful in calibrating existing models to account for these shifts.

Given the increased sensitivity to global price developments, there is a need to improve the quality of indicators of relevant global prices, as well as the need to devote more resources to developing a deeper understanding of the link between global and domestic prices. More reliance is now placed on various measures of core inflation that cover data at the domestic and global level.[19] These improvements have

[19] See Amstad, Huan and Ma (2014).

taken the form of building a more holistic framework[20] to monitor, assess and forecast inflation, which includes collecting and analysing micro-level data on households and businesses.

The ongoing price reforms and more market-based prices can lead to multiple adjustments to prices and market structures that can result in repeated shocks to inflation. The consequence could be periods of persistently higher and more volatile inflation, with the potential to unanchor inflation expectations. In Malaysia's case, while the overall environment supports a generally benign inflation outlook, the introduction of the GST and the removal/reduction of subsidies within a relatively short period have led the public to perceive that their welfare has been eroded by the rising cost of living.

As monetary policy is not the tool for managing the issue of a rising cost of living, there is a role for other policies, including fiscal policy. In the short run, the Malaysian government has undertaken measures to provide basic goods and services at more affordable prices, undertaken efforts to ensure adequate supplies of basic goods, and introduced the monitoring of price increases by firms to address profiteering. Food inflation warrants special attention for a number of reasons: it is currently the largest CPI component (30.3%), it is directly affected by the price reforms, and it plays a prominent role in influencing households' inflation expectations. High food inflation can be mitigated in the long run through structural reforms to increase competition, the removal of agricultural trade restrictions and improvements to domestic supply and supply chain logistics.

The central bank has a role to play in explaining the factors that affect the inflation rate. This is particularly important with respect to shocks that have a transitionary impact on inflation. It has been observed that there is asymmetric coverage by the media with respect to inflation, with more coverage being given to inflation when it is increasing and little or no coverage when it is low or declining.[21] When inflation is increasing in response to a series of supply shocks, such pervasive media coverage could feed into, and exaggerate, public perceptions of the actual inflation rate. The outcome could be excessive demands for higher wages. It is therefore important for the central bank to explain, preferably in layman's terms, the underlying causes of the inflation and its views on its likely persistence.

In order for such communications to be effective, the central bank must understand the situation from the perspective of households and businesses. Otherwise, the central bank risks talking in a language that its stakeholders do not understand. In Malaysia, the central bank has tried to address this by collecting monthly household data through the BNM Consumer Sentiment Survey, carrying out focus group discussions to understand household behaviour and using industrial visits and engagements to understand the conditions faced by firms and their price-setting behaviour.

Given the open nature of the Malaysian economy, the exchange rate is an important economic variable. The increased volatility of the exchange rate has become a key consideration in public perceptions about inflation and corporate price

[20] For the case of Malaysia, the framework for inflation includes cross-checking against three approaches: data-driven analysis, model-driven assessment and outlook, and survey-driven analysis. The framework starts by analysing first-round inflation followed by second-round effects where labour market slack and inflation expectations play an important role.

[21] Singh (2009).

setting behaviour. Uncertainty about the future direction of the exchange rate has become an issue that is often discussed publicly. The role of the central bank has been to explain the different factors, besides the weaker exchange rate, such as low commodity prices and generally benign global inflation, which would ultimately influence the domestic inflation outcomes. Given the generally negative public perceptions about the weaker exchange rate, the central bank has also sought to highlight the benefits of a flexible exchange rate, the factors (global and domestic) that weaken the exchange rate, and the beneficial role of the exchange rate, given the negative terms-of-trade shock to the economy from the sharp decline in the prices of its key commodity exports

5. Conclusion

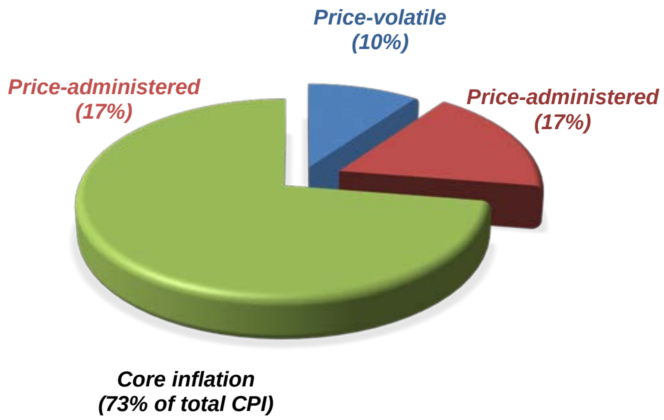
The conduct of monetary policy in a small open economy has always been more complicated than in larger and more closed economies. The structural evolution of the Malaysian economy towards being primarily domestic demand-driven while at the same time being more open to global price developments has been, and will continue to be, the subject of research at the central bank. The central bank views the ongoing structural reforms as beneficial in terms of making the economy more flexible and responsive. The inflation rate will become more responsive to economic developments and this will certainly facilitate the conduct of monetary policy. However, the rapid pace at which some of these price adjustments are occurring does pose short- and medium-term challenges. Over the short term, the challenge is to explain higher inflation to the public and to manage inflation expectations. Over the medium term, the challenge is to adapt the central bank's analytical and surveillance tools to ensure that they continue to provide appropriate guidance to the setting of monetary policy. A part of this exercise is the need to develop an understanding about how households and businesses are reacting to the new environment and the potential implications of any change in behaviour for inflation and growth.

Appendix I

CPI Categories in Malaysia 2010

Graph 5

CPI sub-categories	Weight (%) 2010=100
Food and non-alcoholic beverages	30.3
Alcoholic beverages and tobacco	2.2
Clothing	3.4
Housing and utilities *of which* Rental	22.6 *17.2*
Health	1.3
Transport *of which* Fuels and lubricants	14.9 *8.8*
Communication	5.7
Recreation services	4.6
Education	1.4
Restaurant and services	3.2
Miscellaneous	6.3



Source: Central Bank of Malaysia.

Weights of the main CPI Categories in Malaysia (1990–2010)

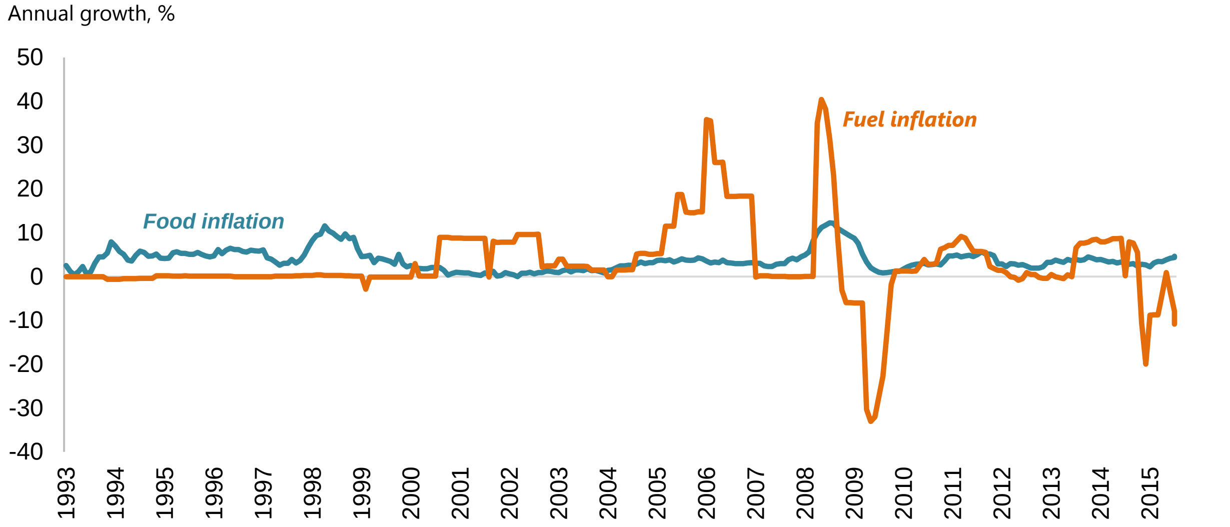
Table 2

<table>
<tr><th>Category</th><th>1990=100</th><th>1994=100</th><th>2000=100</th><th>2005=100</th><th>2010=100</th></tr>
<tr><td>Food and non-alcoholic beverages</td><td>34.6</td><td>34.9</td><td>33.8</td><td>31.4</td><td>30.3</td></tr>
<tr><td>Alcoholic beverages and tobacco</td><td>4.4</td><td>3.6</td><td>3.1</td><td>1.9</td><td>2.2</td></tr>
<tr><td>Clothing and footwear</td><td>2.9</td><td>3.6</td><td>3.4</td><td>3.1</td><td>3.4</td></tr>
<tr><td>Housing, water, electricity, gas and other fuels</td><td>20.5</td><td>21.1</td><td>22.4</td><td>21.4</td><td>22.6</td></tr>
<tr><td>Furnishings, household equipment and routine household maintenance</td><td>5.7</td><td>5.6</td><td>5.3</td><td>4.3</td><td>4.1</td></tr>
<tr><td>Health</td><td>1.7</td><td>1.9</td><td>1.8</td><td>1.4</td><td>1.3</td></tr>
<tr><td>Transport</td><td rowspan="2">18.7</td><td rowspan="2">17.9</td><td rowspan="2">18.8</td><td>15.9</td><td>14.9</td></tr>
<tr><td>Communication</td><td>5.1</td><td>5.7</td></tr>
<tr><td>Recreation services and culture</td><td rowspan="3">5.1</td><td rowspan="3">5.8</td><td rowspan="3">5.9</td><td>4.6</td><td>4.6</td></tr>
<tr><td>Education</td><td>1.9</td><td>1.4</td></tr>
<tr><td>Restaurants and hotels</td><td>3.0</td><td>3.2</td></tr>
<tr><td>Miscellaneous goods and services</td><td>5.4</td><td>5.6</td><td>5.5</td><td>6.0</td><td>6.3</td></tr>
<tr><td>TOTAL CPI</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td><td>100.0</td></tr>
</table>

Source: Department of Statistics, Malaysia.

Food and fuel inflation in Malaysia

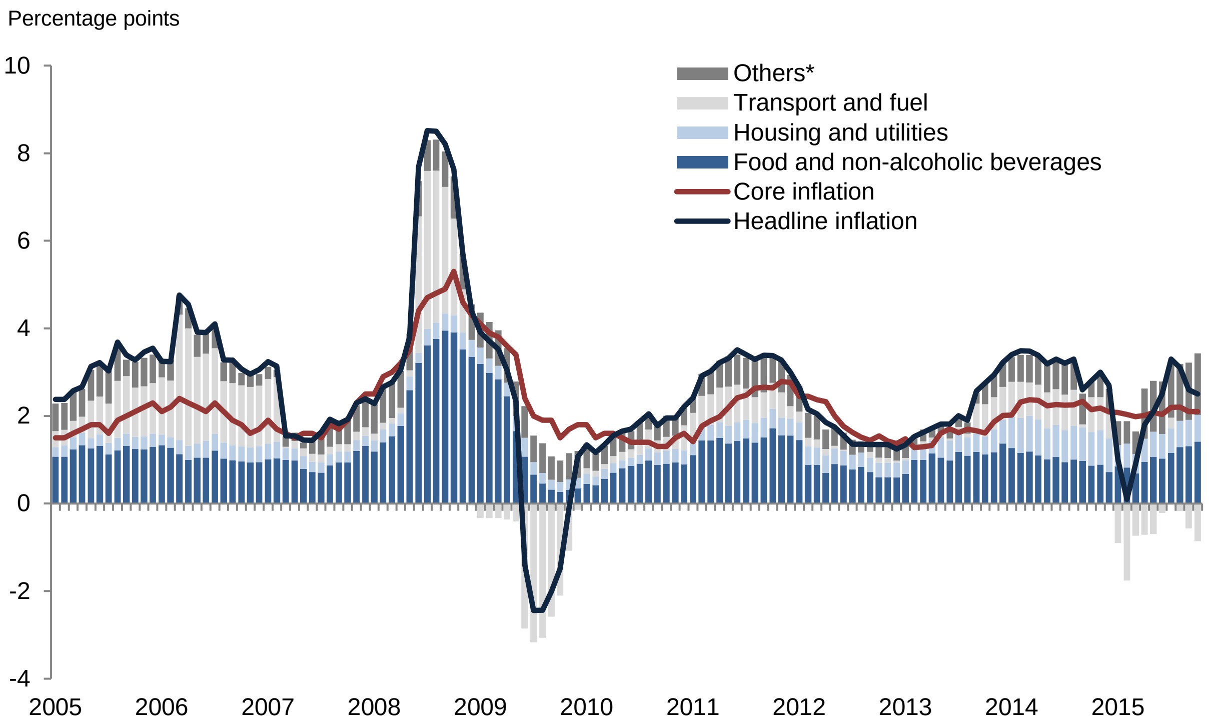
Monthly: 1993–2015 Graph 6



Source: Department of Statistics, Malaysia.

Contribution of selected CPI Categories to headline inflation in Malaysia

Monthly: 2005–2015 Graph 7



* Others include *alcoholic beverages & tobacco; clothing & footwear; furnishings & household equipment; health; communication; recreation services and culture; education; restaurants & hotel, and miscellaneous goods & services.*

Source: Department of Statistics, Malaysia.

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On the costs of deflation: a consumption-based approach

Santiago García-Verdú and Manuel Ramos-Francia[1]

Abstract

We are seeking to understand the costs of deflation. To that end, we assess the extent to which deflationary risks have surged in a selected group of European economies. Specifically, we develop a simple consumption-based asset pricing model and, based on it, we estimate a(n) (in)deflation risk premium. We find that our aggregate risk premium is correlated with a systemic financial stress indicator. The absolute values of their (time averaged) risk premia and their indices of financial development are also correlated, which is in line with what our model predicts. In addition, we estimate panel data regressions to assess the extent to which the interaction between changes in prices and nominal debts are incorporated in the risk premium. We generally find that debt-deflation terms are statistically significant. Moreover, the magnitude of the coefficients associated with the debt-deflation terms tends to be greater than those associated with inflation. This suggests that deflationary costs are comparatively greater than inflationary ones, which again is in line with our model. We rationalise this cost asymmetry with the presence of a credit constraint during deflationary episodes.

Keywords: Consumption-based asset pricing, inflation, deflation, inflation risk premium, deflation risk premium, eurozone

JEL classification: G12, E31

[1] Banco de México. We would like to thank Fernando Pérez-Cervantes for his valuable comments. The opinions expressed in this paper are exclusively those of the authors and do not necessarily reflect those of the Banco de México.

The population is not distributed between debtors and creditors randomly. Debtors have borrowed for good reasons, most of which indicated a high marginal propensity to spend [...]. Typically their indebtedness is rationed by lenders, not just because of market imperfection but because the borrower has greater optimism about his own prospects [...], than the lender regards as objectively and prudently justified". (Tobin (1980))

1. Introduction

Over the past few years, deflation has been observed in a number of European economies. While deflation may evoke negative recollections associated with specific historical episodes, it is not necessarily a negative element for an economy. In fact, deflation has historically taken place under different economic environments, and the negative relationship between deflation and output observed during the Great Depression is not always present (see Borio et al (2015)).[2] However, we believe that one should be concerned about the conditions under which deflation is more likely to entail economic costs.

Against this backdrop, we argue that key to understanding the costs of deflation involves a consideration of the level and type of debt as well as of the development of financial markets. In effect, changes in the price level lead to variations in the real resources needed to fulfil nominal debt contracts. From the point of view of an economy as a whole, changes in the price level might have distributional and wealth effects. Of course, as financial markets develop, agents are in a better position to protect themselves against shocks, including those associated with the price level.[3] In the context of the European debt crisis and its aftermath, we think that it is worth examining some of these elements to better understand the potential costs of deflation.

Naturally, there are other factors that may shape the costs of (in)deflation. For example, price setting mechanisms à la Calvo (1993) can lead to a deviation of output from its trend, bringing about welfare costs. The period since the onset of the Great Financial Crisis (GFC) of 2008–2009 offers a highly relevant example. When nominal interest rates are at or near the zero lower bound, and deflation sets in, then real interest rates increase, adversely affecting aggregate demand. While we acknowledge that such effects might be relevant, *inter alia*, to the economic costs of deflation, we do not explore them here.

In our model, inflation is favourable to debtors, who are subject to a credit constraint. Conversely, it is unfavourable to creditors, who are not as financially constrained. On the other hand, deflation is unfavourable to debtors and favourable to creditors. Moreover, in general debtors tend to have a higher marginal propensity to spend, as underscored by the epigraphic quote from Tobin. There is then an asymmetry in the degree of financial restriction, which implies that deflation – compared with inflation – can lead to larger economic costs. In a deflationary episode,

[2] Buiter (2004) analyses the relationship between deflation and output, and tries to identify changes in the price of a good. In effect, a decrease in the price of a good might be associated with a decrease in demand for it, and thus a reduction in its quantity. Alternatively it might be associated with an increase in its supply and, thus, an increase in its quantity.

[3] Our model is related to the debt-deflation theory first proposed by Fisher (1933).

creditors might be more concerned about debtors' ability to pay back their loans. We find empirical evidence in line with this argument.

To assess the possible effects of changes in the price level, we think it relevant to look beyond the level of debt to the type of debt held. For instance, from the point of view of an economy as a whole, changes in the price level in the presence of domestic debt could mostly lead to a redistribution of wealth while variations in the price level under external debt could mainly result in a change in overall wealth, everything else constant.[4]

Of course, other factors such as currency denomination, maturity and duration could be relevant to assess the possible effects of debt. We focus here on nominal debt. In one of our main exercises we consider economies from the eurozone, which have issued debt denominated mostly in euros. However, we overlook the maturity and duration of that debt, as our model only considers one period debt.

In this context, the distinction between expected and unexpected inflation is pertinent as well. Essentially, any nominal debt contract comprises an implicit expected inflation rate. Hence, deviations of the realised from the expected inflation rate have an incidence on who benefits and who is adversely affected. In this paper, we do not analyse such a distinction explicitly.[5] It is, however, an important topic in its own right (see Cecchetti and Schoenholtz (2015)).

(In)deflation risk has been measured using several methodologies. A common one uses expected inflation, nominal interest rates and real interest rates. The risk premium is defined as the nominal interest rate minus the real interest rate plus expected inflation in period t, and a common horizon n, ie $y_{t,n} - (r_{t,n} + E_t(\pi_{t,n}))$.[6] Since the bondholder is unsure about his return in real terms, the expected nominal return is adjusted by the premium.[7]

This is an appealing approach that has been implemented elsewhere (see García and Werner (2010)). Yet, it relies on having a measure of expected inflation and, importantly, real interest rates derived from index-linked bonds.[8] Generally, the latter are not available for all economies because the associated bond markets are either illiquid or non-existent.

Another possibility is to obtain inflation density data that are implicitly derived from derivatives contracts that have inflation as their underlying rate (see Fleckenstein et al (2013)). Of course, such data may not always be available or representative because derivatives markets can be, likewise, either illiquid or non-existent. However, if data are available, this approach has as the advantage that one can obtain a complete inflation density.

In sum, these two methods can work well if data are available, which is not necessarily the case for most individual economies.

4 For instance, to assess net changes in creditors' wealth one should also consider variations in the real exchange rate.

5 Since the debt we consider is exogenous, the agent takes it as given.

6 Two additional comments are in order. First, expected inflation is conditional on information known at time t. Second, the interest rates are those associated with zero-coupon bonds.

7 A possible extension of this approach considers liquidity premia for nominal and real bonds.

8 In addition, index-linked bonds do not strictly yield a real return since the price index used in determining their return is published with a time lag.

Of course, investing in nominal bonds involves other possible risks such as credit and liquidity risks. Although such risks are important, we focus solely on (in)deflation risk in this paper.

The literature has explored various aspects of the inflation risk premium. For instance, Söderlind (2011) analyses the evolution of US break-even inflation from 1997 to mid-2008, using survey data on inflation uncertainty and proxies for the liquidity premium. He highlights differences in the dynamics of expected inflation, of the inflation risk premium and of the liquidity premium.

Christensen et al (2012) construct probability forecasts for episodes of price deflation using the yields on US Treasury Inflation Protected Securities (TIPS). They identify two deflation episodes during the past 15 years: a mild one after the 2001 recession and a harsher one in 2008. On a related note, Hördahl and Tristiani (2014) use a joint macroeconomic and term structure model to estimate the inflation risk premium and inflation expectations in the United States and the euro area. They document that after 2004, inflation risk premia in those economies have demonstrated similar dynamics. Taken jointly, the results of these two papers are broadly in line with our first findings. We identify two main deflationary episodes in the euro area, which is a result similar to that of Christensen et al (2012).

However, we use a standard consumption-based model. In it, the risk premium depends on the extent to which holding a nominal bond will be conducive to smoothing the consumption path through time and across-states of nature. Hence, (in)deflationary risks are framed in terms of their relation to aggregate consumption growth. Of course, inflation and consumption data are in general readily available for most economies, even if the frequencies at which they are available are lower than for financial data.

Anticipating our results, we first find that the correlation between our aggregate risk premium and a systemic financial stress indicator is negative, and that the absolute values of their (time averaged) risk premia and their financial development indices have a negative correlation. Those results are in line with our model. In it, we consider the number of Arrow-Debreu assets with respect to the number of states of nature as a measure of financial development. Thus, the more assets an agent has access to, the better her hedging capabilities, and hence a smaller risk premium. Second, the economic costs of deflation, as measured by the (in)deflation risk premium, seem to be proportionally greater than those of inflation. In our model, a financial constraint might be binding during deflationary episodes, increasing the magnitude of the premium, as we explain in more detail below. This result is consistent with that of some of the literature (including Fleckenstein et al (2013)).[9]

The rest of the paper is divided into four sections. The second section explains the simple model we developed to frame our analysis. The third section describes the data and discusses the results of preliminary exercises. The fourth one provides an interpretation of the panel regression estimates. The last section offers some concluding remarks.

9 Fleckenstein et al (2013) study deflation risk. Their first main result is that the market price of the economic tail risk of deflation is very similarly to other types of tail risk such as catastrophic insurance losses. Moreover, inflation tail risk bears only a relatively small risk premium. Their second main result is that deflation risk is linked to measures of financial tail risk such as swap spreads, corporate credit spreads and the pricing of super senior tranches of debt.

2. The model

We start with a standard endowment economy model (Lucas (1978)) with two periods, t and $t+1$. We assume, in turn, three possible financial market structures:

i) A market with the full range of Arrow-Debreu securities (ie a complete market);

ii) A market with a proper subset of all the Arrow-Debreu securities, denoted by I (ie an incomplete market);[10] and

iii) A market with a proper subset of all the Arrow-Debreu securities, denoted by I, in addition to a credit constraint (ie an incomplete market).

In ii) and iii), we think of I as fixed but arbitrary.

Those three structures, accordingly, lead to three different kinds of budgets constraint in period t:

$C_t = W_t - D_t/P_t + \sum_{s=1}^{S} \alpha(s)\, B_t(s)\,/P_t$;

$C_t = W_t - D_t/P_t + \sum_{s\in I} \alpha(s)\, B_t(s)\,/P_t$;

$C_t = W_t - D_t/P_t + \sum_{s\in I} \alpha(s)\, B_t(s)\,/P_t$ and

$max_s(\alpha(s)B_t(s)/P_t) \leq \theta E_t[W_{t+1} - (D_{t+1}/P_{t+1})]$.

The respective budget constraints in period $t+1$ for each state s' are:

$C_{t+1}(s') = W_{t+1}(s') - D_{t+1}/P_{t+1}(s') - \sum_{s=1}^{S} \alpha(s)\, 1_{t+1}(s)\,/P_{t+1}(s)$;

$C_{t+1}(s') = W_{t+1}(s') - D_{t+1}/P_{t+1}(s') - \sum_{s\in I} \alpha(s)\, 1_{t+1}(s)\,/P_{t+1}(s)$; and

$C_{t+1}(s') = W_{t+1}(s') - D_{t+1}/P_{t+1}(s') - \sum_{s\in I} \alpha(s)\, 1_{t+1}(s)\,/P_{t+1}(s)$;

where C_t is the agent's consumption, $C_{t+1}(s')$ is its consumption in state s', W_t is its endowment, $W_{t+1}(s')$ is its endowment in state s', D_t is an exogenous nominal debt if positive (and credit if negative), P_t is the price level, $\alpha(s)$ is the number of Arrow-Debreu securities s the agent buys or sells, and $B_t(s)$ is the price of such securities, with $s = 1,2,3,\dots,S$.[11] The indicator function $1_{t+1}(s')$ equals one in state s', and zero in all other states. In short, the Arrow-Debreu security s' costs $B_t(s')$ and pays one if state s' occurs and zero in other states. The price level, P_{t+1}, is an exogenous random variable.[12] The agent's asset holdings are given by $\boldsymbol{\alpha}^{\boldsymbol{T}} \equiv (\alpha(1), \alpha(2), \alpha(3), \dots, \alpha(S))^T$, where the superscript T denotes the transpose in the complete markets case. Similarly, $\hat{\boldsymbol{\alpha}}$ is a vector representing portfolio holdings in the incomplete markets cases. Thus, its dimension is strictly smaller than S. Also, θ is a pledgeability parameter, as we explain in greater detail below.

All variables are in real terms, except for debts and Arrow-Debreu prices. Accordingly, we have divided them by their corresponding price levels, depending on

10 By a proper set, we mean that I is such that $I \subset \{e_1, e_2, \dots, e_S\}$ but $I \neq \{e_1, e_2, \dots, e_S\}$, where the elements e_s denote Arrow-Debreu securities, and S is the total number of states of nature.

11 A positive $\alpha(s)$ means that the agent is selling security s, ie borrowing; and a negative one that it is buying it, ie saving.

12 The singleton ω_{t+1} is an element of the finite sample space Ω with cardinality S. The subscript s is associated with a unique element in Ω, where $s = 1,2,3,\dots,S$. We assume a probability space (Ω, F, P), where F, the σ-algebra, is given by 2^{Ω}. We focus on the singleton elements in F, denoted by $\{\omega_1\}$, $\{\omega_2\}$, ..., $\{\omega_S\}$ and associate each of them to the corresponding Arrow-Debreu security $\{s_1, s_2, \dots, s_S\}$.

their periods and states. Hence, the agent maximises the following utility function with respect to $\boldsymbol{\alpha}$ in the complete markets case, and with respect to $\widehat{\boldsymbol{\alpha}}$ in the incomplete markets cases:

$$u(C_t) + \beta E_t(u(C_{t+1}))$$

subject to the respective budget constraint i); ii); or iii). The subjective discount factor β is $0 < \beta < 1$, and E_t is the expectation conditional on information known at time t.

Having posited the main elements of our model, we analyse, in turn, the covariance between consumption growth and inflation for each market structure. This covariance has a direct relationship with the (in)deflation risk premium, as we examine in more detail later.

2.1 Complete markets

Under complete markets, we have the following Euler equations, obtained from the first order condition with respect to each $\alpha(s)$, for $s = 1,2,3, \dots, S$.

$E_t[\beta(u'(C_{t+1})/u'(C_t))1_{t+1}/P_{t+1}] = B_t(s)/P_t$ for $s = 1,2,3, \dots, S$.

We will show that the covariance between consumption growth and inflation is zero if all securities have actuarially fair prices.[13] To see this, consider the Euler equation of a given Arrow-Debreu security s.

$\beta(u'(C_{t+1}(s))/u'(C_t))q(s)/P_{t+1}(s) = B_t(s)/P_t,$

where the probability of state s has been denoted by $q(s)$. Since we assume that all securities have actuarially fair prices, it follows that $u'(C_{t+1}(s))/u'(C_t) = 1$ and, thus, $C_{t+1}(s) - C_t = 0$. Hence, we have that $C_{t+1}(s) = C_{t+1}(s')$ for all $s \neq s'$, and $Cov_t(\Delta c_{t+1}(\boldsymbol{\alpha}^{CM}), \pi_{t+1}) = 0$, where we have that $\Delta c_{t+1} = \log(C_{t+1}/C_t)$, $\pi_{t+1} = \log(P_{t+1}) - \log(P_t)$, and $\boldsymbol{\alpha}^{CM}$ is the vector that solves the respective optimisation problem. The superscript CM stands for complete markets.

2.2 Incomplete markets

Consider the market structure with a proper subset of all Arrow-Debreu securities. As first order conditions we have:

$\beta(u'(C_{t+1})/u'(C_t))q(s)/P_{t+1}(s) = B_t(s)/P_t$ for all $s \in I$.

Similarly, assuming that all securities prices are actuarially fair, we obtain $u'(C_{t+1}(s))/u'(C_t) = 1$ and, thus, $C_{t+1}(s) - C_t = 0$ for all $s \in I$. Hence, $C_{t+1}(s) = C_{t+1}(s')$ for all $s \neq s'$ and $s, s' \in I$. Nonetheless, for those $s \notin I$, it is generally not the case that $C_{t+1}(s) - C_t = 0$, which implies that:

$0 = Cov_t(\Delta c_{t+1}(\boldsymbol{\alpha}^{CM}), \pi_{t+1}) \leq |Cov_t(\Delta c_{t+1}(\widehat{\boldsymbol{\alpha}}^{IM}), \pi_{t+1})|,$

where $\widehat{\boldsymbol{\alpha}}^{IM}$ is the portfolio that solves the optimisation problem under incomplete markets. The superscript *IM* stands for incomplete markets.

[13] In a two period model, a security has an actuarially fair price if it is equal to its expected discounted payoff. Thus, in the context of our model and in the case of an Arrow-Debreu security, this happens if $(\beta/P_{t+1}(s))q(s) = B_t(s)/P_t$, where $q(s)$ denotes the probability of state s occurring.

2.3 Credit constraint

Our credit constraint is motivated by the creditor's concern that the debtor might not have the capacity or the incentives to honour its debts. In our model, such concern is heightened under deflationary episodes and a high debt level, as they would call for the agent to obtain more real resources to repay its debts. Specifically, we add to the agent's problem the following exogenous credit constraint in period t:

$$max_s(\alpha(s)B_t(s)/P_t) \le \theta E_t[W_{t+1} - (D_{t+1}/P_{t+1})]$$

In short, the debtor's maximum debt at time t is bounded by a fraction of its expected wealth in period $t+1$. Since the borrower knows that the lender will not grant it additional resources if the inequality is binding, it considers it to be part of its own constraint.

Under a deflationary environment (ie a higher value of $E_t[P_t/P_{t+1}]$), and under a higher debt D_{t+1}, the upper bound becomes tighter. On the other hand, a larger endowment W_{t+1} provides the agent with financial slack.

We interpret θ as a pledgeability parameter, with $0 \le \theta \le 1$. We think of pledgeability as the fraction of expected net endowment that is automatically directed to the creditor. In practice, it is determined by several factors including the information possessed by the creditor and the capacity to enforce contracts. This notion of pledgeability is based on Diamond et al (2016).[14]

Having pledgeability concerns, the creditor is not willing to lend more than a fraction of the borrower´s expected net endowment. Hence, if θ is small, it reflects a higher concern, tightening the constraint. On the other hand, a sufficiently large θ might lead to an unbinding constraint. There is also a possibility that the agent´s portfolio positions are sufficiently small for the constraint not to be binding.

In addition, the credit constraint is similar to the one posited by Aiyagari and Gertler (1999), although it exhibits two important differences. First, the constraint does not depend on any variable determined by the model, making it exogenous. Second, it depends on an expected value and, thus, might not hold ex-post. Overall, we assume that θ is sufficiently small for the credit constraint to be effectively binding for at least one $s' \in I$. The first order conditions for this problem are:

$\beta(u'(C_{t+1})/u'(C_t))q(s)/P_{t+1}(s) \le B_t(s)/P_t$ for all $s \in I$; and,

$\beta(u'(C_{t+1})/u'(C_t))q(s')/P_{t+1}(s') < B_t(s')/P_t$ possibly for one or more $s' \in I$ for which $(\alpha(s')B_t(s')/P_t) = \theta E_t[W_{t+1} - (D_{t+1}/P_{t+1})]$.

It follows that $|Cov_t(\Delta c_{t+1}(\widehat{\boldsymbol{\alpha}}^{IM}), \pi_{t+1})| \le |Cov_t(\Delta c_{t+1}(\widehat{\boldsymbol{\alpha}}^{CC}), \pi_{t+1})|$, where $\widehat{\boldsymbol{\alpha}}^{CC}$ is the portfolio that solves the optimisation problem under incomplete markets and the presence of the credit constraint. The superscript CC stands for credit constraint. Hence, in this case, the agent generally does not borrow as many resources as it would like: ie $\widehat{\boldsymbol{\alpha}}^{CC} \le \widehat{\boldsymbol{\alpha}}^{IM}$.

To gain an intuitive understanding of the inequality involving the covariance terms, consider the following remarks. Any portfolio that is feasible under problem iii) is also feasible under problem ii). Thus, given the assumption of actuarially fair prices,

[14] Naturally, our context and theirs is quite different. Ours refers to aggregate debt/credit in an economy while theirs refers to corporate debt/credit.

the agent will insure itself in every possible state, ie $C_{t+1}(s) - C_t = 0$. In particular, for every state it insures for in problem iii), it will also do so in problem ii).

Accordingly, if the credit constraint binds, then the following inequality generally holds $|Cov_t(\Delta c_{t+1}(\boldsymbol{\alpha}^{IM}), \pi_{t+1})| \leq |Cov_t(\Delta c_{t+1}(\boldsymbol{\alpha}^{CC}), \pi_{t+1})|$. This is the case because the credit constraint will not allow the debtor to insure itself fully for one or more states. However, if the credit constraint does not bind, then we would obtain equality of the covariances.

Intuitively, if there is one or more states of nature against which the agent cannot insure, then it probably will not be able to smooth its consumption as much as it would like, thus increasing the covariance between consumption growth and inflation.

What is more, if there are further states of nature against which the debtor cannot insure itself because of a binding credit constraint (in our case, a binding pledgeability factor), then even less consumption smoothing would take place, further increasing the covariance between consumption growth and inflation.

More generally, based on the budget constraint, the sign of $Cov_t(\Delta c_{t+1}, \pi_{t+1})$, depends on at least the following three factors.

i) The covariance between inflation and the endowment;

ii) Whether the agent has debt or credit (ie the sign of D); and

iii) The extent to which the agent is able to hedge its consumption growth through the Arrow-Debreu securities.

Some additional comments are in order. First, in the model, a greater covariance's magnitude can be the product of a tighter credit constraint or of less developed financial markets. Although the empirical identification of the relative importance of these two elements is a significant problem, and we recognise the presence of both, we do not intend to determine their relative weight.

Second, the model does not distinguish between different types of debt. However, as mentioned, these are relevant for the kind of economic costs one would observe given changes in the price level. Thus, we estimate separate data panel regressions using different types of debt in each case, as we explain in more detail later.

Third, the sign of the covariance between output and inflation varies (see Plosser (2003) and Borio et al (2015)). Of course, this also depends on the time frequency considered (Walsh (2010)).[15] While our model allows for any sign, we do not take a stand on which sign to expect, and focus instead on how the interaction between changes in prices and debt, and financial development might affect the risk premium.

[15] For instance, at business cycle frequencies, one can think that if output is negatively correlated with inflation, aggregate supply shocks are dominant. On the other hand, if output is positively correlated with inflation, then aggregate demand shocks predominate. There is a large consensus that their correlation, at a low frequency, is close to zero (see McCandless and Weber (1995)).

3. The (in)deflation risk premium

In this section, we derive the (in)deflation risk premium and show that the covariance between consumption growth and inflation has a direct relationship with it. To see this, consider that one can also obtain the Euler equations with respect to one-period real and nominal bonds:[16]

$$\beta E_t[u'(C_{t+1})/u'(C_t)\,] = R_t$$

$$\beta E_t[u'(C_{t+1})/u'(C_t)(1/P_{t+1})] = S_t/P_t$$

where R_t denotes the price of a real bond which pays one unit of consumption in period $t+1$, and S_t is the price of a nominal bond that pays one unit of money in period $t+1$. As a result, we introduce the following definitions for the one-period real (r_t) and nominal (i_t) interest rates:

$$\beta E_t[\,u'(C_{t+1})/u'(C_t)] \;= R_t \equiv \exp(-r_t)$$

$$\beta E_t[(u'(C_{t+1})/u'(C_t))(P_t/P_{t+1})] \;= S_t \equiv \exp(-i_t)$$

Moreover, assuming a constant relative risk-aversion (CRRA) utility function $U(C_t) = (C_{t+1}^{1-\gamma})/(1-\gamma)$ would yield:

$$\beta E_t[\exp(-\gamma\Delta c_{t+1})\,] = \exp(-r_t) \tag{1}$$

$$\beta E_t[\exp(-\gamma\Delta c_{t+1} - \pi_{t+1})] = \exp(-i_t), \tag{2}$$

where γ is the coefficient of relative risk aversion. We express (2) as follows:[17]

$$\beta cov_t[\exp(-\gamma\Delta c_{t+1}), \exp(-\pi_{t+1})] + \beta E_t[\exp(-\gamma\Delta c_{t+1})]E_t[\exp(-\pi_{t+1})] = \exp(-i_t)$$

We combine this last expression with (1), to obtain:

$$\beta cov_t[\exp(-\gamma\Delta c_{t+1}), \exp(-\pi_{t+1})] + \exp(-r_t)\, E_t[\exp(-\pi_{t+1})] = \exp(-i_t) \tag{3}$$

One could interpret (3) as a generalisation of the Fisher equation.[18, 19] Moreover, using the Taylor series of the exponential function around zero, and assuming that higher order terms and cross-terms in the second component are negligible, we can obtain a simplified version of (3): $-\beta\gamma cov_t[\Delta c_{t+1}, \pi_{t+1}] + r_t + E_t\pi_{t+1} = i_t$.

Hence, the term $-\beta\gamma cov_t[\Delta c_{t+1}, \pi_{t+1}]$ can be understood as an (in)deflation risk premium.[20] In the appendix, we obtain an exact expression for the case when consumption growth and inflation follow a joint normal distribution. In the empirical exercises, we use the latter.

To gain some intuition, consider the following remarks. First, the debt is seen as a stock variable already held by the agent. On the other hand, the nominal bond

16 Real bonds include the already discussed TIPS in the United States and index-linked gilts in the United Kingdom.

17 For this step, we have used the well-known equality $cov(X,Y) = E(XY) - E(X)E(Y)$.

18 The original Fisher equation is: $(1+r_t)(1+E_t\pi_{t+1}) = (1+i_t)$, ie it assumes that there is no (in)deflation risk premium.

19 One could use a more general utility function and the relationship would still hold.

20 Moreover, since $E_t\pi_{t+1}$, the expected inflation conditional on the information at time t, is known at t, we can rewrite the risk premium as $-\beta\gamma cov_t[\Delta c_{t+1}, \pi_{t+1} - E_t\pi_{t+1}]$, naturally interpreting $\pi_{t+1} - E_t\pi_{t+1}$ as an inflation surprise or shock.

pricing decision takes place at the margin. Pricing will depend on the extent to which holding the nominal bond will allow for consumption to be smoothed.

Second, we assume incomplete markets that, in our model, provides us a covariance between consumption growth and inflation different from zero. Moreover, the credit constraint gives us the asymmetry in inflation and deflation costs. Consider then two general settings. First setting, suppose that a lower (higher) inflation is associated with lower (higher) consumption growth, i.e., the covariance term is positive. If deflation (inflation) takes place then her consumption would typically decrease (increase). In general, as a direct effect, more deflation (inflation) will increase (decrease) the real return of a nominal bond. This effect is favorable to her consumption-smoothing motive because she will be getting a higher (lower) real return from the nominal bond when consumption growth is lower (higher). Thus, in equilibrium, she is willing to hold a nominal bond albeit it would have a negative premium.[21]

Second setting, suppose that a higher (lower) inflation is associated with lower (higher) consumption growth, i.e., the covariance term is negative. If deflation (inflation) takes place then her consumption would usually increase (decrease). In general, as a direct effect, more deflation (inflation) will increase (decrease) the real return of a nominal bond. This effect is unfavorable to her consumption-smoothing motive since she will be getting a higher (lower) real return from the nominal bond when consumption growth is higher (lower). Thus, in equilibrium, she is willing to hold the nominal bond with a positive premium.[22]

Thus, in our model, one could consider four cases. The first and second cases occur if the agent holds nominal debt, respectively, under the first and second settings. Clearly, the interaction of debt with (in)deflation contributes towards the level of the covariance being greater. On the other hand, the third and fourth cases take place if the agent is a creditor in nominal contracts, in turn, under the first and second settings. The interaction of credit with (in)deflation would contribute towards the level of the covariance being smaller. Our motivation for assuming that the agent holds nominal debt results from the present juncture in the eurozone. For that reason, in our empirical exercises, the first and second cases are the relevant ones.

Additionally, if the agent is more risk-averse, ie, if γ is larger, the risk premium increases. Moreover, under a CRRA utility function, the intertemporal elasticity of substitution is equal to γ^{-1}. Thus, a lower intertemporal elasticity of substitution, which implies that the agent is less willing to substitute consumption across time, leads to a higher premium, as the agent has to be compensated.

Finally, consider the agent's subjective discount factor β, which affects the premium positively. As the agent cares more about its future consumption, the

21 A more familiar example of this phenomenon is car insurance. The car owner is willing to pay a premium above its actuarially fair price since the insurance will pay her in the state of nature when she needs resources, i.e., when a crash takes place. She buys insurance although, in expected value, the agent will lose money. In effect, the insurance premium is not actuarially fair.

22 Fleckenstein et al's (2013) explanation is different from ours. They motivate the difference in the risk premium' sign based on the price level cyclicality or counter-cyclicality with output. In the former case, most of the output variation is due to aggregate demand shocks, leading to a positive covariance. In the latter, most of its variation is due to aggregate supply shocks, implying a negative covariance.

larger β is, the more it needs to be compensated, bearing in mind that changes in the price level distort intertemporal consumption.

4. Data and estimation

For the estimation of the risk premium, there are, at least, three important issues to consider. First, evidently, the consumption and inflation indices have to be associated with the same consumption basket.

Second, inflation targets are commonly formulated in terms of the annual percentage change of a specific price index. In the case of the eurozone, it is the Harmonised Index of Consumption Prices (HICP). This index is widely known, frequently referred to and extensively used. Thus, to measure changes in the price level, we always use the HICP.

Third, an agent obtains her or his utility from the services, the nondurables goods and, importantly, the *portion* of durables goods consumed in a given period. Ideally, one should make a distinction between the durables goods bought, which is what the data generally measure, and the *portion* of the durables goods consumed in a given period.[23] Distinguishing such concepts explicitly would entail a separate model. Thus, while we still use general consumption indices, we also estimate our risk premium with an index that excludes durable goods (index iv)).

Overall, we estimate risk premia using the following consumption and price indices: [24]

i) Final consumption expenditure (FCE);[25]

ii) Final consumption expenditure of households (Total); (a subset of i));

iii) Final consumption expenditure of households (HFCE); (a subset of ii)); and

iv) Semi-durable goods, non-durable goods and services (a subset of ii)).

In the initial exercises, we use the risk premia estimated with i) since that index has the broadest coverage across all the economies in our data set. However, in the case of the panel regressions, we estimate the risk premia using the ii), iii) and iv) indices for the reasons just explained and to maintain comparability across such regressions.[26]

[23] For similar reasons, the income elasticity of demand for durable goods tends to be greater than that for nondurable goods.

[24] The interested reader is referred to the European System of Accounts (ESA (2010)), page 70, for further details. The respective codes in the Eurostat database are P3, P31, P31_S14 and P312N.

[25] This final consumption expenditure index "consists of expenditure incurred by resident institutional units on goods or services that are used for the direct satisfaction of individual needs or wants or the collective needs of members of the community".

[26] The HFCE essentially measures the same consumption basket as the HICP, except for the coverage of expenditure for housing by homeowners It is the closest to the HICP. See: https://www.ecb.europa.eu/stats/prices/hicp/html/index.en.html and http://ec.europa.eu/eurostat/statistics-explained/index.php/HICP_methodology for further methodological details.

We estimate consumption growth and inflation in year-on-year terms, which addresses seasonal effects.[27] The frequency of all the time series used is quarterly. In this context, one is generally restricted by the lower frequency of the consumption series used, as other series are commonly available at higher frequencies. In addition, consumption data are available with a longer lag compared with the other variables. Hence, the quarterly frequency of the data, together with the model's set up, associates our risk premium with a three-month horizon.

Concretely, the estimation of the (in)deflation risk premium entails the covariance of consumption growth and inflation, conditional on the information available in period t, eg $cov_t(\Delta c_{t+1}, \pi_{t+1})$. To estimate it, we use the following expression:

$$cov_t(\Delta c_{t+1}, \pi_{t+1}) = \left((k+2)^{-1} \sum_{i=t-k}^{t+1} (\Delta c_i - E\Delta c_t)(\Delta\pi_i - E\pi_t)\right),$$

where $E\Delta c_t = (k+2)^{-1} \sum_{j=t-k}^{t+1} \Delta c_j$, and $\mathrm{E}\pi_t = (k+2)^{-1} \sum_{j=t-k}^{t+1} \pi_j$. Specifically, we take $k = 2$, ie the last four observations, which is equivalent to a year. This captures in a simple way the most recent changes in the covariance.[28]

For the relative coefficients of risk aversion, we use estimates from Gandelman and Hernández-Murillo (2014). Moreover, for those economies that are not considered in their paper, we simply take the average for the economies intersecting our database and theirs. We note that the risk aversion coefficient has implications for the magnitude of the risk premium but not for its dynamics.[29]

To determine a value for the subjective discount factor, we assume that the steady state real interest rate has a value of 2.0% a year. Since in the steady state $C_{t+1} = C_t$, based on equation (1), we have that $\beta = \exp(-0.02/4)$. This implies an estimate for β of 0.995. This value is below the 3.0% used in, for example, Schmitt-Grohé and Uribe (2007). Yet, it accounts for the secular reduction in the level of real interest rates in recent years. Similarly, in the case of the CRRA utility function, the subjective discount factor affects the magnitude of the risk premium but not its dynamics.[30]

We use three types of debt. As mentioned, such distinction is important to assess the possible effects of changes in the price level. Consider then each type in general. First, both residents and non-residents can hold total external debt, and residents owe it. Second, residents and non-residents can hold total government debt, and the government owes it. Third, both residents and non-residents may hold total domestic

[27] We also estimated the quarter-on-quarter seasonally adjusted consumption growth and inflation. Their dynamics were not particularly different from those of the year-on-year estimates. We used the latter to sidestep any seasonality adjustment procedures.

[28] One could use an explicit model of consumption growth and inflation such as a state-space model, and then estimate a covariance term based on it.

[29] We could have used higher relative coefficients of risk aversion as is sometimes done in the literature to account for the variability of the returns on assets. However, we are interested in documenting the asymmetry in the costs of deflation and inflation, rather than their absolute values.

[30] In a representative agent model, one can consider consumption growth per capita. Thus, accounting for population growth is potentially relevant. In our case, a drawback of using population data is that they are not available at a quarterly frequency for some economies in our database. Thus, we use as a working assumption that population growth is constant and equal to zero. This is not an innocuous assumption at a low frequency (see Juselius and Takáts (2015)); however, the period covered in our estimation does not surpass 15 years and comprises quarterly data.

debt. We use each type separately as the empirical counterpart to the debt term in the model.

The economies in our dataset are shown in Tables 1–5. The periods depend on the specific series and the economy in question. Some are available starting in earlier quarters. Yet, for the estimations, we have used a common starting point: Q1 2001 but the ending quarters of the time series depend on the specific economy.[31] We do this in order to have, as much as possible, a balanced panel data set. Some economies lack certain time series and are thus excluded from the respective panel regression.[32] These are indicated by a dash in Tables 1–5.

Next, we consider the main statistics of each time series. First, in almost all the economies in our database there have been deflationary periods (last column of Table 1).

Second, risk premia are both positive and negative, reflecting their time-varying nature. Moreover, all economies, except for Denmark, Iceland and the UK, have experienced negative values (last column of Table 2), potentially reflecting the presence of deflation risks.

On a related note, Greece, Ireland, Portugal and Spain present an average negative premium, possibly indicating the need for real exchange depreciation through deflation, given the lack of independent exchange rate policy at the individual country level.

Third, debt levels with respect to GDP are, in essentially all cases, sizeable (Tables 3–5).

Next, we have some additional comments on the statistics of deflation. To that end, consider a(n) in(deflation) data point $\pi_{i,t}$, which we associate with an economy i and a quarter t, in our database. First, we have that 91 data points (out of 2,186) presented deflation, accounting for 4.16% of the total. Second, on average, an economy has had 3.4 periods (out of an average of 55.3 periods) of deflation. In other words, typically, an economy has seen deflation 6% of the time. The standard deviation of this last statistic is 7%. Third, clearly, a given economy may very well face the probability of a deflation episode without actually experimenting one.

31 As of this paper's date, the complete set of times series we have used had not been completely updated on the Eurostat website.

32 Bulgaria and Romania are dropped altogether from the analysis as their risk premia are unconceivably large, suggesting that the associated series are probably not stationary.

Inflation statistics (HICP) Table 1

	Mean	Std. D.	Kurt.	Skew.	Max	Min
Austria	2.05	0.89	3.51	0.17	4.05	-0.31
Belgium	2.06	1.26	4.43	0.29	5.75	-1.04
Croatia +	2.69	1.49	3.74	0.75	7.30	-0.07
Cyprus	2.24	1.57	3.22	-0.01	6.35	-1.25
Czech Republic	2.22	1.76	3.54	0.89	7.14	-0.62
Denmark	1.83	0.95	3.22	0.23	4.54	0.17
Estonia	4.02	2.81	3.92	0.53	11.47	-1.87
Finland +	1.93	1.09	2.91	0.35	4.72	-0.44
France	1.79	0.85	3.93	-0.30	3.98	-0.57
Germany +	1.68	0.79	3.08	-0.10	3.37	-0.46
Greece	2.63	1.84	3.01	-0.90	5.66	-1.82
Hungary	4.85	2.34	3.26	-0.02	10.46	-0.52
Iceland +	5.64	4.84	4.86	1.52	21.03	0.35
Ireland +	1.91	2.01	2.89	-0.69	5.08	-3.01
Italy	2.22	0.97	2.82	-0.37	4.01	-0.08
Luxembourg +	2.56	1.31	3.25	-0.47	5.34	-0.98
Malta	2.32	1.28	2.61	-0.10	4.98	-0.58
Netherlands +	2.13	1.26	3.42	0.78	5.30	-0.03
Norway	1.72	1.11	2.97	0.14	4.83	-0.40
Poland	2.65	1.60	2.04	0.08	6.18	-0.24
Portugal +	2.28	1.58	2.86	-0.77	5.13	-1.80
Slovakia	3.62	2.59	2.47	0.52	9.37	-0.16
Slovenia +	3.58	2.39	2.68	0.77	9.67	-0.10
Spain	2.58	1.40	3.36	-0.94	5.06	-0.95
Sweden	1.59	0.97	3.19	0.65	4.18	-0.35
Switzerland	0.42	1.01	3.38	0.67	2.84	-1.24
United Kingdom	2.33	1.07	3.25	0.78	5.25	0.63
Average	2.50	1.59	3.25	0.16	6.41	-0.66

Notes: year-on-year quarterly observations. Sample periods: Q1 2001 to Q2 2014 (indicated by a +) or Q3 2014, depending on the economy.

Source: Own estimations with data from Eurostat.

Risk premium statistics

Table 2

	Mean	Std. D.	Kurt.	Skew.	Max	Min
Austria	0.12	0.26	6.26	-0.41	0.80	-0.86
Belgium	-0.06	0.77	13.41	-2.77	1.18	-3.76
Croatia +	0.01	0.14	12.97	-2.31	0.35	-0.65
Cyprus	-0.79	1.91	14.51	-3.25	1.31	-9.86
Czech Republic	0.29	0.76	11.23	2.83	3.39	-0.64
Denmark	0.04	0.20	7.93	1.59	0.86	-0.41
Estonia	-0.23	1.15	8.04	-2.29	1.13	-4.83
Finland	0.01	0.18	10.60	-0.94	0.60	-0.76
France	0.07	0.35	7.22	1.09	1.24	-0.80
Germany +	0.00	0.07	8.20	1.31	0.30	-0.15
Greece	-0.59	2.48	9.22	-2.41	3.03	-10.74
Hungary	0.47	1.81	5.27	1.13	6.61	-3.03
Iceland +	4.14	7.20	12.37	2.90	37.92	-0.58
Ireland +	-0.04	0.21	10.21	-2.66	0.19	-0.91
Italy	0.03	0.21	6.50	0.33	0.69	-0.66
Luxembourg +	0.16	0.60	9.56	1.78	2.86	-1.10
Malta	0.93	1.37	4.01	1.03	4.79	-1.56
Netherlands +	0.00	0.00	4.46	0.04	0.00	-0.01
Norway	0.17	0.82	4.22	1.16	2.77	-1.12
Poland	-0.01	0.10	3.11	-0.11	0.23	-0.26
Portugal +	-0.16	0.89	5.55	-1.29	2.05	-2.84
Slovakia	0.72	1.91	16.83	2.93	10.96	-2.95
Slovenia +	-0.08	0.53	11.39	-2.22	0.97	-2.52
Spain	-0.09	0.54	13.48	-2.85	0.79	-2.43
Sweden	0.18	0.26	3.89	1.11	0.96	-0.28
Switzerland	0.22	0.31	4.39	1.07	1.22	-0.49
United Kingdom	0.02	0.37	6.95	-0.68	0.99	-1.28
Average	0.20	0.94	8.58	-0.14	3.27	-2.05

Notes: Sample periods: Q1 2001 to Q1 2014 (indicated by a +) or Q2 2014. d. Estimations based on equations (3), (4) and (6).

Sources: Own estimations with data from Eurostat, and Gandelman and Hernández-Murillo (2014).

Total government debt as a percentage of GDP, statistics

Table 3

	Mean	Std. D.	Max	Min
Austria	-	-	-	-
Belgium	120.63	8.87	136.88	101.05
Croatia	42.26	15.92	77.86	28.16
Cyprus	-	-	-	-
Czech Republic	25.97	9.82	42.46	11.08
Denmark	62.58	8.93	72.48	40.02
Estonia	3.34	1.76	7.33	1.02
Finland	53.34	8.82	71.74	36.02
France	92.25	14.85	123.61	73.64
Germany	71.23	8.75	86.73	57.39
Greece	135.59	22.49	192.32	112.73
Hungary	68.21	7.46	78.25	55.23
Iceland	-	-	-	-
Ireland	58.83	35.89	122.71	24.81
Italy	111.15	11.01	144.11	97.33
Luxembourg	12.24	7.05	27.67	5.60
Malta	66.23	4.22	75.44	57.39
Netherlands	61.83	9.48	79.36	47.31
Norway	48.60	8.08	61.14	32.51
Poland +	44.45	3.60	50.47	35.06
Portugal	80.82	27.97	139.23	48.37
Slovakia	37.80	8.68	54.95	23.30
Slovenia	31.24	13.21	68.06	18.64
Spain	71.63	26.81	141.01	43.95
Sweden	51.27	6.67	65.21	41.01
Switzerland	21.38	3.44	26.12	16.79
United Kingdom	60.23	23.73	100.76	38.32
Average	59.71	12.40	85.25	43.61

Notes: Sample periods: Q1 2001 to Q2 2014 (indicated by a +) or Q3 2014, depending on the economy.

Source: Haver Analytics.

Total domestic debt as percentage of GDP, statistics

Table 4

	Mean	Std. D.	Max	Min
Austria	-	-	-	-
Belgium	418.91	48.61	494.79	360.77
Croatia	-	-	-	-
Cyprus	-	-	-	-
Czech Republic	242.93	1.27	244.74	241.25
Denmark	521.72	86.56	627.80	384.19
Estonia	-	-	-	-
Finland	275.74	39.95	336.43	225.25
France	395.11	54.25	476.42	326.79
Germany	327.04	12.73	358.05	296.65
Greece	260.51	57.91	385.72	188.84
Hungary	271.65	54.33	338.95	187.73
Iceland	-	-	-	-
Ireland	1,683.27	572.81	2,347.57	719.99
Italy	335.21	42.06	399.13	273.72
Luxembourg +	2,786.48	1,101.57	4,871.34	1,489.88
Malta	-	-	-	-
Netherlands	801.47	13.68	820.63	780.01
Norway	368.32	39.21	443.62	299.91
Poland +	179.01	23.03	212.76	146.49
Portugal	333.15	66.20	430.74	234.88
Slovakia	199.27	5.27	205.99	191.22
Slovenia	292.84	4.61	299.48	285.86
Spain	384.15	78.71	484.13	257.96
Sweden	409.21	51.31	482.29	341.82
Switzerland	-	-	-	-
United Kingdom	444.14	70.83	541.06	335.00
Average	546.51	121.25	740.08	378.41

Notes: Sample periods: Q1 2001 to Q2 2014 (indicated by a +) or Q3 2014, depending on the economy.

Source: Haver Analytics.

Total gross external debt as percentage of GDP, statistics

Table 5

	Mean	Std. D.	Max	Min
Austria	177.61	26.66	211.89	128.22
Belgium	266.75	33.48	349.46	204.42
Croatia	81.28	20.84	109.77	48.05
Cyprus	522.92	95.20	784.07	350.93
Czech Republic	43.14	12.28	64.39	28.11
Denmark	168.05	16.75	191.26	134.85
Estonia	89.61	23.49	132.12	49.30
Finland	142.37	47.12	235.72	93.80
France	189.35	10.19	203.78	165.88
Germany	140.10	14.59	167.68	111.69
Greece	160.38	48.90	234.14	87.70
Hungary	100.58	33.72	149.48	52.34
Iceland	500.26	312.34	982.48	102.26
Ireland	815.50	235.65	1,121.80	375.02
Italy	105.69	13.40	123.09	78.89
Luxembourg	3,897.52	955.66	5,745.15	2,698.82
Malta	762.57	371.73	1,143.63	226.13
Netherlands	505.93	16.07	530.42	470.97
Norway	129.63	21.30	173.28	91.71
Poland	53.33	11.75	72.40	35.93
Portugal	193.58	33.42	238.22	128.24
Slovakia	62.10	13.85	88.87	41.52
Slovenia	85.56	29.18	124.67	39.69
Spain	134.97	28.97	168.32	81.64
Sweden	175.39	23.25	204.73	122.96
Switzerland	220.06	23.22	284.33	185.13
United Kingdom	322.34	57.06	414.76	232.78
Average	372.10	93.71	527.77	235.81

Notes: Sample periods: Q1 2001 to Q3 2014.

Source: Haver Analytics.

5. Panel data regression model

We explore the extent to which some of the factors we have thus far considered are priced in by the risk premium. In this context, it is worth revising some of our previous results. First, incomplete markets imply that the risk premium is different from zero. Second, in the presence of debt, more deflation contributes towards the risk premium being smaller. Third, the presence of the credit constraint implies that the effect deflation has on the risk premium is greater than that of inflation. Fourth, better financial development implies a smaller risk premium's magnitude. Thus, a key feature we want to assess is the extent to which the pricing implications of inflation and deflation differ..

Hence, we posit the following data panel regression:

$$RP_{i,t+1} = \gamma_0 + \gamma_1 RP_{i,t} + \gamma_2 \Delta GDP_{i,t} + \gamma_3 \left(P_{i,t}\right)^+ + \gamma_4 \left(P_{i,t}\right)^- + \gamma_5 \Delta D_{i,t} + \gamma_6 (D_{i,t}/P_{i,t} - D_{i,t})^+ + \gamma_7 (D_{i,t}/P_{i,t} - D_{i,t})^- + u_{i,t}, \quad (5)$$

where $RP_{i,t}$ is the (in)deflation risk premium, $GDP_{i,t}$ is the gross domestic product, $P_{i,t}$ is a price index such that $\pi_{i,t} = \log(P_{i,t}) - \log(1)$ is the rate of inflation or deflation, $D_{i,t}$ stands for the debt, $(P_{i,t})^+ = \max\{P_{i,t}, 1\}$ and $(P_{i,t})^- = \min\{P_{i,t}, 1\}$. Similarly, we define $(D_{i,t}/P_{i,t} - D_{i,t})^+ = \max\{D_{i,t}/P_{i,t} - D_{i,t}, 0\}$ and $(D_{i,t}/P_{i,t} - D_{i,t})^- = \min\{D_{i,t}/P_{i,t} - D_{i,t}, 0\}$. Finally, $u_{i,t}$ is the error term of economy i in quarter t with a fixed effects model.

Thus, we construct specific variables making the distinction between the effects that inflation and deflation might have as they interact with debt. In particular, the term $D_{i,t}/P_{i,t} - D_{i,t}$ is the real change in the value of debt due to changes in the price level, recall that $\pi_{i,t} = \log(P_{i,t})$. Furthermore, $(D_{i,t}/P_{i,t} - D_{i,t})^+$ measures the real change in the value of debt under the presence of deflation and $(D_{i,t}/P_{i,t} - D_{i,t})^-$ does so under the presence of inflation. Note that our price index $P_{i,t}$ is less than one under deflation and more than one under inflation.

Before proceeding to our results, it is worth mentioning four additional points. First, for the panel estimation we have only considered economies from the eurozone. This is so since they have issued most of their debt in euros, allowing us to focus on changes in debt due to variations in the price level.

Second, we have lagged the explanatory variables to address the possible presence of endogeneity. In effect, it is plausible that a change in the (in)deflation risk premium is contemporaneously associated with some of the explanatory variables, prominently, inflation.

Third, we use fixed effects to account for the different levels of financial development across our sample of economies, along with other unobserved heterogeneity.[33] Thus, we are tacitly assuming that financial development is a slow moving variable. It is worthwhile mentioning that financial development indices are only available at a yearly frequency and for a limited number of economies.

Fourth, for the panel data, we use the moving average of adjacent observations of the risk premia. This allow us to focus on their low to medium frequencies,

[33] In our model, again, we think of financial development as the number of Arrow-Debreu assets available and, thus, a reflection of the agent's capabilities to hedge changes in the price level.

discarding high frequency changes and, in tandem, attenuating possible measurement errors in these variables.

6. Estimates and discussion

6.1 Initial estimates

As a prelude to our discussion of the panel data regression model's estimates, we document two relationships in this subsection.[34]

i) A correlation between the time series of the aggregated inflation risk premium, built using the (FCE) consumption and inflation series of the EU-28 countries in Eurostat, with a systemic stress index of the financial system (Composite Indicator of Systemic Stress (CISS)); and

ii) A correlation between the absolute value of the countries' time average risk premium and their financial development indices.

With respect to the first relationship, in general, periods during which the risk premium is negative are associated with increments in the CISS (Figure 1). On the other hand, periods during which the risk premium is positive, financial stress tends to diminish. In fact, regressing the risk premium against the CISS leads to a statistically significant negative slope coefficient and a value of 0.32 for R^2.

In our model, as explained earlier, the contribution towards the covariance between inflation and consumption growth due to an agent's debt holding is positive and, hence, negative for the premium. We think of the premium as a compensation of the extent to which the holding of nominal bond leads to a smoother consumption path, which is largely determined by the interaction between changes in the price level and nominal debt.

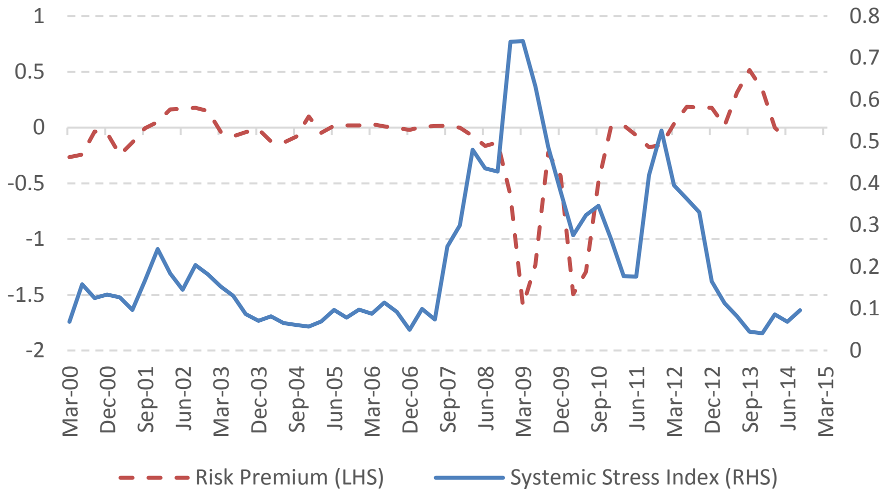
Moreover, a higher level of inflation might unbind the credit restriction, allowing the agent to secure consumption in more states of nature and enjoy smoother consumption growth, thus leading to a smaller premium in magnitude. In contrast, higher deflation might make the credit restriction bind, constraining consumption growth in more states of nature, increasing consumption variability and, hence, making the premium larger in magnitude. This is consistent with the property that the premium's magnitude tends to be greater during deflationary episodes than during inflationary ones. In addition, the plot allows us to see that this result is driven by the second part of the sample period, mostly during the European debt crisis and its aftermath (Figure 1).

Second, for this exercise, the economies considered are restricted to those for which individual country indices of the Financial Development Index 2014 of the World Economic Forum (WEF) are available, namely for: Austria, Belgium, Czech Republic, Denmark, Finland, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Sweden and Switzerland. We use 2014, since it is the last year of our estimation sample.

[34] For reasons explained in the main text, for these estimations we have used the FCE index.

We plot the absolute value of the average of each risk premium time series (sample period Q1 2000–Q2 2014) with the financial development indices from 2014 (Figure 2). We have an R^2 of 0.35 but if the two data points at the top (the Czech Republic and Hungary) are excluded from the estimation, the R^2 decreases to 0.2.

Inflation risk premium for the EU-28 countries and Composite Systemic Stress indicator (CISS) Figure 1

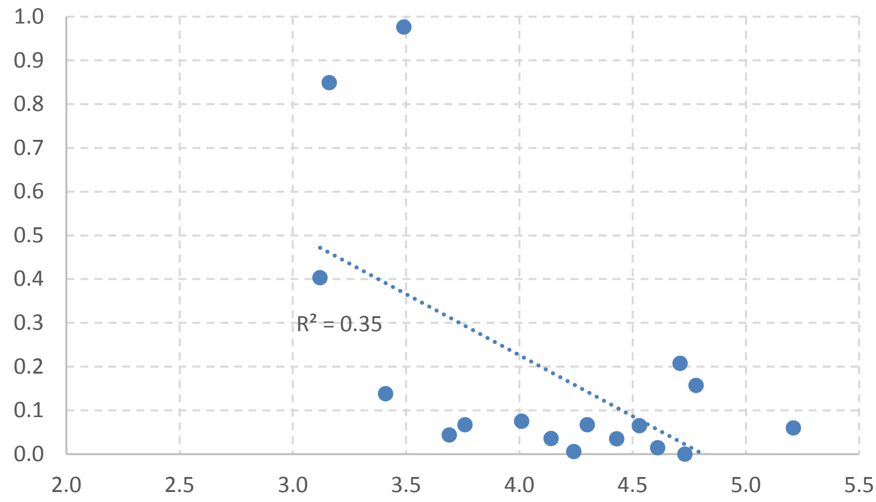


Sources: Own estimations with data from Eurostat and Gandelman and Hernández-Murillo (2014) Composite Indicator of Systemic Stress (CISS) (Holló et al (2012)).

Evidently, the risk premia could also depend on other factors. Nonetheless, our statistics are indicative of the importance played by the level of financial development in determining the magnitude of the (in)deflation risk premium. This is in line with our model insofar as financial development is captured by the number of Arrow-Debreu securities with respect to the total number of states of nature and the actuarially fair pricing assumption made.

Absolute values of the average risk premia and financial development indices for a set of economies

Figure 2



Notes: the average risk premia and financial development indices variables are represented on the y-axis and x-axis, respectively.

Sources: Own estimations with data from Eurostat, and Gandelman and Hernández-Murillo (2014). The financial development index used is the World Economic Forum's Financial Development Index (2014).

6.2 Panel data regression estimates

In this subsection, we present the panel data regressions' estimates. We consider separate regressions, depending on the type of debt that is included as part of the explanatory variables, as well as on the series with which the (in)deflation risk premium has been constructed, for reasons previously explained. Thus, we estimate several versions of the data panel model (5) in which the type of debt is varied as follows: total government debt ($GD_{i,t}$), total domestic debt ($DD_{i,t}$) and total gross external debt ($ED_{i,t}$). Respectively, we replace each for $D_{i,t}$ in (5).[35]

Similarly, we use the indices ii) final consumption expenditure of households, (total); iii) final consumption expenditure of households; and iv) semi-durable goods, non-durable goods and services to construct the risk premia.

A few comments are in order. First, we limit our panel data estimation to the following eurozone economies, namely Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain.[36] As explained earlier, this is because the bulk of their debts are denominated in euros.[37]

[35] In our model, the agent has, in particular, to pay back debt in the second period. A possible interpretation is that a closer empirical analogue is debt service, a datum that is generally not available. Thus, the levels of debt are used as proxies. This is a reasonable approximation provided that we can think of the debt being paid as a perpetual security, ie $D = P/r$ where r is a constant interest rate and P the periodic payment.

[36] Latvia and Lithuania just recently joined the eurozone in 2014 and 2015, respectively. Thus, they have not been included in the panel regressions.

[37] See www.ecb.europa.eu.

Second, the coefficients we are mostly interested in are γ_6; which are those associated with the terms $(D_{i,t}/P_{i,t} - D_{i,t})^+$, as highlighted in grey in Table 6.

When there is deflation $P_{i,t} < 1$ then $D_{i,t}/P_{i,t} - D_{i,t} > 0$. Based on our model, we would expect to obtain a negative coefficient. In effect, in our model, with debt, an increase in deflation is associated with lower consumption and vice versa. Thus, one would expect the debt-deflation term to be associated with a coefficient such that it contributes *negatively* towards the premium. In tandem, an increase in the level of debt would increase the effects deflation would have on the premium.

We note that, in accordance with the model, six of the nine regressions have a negative and statistically significant coefficient and two have a negative coefficient (although not statistically insignificant). We only observe a positive and statistically significant coefficient in one case.

Third, other coefficients of interest are γ_7; associated with the terms $(D_{i,t}/P_{i,t} - D_{i,t})^-$. When there is inflation $P_{i,t} > 1$, then we would have $D_{i,t}/P_{i,t} - D_{i,t} < 0$. Based on our model, under debt, we would expect to observe negative coefficients for these terms. In effect, an increase in inflation is associated with more consumption and vice versa. Thus, the debt-inflation term should contribute *positively* towards the risk premium.

In addition, out of the three cases for which we obtain a statistically significant coefficient, all are negative. The other six coefficients are not statistically significant. In the same vein, out of the three cases for which the coefficient is statistically significant, we observe that their magnitudes are less than that of their counterpart coefficients associated with the term $(D_{i,t}/P_{i,t} - D_{i,t})^+$.

Note two features. First, a fewer number of coefficients associated with the debt-inflation terms discussed above are significant than that of the debt-deflation terms. Second, the latter have greater magnitudes. Moreover, consider the six cases that have statistically significant coefficients associated with the debt-deflation term and a consistent negative sign. For those cases, we test whether in each debt-deflation coefficient is equal to the corresponding debt-inflation one. We find that, in only one case, the test fails to reject the null hypothesis of equal coefficients. Both results point to the asymmetric costs between inflation and deflation.

In short, the coefficients' signs associated with the (in)deflation-debt terms are consistent with the consumption smoothing motive. Indeed, when holding debt, buying a nominal bond during deflationary episodes is in general favourable to consumption smoothing. This means that the debt holder does not need to be compensated, which decreases the premium. On the other hand, buying a nominal bond during inflationary episodes is in general unfavourable to consumption smoothing and, hence, the investor would need to be compensated, increasing the premium. Moreover, the differences in the coefficients' magnitudes are an implication of the credit constraint. In sum, during deflationary episodes, in the presence of debt, those that are more financially constrained happen to be the more adversely affected.

A comment about measurement errors is required. As known, measurement error biases the coefficients' estimates; ie the so-called attenuation bias.[38] Of course, macroeconomic variables probably also contain measurement errors. Thus, albeit we have used the rolling-over sample covariance, and have taken the moving average of

[38] The presence of measurement errors introduces biases in the estimated coefficients towards zero.

adjacent observations, as mentioned, the fact that our coefficients are statistically significant is encouraging.

Fourth, the five significant coefficients associated with the inflation term $(P_{i,t})^{+}$ have positive signs. Although the model is silent regarding their sign, we find it intuitive that the presence of inflation leads directly to a higher premium. Conversely, the six significant coefficients associated with the deflation term $(P_{i,t})^{-}$ are negative. Hence, the presence of deflation reduces the magnitude of the risk premium.

Fifth, the differences in output, when significant, have positive coefficients. This is in line with the interpretation that a greater output provides slack to our credit constraint, since its right-hand side would increase. However, rather than interpreting this result, we think of the output change as a control variable.

7. Final remarks

We have presented evidence suggesting that deflation, under the presence of debt, might lead to economic costs. Such costs result from the presence of incomplete markets and credit constraints. Of course, other factors might also play a role in determining those costs.

In addition, our empirical results are indicative of a pricing in of deflation risks in terms of consumption growth. Importantly, they point towards deflation being relatively more costly than inflation.

This brings us to a number of general points. First, we think that one should be concerned about the conditions under which deflation might bring about economic costs. In our simple model, changes in the price level distort wealth intertemporally and, in tandem, affect the (in)deflation risk compensation for a nominal bondholder. A more developed financial system seems to mitigate such costs.

Second, a strand of the literature has assessed the costs of (in)deflation in terms of its relationship to output. On a related note, the literature measuring the costs of business cycles has focused on doing so in terms of consumption (directly as in Lucas (1991) or indirectly as in Alvarez and Jermann (2004)).[39] Similarly, we think that the assessment of the possible costs of deflation should also explore the impact of deflation in terms of consumption, measured directly or indirectly, as we have done.[40] Naturally, this approach comes with specific challenges and data requirements.

Third, in the periods and in the economies that we considered, we documented that deflationary episodes had been brief. In this context, one cannot robustly quantify econometrically the potential costs of deflation. Nonetheless, as we underscored, a given economy might face the probability of a deflationary episode, possibly reflected in a negative risk premium, without actually undergoing one.

Fourth, from a historical perspective, one could argue that as financial markets have developed, the potential costs of deflation have generally diminished. This is not to say, however, that one can ignore the possibility that such costs could surge if a dislocation in financial markets took place. Such a dislocation would effectively

[39] Alvarez and Jermann (2004) use asset prices to measure the costs of business cycles.

[40] In fact, in the derivation of some monetary models, one substitutes consumption for output.

disrupt their development, as the Great Financial Crisis and the European debt crisis have illustrated.

Fifth, central bankers seem to exhibit a particular dislike of deflation and, in many of the economies we have considered, have made significant efforts to avoid a deflationary scenario. We think that their distaste for deflation is not unfounded.

Finally, traditional consumption-based asset pricing models are not as popular in empirical work as they used to be.[41] For example, Hansen and Singleton (1983) documented some of their limitations. One such limitation relates to the implied magnitude of excess asset returns. Yet, our focus has been on the costs of deflation relative to inflation. We could have also used, for example, a more general utility function, and an explicit model for the consumption and inflation processes.[42] We leave such analysis for future research.

41 By traditional we mean consumption models that use utility functions that are time-separable.

42 One could consider, for example, the use of an Epstein and Zin (1989) utility function. It would lead to additional variability in the stochastic discount factor (given that the counterpart term to $\beta \exp(-\gamma \Delta c_{t+1})$ would be more variable) and possibly to a greater risk premium.

Panel regression estimates

Table 6

VARIABLES	Model 1 RP ii)	Model 2 RP ii)	Model 3 RP ii)	Model 4 RP iii)	Model 5 RP iii)	Model 6 RP iii)	Model 7 RP iv)	Model 8 RP iv)	Model 9 RP iv)
Risk Premium$_t$	0.616***	0.592***	0.574***	0.589***	0.509***	0.538***	0.593***	0.577***	0.566***
	(0.0327)	(0.0329)	(0.0420)	(0.0313)	(0.0295)	(0.0372)	(0.0317)	(0.0310)	(0.0374)
Δ GDP$_t$	0.0136	-0.0366	0.0449	0.0991***	0.109***	0.202***	0.0271	-0.0452	0.0586*
	(0.0224)	(0.0342)	(0.0348)	(0.0375)	(0.0335)	(0.0531)	(0.0227)	(0.0294)	(0.0306)
P^+	5.899*	2.684	15.35***	5.099	-0.810	10.47**	5.613*	1.870	8.361*
	(3.050)	(2.974)	(5.547)	(3.191)	(3.450)	(4.740)	(3.162)	(2.832)	(4.630)
P^-	-48.21**	-34.72	-77.53**	-90.96***	5.929	-163.1***	-41.43**	-24.08	-45.89***
	(24.37)	(25.91)	(33.70)	(25.58)	(29.63)	(30.98)	(16.63)	(15.45)	(16.60)
ED_t-ED_{t-1}	5.86e-05**			-1.09e-05**			-6.64e-06		
	(2.82e-05)			(5.33e-06)			(2.87e-05)		
$(ED_t /P_t – ED_t)^-$	-0.000345			2.44e-06			-0.000301		
	(0.000676)			(3.15e-05)			(0.000691)		
$(ED_t /P_t – ED_t)^+$	-0.00795**			-0.000377*			-0.00221		
	(0.00375)			(0.000194)			(0.00304)		
GD_t-GD_{t-1}		0.000972*			-0.000154*			0.00109**	
		(0.000543)			(9.16e-05)			(0.000481)	
$(GD_t /P_t – GD_t)^-$		-0.0246**			-0.00105**			-0.0292***	
		(0.0110)			(0.000487)			(0.0104)	
$(GD_t /P_t – GD_t)^+$		-0.0780**			0.00493**			-0.0831***	
		(0.0393)			(0.00243)			(0.0314)	
DD_t-DD_{t-1}			4.25e-05			-9.58e-07			-3.36e-05
			(3.88e-05)			(3.88e-06)			(2.59e-05)
$(DD_t /P_t – DD_t)^-$			-0.000561			3.29e-05			-0.000619
			(0.000914)			(2.61e-05)			(0.000662)
$(DD_t /P_t – DD_t)^+$			-0.00849*			-0.000492***			-0.00186
			(0.00481)			(0.000119)			(0.00197)
Constant	42.14*	31.94	61.81*	85.67***	-5.331	152.3***	35.63**	22.09	37.28**
	(23.68)	(25.26)	(32.07)	(24.93)	(29.07)	(29.96)	(16.06)	(14.99)	(15.56)
Number of observations	619	651	415	725	777	539	703	754	518
R^2	0.411	0.390	0.382	0.391	0.365	0.384	0.375	0.376	0.351
Number of Economies	15	13	11	17	15	13	17	15	13

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 Sample periods: Q1 2001 to Q3 2014 or Q4 2014, depending on the economy. Debt levels are estimated based on their ratios over GDP, GDP growth and setting GDP Q1 2001 equal to 100.

Sources: Own estimations with data from Eurostat, Gandelman and Hernández-Murillo (2014) and Haver Analytics.

Appendices: the (in)deflation risk-premium under a normal distribution

Sometimes it is useful to obtain an exact expression for the risk premium. This is possible if one is willing to make an assumption about the distribution of consumption growth and inflation. To see this, consider equation (3) in the main text, which we reproduce here for convenience:

$$\beta cov_t[\exp(-\gamma\Delta c_{t+1}), \exp(-\pi_{t+1})] + \exp(-r_t)\, E_t[\exp(-\pi_{t+1})] = \exp(-i_t)$$

Assuming that inflation and consumption growth have a joint conditional normal distribution with parameters (μ, Σ), and applying Stein's Lemma twice, we obtain the following expression for the left side of the equation:[43]

$$\beta\, E_t[\gamma \exp(-\gamma\Delta c_{t+1})]E_t[\exp(-\pi_{t+1})]cov_t[\gamma\Delta c_{t+1}, \pi_{t+1}] + \exp(-r_t)\, E_t[\exp(-\pi_{t+1})]$$

Hence, the exact expression for the risk premium is given by:

$$-\beta\gamma E_t[\gamma \exp(-\gamma\Delta c_{t+1})]E_t[\exp(-\pi_{t+1})]cov_t[\Delta c_{t+1}, \pi_{t+1}]$$

Thus, to the extent to which the normality assumption holds, the premium depends on the expected values of consumption growth and inflation, relative to their variances, and on the relative risk aversion and subjective discount coefficients.

Eurostat abbreviations

EU-15: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom, Austria, Finland and Sweden.

EU-27: EU-15 and Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

EU-28: EU-27 and Croatia.

[43] Charles Stein's Lemma states that if X and Y are two jointly normal distributed variables, then $cov(f(X), Y) = E(f'(X))cov(X, Y)$, provided that f is such that all moments exist, i.e., they are finite.

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Inflation expectations and dollarisation in Peru[1]

Renzo Rossini, Marco Vega, Zenon Quispe and Fernando Perez

Abstract

Dollarisation intensifies the challenges posed to monetary policy by the pass-through of the exchange rate to domestic prices. These challenges become even greater when real transactions are dollarised, contaminating the formation of inflation expectations. This introduces non-linearities and asymmetries into the implications of the exchange rate for inflation during larger currency depreciations, in contrast to the case of smaller depreciations and appreciations.

Keywords: Inflation expectations, exchange rate pass-through into prices, SVAR models

JEL classification: E52, E58, F31

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1. Introduction

During periods of high and hyperinflation, the use of the local currency is often abandoned in favour of a foreign one. The sequence of substitution begins with the currency's role as a store of value, followed by its roles as a unit of account and, last, as a medium of exchange. A well documented fact is that, after inflation is brought down, even to the point of sustained price stability, economic agents stick to using the foreign currency in all its roles. This lack of reversibility is known as hysteresis, since the end of inflation does not necessarily ensure the end of dollarisation.[2]

The high degree of dollarisation inertia can be attributed to transactional costs associated with contract revisions, or to insufficient incentives to change market practices. The dollarisation literature mostly emphasises the financial risks involved with dollar liabilities within the local banking system. However, the existence of an extended practice of keeping prices in dollars generates important complications to the objective of price stability, given the greater uncertainty about the pass-through of a depreciation to inflation and about the feedback loops of these variables with inflation expectations.

In this article, we revise the estimates of the exchange rate pass-through (ERPT) to inflation in the case of a partially dollarised economy, like that of Peru. We also try to identify how far movements in the exchange rate contaminate inflation expectations. In Section 2, we outline the high rate of dollarisation for transactions in contrast to the significant reduction in financial dollarisation. In Section 3, we discuss the ERPT and its feedback into inflation expectations, while Section 4 develops a simple view of the determinants of inflation expectations and discusses the stability of the parameters weighting the importance of each determinant. Finally, conclusions are presented.

2. Dollarisation of transactions between firms

Financial dollarisation has declined significantly in Peru, for both deposits and loans, but there is still a high degree of dollarisation in transactions. For example, some 57% of contracts between firms are still settled in dollars (see Graph 1). Big-ticket items for consumers, such as durables, house rents or apartments, are also priced in dollars. To some degree, inertia and transaction costs explain this persistence, despite the prevailing low inflation. An additional factor is that exchange rate movements imply arbitrary redistributive effects among buyers and sellers.[3]

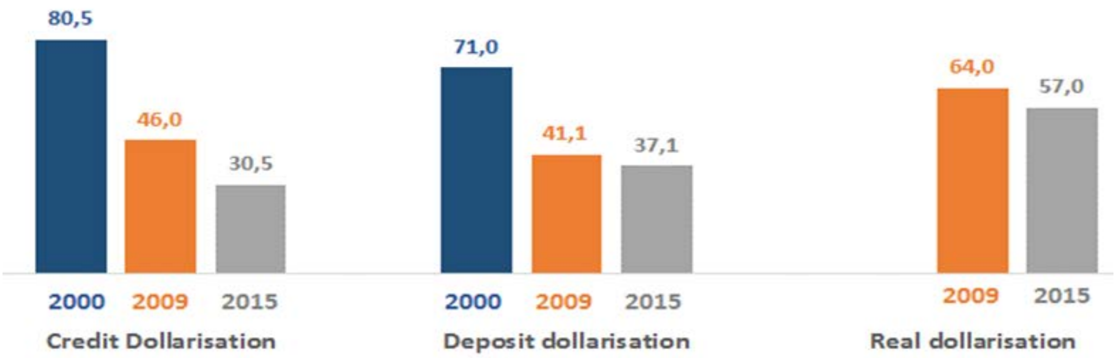
The sectors with the highest proportion of dollar transactions are commerce (72%), manufacturing (64%), transportation and communications (50%) and services (45%) (see Table 1). This shows that typical producers of non-traded goods index their prices to the exchange rate, which has important implications for real exchange rate adjustment in a dollarised economy.

2 See Calvo and Vegh (1996).

3 The Peruvian constitution guarantees the freedom to hold and transfer foreign currency.

Dollarisation[1]

(Percentages) Graph 1



1/ For credit and deposit dollarisation the ratios are shares from total credit and total deposits. The real dollarisation corresponds to surveyed firms acknowledging that most of their imput costs are denominated in foreign currency

Currency denomination of input purchases

(As percentage of surveyed firms) Table 1

Industry	Purchase of inputs	
	Domestic currency	Foreign currency
Agriculture	50	50
Commerce	28	72
Construction	67	33
Energy (Electricity, Gas and Water)	57	43
Manufacturing	36	64
Mining and oil	48	52
Fishing	67	33
Services	55	45
Transportation and comunications	50	50
Total	43	57

To understand the dollarisation of transactions and its implications in price-setting behaviour, it is important to study the process of price determination. To this end, one common explanation for inertia in inflation is the fact that firms adjust their prices in a discrete fashion, at different moments in time and at different frequencies. This affects the realisation of shocks over time.

In order to identify the speed of adjustment of prices to changing economic conditions, the Survey of Macroeconomic Expectations of the Central Reserve Bank of Peru included one question about the frequency of firms' price adjustments. At the sector level, manufacturing firms adjust their prices every eight months, commercial firms every 7.5 months and the services sector every 6.7 months on average. Using the 1983 Calvo model of price rigidities, where the frequency of price adjustments is related to the economy's degree of price rigidity, the degree of price rigidity in Peru would be 0.87, slightly lower than the value estimated for other economies (Table 2).

Indicators of price rigidity

Table 2

	United States	Eurozone	Peru
Frequency of price adjustments (f months)	8.3	10.8	7.5
Rigidity (Θ)	0.88	0.91	0.87

Source: Alvarez et al. (JEEA, 2006); EEM BCRP (2015)

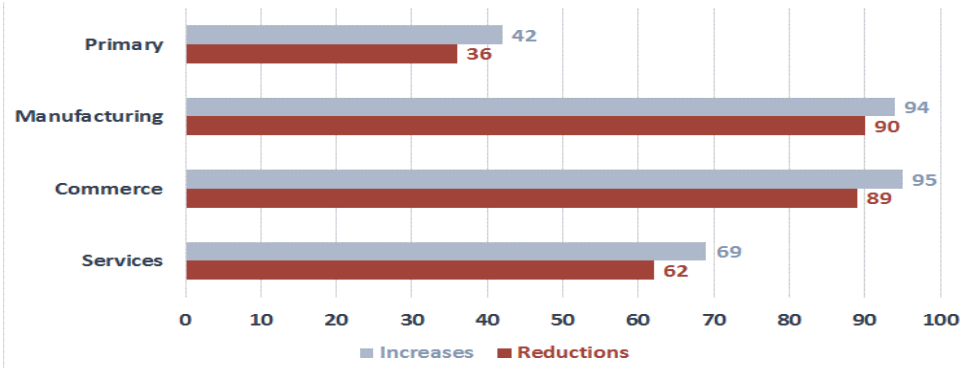
From Calvo's (1983) Price rigidity model: $f = \frac{1}{1-\theta}$

There are also some asymmetries in the impact of changing costs on prices. Graph 2 shows that reductions in input prices (whether policy- or market-driven) would not fully translate into the final prices; instead, they would also induce margins to be raised. Final prices also evince some downside rigidities in responding to lower labour costs, mainly in the services sector (Graph 3). However, in all the sectors, the impact of changes in input prices is greater than the impact of changes in labour costs.

Asymmetries of price adjustments to changes in input prices

(As a share of surveyed firms per sector)

Graph 2

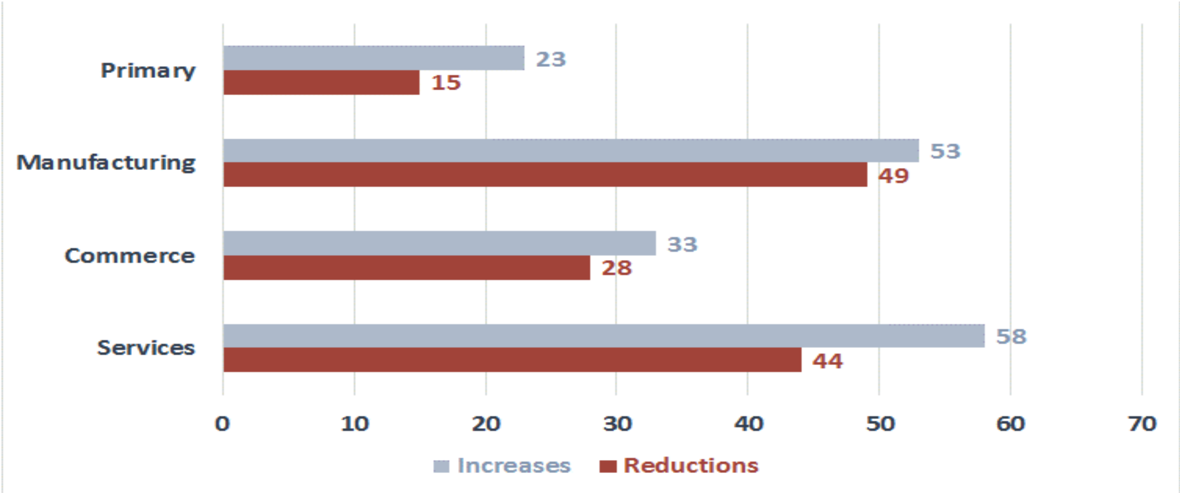


On the demand side, the responses are higher for reductions in demand than for increases in demand. Moreover, a firm's prices respond more to a competitor's price reductions than to its price increases. Furthermore, one of the main reasons to consider price adjustments is market share (Graph 4).

Given these asymmetries in price adjustments to changes in input prices and labour costs, and with an implied degree of rigidity in prices similar to that of the United States, the next section will discuss the role of the exchange rate on inflation and inflation expectations in a partially dollarised Peru.

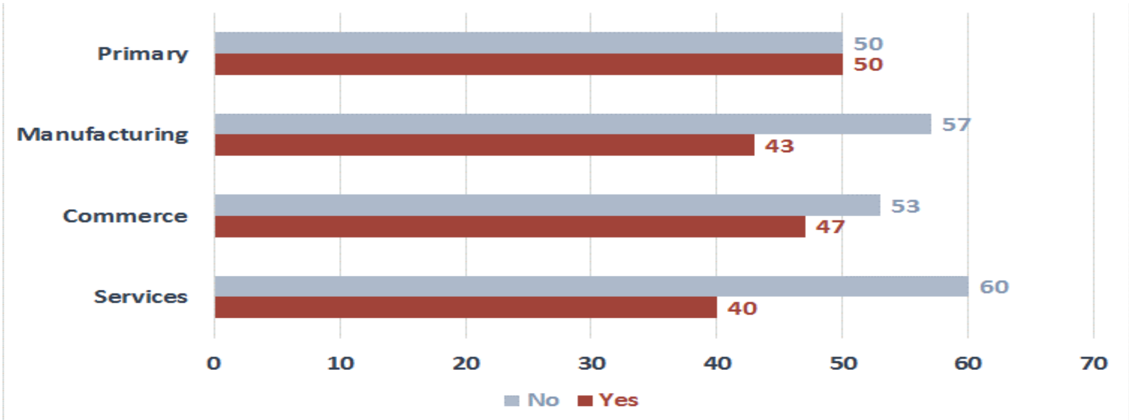
Asymmetries of price adjustments to changes in labour costs

(As a share of surveyed firms per sector) Graph 3



Likelihood of market share losses from rising prices

(As a share of surveyed firms per sector) Graph 4



3. Inflation expectations and the exchange rate

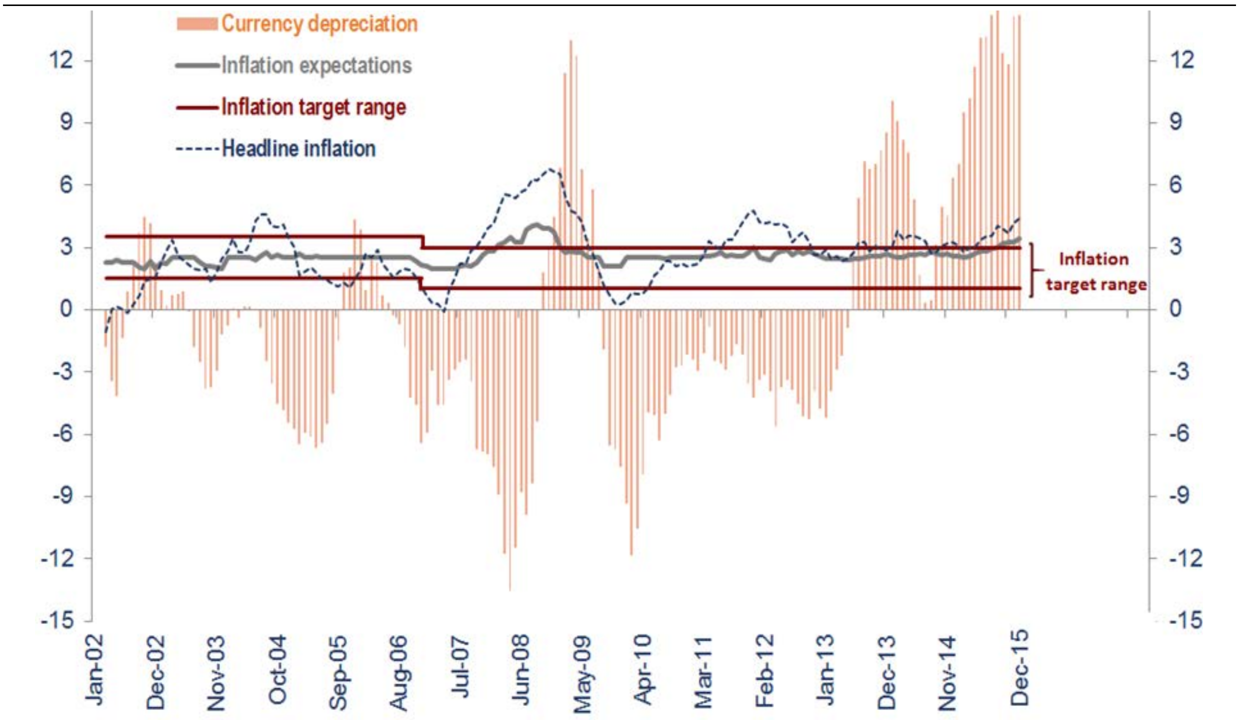
Although the fluctuations of inflation and inflation expectations are much smaller than those of currency depreciation, these dynamics signal a lower correlation and a non-proportional ERPT (Graph 5).

The empirical research on the ERPT provides a variety of results for different scenarios such as pre- and post-inflation targeting framework periods, asymmetries during different stages of exchange rate behaviour and during different phases of the business cycle.

During the years before the inflation targeting framework was implemented in 2002, the estimated ERPT averaged 21% in the short run and 47% in the long run (with specific estimates ranging from 10% up to 50% for the short run and up to 100% for the long run).[4] After the inflation targeting framework was implemented, the estimates ranged from 0 to 10% in the short run and from 6 to 10% in the long run.[5]

Headline inflation, inflation expectations and currency depreciation

(Year-on-year percentages) Graph 5



Considering the behaviour of the exchange rate, Perez and Vega (2015) found evidence of an asymmetric ERPT, with a persistent and significant 30% pass-through to CPI inflation during periods of currency depreciations. But during periods of currency appreciations, estimated pass-through is neither persistent nor significant. Winkelried (2003) found a 25% pass-through rate during higher currency depreciations (larger than 2.5%), versus 18% during smaller depreciations; he also found 31% pass-through during economic expansions versus 14% during contractions; and 30% pass-through when inflation is accelerating versus 12% when inflation is slowing.

According to the Central Bank of Peru’s Quarterly Forecasting Model, the ERPT is estimated to be 26% after two years (Table 3). More recently, the currency depreciation seems to be strongly influencing inflation expectations. For the design and implementation of monetary policy, the central bank’s inflation forecast takes into account the high ERPT and the relatively large impact of food and energy prices.

4 Clinton and Perrault (2001), Gonzales (2000), Hausmann et al (2000), Mihaljek and Klan (2001), Miller (2003), Morón and Winkelried (2002), Quispe (2001).

5 Maertens, Castillo and Rodriguez (2012), Winkelried (2012).

Impact of structural shocks on inflation

Table 3

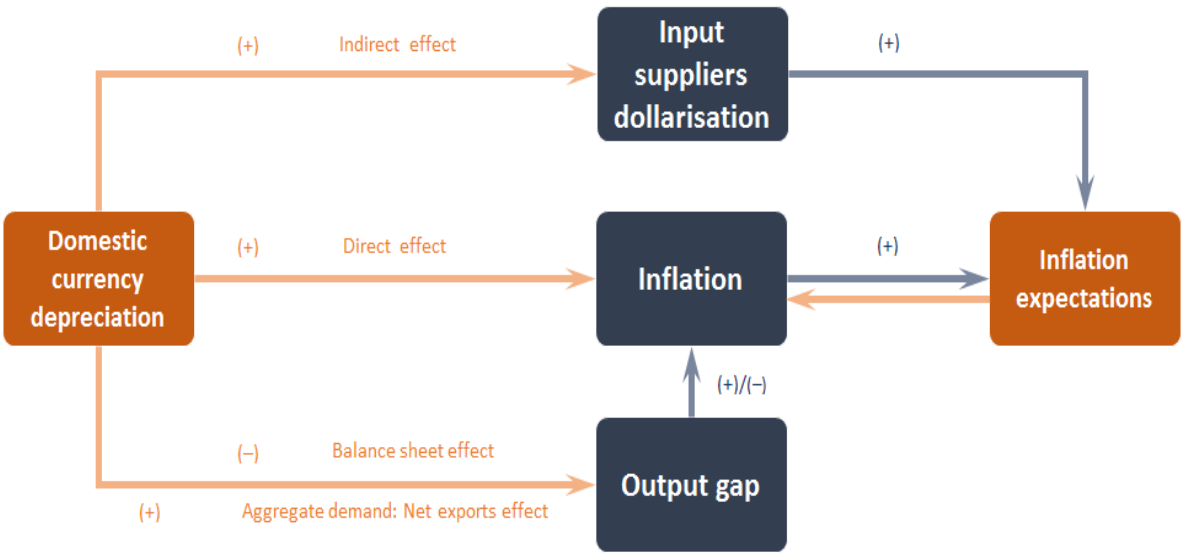
	Headline Inflation	
	Passthrough (years)	
	1	2
Imported Inflation	0.25	0.30
Currency Depreciation	0.13	0.26
Inflation Expectations	0.44	0.54
Output Gap	0.10	0.15
Food and Energy	0.44	0.46

Source: Quarterly Forecasting Model, Central Reserve Bank of Peru

A better understanding of the exchange rate's effect on the formation of inflation expectations requires a study of the transmission mechanisms of monetary policy implied in the central bank's Quarterly Forecasting Model. Variation in the nominal exchange rate passes directly into inflation through the prices of final goods and indirectly through dollarised input prices, which also influence inflation expectations. The exchange rate also generates a balance sheet effect and translates into inflation through the output gap (Graph 6).

Currency depreciation channels towards inflation

Graph 6



Also, it would be helpful to measure how correlated the components of the CPI basket are with the exchange rate. Although the components of the CPI basket with a very high correlation to the exchange rate have reduced their share from 9.2% to 4.0%, the components with a high correlation have increased from 11.9% to 27.8%. Those with a medium correlation have remained at a similar level, while those with a low correlation have fallen from 17.5% to 6.1% (Table 4).

Share of the CPI basket according to the degree of correlation with the exchange rate

Table 4

Correlation (ρ)		Jan-96 : Dec-05	Jan-06 : Dec-15
Very high	: $\rho \geq 0.75$	9,2	4,0
High	: $0.50 \leq \rho < 0.75$	11,9	27,8
Medium	: $0.25 \leq \rho < 0.50$	61,4	62,1
Low	: $\rho < 0.25$	17,5	6,1

Given the previous evidence of partially dollarised contracts for price-setting, it is natural to assume that exchange rate fluctuations do affect decisions and the expectations of price setters. There is ample evidence for the ERPT to prices in Peru but the pass-through to inflation expectations has not been studied so far. In terms of the ERPT, the evidence in Peru[6] shows that it is low; about 10% one year after an exchange rate shock. Furthermore, there is also evidence of an asymmetric behaviour, ie the ERPT to prices after a depreciation is 20%, whereas the ERPT to prices after an appreciation is 10% (Pérez-Forero and Vega (2015)).

In this section we extend the asymmetric framework of Pérez-Forero and Vega (2015) to consider the case of the Survey of Expectations presented above. That is, we study the effect of exchange rate fluctuations on inflation expectations. Specifically, we include the time series of one-year ahead inflation expectations in the Structural Vector Autoregressive (SVAR) model in Pérez-Forero y Vega (2015). The effective sample for this exercise is from March 2002 to October 2015, which coincides with the inflation targeting period.

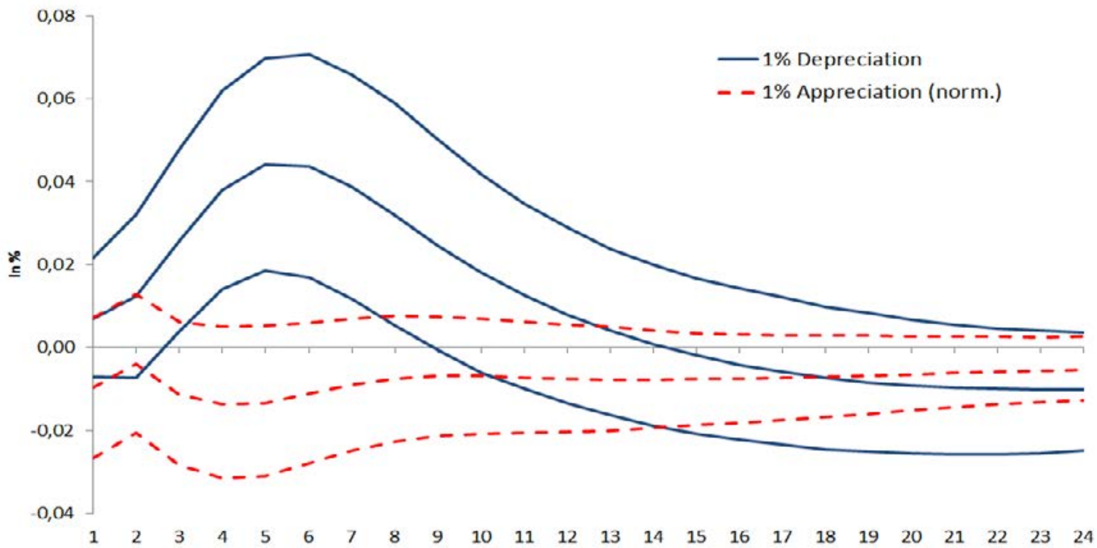
We present the results in Graph 7. In particular, we observe that a 1% depreciation will increase inflation expectations by approximately 5 basis points within six months. Moreover, as the new sol depreciation in 2015 was around 14.2%, we can estimate that the rise in inflation expectations explained by the exchange rate is around 0.7% in 2015. On the other hand, the response of inflation expectations after an appreciation shock is not significant at all.

There are two possible regimes, depreciation and appreciation. We observe that inflation expectations respond strongly and persistently after a depreciation shock, and the response is hump-shaped. The latter indicates that there are informational frictions, suggesting that, in the process of expectations formation, economic agents have to forecast the forecasts of others (Townsend (1983)) so that higher-order expectations matter. These results can be associated with theoretical models for price setters with informational frictions, such as Nimark (2008). The main idea is the fact that agents use public and private information in order to form their expectations. Furthermore, because of strategic complementarities, and because public signals might be observed with a lag, inflation and expectations respond with some inertia to aggregate shocks.

[6] For instance, see Winkelried (2003), Miller (2003), Maertens Odría, Castillo, and Rodríguez (2012), Winkelried (2013).

Response of one-year-ahead inflation expectations

(Percentages) Graph 7



Note: The responses for the appreciation shock are multiplied by minus one in order to compare both type of shocks. Under the symmetric case, both impulse-response functions would overlap.

Regarding the appreciation episode, we found no evidence of a significant reaction on the part of expectations. Of course, many factors can explain this result. First, prices and expectations exhibit downward rigidity. Therefore, a negative shock to the exchange rate of the same size as the depreciation will not produce the same results. We also have to take into account that appreciation episodes are long and persistent, whereas depreciation episodes are fast and abrupt. Therefore, it is less obvious to expect a strong negative response on the part of expectations after an appreciation.

We now turn our attention to the features of each identified regime. In reality, it turns out that depreciation episodes produce more news about inflation than appreciations do (more public signals available). That is, agents are more concerned about inflation whenever there is a depreciation episode.[7] Therefore, the expectations formation procedure is different with respect to the appreciation regime, and that is why the expectations reaction to an exchange rate shock is larger and more significant. However, these public signals can potentially be very noisy, meaning that there is more uncertainty about the future inflation rate during a depreciation episode.[8] Moreover, using the argument of Morris and Shin (2002), a public signal works as a coordination device, especially when economic agents face strategic complementarities, as is the case with price setters. Nevertheless, if the public signal

7 In fact, another way to interpret the same phenomenon is by using a Rational Inattention argument (Sims (2002)). That is, price setters pay more attention to public signals about inflation whenever there is a depreciation episode. On the other hand, price setters pay more attention to their private information whenever there is an appreciation episode.

8 See Nimark (2014) for a detailed characterisation of this setup.

is too noisy, then more information does not necessarily produce a better outcome for society.

In sum, we found that inflation expectations are more sensitive and volatile during depreciation episodes, whereas they remain anchored in the case of appreciation episodes. This result helps to inform the role of monetary policy communication (see also Svensson (2006)), in the sense that more precise signals about inflation are needed during a depreciation episode than during an appreciation.

4. Determinants of inflation expectations

For a simple view of how inflation expectations are determined, we run a very straightforward regression:

$$\boldsymbol{\pi_t^e = \alpha_0 \pi_{t-1}^e + \alpha_1 \pi_{t-1} + \alpha_2 \bar{\pi}_t + \varepsilon_t}$$

Where π_t^e is the inflation expectation for next calendar year observed at the end of period t; π_{t-1} is the year-on-year inflation rate and $\bar{\pi}_t$ is the central bank's inflation target. Expectations are taken from the monthly surveys gathered by the central bank. We take the simple average of what analysts and financial firms expected for next calendar year. The sample period goes from February 2002 to December 2015 (Table 5).

Determinants of inflation expectations

(As percentage of surveyed firms) Table 5

	Coefficients (t-stats)	
Lagged inflation expectations (π_{t-1}^e)	0.915	***
	(24.57)	
Lagged inflation (π_{t-1})	0.023	*
	(1.92)	
Inflation target ($\boldsymbol{\bar{\pi}_t}$)	0.073	**
	(2.202)	
R^2	0.85	

Note: t statistics are in parenthesis (estimated with HAC errors). *** [**] {*} denotes rejection of the null hypothesis about the no significance at 1% [5%] {10%}. The adjusted sample goes from March 2002 to December 2015.

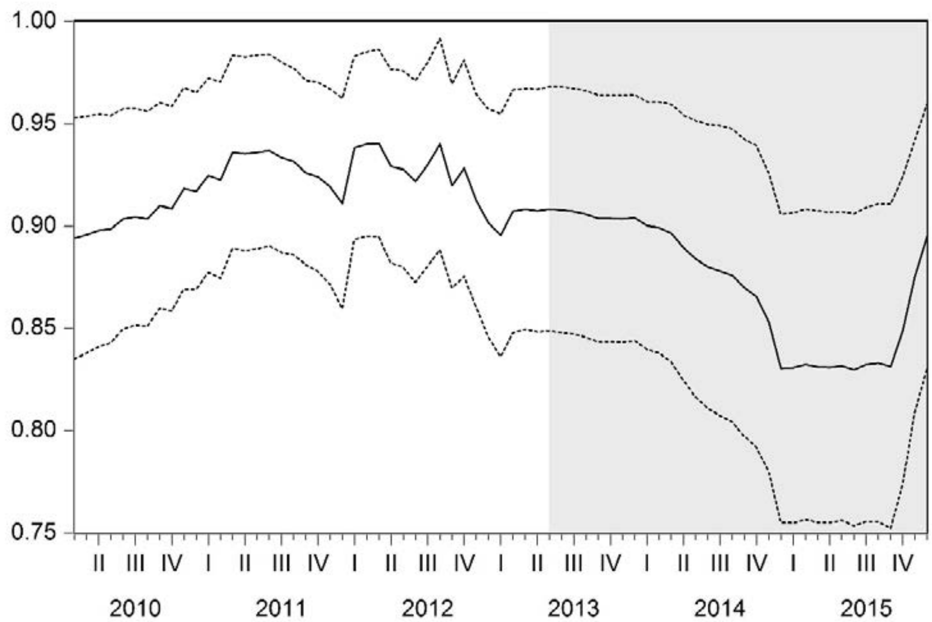
This result is similar to that in Armas et al (2011), where the estimated coefficients are broadly similar. With the updated data, there is a slight increase in the coefficient of lagged inflation expectations.

The key question is whether these coefficients have been stable during the sample period. We run rolling regressions using various possible sample sizes, starting with 60 months up to 120 months. Results for sample periods show similarities and qualitative conclusions are the same. We present the results for 96 months samples (rolling regressions for eight years).

The α_0 coefficient (parameter capturing the importance of the history of inflation in explaining inflation expectations) falls after the taper tantrum until mid-2014 when it reaches a relatively stable level. At the end of the sample, the coefficient starts increasing again very quickly. According to our specification, inflation expectations are themselves a function of all past inflation levels. In a sense, α_0 measures the weight of all past inflation history while α_1 is the effect of the most current inflation level.

The apparent reason for the decrease in the value of the α_0 coefficient is that observed inflation increased in 2013 as a result of the increased depreciation of the sol brought about by the taper tantrum. But this increased inflation did not translate into inflation expectations, which remained fairly stable (Graph 8).

Test of parameter stability: coefficient of lagged inflation expectations (α_0) Graph 8



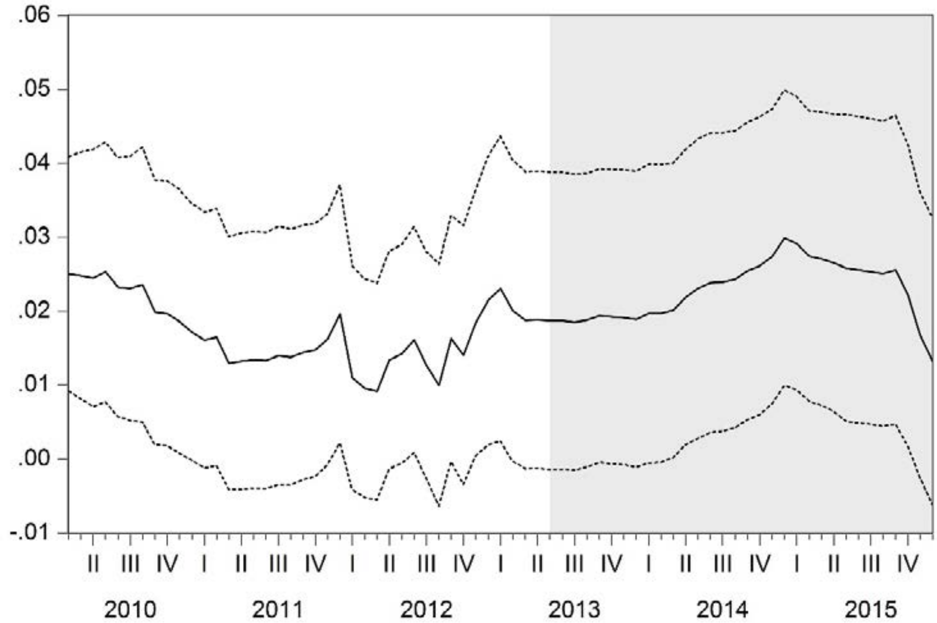
Note: One standard deviation confidence bands.

On the other hand, the coefficient α_1 does not change by much with the advent of the taper tantrum, as Graph 9 shows. It is the long-run, forward-looking element of inflation that explains the build-up of inflation expectations according to Graph 9 where we depict the coefficient α_2 associated with the constant inflation target.

Graph 10 indicates that, for a given level of the inflation target (2%), inflation expectations have been growing since 2013 and reached a high level during 2015. The coefficient collapses at the end of 2015 but, by that time, the inflation expectation component associated with the inflation history is the one that gains strength.

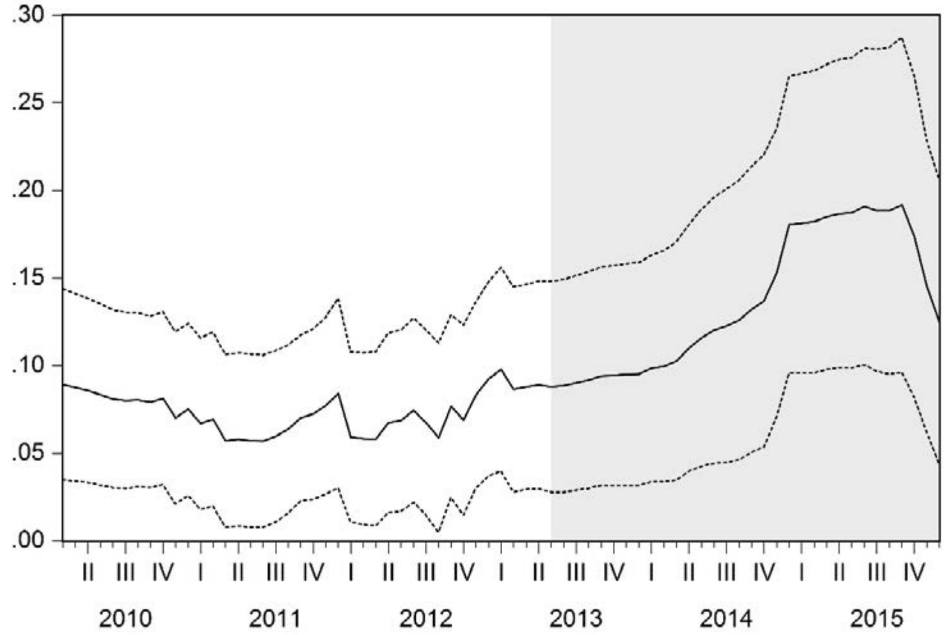
Therefore, the build-up of higher inflation expectations seems to be explained first by an increase in the long-run component of inflation expectations (associated to the constant term in inflation expectation equation) and then by the higher inflation levels embedded in past inflation expectations.

Test of parameter stability: Coefficient of lagged inflation (α_1) Graph 9



Note: One standard deviation confidence bands.

Test of parameter stability: Coefficient of lagged inflation (α_2) Graph 10



Note: One standard deviation confidence bands.

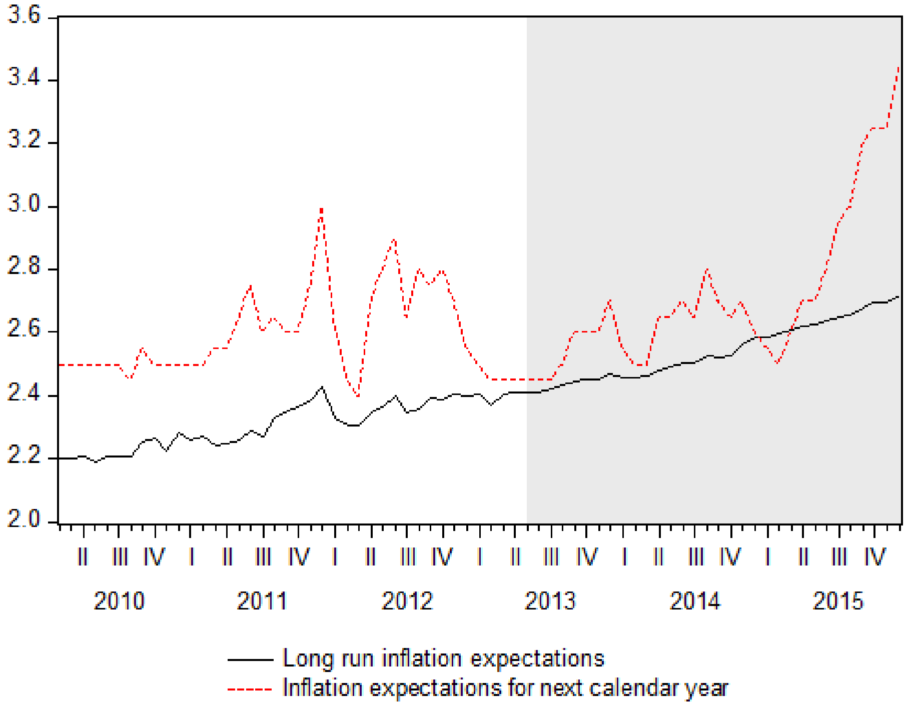
With the rolling coefficient estimates, we can approximate a measure of long-run inflation expectations by assuming that, in the long run, inflation expectations and inflation are constant and have the same value. This means

$$\pi_{LR}^{e} = \frac{\alpha_{2,t}}{1 - \alpha_{0,t} - \alpha_{1,t}} \overline{\pi}_t$$

Where, π_{LR}^{e} are the long-run inflation expectations. This expectation level is proportional to the target. In fact, given the coefficient estimates, the coefficient of proportionality should be close to unity. When the parameter α_2 alone rises, it directly implies a rise in long-run inflation expectations. Also, when α_0 or α_1 rise, they also indicate a rise in long-run expectations. When we combine the dynamics of all three coefficients as the above equation suggests, we see that the estimated long-run expectations increase over the 2013–15 period (Graph 11). This period coincides with the period of increased volatility in financial markets that have delivered higher depreciation pressures for the sol against the dollar.

Long-run inflation expectations

Graph 11



As we have seen in the previous section, the implied pass-through of exchange rate depreciation to inflation expectations has contributed to this build-up of higher inflation expectations. On the other hand, Table 8 shows Granger causality tests among the central bank projections published in the inflation reports and analysts' inflation expectations obtained from the Survey of Inflation Expectations. We perform the tests for two types of projection and expectations: short-run (current calendar year-end) and for the next calendar year. We reject only the hypothesis that central bank short-run projections do not cause private sector short-run expectations. This means that, in the short run, there is evidence of causal precedence that goes from the central bank's communications to short-run inflation expectations.

All in all, in terms of causal precedence, the communication tools of the central bank do affect short-run expectations (expectations for the current calendar year) but expectations for the next calendar year and long-run inflation expectations are both influenced by the historical record of inflation and the monetary policy stance.

Granger causality tests			Table 6
	F-statistic	Prob.	Result
Granger causality for short-run inflation expectations (Null hypothesis)			
Analysts inflation expectations for current year do not granger cause Inflation Report projections for current year	1.038	0.37	Cannot reject
Inflation Report projections for current year do not granger cause analysts' inflation expectations for current year	10.74	0.00	**Reject**
Granger causality for short run inflation expectations (Null hypothesis)			
Analysts inflation expectations for next year do not granger cause Inflation Report projections for next year	1.28	0.29	Cannot reject
Inflation Report projections for next year do not granger cause analysts' inflation expectations for next year	0.40	0.68	Cannot reject

5. Conclusions

Anchoring inflation expectations is crucial for the effectiveness of monetary policy if the price stability goal is to be attained. This objective is more challenging when an economy faces the vulnerabilities associated with partial dollarisation, in particular when price setters are influenced by exchange rate movements. This requires them to evaluate the implications of the exchange rate for price formation through input costs. It is also important to understand the speed and magnitude of price adjustments to changing economic conditions.

In Peru, inflation expectations were anchored within the inflation target range for most of the period 2002–15, and the importance of the inflation expectations channel has increased sustainably. The exchange rate pass-through to inflation is around 20%. Also, if most firms adjust prices more than once a year (ie every 7.5 months or so), the degree of price rigidity would be 0.87, a level slightly lower than those estimated for many other economies.

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The role of expectations in inflation dynamics in the Philippines – has it changed following the global financial crisis?

Diwa C Guinigundo[1]

Abstract

This paper discusses the role of inflation expectations in the inflation dynamics of the Philippines since its adoption of inflation targeting in 2002. It places a particular focus on the post-crisis period. A key finding is that agents have become more forward-looking with the adoption of inflation targeting. With the increased credibility of monetary policy, expected inflation started to weigh more on the pricing decisions of firms and households. Moreover, inflation expectations have become increasingly tied to the BSP's inflation target, even in the face of the recent below-target inflation rate. The change in the inflation gap has the largest impact on inflation expectations, holding other factors constant. The other factors that affect inflation expectations include the policy interest rate, past inflation, past inflation volatility, nominal wage growth and industrial production growth.

Keywords: Inflation expectations, inflation targeting, monetary policy, Philippines

JEL classification: E31, E52, E58

[1] Deputy Governor, Monetary Stability Sector, Bangko Sentral ng Pilipinas. The views expressed in this article are solely the responsibility of the author and do not necessarily represent those of the BSP.

1. The context

An important element for the successful conduct of monetary policy is the central bank's ability to manage and anchor inflation expectations. It is crucial that inflation expectations are well anchored, as this allows central banks to achieve price stability while helping to reduce the volatility of other important variables, such as interest rates and output (Côté (2015)). Studies have shown that the adoption of inflation targeting in a number of emerging and developing economies have supported the anchoring of inflation expectations (eg Davis and Presno (2014); Gürkaynak et al (2010); Johnson (2002)). Inflation targeting enhances monetary policy credibility through its emphasis on transparency, accountability and good communication strategy. These, in turn, contribute to better anchored inflation expectations.

In the Philippines, the expectations channel took on more importance in the transmission of monetary policy following the adoption of inflation targeting in 2002. The increased transparency associated with inflation targeting has increased policymakers' awareness of the importance of gauging public inflation expectations in the conduct of monetary policy (Guinigundo (2008)). Thus, the BSP initiated and institutionalised expectations surveys to better assess firms' and consumers' views on the future path of inflation.

While there is wide agreement that increased central bank credibility led to better anchoring of inflation expectations in developed and emerging market economies, developments during the recent Global Financial Crisis (GFC) have caused inflation expectations to become less anchored, particularly in advanced countries (Galati et al (2011)). It has likewise been observed that the behaviour of expectations is asymmetrical, depending on whether inflation lies above or below the target. There is a greater risk that expectations will become unanchored when inflation is persistently low, as is currently the case in a number of economies. This implies that when inflation is low for an extended period, central banks have to expect a longer delay in returning it to the target (Côté (2015)).

In the light of these observations, this paper discusses the role of inflation expectations in the inflation dynamics of the Philippines since its adoption of inflation targeting in 2002. It focuses on the behaviour of inflation expectations after the GFC. It finds that during the initial years of the implementation of inflation targeting in the country (ie 2002–08), agents were more backward-looking, with lagged inflation weighing more on the determination of current inflation. However, starting in late 2008, agents had become more forward-looking, with inflation expectations playing a more significant role in the determination of current inflation. This observation is attributed partly to inflation having remained within the set target range. With the increased credibility of monetary policy, expected inflation started to weigh more on the pricing decision of firms and households. Moreover, inflation expectations have been increasingly tied to the BSP's inflation target. It is for this reason that, even with the recent below-target inflation rate, inflation expectations remain anchored. This is confirmed by looking at the drivers of inflation expectations. Some regression analysis reveals that a change in the inflation gap has the largest impact on inflation expectations, holding other variables constant. The other factors that affect inflation expectations include the policy interest rate, past inflation, past inflation volatility, nominal wage growth and industrial production growth.

The rest of this paper is organised as follows. Section 2 discusses the dynamics of inflation expectations since the adoption of inflation targeting in 2002. Section 3 evaluates the determinants of inflation expectations in the country. The last section concludes.

2. Role of inflation expectations in inflation dynamics

Prior to the adoption of inflation targeting, the BSP adhered to monetary aggregate targeting as its framework for monetary policy. Monetary aggregate targeting was adopted in an attempt to reduce inflation, which rose to double-digit levels and peaked at 60% in 1984.[2] Under this framework, the BSP managed to bring down inflation to single digits by tightening monetary policy. The average year-on-year inflation rate during the 1988–2001 period stood at 9.4%.[3]

In 2002, the BSP formally adopted inflation targeting as its framework for monetary policy. Inflation targeting focuses mainly on price stability as the ultimate objective of monetary policy. Under this approach, the central bank announces an explicit inflation target and promises to achieve it over a given time period. Following the implementation of inflation targeting, average inflation declined to 4.7% between 2002 and 2008 and further to 3.5% during the 2009–15 period (Table 1). Inflation volatility likewise declined from 4.0% during the pre-inflation targeting period (ie 1988–2001) to 2.3% during the first eight years of inflation targeting (ie 2002–08) to 1.3% in the years after the GFC.

Year-on year average and volatility of inflation

Standard deviations, percentage points Table 1

	Year-on-year average	Volatility
1988–2001 (Pre-IT)	9.4	4.0
2002–08 (Pre-GFC IT)	4.7	2.3
2009–15 (Post-GFC IT)	3.5	1.3

Source: Author's estimates.

The decline in the inflation rate and volatility was traced to the BSP's ability to bring inflation down to within target levels. This, in turn, led to the better anchoring of inflation expectations. Levin et al (2004) observe that inflation targeting plays a key role in anchoring inflation expectations and in reducing inflation persistence. Inflation targeting requires monetary authorities to ascertain that policy decisions and actions are properly communicated to the public. When market agents are better informed

[2] Based on the CPI (2000=100).

[3] In the second semester of 1995, the BSP adopted modified monetary aggregate targeting. This framework puts greater emphasis on price stability instead of strictly observing the targets set for monetary aggregates. The modified monetary targeting framework was intended to enhance the effectiveness of monetary policy by complementing monetary aggregate targeting with some form of inflation targeting (Guinigundo (2014)). Monetary targets could thereby be exceeded as long as inflation targets are met. Under this modified approach, the BSP monitors a larger set of economic variables in making decisions regarding the appropriate stance of monetary policy. This includes movements in key interest rates, the exchange rate, domestic credit and equity prices, indicators of demand and supply, and external economic conditions, among other variables.

about the goals and intentions of the central bank, they are less likely to change their expectations about future inflation drastically even with transitory shocks to inflation (Davis and Presno (2014)). This improves the efficiency of monetary policy in attaining its primary objective of price stability, notwithstanding shocks to the economy. The enhanced transparency and accountability associated with the shift to inflation targeting in 2002 increased the significance of the expectations channel in the conduct of monetary policy (Guinigundo (2014)).

The changes in inflation expectations dynamics can be assessed using some inflation models. However, Fuhrer (2012) noted that full-sample estimates of inflation models are underpinned by an array of results for subsamples within the study period. These results provide a better picture of the evolving dynamics of the variables under observation over a given period. Thus, to capture the changes that occurred in the behaviour of lagged inflation and expected inflation under inflation targeting, their coefficients are estimated over different subsamples during the period Q1 2002–Q3 2015. One way of doing this is by using a rolling regression. The following specification of an expectations-augmented Phillips curve is estimated over a 16-quarter rolling window:

$$\pi_t = \alpha + \beta_1 \cdot \pi_{t-1} + (1-\beta_1) \cdot E_t\pi_{t+1} + \beta_2 \cdot ygap_{t-1} + \beta_3 \cdot zgap_t + \varepsilon_t, \quad (1)$$

where: π_t is quarterly inflation, $ygap$ is an estimate of the output gap and $zgap$ is the deviation of real exchange rate from its trend. Current inflation is partly dependent on the weighted average of its lagged and expected values. The lags of inflation are meant to capture the observed persistence in inflation.[4] The $zgap$ captures potential external supply shocks. All data used are quarterly time series over the period Q1 1988–Q3 2015. Inflation is measured as the quarterly year-on-year percent change in the CPI. For expected inflation, survey-based inflation expectation estimates are used.[5] Output gap and the real exchange rate gap were estimated using an HP filter.

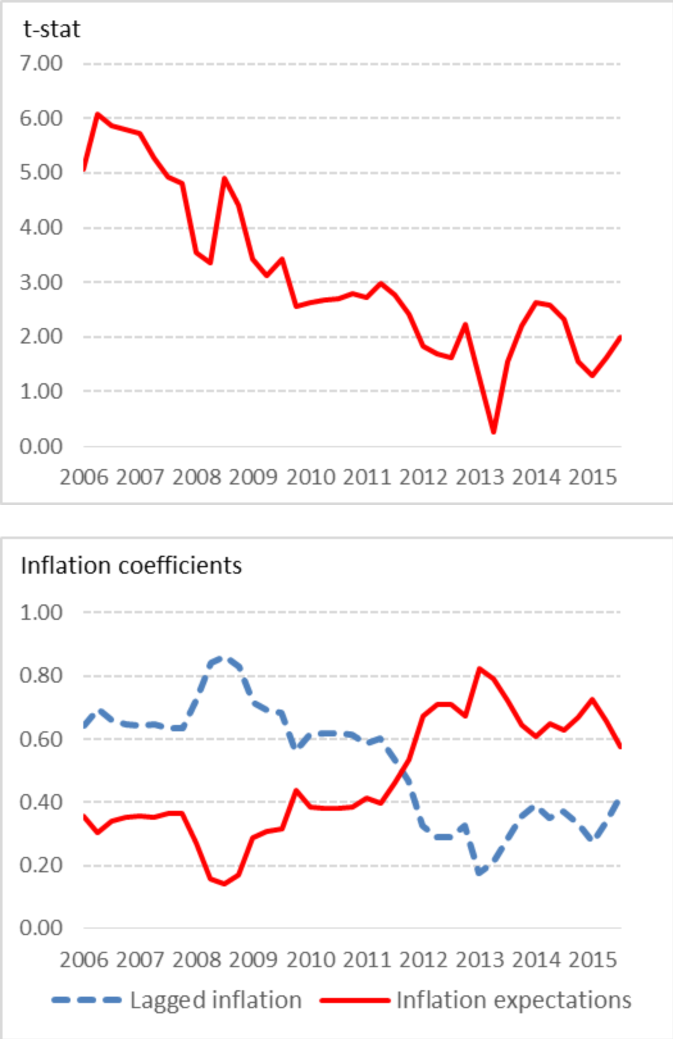
Graph 1 shows that, during the initial years of the implementation of inflation targeting, agents were more backward-looking, with lagged inflation weighing more on the determination of current inflation. Bayangos et al (2010) arrived at a similar conclusion when they looked into the expectations channel for the Philippines between Q1 2002 and Q1 2008. Nonetheless, starting in the last quarter of 2008, the coefficient of lagged inflation began to steadily decline. This indicates that inflation expectations started to weigh more on the assessment of current inflation. By the latter part of 2011, the inflation process had become more forward-looking.

4 The coefficients on the lags of inflation are often restricted to sum to 1 (with the constant restricted to be 0). This is to ensure that, in the long run, the Phillips curve is vertical (ie the "accelerationist" model of inflation).

5 Based on the AP Consensus Forecast 12-months ahead inflation forecast.

Coefficient estimates for inflation, 16-quarter rolling regression

Graph 1



Source: CMFP estimates.

Another way of examining changes in the inflation coefficients is by using the Kalman filter. The main advantage of the Kalman filter is that it provides two-sided estimates, or it uses all the information in the entire sample at all points of time.[6] Results from this exercise describe a picture that is similar to the rolling regression (Graph 2). The coefficient of lagged inflation started to decline during the latter half of 2008 (ie a quarter earlier than in the rolling regression) implying an increasingly forward-looking inflation process.

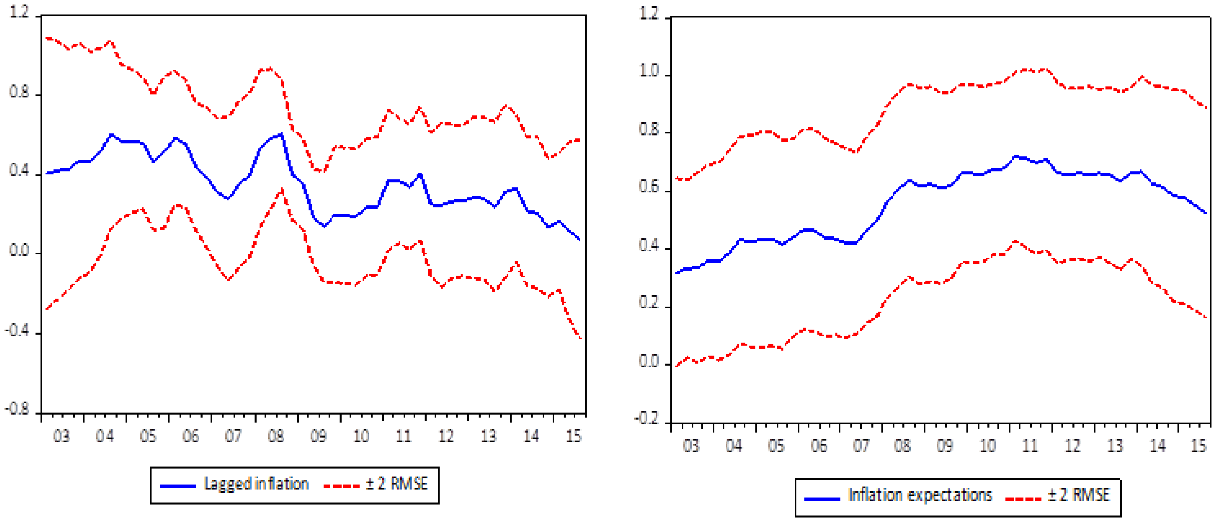
Interestingly, the changes in inflation dynamics denoted by the results from both the rolling regression and Kalman filter exercises coincided with important developments in the implementation of inflation targeting. During the first seven years of inflation targeting in the country (ie 2002–08), actual inflation breached the inflation targets (ie upper or lower-bound). The breach in targets during this period

6 Lagged inflation follows a random walk process while inflation expectations is a function of both the current inflation and the inflation target.

was primarily traced to supply shocks, such as increases (or decreases) in the world price of oil and higher (lower) rice and other food prices. Moreover, second-round effects affected the wage and price-setting behaviour of businesses and households as well as inflation expectations. Nonetheless, for six consecutive years (2009–14), the BSP managed to keep inflation within the National Government's inflation target range. For 2015, the inflation rate averaged 1.4% due mainly to slower increases in the prices of food items caused by ample domestic supply and falling oil and commodity prices. Inflation remained relatively stable even as the Philippine economy emerged as one of the strongest in Southeast Asia and experienced substantial capital inflows.

Inflation coefficient estimates

(+/– two standard error band) Graph 2



Source: CMFP estimates.

A crucial insight that emerges from these observations is that the BSP's ability to keep inflation within the target range led agents to adopt a more forward-looking orientation in their assessment of current inflation. With the increased credibility of monetary policy, expected inflation started to weigh more on the pricing decisions of firms and consumers. Guinigundo (forthcoming, 2016) arrived at a similar conclusion when he assessed the changes that occurred in the inflation dynamics between two periods: Q1 1988–Q4 2001 (ie pre-inflation targeting period) and Q1 2002–Q2 2015 (ie the inflation targeting period). His results showed that, with the adoption of inflation targeting, inflation persistence gradually declined as the inflation process shifted from being more backward-looking to being more forward-looking. This implies that market agents now put more weight on expected inflation in their assessment of current inflation. Moreover, the correlation between private sector inflation expectations and the BSP's inflation target (ie midpoint) markedly rose from 0.15 in the 2002–08 period to 0.46 in the Q1 2009–Q3 2015 period. This signifies that private sector inflation expectations have increasingly been anchored to the BSP's inflation target.

Supply shocks, such as movements in food and oil prices, have been identified as the major contributing factors to the breach in inflation targets during the early years of inflation targeting. They likewise contribute to second-round effects, which drive the wage and price-setting behaviour of businesses and households. Consequently, this leads to higher inflation expectations. Table 2 presents the correlation between inflation expectations, food inflation, particularly changes in rice and oil prices.

The correlation between inflation expectations and food inflation declined from 0.48 in 2002–08 to 0.40 in Q1 2009–Q3 2015. Also, the contribution of rice price changes to inflation expectations weakened from 0.45 in 2002–08 to 0.16 in Q1 2009–Q3 2015. This may indicate that agents have come to view fluctuations in food and rice prices as being temporary and, thus, does not necessarily lead to changes in inflation expectations. The results, however, differ for oil prices. Inflation expectations appear to be weakly correlated with oil price changes in the period characterised by high and volatile oil prices (ie 2002–08). Meanwhile, in the period with relatively low oil prices, the correlation between inflation expectations and oil prices appears to be stronger. This may be due in part to the factors driving the oscillations in international oil prices. During the 2002–08 period, geopolitical tensions and natural disasters led to strong short-term movements in oil prices. The changes are perceived as being temporary. However, the recent episode of low oil prices has a more structural dimension to it, in that it is attributed to global excess capacity. There may be some perception among agents that this development could result in some fundamental changes to international oil markets and prices.

Inflation expectations and supply-side factors — Table 2

	Food inflation	Rice price changes	Oil price changes
2002–Q3 2015	0.47	0.35	0.41
2002–08	0.48	0.45	0.04
2009–Q3 2015	0.40	0.16	0.47

Source: Author's estimates.

Ehrmann (2015) observed that, under persistently low inflation, inflation expectations are not as well anchored as when inflation is around target – that is, inflation expectations are more dependent on lagged inflation and inflation forecasters tend to disagree more. Furthermore, inflation expectations are revised in response to lower-than-expected inflation but do not respond to higher-than-expected inflation. Since the last quarter of 2014, the Philippines has experienced low inflation. Average inflation in 2015 stood at 1.4%, below the low-end inflation target of 2.0%. Nevertheless, inflation expectations based on the latest surveys of private sector economists[7] remained within the inflation target range over the policy horizon but fell below the lower bound of the target range for 2015. The latest inflation forecasts for 2016 and 2017, however, yielded lower means relative to previous forecasts. This may reflect downward revisions to inflation expectations given lower-than-expected inflation.

[7] Based on the October 2015 BSP survey of private sector economists.

3. What drives inflation expectations?

Empirical results in the previous section highlight the importance of the inflation expectations channel in influencing inflation under inflation targeting. Hence, the BSP closely monitors inflation expectations and ensures that they are consistent with the institution's policy objectives. There are various measures of inflation expectations that the BSP considers in its assessment of inflation developments. The BSP utilises survey-based measures of inflation expectations, which include results from quarterly consumer and business expectations surveys, a monthly survey of private forecasters, which is part of the report of the staff to the Monetary Board on the monetary policy stance, and other monthly surveys conducted by private organisations such as the Asia Pacific (AP) Consensus and Bloomberg. Another important indicator is the yield curve, which provides information on expected inflation based on the price of financial market assets.

Since the adoption of inflation targeting in 2002, inflation expectations have appeared to be on a declining trend except for upward shifts in the latter part of 2005 and in 2008. Starting in 2011, inflation expectations have likewise become less volatile. The upward shift in the latter part of 2005 could be attributed in part to the expected price adjustments arising from the implementation of the reformed value added tax (RVAT). However, this was only short-lived as the BSP's policy pronouncements continued to emphasise that the RVAT's impact would consist mainly of one-off price increases, and would thus be unlikely to fuel a sustained rise in inflation. Such a policy message helped ease public expectations about the price increases from RVAT, particularly when combined with mitigating measures to stabilise commodity supplies through timely imports and strict enforcement of regulations against unreasonable price increases.

Moreover, there is also some evidence that supply side developments, particularly the increases in oil prices, were already feeding into inflation expectations. In 2008, the upward spike in inflation expectations was due partly to supply shocks from rising food and energy prices that continued over a longer period and contributed to second-round effects. These affected the wage- and price-setting behaviour of businesses and households, but the BSP responded with decisive action, raising key policy rates by a total of 100 basis points from June to August, and making strong anti-inflation pronouncements. The reduced volatility of inflation expectations particularly from 2011 can be attributed in part to within-target actual inflation since 2009.

Understanding the changes in inflation expectations dynamics requires the key variables that drive these developments to be determined. A simple OLS regression of Philippine monthly data during the period 2002–15 was undertaken to identify the factors that feed into inflation expectations in the country. Results show that a change in the inflation gap is expected to have the largest impact on inflation expectations, holding other variables constant (Table 3). Other economic variables that affect inflation expectations include policy interest rates, past inflation, past inflation volatility, nominal wage growth and industrial production growth. The coefficients of public debt, asset price growth, NEER and primary fiscal balance are not statistically significant but they exhibit the expected signs (ie positive for public debt and asset price growth and negative for NEER and primary fiscal balance).

Determinants of inflation expectations		Table 3
	Dependent variable: inflation expectations	
Independent variables	Estimated coefficients	Standard error
Inflation gap	0.39***	0.14
Policy rate (RRRP)	0.28**	0.12
Past inflation (2 months lag)	0.15***	0.05
Past inflation volatility (3 months lag)	0.13*	0.07
Nominal wage growth rate	0.02*	0.02
Industrial production growth rate	0.01**	0.00
Public debt to GDP	0.01	0.01
Asset price growth	0.00	0.00
Primary balance to GDP	–0.00	0.01
NEER growth rate	–0.01	0.01

Notes: * Significant at 10%. ** Significant at 5%. *** Significant at 1%.

Source: Author's estimates.

It is worth noting that between two periods (ie pre-2008 and post-2010), the sign for the coefficient of the inflation gap has shifted from positive to negative and it has become statistically more significant. Thus, when actual inflation deviates from the target, agents expect that the BSP will undertake the necessary measures to bring inflation back to target. As the BSP was able to achieve its inflation target for six consecutive years from 2009 to 2014, this has led to an increase in market confidence in the BSP's capacity to implement inflation targeting. This also indicates that inflation expectations in the country are well anchored to the inflation target.

The role of policy interest rates in the formation of inflation expectations appears to have also improved post-2010 as the coefficient[8] of policy interest rates became statistically significant under a regression that considered the post-2010 period. Like the inflation gap, this could be attributed to the increasing credibility of monetary policy. The role of past inflation and past inflation volatility seems to have decreased as their coefficients under regression estimates that considered the post-2010 period were lower relative to regression estimates that considered the pre-2008 period. This could be due to the increasing influence of other variables, particularly the inflation gap, and the changing structure of and recent developments in the Philippine economy that affect the outlook and the level of confidence of public agents. In terms of nominal wage growth, this variable's role in the evolution of inflation expectations appears to have not changed and this could be attributed to the greater influence of other factors, given the country's slower wage growth in recent years. The importance of industrial production growth has also not changed. This seems to indicate that the influence of manufactured goods (as against primary commodities) in the expected growth in prices of consumer basket has yet to increase.

Institutional factors have likewise contributed to the changes in inflation expectations. As inflation expectations have been within the inflation target set by the government since 2009, we deem that the central bank's independence is the most important factor in setting inflation expectations. This is primarily because of the

[8] Please note that discussions on estimated coefficients under this section are based on preliminary runs. Results may change with further study and use of more analytical techniques.

timely and clear communication that goes with the inflation targeting framework to facilitate the management of inflation expectations.

Bayangos et al (2010) attributed the backward-looking behaviour of inflation expectations during the initial years of the implementation of inflation targeting to imperfect information about the BSP's policy intentions, which was a source of inertia in the formation of inflation expectations. By the same token, imperfect knowledge of the market's inflation expectations imparted inertia to monetary policy responses. Given these observations, the BSP took initiatives to engage in timely and clear communication of its monetary policy decisions and actions with a view to influencing inflation expectations. A clear communication of policy goals and strategies is crucial in anchoring market expectations, particularly in times of heightened volatility. The BSP initiated a number of disclosure and reporting mechanisms to help the public in gauging the BSP's commitment to attaining the inflation target. The BSP publishes various reports and publications, including the *Quarterly Inflation Report* and the *Highlights of the Meeting of the Monetary Board on Monetary Policy*. Furthermore, the BSP conducts road shows and financial literacy campaigns under its Economic and Financial Learning Program (EFLP). Through the EFLP, the BSP takes a proactive stance in promoting greater awareness and understanding of the role it plays in the economy as well as the relevant fundamental economic and financial issues confronting it. The audience of the EFLP embraces different sectors and age groups – students, academics, business sector, overseas Filipinos and their families, government employees and the banking community.

Meanwhile, the increasing importance of the policy interest rate in the formation of inflation expectations indicates that reforms in the financial sector, which serves as the channel of changes in interest rates, appear to be an important institutional factor that affects the formation of inflation expectations.

4. Conclusion

The successful conduct of monetary policy involves managing and anchoring inflation expectations. It is crucial that inflation expectations are properly anchored because this allows central banks to achieve price stability while reducing the volatility of other important variables (eg interest rates or output). With the adoption of inflation targeting in 2002, the expectations channel took on a more important role in the transmission of monetary policy.

A significant observation emerging from the empirical exercises undertaken in this short paper is the increased role of inflation expectations in the inflation process after the GFC. Since the latter part of 2008, agents have adopted a more forward-looking orientation in their assessment of current inflation. The shift in agents' behaviour is attributed to the increased credibility of monetary policy. As the BSP was able to achieve its inflation target, it led to increased market confidence in the BSP's capacity to implement inflation targeting. Moreover, private sector inflation expectations have increasingly become anchored to the BSP's inflation target. It is for this reason that, even with recent below target inflation rate, inflation expectations remain manageable and in line with the inflation target.

The behaviour of inflation expectations is driven by a number of factors. Of these, the change in inflation gap has the largest impact on inflation expectations, holding other factors constant. Other economic variables that affect inflation expectations include the policy interest rate, past inflation, past inflation volatility, nominal wage growth and industrial production growth.

The country's low and stable inflation and manageable inflation expectations are positive outcomes of the successful implementation of inflation targeting. While much has already been achieved, there is still room to enhance inflation targeting. To improve monetary policy transmission, the BSP is looking at implementing an interest rate corridor (IRC). This is expected to strengthen the use of interest rates as the main policy instrument for inflation targeting.

Given the importance of managing inflation expectations, the BSP engaged in timely and clear communication of its monetary policy decisions and actions. Such communication is crucial in anchoring market expectations, particularly at times of heightened volatility. As central banks recognise the need for greater flexibility, there are greater pressures for more effective communication to manage expectations – not only inflation expectations but also risk aversion. This would require a more "nuanced" degree of transparency that does not amplify market expectations (ie not propagandist) but provides stability and the assurance of disciplined policymaking. To this end, the BSP started in 2015 an enterprise-wide communication plan with the aim of more systematically monitoring upcoming issues that will require market communication. This is expected to further improve the effectiveness of the BSP's monetary policy tools.

Other initiatives that the BSP will undertake include a review of inflation expectations measures, data improvement and the use of financial market information. These are intended to further enhance inflation targeting and keep inflation expectations at manageable levels. This is essential to achieving more durable and inclusive economic growth.

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Negative bond term premia – a new challenge for Polish conventional monetary policy[1]

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Abstract

While the euro area ponders another round of quantitative easing, Poland's monetary policy remains stubbornly conventional. Although the NBP's Monetary Policy Council has delivered a monetary easing cycle, policy rates in Poland remain above those of many peers, most notably the largest trading partner – the euro area. In this paper we seek to explain the motives behind the NBP's strategy, presenting the views on price stability and economic growth developments that shape short-term rate policy. In addition, we argue that – amid exceptionally low inflation and the euro area's relaxed monetary policy – the range of interest rates in a small open economy is not fully dependent on the domestic level of short-term rates. More specifically, using a formal term structure model, we show that Poland's bond term premium has been driven to negative levels by yield-hungry foreign investors in the context of a restricted supply of short-term Treasury paper and reduced uncertainty about the future path of short-term rates. As a result, long-term yields have fallen below the expected path of future short-term rates, adding to the monetary stimulus even as policy rates remain unchanged.

Keywords: Monetary policy independence, small open economy, term premium

JEL classification: E43, E58, G12

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1. Issue of monetary policy independence

The recent financial crisis and the subsequent unprecedented easing of monetary conditions by major central banks has prompted an ongoing debate about monetary policy spillovers from advanced to emerging market economies (EMEs). Old questions about the preconditions for monetary policy independence – that once seemed to have been settled – are now being revisited. One view voiced in these discussions is that, given the scale of financial globalisation, global liquidity conditions have generated a cycle to which EMEs must simply adjust (Edwards (2015); Rey (2015)). Monetary policy independence is thus "an illusion", even for countries pursuing fully floating exchange rate regimes. As a result, we should expect small open economies to set policy rates that accord with those of the major central banks.

With this point in mind, we review evidence from Poland over the past few years. At first glance, the Polish monetary policy should track ECB decisions. First, Poland's GDP path is highly correlated with the European business cycle. Second, the single European market transmits impulses via the foreign trade channel that influence not only industrial production and employment, but also the price level. The observed price convergence process has linked the Polish inflation index with European price movements. Third, the common rules of the single European market, while boosting the flow of goods, labour and capital, exclude capital control instruments. Therefore, interest rate differences should fuel the free float of financial capital affecting exchange rates.

We will argue that, although Poland's monetary authorities have observed other central banks' actions – especially those of the ECB – the NBP's monetary policy has been shaped mainly by inflation prospects and changes in the output gap. Hence the direction of the Polish central bank's interest rate changes has been consistent with the ECB's interest rate adjustments due to a similar process of decreasing inflation rates both in Poland and the euro area. On the other hand, domestic macroeconomic conditions shaped the level of NBP's interest rate. Finally, the Polish interest rate has been stabilised on a slightly higher level than the ECB's rate.

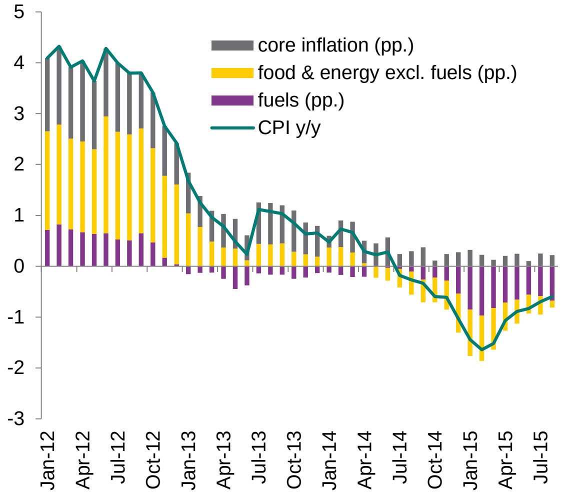
2. The thinking behind the NBP's monetary policy decisions in 2014 and 2015

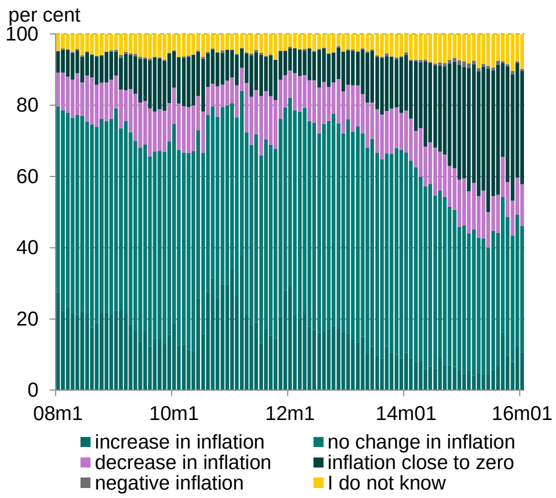
Faced with abruptly falling inflation in 2014 and 2015, the NBP had to decide on the sources and persistence of the shock, as any inflation targeting central bank must do in such circumstances. This is never an easy task ex ante. Several considerations seem to have played a role in guiding the MPC's thinking.

First, deflation in Poland has been seen as primarily the effect of a positive supply shock related to falling commodity prices, particularly oil (by 75% between June 2014 and January 2016), amid ample supply and weak global demand growth (Graph 1, left-hand panel). In the case of Poland, the direct impact of falling oil prices on CPI inflation amounted to –0.5 pp on average between July 2014 and August 2015, ie when headline inflation averaged –0.8% year on year. However, accounting for the indirect effects that reduced oil prices may have had on inflation, through lower costs for firms and higher household disposable income, suggests that the overall impact of oil prices on headline inflation could have been as high as –1.1 pp (at its peak in the third quarter after the oil prices drop). The textbook monetary policy response to a supply shock[5] consists in weighing the risks that deflation may pose to the central bank's reputation and inflation expectations against its positive impact on GDP growth.

Second, deflation has not created deflationary expectations in the business and household sectors. Even though an increasing share of households expects prices to remain at the current level, there has been no increase in the anticipation of deflation in the next 12 months (Graph 1, right-hand panel). At the same time, the majority of surveyed households expects positive inflation, which has fuelled positive real growth in retail sales. Thus, the current deflation has neither induced additional household saving nor undermined consumer confidence. Therefore, the information gathered confirms that inflation expectations are well anchored and should not weaken the NBP's reputation.

The decomposition of the inflation rate in Poland in 2012–15 (left-hand panel) and the structure of households' inflation expectations — Graph 1





Source: NBP data.

Third, Poland's GDP exhibited stable growth throughout 2014–15 at a rate of roughly 3.5%, close to its potential, and was expected to remain at this level in 2016 and 2017. As a result, the output gap is close to zero and is expected to remain so in 2016 and 2017. This stands in contrast to the persistently negative output gap in the euro area (Graph 2, left-hand panel), which called for further monetary easing in this economy (Graph 2, right-hand panel). Adding to the robustness of the Polish economy, the unemployment rate fell to single-digit levels by early 2015 and nominal wages have kept growing at a solid pace which – together with persisting deflation – further increased households' purchasing power in real terms. Furthermore, there were no signs that corporate profits suffered a negative impact from deflation, as

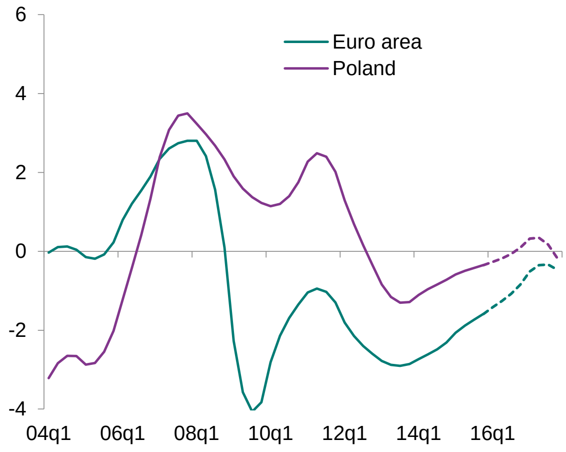
[5] See eg Rosengreen (2011) for an elaboration on the impact of supply shocks on the US economy and Fed policy.

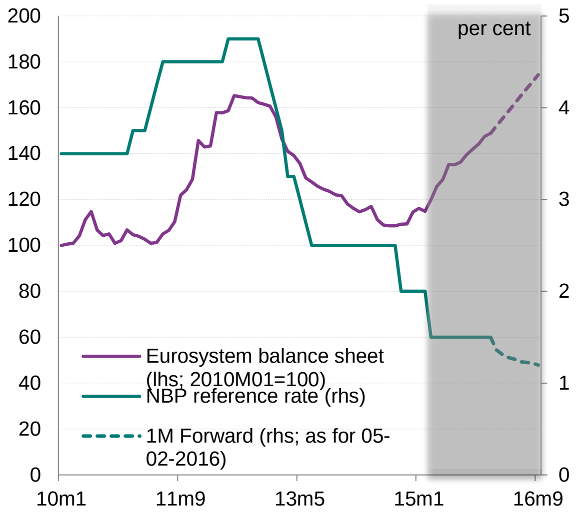
firms seemed to be able to offset falling merchandise prices by proportionate cuts in production costs.

Against this background, the MPC decided to end its monetary easing cycle in March 2015. Over and above the mostly supply-shock nature of deflation and stable GDP growth, the decision not to pursue further cuts also reflected the intention to prevent the potential build-up of imbalances in the Polish economy that might have taken place if interest rates had been set too low.[6] The MPC also seemed to believe that not cutting rates any further would leave it better placed in the event of a major adverse external shock.

Output gap in Poland and in the euro area (left-hand panel), NBP interest rates and the Eurosystem balance sheet

(expanded asset purchases are depicted by the grey background; right-hand panel) Graph 2





Sources: NBP; Ameco; Bloomberg.

Despite reaching historical lows, interest rates in Poland are still higher than those of many peers – most notably the major trading partner, the euro area. In fact, towards the second half of the year, the divergence in the degree of monetary easing between the ECB and NBP became even more pronounced in the face of hints from some ECB Governing Council members that QE could be adjusted to provide more stimulus (Graph 2, right-hand panel). This raises a natural question as to why the NBP's policy of keeping a positive interest rate differential vis-à-vis the euro area wasn't self-defeating. According to the standard macroeconomic framework, a significant difference in the monetary policy stance between a small open economy and the "rest of the world" poses the threat of a rapid inflow of short-term portfolio capital that might lead to excessive currency appreciation and credit and asset price booms.

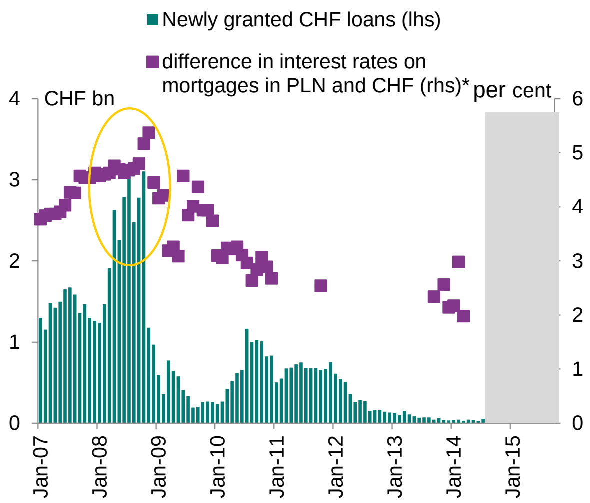
6 See www.voxeu.org/article/low-interest-rates-secular-stagnation-and-debt.

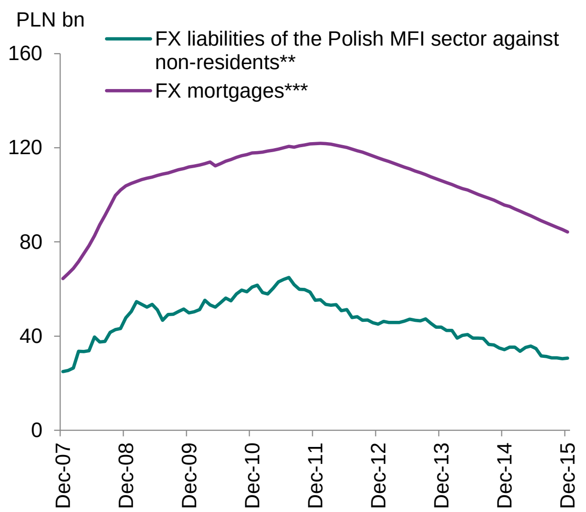
3. Foreign financing inflow undercuts the effectiveness of domestic monetary policy (Polish case 2007–08)

In fact, the above-mentioned scenario did play out in Poland in the years 2007–08. During this period, households were induced to take out Swiss franc-denominated mortgages by the positive interest rate differential between short-term interest rates in the Polish zloty and the Swiss franc coupled with expectations of convergence-driven appreciation of the zloty (Graph 3; left-hand panel).[7] In effect, FX loans were the vehicle of a carry trade arranged by domestic banks. The Swiss franc mortgages were refinanced mostly by banks borrowing short-term from parent banks abroad (see Graph 3, right-hand panel). The disbursement and repayment of mortgages were in Polish zloty. Hence, domestic banks that borrowed funds abroad had to convert foreign currency into Polish zloty. These F/X operations involved a significant appreciation of the Polish zloty, which accelerated the mortgage boom.

FX mortgage boom in Poland (left-hand panel; the period when FX loans were banned for households with PLN income is depicted by the grey background) and its foreign-currency funding (right-hand panel)

Graph 3





Notes: * series limited due to data availability. ** levels are presented at the exchange rate from January 2004. *** liabilities in currencies other than EUR and PLN.

Sources: NBP; Bloomberg.

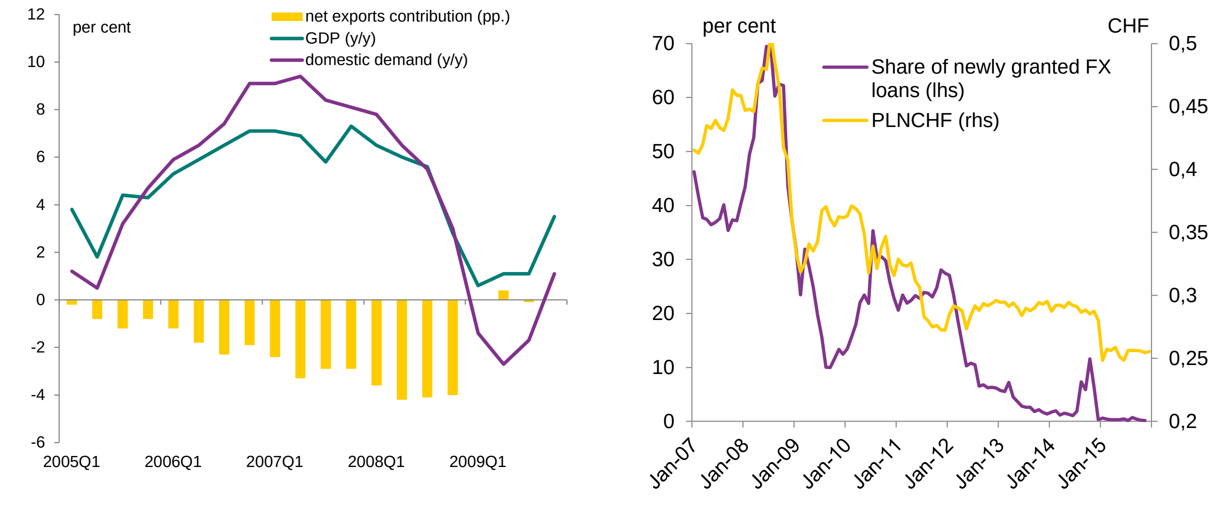
The strong appreciation of the zloty fuelled by the credit boom led many exporters to hedge the risk of further appreciation via FX options. However, to avoid paying the protection premium, corporates often entered zero-cost strategies,

7 Although mortgages were long-term loans, the interest rate formula was floating and calculated on the basis of short-term interest rates (domestic or Swiss base rate). Therefore, the interest rate of the mortgage loan equals the short-term interest rate plus a fixed margin as appropriate for the credit risk.

whereby they would purchase a put and at the same time write a call, thus synthetically creating exposures with potentially unlimited downside in the case of zloty depreciation.[8] In other words, instead of hedging their FX risk, some corporates turned to speculating on currency movements. Although the banks that sold option contracts to corporates typically closed the positions back-to-back, and hence assumed no market risk, they nonetheless retained credit exposure against the purchased options and their corporate customers' ability to meet their obligations.

These developments in household and corporate balance sheets illustrated a severe weakening of the effectiveness of domestic monetary policy. Indeed, when in 2007 burgeoning inflation forced the NBP to increase its main policy rate from 4% to 6%, the zloty appreciated against the euro by about 50% between April 2007 and June 2008. While this should have brought about a tightening of domestic monetary conditions, it also widened the interest rate differential between the PLN and CHF, clearly increasing the incentive to substitute FX-denominated lending for PLN-denominated lending (Graph 4; right-hand panel). The net result was that, although the sale of PLN-denominated mortgage loans had slowed considerably, as one would have expected, the sale of FX-denominated loans kept rising until mid-2008, providing further fuel for residential property prices, the boom in domestic demand and external imbalances (Graph 4; left-hand panel).

Economic boom in 2005–08 (left-hand panel) and newly granted FX mortgages after 2007 (right-hand panel) Graph 4



Sources: NBP; Eurostat; Bloomberg.

Even though the Polish Commission for Banking Supervision warned against the risks associated with FX mortgages as early as 2005, it was not able to limit the extension of new mortgage loans effectively until exchange rate risks materialised

[8] What made the synthetic forward positions speculative was that the value of the written option (call) was larger than the value of the purchased option to guarantee a more favourable strike price in the put. Sometimes the nominal of the written option was even higher than the expected currency income of an enterprise.

after the collapse of Lehman Brothers. The subsequent strong depreciation of the zloty increased the instalments on FX loans and depressed the valuation of companies' options portfolios, weakening the balance sheets of both corporates and households.

The positive aspect of these misadventures was to provide political space for more decisive action against FX-denominated lending. This helped produce a regulatory framework that put an effective curb on FX lending by imposing LTV caps as well as a 100% risk weight on FX-denominated mortgages, and strongly discouraging the extension of FX loans to entities without a natural hedge, such as, for example, a stable source of income in that currency. Regulatory changes, along with the previous costly experiences with FX derivatives, have also fuelled firms' aversion towards unhedged FX loans or options. In fact, corporate demand for options has all but evaporated, as reflected in the fact that the value of transactions in OTC FX options involving the zloty significantly lags behind regional peers, despite the fact that Poland has overall the deepest and most liquid FX market in the region (Table 1).

Average daily turnover in foreign currency spot and option markets in CEE

USD millions — Table 1

	PLN	HUF	CZK
Spot	10759	7379	5874
FX options	70	75	92

Sources: NBP; BIS.

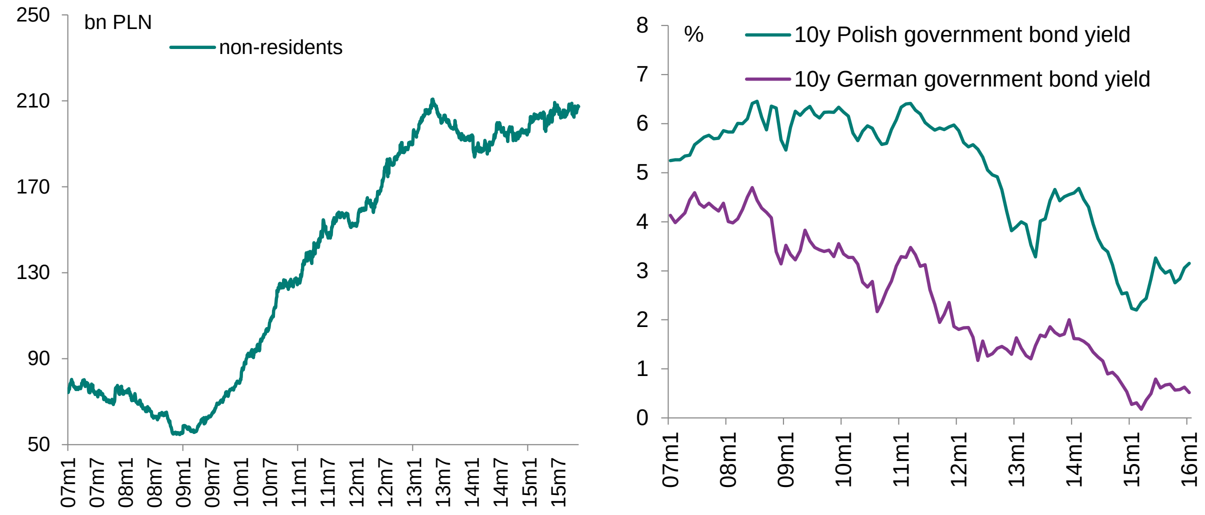
These factors go a long way towards explaining why the MPC, in its recent episode of monetary policy easing, may have felt relatively comfortable with leaving a positive policy rate differential against the euro. The main channel via which foreign capital – attracted by a positive interest rate differential – could have flowed into the Polish economy had been effectively blocked, and as a result, a slightly higher interest rate than the ECB's was unlikely to lead either to excessive monetary tightening (through exchange rate appreciation) or unhealthy credit expansion.

4. Impact of a recent external vs internal basic interest rate disparity on long-term interest rates

Yet another factor complicated the conduct of conventional monetary policy in Poland amidst monetary easing in the euro area and the stable zloty exchange rate – namely additional easing delivered by the flattening of the yield curve and the decline in government bond yields.

To see this, note that the short-term interest rate differential has fed through to the entire term structure of interest rates, resulting in a spread of almost 300 bp between the five-year Polish government bond yield and that of a corresponding German bund (Graph 5, right-hand panel). Since the CDS spread on Polish sovereign debt has averaged around 75 bps since the beginning of 2013, with the realised 90-day volatility of EURPLN averaging below 9 points throughout that time, exposure to Polish government bonds was also attractive on a risk-adjusted basis. In the face of a clogged credit channel, this provided incentives for portfolio capital inflows directed not towards the banking sector – as had been the case in the run up to the global financial crisis – but rather towards the Polish government bond market. Over and above the attractive risk-return characteristics, Polish sovereign debt was included in major global bond indexes, often treated as benchmarks by global investors, in particular the so called real money ones. Thus, over the past six years, the value of non-residents' portfolios of Polish government bonds has increased almost fourfold and experienced only a modest fall – by international comparison – driven by spikes in risk aversion following the so-called taper tantrum and the subsequent deterioration of China's economic prospects (Graph 5, left-hand panel).

Non-residents' portfolio of Polish government bonds (left-hand panel), yields on 10-year Polish and German government bonds (right-hand panel) Graph 5



Sources: Ministry of Finance; Bloomberg.

The continued strong presence of foreign investors in the Polish sovereign debt market has clearly impacted valuation, with yields on a benchmark five-year bond declining since mid-2012 by over 300 bps, ie roughly on par with the total of policy rate cuts delivered by the MPC in that easing cycle. The economic impact of low long-term interest rates was acute. First, interest payments on government debt fell to 2.0% of GDP in 2014 and are set to fall further, to as low as 1.6% of GDP, according to European Commission estimates. The material decline in debt service costs translated into a fall of the government debt-to-GDP ratio in 2014 (via the negative contribution of the so-called snowball effect), providing the government with more fiscal space, should the policy mix call for it. Importantly, lower government bond yields have also translated into lower borrowing costs for enterprises whose debt is priced off the government yield curve (assumed to be risk-free). The mid-term benefits should not be a reason to accept a long-term risk. We need to assess if foreign capital inflows into the treasury market may undermine domestic monetary policy and create a substantial financial stability risk, as did the foreign currency mortgage boom previously. A good measure of a potential yield adjustment is an estimation of the negative bond term premium which is presented below.

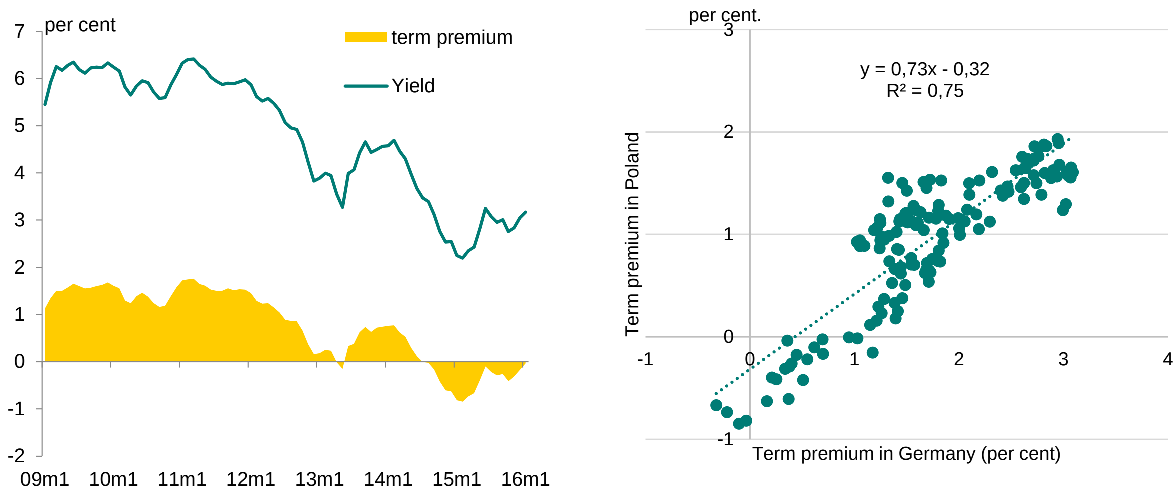
5. Negative bond term premium as a signal of monetary policy constraints

According to the expectations hypothesis, long-term nominal interest rates can be decomposed into two major elements: the expected path of future short-term rates and the risk premium. The most important component of the latter is likely to be the term premium, ie the additional compensation that investors expect for taking on the risk that interest rates do not evolve as predicted by the given term structure of interest rates. Conceptually, then, the above-mentioned decline in Poland's long-term interest rates could have resulted from a lowering of the path of future expected short-term rates or a fall in the term premium, or some combination of the two. Accordingly, two distinct economic narratives could be used to explain the historically low level of these government bond yields. The first one assumes that low yields reflect a worsening outlook for the Polish economy amidst the disappointing recovery in the euro area and foresees further cuts of the NBP policy rate along the way. The second explanation assumes that the reduced yields are associated less with domestic conditions than with the exogenous impact of the QE programmes conducted by the ECB and other major central banks, which led to a repricing of global safe assets and – via so-called portfolio effects – also EM assets. According to this view, although low long-term interest rates in Poland can be regarded as a monetary easing similar to those orchestrated by the major central banks through QE programmes, they were to a large extent imported from abroad.

To verify which hypothesis is more likely to be correct, we build a model of the Polish yield curve based on the methodology described in Adrian et al (2013). We then extract the term premium and the expected average short-term interest rate components from fitted government bond yields (Graph 6, left-hand panel). The results of this exercise suggest that, although the path of expected short-term interest rates has fallen since 2010, the term premium has also significantly decreased, even reaching negative values in recent quarters. As a result, nominal bond yields are below the level implied by the expected path of future short-term rates. In the second step, we calibrated our term structure model to German government bond yields, obtaining an analogous decomposition of long-term rates into the expected short rate component and the term premium. We then regressed the term premium contained in 10-year Polish government bonds on that extracted from the 10-year bund (Graph 6, right-hand panel). This in turn confirmed our initial hunch that developments in Polish term premia have to a large extent – and especially so after the outbreak of the recent crisis – been driven by the evolution of term premia in the euro area.

Government bond yields decomposition (left-hand panel) and the relationship between term premium in yields on Polish bonds and German bunds* (right-hand panel)

Graph 6



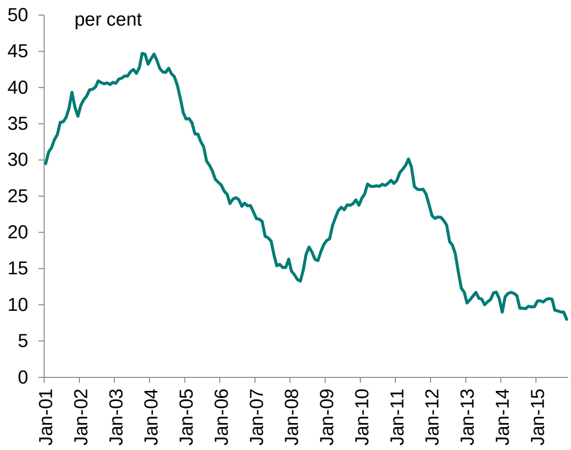
Note: * term premia obtained from estimations based on Adrian et al (2013).

Sources: Bloomberg; authors' calculations.

The negative term premium may be perceived to be at odds with basic economic intuition, as it implies that investors are willing to pay to bear the interest rate risk inherent in Polish long-term government bonds. However, such a perspective applies primarily to domestic long-term investors, who may arbitrage between holding a long-term asset and rolling over short-term ones – which should prevent the term premium from falling below zero. In the case of foreign investors – who hold roughly 40% of the local government bond market – foreign yields and expectations about exchange rate changes abroad seem to be a more important yardstick than the expected path of domestic short-term rates. Moreover, investors – foreign and domestic alike – may find it difficult to arbitrage between the expected path of Poland's short-term rates and long-term rates, given the limited supply of short-term Treasury bills. This is due mainly to the government's continuous efforts to extend the duration of public debt, which have reduced the share of short-term Treasury bills and zero coupon bonds from 45% in early 2004 to below 10% (Graph 7). Thus, if investors want to invest in low-risk zloty-denominated assets, longer-term sovereign bonds are "the only game in town".

The share of short-term bills and zero coupon bonds in total outstanding stock of Polish government debt

Graph 7



6. Yield curve flattening as a risk to financial stability

The reasoning presented so far allows us to draw the following conclusion: the decrease in the euro area yields, in particular those of German bunds, has induced Poland's long-term interest rates to fall far below (up to 1 percentage point) what might be expected from domestic economic conditions. This was facilitated by the significant presence of foreign investors in the domestic bond market, particularly since 2009, ie when the major central banks launched their QE programmes.

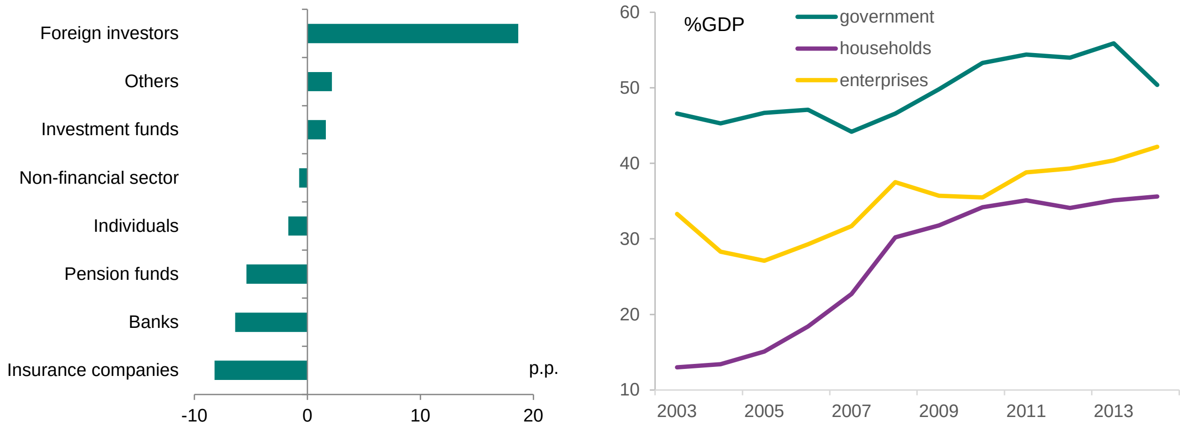
These circumstances define the extent of monetary policy independence under which the NBP – but possibly also other central banks in EMEs – had to operate: the MPC could remain conservative and refrain from cutting policy rates all the way down to zero, because additional easing was imported from abroad through changes in government bond yields. Claro and Opazo (2015) report a similar conclusion for Chile, arguing that, post-crisis, the correlation between Chile's short-term interest rate and those in developed countries has essentially broken down, while correlations between long-term interest rates have materially increased. We believe this pattern has resulted from the co-movement in bond term premia between emerging and developed markets.

Although the inflow of foreign financing has not undermined the NBP's autonomy in steering its short-term rates and has built in a potential decrease in treasury yields, the main question is the outcome of future monetary policy tightening by leading central banks. Should Polish authorities worry about such a scenario?

Foreign investors increased their share in total Polish government bond holdings (Graph 8, left-hand panel), thus freeing up domestic banks' capacity to provide credit to the private sector (Graph 8, right-hand panel). In the event of an abrupt outflow of foreign investors from the treasury bond market, domestic banks would have to take their place, encouraged by lower bond prices. However, banks' growing bond portfolios could potentially discourage them from lending to the private sector. In other words, credit would be "crowded out" of the economy by treasury bonds.

Changes in share in the secondary bond market between December 2008 and December 2013 (left-hand panel) and public and private sectors' debt in Poland (right-hand panel)

Graph 8



Sources: Eurostat, Polish Ministry of Finance.

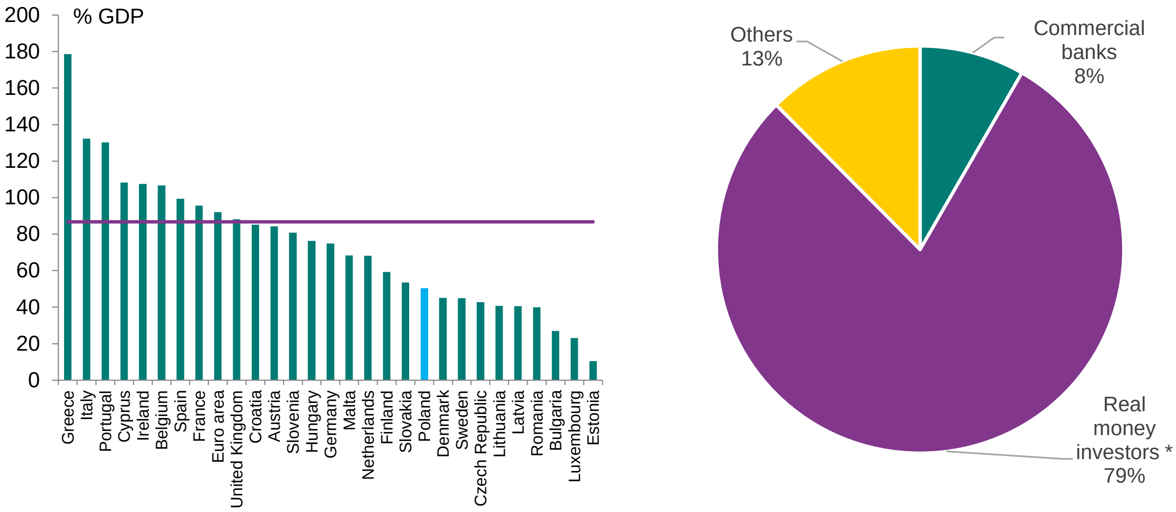
The current free float exchange rate framework should mitigate foreign investor outflows. The expected exchange rate losses could slow the pace of bond selling by foreign investors. Therefore, the potential outflow should be gradual rather than a sharp collapse.

Furthermore, the government debt is held mainly by real money investors, who are perceived as a stable source of financing (Graph 9, right-hand panel). This implies that there is little risk of a sudden capital outflow from the government bond market.

So far, prudent fiscal policy has not undermined the confidence of foreign investors. Financial inflows to the government bond market have not led to a substantial increase in public debt (Graph 8, right-hand panel), which is still below the EU average (Graph 9, left-hand panel).

Debt-to-GDP ratio in European economies (left-hand panel) and structure of secondary Polish government bonds market (right-hand panel)

Graph 9



Note: *The category "Real money investors" comprises central banks, public institutions, insurance companies, and pension and investment funds.

Sources: Eurostat, Polish Ministry of Finance.

To sum up, the short-term interest rate differential did not lead to the build-up of economic imbalances, as was the case in 2007–08. However, the risk of an abrupt outflow of foreign financing from the treasury bond market may materialise in the event of a rapid deterioration of confidence in Polish fiscal policy, or such outflows could be sparked by a fast and unexpected tapering of the ECB's monetary policy.

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The Bank of Russia's inflation challenge

The Central Bank of the Russian Federation

Abstract

Since the early 2000s, inflation in Russia has never fallen below 6%, except for brief intervals following the major crisis of 2008 and the changes in 2012 to the seasonal indexation of administered prices.

Persistently high inflation expectations have posed a challenge to the Bank of Russia in setting its 4% inflation targeting course. A further complication was the drop in oil prices and the precipitous weakening of the rouble seen between 2014 and 2015. These factors called for a balanced approach to monetary policy based on the tracking of changes to relative CPI prices and a rigorous assessment of the second-round effects of the exchange rate pass-through (ERPT) on prices.

The central bank has accordingly increased its focus on analytics for underlying inflation and alternative indicators for secondary price shock effects. The following components now constitute the basis for understanding inflation developments in Russia: first, companies' and consumers' perceptions of (or sentiments about) oil price dynamics, the exchange rate and aggregate demand; second, an in-depth study of second-round price effects; third, competent communication on the part of the Bank of Russia on the trajectory towards the 4% target in the medium term; and, finally, concerted policy efforts by both monetary and fiscal authorities.

Keywords: Central banks, inflation

JEL classification: E58 – Central Banks and Their Policies, E31 – Price Level; Inflation; Deflation

I. Inflation targeting as a new policy framework

Throughout the post-Soviet period, inflation has never fallen below 6% in Russia, except for brief intervals following the major crisis of 2008 and the changes in 2012 to the seasonal indexation of administered prices. When implementing inflation targeting, therefore, the central bank faced the challenge of combating persistently high inflation expectations brought about by the high inflation years (Graph 1).

The operating landmark in Russia, as in many other countries with inflation targeting, is the consumer price index (CPI). Importantly, its Russia-specific calculation should take account of, first, the substitution effect (the current year's consumer basket weights are calculated on the basis of average income for eight quarters preceding the prior year's last quarter). The CPI is therefore subject to substitution, quality, product replacement and new product biases, all of which tend to overestimate inflation (Graph 2).

Second, in contrast to the CPIs of advanced economies, the calculation of Russia's CPI is based on the underestimation of service (rent) prices for owner-occupied dwelling, because of computational difficulties. At present, the CPI assigns only a minor weighting to rental payments for standard one- and two-room apartments (0.3% of the CPI basket in 2015), as well as for payments for state-owned apartments (0.4%). Third, the CPI structure does not account for imputed household services (eg self-cleaning). As a result, the CPI is excessively volatile and only poorly reflects financial stability risks.

High inflation expectations are the focus of the Bank of Russia's inflation targeting policy. It is important that the evolution of expectations towards the target is closely monitored as this shows how far the Bank of Russia has been successful in building its credibility. As an indirect effective monetary policy indicator, expectations are a useful instrument in monetary policy setting. On behalf of the Bank of Russia, the Public Opinion Foundation (FOM) conducts monthly surveys of households' inflation expectations. The reports are published on the Bank of Russia website.[1] In addition, the Bank of Russia monitors producer expectations (using the Russian Economic Barometer surveys and PMI surveys) as well as professional analyst forecasts (Bloomberg, Reuters) – see Graphs 3–6.

Households' and producers' expectations do not predict inflation accurately in Russia. They are not yet anchored to the target, as inflation targeting in Russia has a very short history. The population habitually expects inflation to be higher than the actual outcome – see Graph 7. Estimates show that inflation expectations are backward-looking, reflecting subjective biases on the part of the survey respondents (and probably also a perceived lack of competitiveness and low productivity in the economy). Together, these factors account for the stubborn persistence of inflation.

The Bank of Russia also extracts information about inflation expectations from inflation-indexed government bonds (OFZ-IN). This information reflects primarily the inflation expectations of institutional investors (both residents and non-residents), especially those of the Russian banks that account for the largest share of government bond trading volume (53% as of October 2015). Non-residents, non-bank legal

[1] Available in Russian at: www.cbr.ru/DKP/?PrtId=infl.

entities, households and pension fund/asset management companies with government bonds account for 22%, 10%, 9% and 6%, respectively.

The expected inflation is derived from OFZ-IN yields in the following way:

First, a breakeven inflation rate (BEIR), widely used by market participants and central banks as a proxy for inflation expectations, is obtained as the difference between a nominal yield on a fixed-rate bond (OFZ-PD) and a real yield on an inflation-linked bond (OFZ-IN) with the same maturity. Inflation expectations are then calculated by adjusting the BEIR for the inflation risk premium (IRP), which is required by investors in excess of their inflation expectations for bearing the risk of inflation. Thus,

$$(1+\pi^e) = \frac{(1+BEIR)}{(1+IRP)} = \frac{(1+n)}{(1+r)(1+IRP)},$$

where π^e – expected inflation,

n – nominal yield on a fixed-rate bond,

r – real yield on an inflation-linked bond with the same maturity.

In turn, the IRP is obtained from a structural VaR-model where term premium shocks inferred from the yield curve of fixed-rate bonds are decomposed into inertial, inflation and other shocks and IRP is equated to the sum of inertial and inflation shocks. The basic equation describing the dynamics of the term premium is formulated as follows:

$$RP_t = \alpha + \beta_j \sum_{j=1}^{13} CPI_{t-j} + \gamma_k \sum_{k=1}^{13} RP_{t-k},$$

where RP_t – term premium at time t,

CPI_{t-j} – CPI Index at jth lag of t (j months before t),

RP_{t-k} – term premium at kth lag of t (k months before t).

Unfortunately, it is not possible to draw any credible conclusions about the predictive potential of this market-based measure since the history of this market instrument is very short. The solitary issue of inflation-linked bonds has been trading on the secondary bond market only since mid-July 2015.

II. Inflation targeting in Russia: a difficult first year

Due to the very short history of inflation targeting (IT) in Russia, the Bank of Russia lacked experience with disinflation under an IT regime. Further complicating the task of disinflation were the exchange rate shocks arising from both terms-of-trade shocks (TOT) and the Russian counter-sanctions (import bans), which prompted additional supply shocks. In Russia, exchange rate volatility is strongly linked to TOT shocks. In turn, the significant degree of exchange rate volatility (especially during the periods of currency depreciation) prompts a rise in households' inflation expectations as imported goods account for a significant share of the consumer basket.

As high and unanchored inflation expectations in Russia have amplified the negative effect of price shocks on inflation expectations, the Bank of Russia and other authorities have sought to explain the temporary nature of these shocks and to limit the channels for second-round effects, including the maintenance of higher interest rates and the indexation of administered price and wages.

The lack of monetary policy credibility made the achievement of lower actual inflation the principal tool in anchoring inflation expectations in Russia.

Due to its construction, the Russian CPI is highly sensitive to relative price shocks. As in many other EMEs, food has a high weight in Russia's CPI (37.3% in 2015), making it rather volatile and sensitive to supply shocks. Fresh food constitutes the most volatile group within food inflation, along with regulated tariffs and certain non-food goods with pronounced seasonality. Importantly, low-income population groups are more exposed to negative relative price shocks as they have a higher share of food and utilities services in their consumption basket. This makes relative price shocks politically sensitive.

The exchange rate plays a substantial role in inflation dynamics in Russia due to the large share of imported consumer goods in retail trade (36% of resources of retail trade in Q2 2015) and in the CPI. To some extent, inflation is also dependent on state price and tariff policies, as about 10% of prices and tariffs in the CPI are regulated. Demand constraints stemming from a deep decline in wages and incomes have also become more important recently for Russia's inflation dynamics.

Fresh food prices (as well as regulated and some other prices and tariffs) are not included in the core inflation measure, which captures 72.9% of the CPI consumer basket in 2015. This makes core inflation less volatile. Still, certain food items cause marked temporary fluctuations to core inflation when supply shocks occur. Thus, the Bank of Russia uses core inflation net of food for analytical purposes. Numerous exclusion-based indices and trimmed measures of inflation are also used by the Bank of Russia, adding value to its inflation analysis.

The significant exchange rate depreciation in late 2014 sharply increased the pass-through effect to consumer prices, and was the major factor behind the inflationary upswing in 2015. This upswing prompted significant changes in relative prices, lifting inflation expectations. Food prices, especially for fresh food, react most quickly to exchange rate moves, while the response of non-food prices takes longer. The prices of some services are also sensitive to exchange rate movements (eg overseas tourist services).

Before 2015, we estimated the pass-through effect at 0.10–0.15. The increased exchange rate volatility magnified the second-round effects of currency depreciation, which took the form of spikes in feverish demand, episodic decreases in the domestic supply of certain goods due to increased export profitability and a rise in inflation expectations. The pass-through effect temporary rose to 0.40 in that period. According to our estimates, some 7 percentage points out of the 15.7–15.8% year-on-year inflation in September 2015 were related to the rouble depreciation. The power of the pass-through effect diminished later in 2015 when the exchange rate path ceased to be unidirectional, and started to move together with oil prices. At present, we estimate the pass-through effect at about 0.20.

Another source of changes in relative prices is tariff regulation in public utilities and public transportation. Core inflation is less sensitive to relative price changes than headline inflation, due mainly to the exclusion of fresh food and regulated prices in the core inflation measure. However, strong exchange rate movements made practically all inflation measures sensitive to relative price changes. The Bank of Russia has recently started estimating underlying inflation, which has become a useful tool in capturing the inflation trend regardless of relative price changes.

Along with weak demand, moderately tight monetary policy and the favourable base effect are on course to bring inflation down to 7% by the end of 2016. The Bank of Russia will continue to monitor inflation risks as it pursues a monetary policy focused on the 4% inflation target to be delivered by late 2017.

III. Understanding the dynamics of future inflation and prospects for IT

Some serious challenges stood in the way of inflation targeting at the start of its implementation. However, the Bank of Russia's response in December 2014, when the key policy rate was raised to 17%, underlines its commitment to achieving the inflation target while safeguarding both financial stability and GDP growth. But the ongoing slump in oil prices and the rouble's depreciation in early 2016 have posed new challenges for the Bank of Russia that may hinder progress towards the set goals.

The forecasting of future inflation dynamics in Russia takes account of the following elements:

First, business and consumer perception and sentiment regarding the oil price, exchange rate and aggregate demand are monitored. Producer expectations for an oil price recovery imply that the rouble is expected to appreciate and demand to grow. The former limits the exchange rate pass-through (ERPT) to prices, while the latter tends to reinforce it. The cumulative effect will manifest itself in the coming months. Generally speaking, the higher the exchange rate volatility is, the weaker is the ERPT (see Devereux and Engel (2002), Krugman (1989)). At the same time, if businesses and consumers realise that the exchange rate will not return to the previous level because of a shift in the equilibrium exchange rate, the ERPT will be boosted in the same way as it was after the rouble slump in December 2014. Such risks still persist.

Second, the secondary effects of exchange rate movements on inflation need to be understood. Our estimates of such effects suggest that they are modest: a 10% depreciation of the rouble in nominal effective exchange rate terms prompts an ERPT of about 1.5 pp within the first year; in subsequent years, the secondary effects account for only 0.3 pp (Graph 8).

Third is the role of stubbornly high and persistent inflation and inflation expectations in Russia. Domestic inflation is persistently high at about 7%. Furthermore, it increased by about 2 pp in 2015 (Graph 9). In order to secure steady disinflation, a tighter monetary policy may be required in such circumstances.

Fourth, the Bank of Russia's communications are an important tool for achieving the 4% target in the medium term. The central bank has to convince all market participants and households that the inflation target is achievable and unchangeable. A decline in the actual inflation in line with the Bank of Russia's forecast will boost confidence in the disinflation policy and bring down inflation expectations.

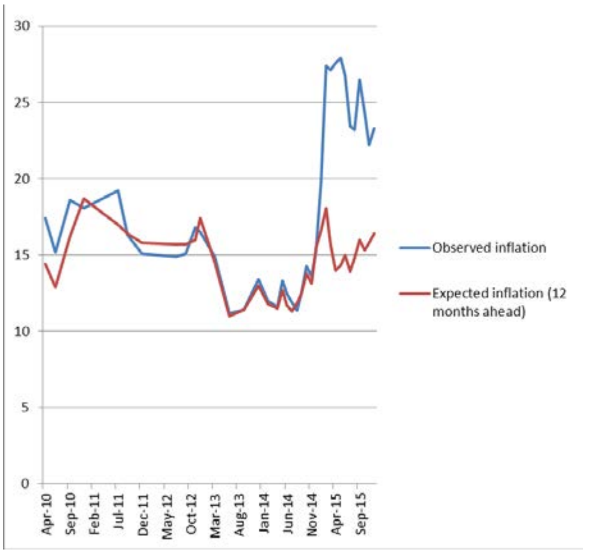
Fifth, the Bank of Russia and the government need to pursue a concerted policy to curb price growth. It is essential that wage indexation in the public and private sectors does not overtake actual price growth. The federal expenditure cuts now under discussion for 2016 should trigger disinflation.

Despite these new challenges, the Bank of Russia remains committed to reaching its inflation target and is convinced that this target is achievable.

Appendix

Direct inflation estimates: median values

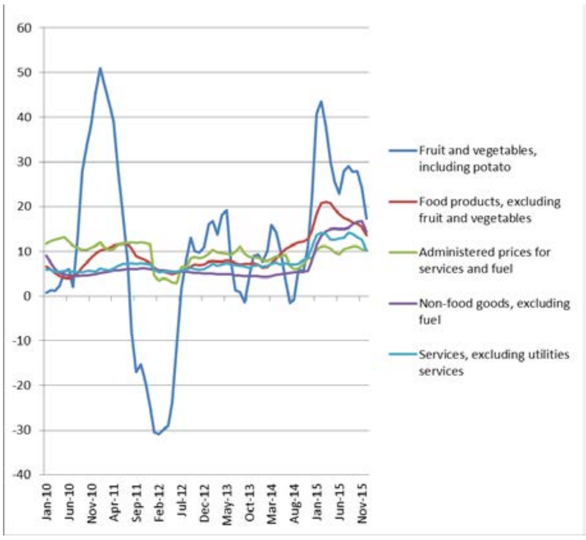
Graph 1



Sources: Public Opinion Foundation, in FOM.

Individual CPI sub-indices

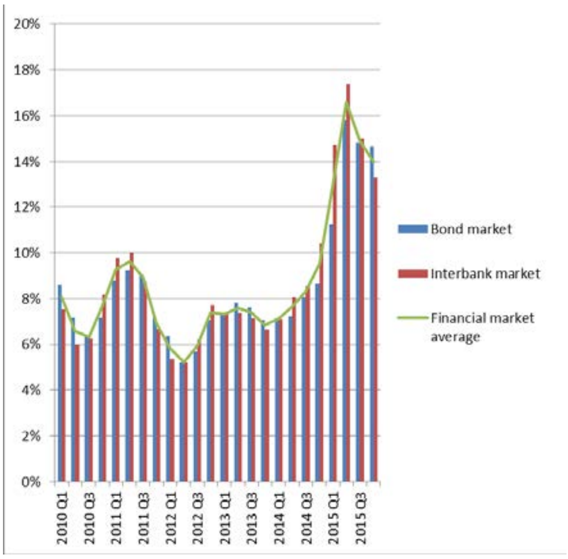
Graph 2



Sources: Rosstat, Bank of Russia calculations.

Inflation expectations (estimates based on financial market data)

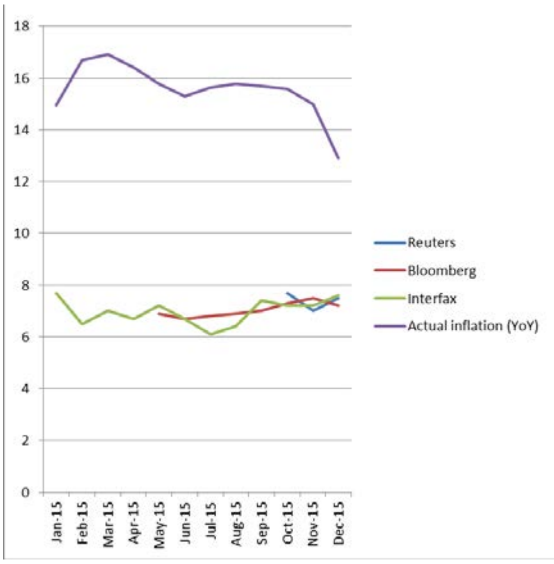
Graph 3



Sources: Bank of Russia calculations.

Professional analysts' consensus forecasts of consumer price inflation in 2006

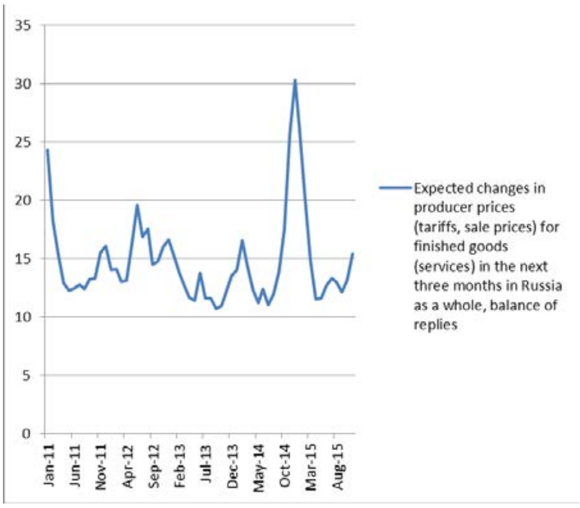
Graph 4



Sources: Reuters, Bloomberg, Interfax, Rosstat.

Expected changes in producer prices (tariffs, sale prices) for finished goods (services) in the next three months in Russia as a whole, balance of replies

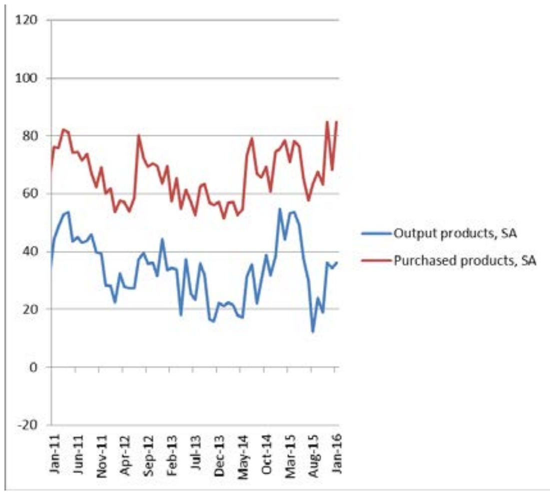
Graph 5



Source: Bank of Russia Banking Supervision Department.

Expected changes in prices for output and purchased products in industrial production, balance of replies (enterprises showing higher rates over the three months)

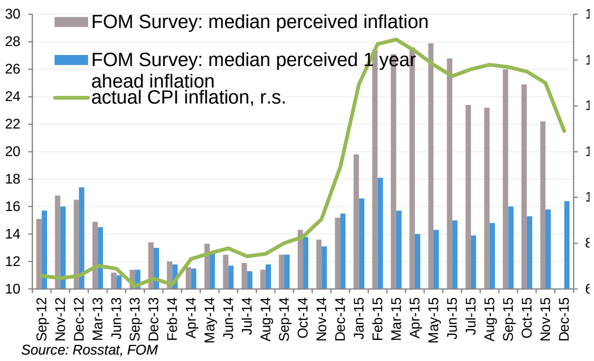
Graph 6



Sources: Russian Economic Barometer, Bank of Russia calculations.

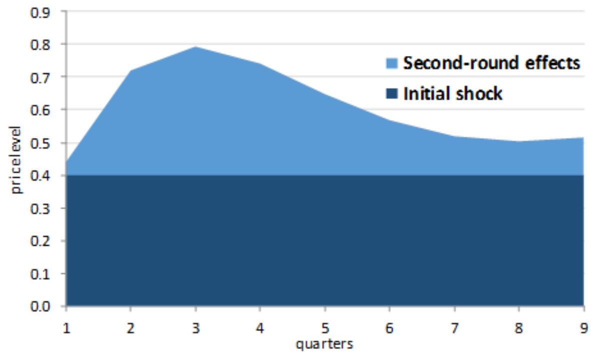
Inflation expectations

Graph 7



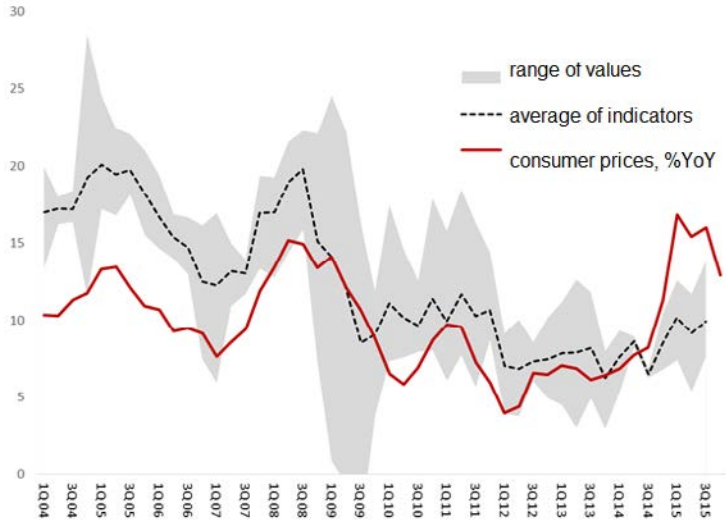
Second-round effects of 10% oil price decline

Graph 8



Range of domestic inflation* indicators, % per year

Graph 9



Sources: Rosstat, Bank of Russia calculations.

* – ULC, GDP deflator excluding government consumption, prices of services.

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Inflation mechanisms, expectations and monetary policy in Saudi Arabia

Saudi Arabian Monetary Agency

Abstract

Saudi Arabia is a fiscally dominant open economy. The exchange rate anchor provides the long-term framework for monetary policy. There is only limited scope to diverge from US interest rates but SAMA retains flexibility in deploying prudential guidelines, adjusting reserve requirements and issuing SAMA bills to manage liquidity. Inflation developments depend strongly on international prices, as well as domestic supply side factors such as housing in particular.

Keywords: Saudi Arabia, inflation, monetary policy, inflation expectation, macroprudential tools, central bank, financial system

JEL classification: A11, A10, C32, E21, E51, E52, F10

1. Introduction

Saudi Arabia is a fiscally dominant open economy. The exchange rate anchor provides the long-term framework for monetary policy. There is only limited scope to diverge from US interest rates but SAMA retains flexibility in deploying prudential guidelines, adjusting reserve requirements and issuing SAMA bills to manage liquidity. Inflation developments depend strongly on international prices, as well as on domestic supply side factors, such as housing in particular.

2. Inflation mechanisms

The literature for Gulf countries indicates that the long-term drivers for inflation are external, comprising inflation in trading partners and exchange rate pass-through.[1] But the first factor has historically been related to higher oil prices, which also lead to higher government spending domestically. Changes in Saudi economic activity are driven by government spending, and spending on infrastructure projects and welfare programmes rose sharply in line with the higher oil price in the 2004–14 period. This demand-pull inflation from government spending affects the core inflation rate (especially in the housing market when public sector salaries are hiked) and reinforces the conclusion that Saudi inflation is related to oil prices.

Saudi Arabia has maintained over the years a broadly countercyclical fiscal stance with the aim of reducing the volatility of domestic growth and maintaining stable consumer prices. Since oil revenues cannot be systematically forecast (exhibiting nil duration dependence, also described as a random walk effect), fiscal spending is highly flexible and annual budgetary targets are indicative rather than prescriptive.

After 2006, inflation started to accelerate, reflecting higher energy prices. Externally, more expensive energy led to a rise in imported food prices and domestically it resulted in higher government spending. Housing costs rose, stimulated by higher government wages and benefits.

From a peak of 6.1% in 2008 (using 2007 as the base year), inflation has fallen to low and relatively stable levels in recent years. It stood at 2.7% in 2014 and at 2.4% year-on-year in October 2015.

Food inflation in September 2015 was 1.1% and housing inflation was 4.4%. These figures are key because food and housing are both the largest and the most volatile components of Saudi CPI basket: food (with a weight of 21.7%) peaked at 13.7% in 2008, and housing (with a weight of 20.5%) peaked at 11.4% in 2011.

Food**:** Even if SAMA had more flexibility in setting monetary policy, this would have little effect on demand for basic foodstuffs, as demand is price-inelastic. Food prices reflect global prices, which are affected by weather conditions, demand in other (especially developing) countries, and energy prices. The latter factor means that food prices are likely to rise just as the Saudi economy strengthens due to high oil prices.

[1] See eg M Hasan and H Algoleel, "Understanding the inflationary process in the GCC Region", *IMF Working Paper*, WP/08/193, August 2008.

***Housing*:** This is both a demand-pull and a supply-side issue. Rents have been driven up by demographic pressures. The indigenous population will double by 2040, according to reliable forecasts. In the past, lack of access to conventional mortgage products inhibited the development of the housing market (and hence also SAMA's ability to influence it via interest rate changes). But recently, conventional mortgages have become available. The mortgage suppliers (mainly the commercial banks) are regulated by SAMA, which inter alia caps the loan-to-value ratio at 70%. Meanwhile, a tax on undeveloped land to free up sites for house building has been approved by the Shura Council (November 2015) and will shortly be implemented.

3. Inflation expectations

Since inflation is driven by external factors, inflation expectations based on domestic factors are unlikely to have a marked effect on prices. That said, policymakers need to have a reliable indication of where inflation is likely to head. Forward-looking estimates of inflation are lacking in Saudi Arabia (for instance there is no inflation-linked government bond market from which an implied forward inflation premium could be extracted).

Work by SAMA on an appropriate measure of inflation as a guide for policymakers, using the CPI index compiled by the Central Department of Statistics, has led to the conclusions that:

- The traditional exclusion method of constructing a core index by taking out food and housing/rent inflation (42.5% of CPI index) produces a more (not less) volatile index.
- Because energy prices are fixed administratively and are not changed frequently, their exclusion likewise does not produce a more stable number.
- A Generalised Dynamic Factor Model (GDFM) approach is more useful[2] (see footnote).

SAMA has subsequently developed a short-term inflation-forecasting model that is consistent and provides reasonably accurate results.

4. Monetary policy

(i) Framework

The SAMA Charter of 1957 (Article 1) states that SAMA's mandate is to stabilise the internal and external value of the Saudi riyal. SAMA has never treated this as an inflation target objective. Using the familiar concept of the monetary policy trilemma, whereby it is impossible for a central bank to achieve more than two of the following three objectives simultaneously, namely, a stable exchange rate, free capital

[2] GDFM methodology allows the identification of the various sources of price fluctuations by using a few common factors that can explain a large proportion of the covariation across economic series. The biggest advantage of GDFM is its ability to separate long-term movements of variables from short-term fluctuations.

movement (absence of capital controls) and an independent monetary policy, Saudi Arabia has chosen the first two. The exchange rate has been pegged to the dollar at a fixed rate since 1986, and there are no capital controls. But the course of monetary policy is closely tied to the policy of the Federal Reserve. However, SAMA has developed a variety of tools ranging from altering reserve requirements to targeted prudential guidelines with respect to affecting the volume of various types of bank credit available in the economy.

The exchange rate targeting regime has the rationale that:

- Changes in the exchange rate have no effect on exports since they are dominated by oil and petrochemicals, whose prices are set in the world market.
- Foreign exchange receipts and payments are primarily in dollars.
- Exchange rate stability encourages investments and promotes diversity in the economy.
- The current exchange rate arrangement anchors inflationary expectations in the household and business sectors since Saudi inflation has tracked US inflation reasonably well over time.

(ii) Monetary process and causative factors for money supply

In fiscally dominant economies, such as Saudi Arabia, the role of monetary policy is to support fiscal policy by maintaining price stability. Oil revenues are the most important driver for the Saudi economy. About 80% of government spending is financed by oil revenues, in contrast to other economies where public spending is largely financed by local taxes. SAMA receives oil income in dollars and deposits the riyal equivalent of dollars to the Ministry of Finance's account. Since the dollars go into the FX reserves, there is no immediate impact on domestic liquidity. As the government disburses funds, these generate rounds of economic activity in the private sector through a multiplier process. This activity can be categorised as the non-oil economy.

Ultimately, the foreign exchange outflows (the private sector balance of payments deficit) closely approximate over time the riyal spending by the government in excess of local taxes/service charges.

It is the combination of the government's net domestic spending and the resulting private sector balance of payments deficit that dominates changes in domestic liquidity. The data for 2014 illustrate this (Table 1). M3 growth was 11.9% up from 10.9% in the previous year. The change in bank claims on the rest of the economy accelerated to SAR 134.3 billion from SAR 124.5 billion in 2013. Other items and residuals amounted to SAR 53.5 billion. The result was a change in M3 of SAR 184.3 billion. But bank credit creation and residual factors were overwhelmed by the size of the government's net domestic expenditure, which would have resulted in a far higher rate of M3 growth had it not been wholly offset by the private sector balance of payments deficit.

Causative factors for change in broad money supply (M3) Table 1

Billions of Riyals	
	2014
Net government domestic expenditure *	834.5
Less: private sector balance of payments deficit	-838.0
Equals: Change in domestic liquidity due to fiscal spending	-3.5
Change in bank claims on private and non-financial public sector	134.3
Other items (net)	53.5
Total: Change in M3	**184.3**
* Domestic spending not financed by domestic taxes	
Source: SAMA 51st Annual Report (table re-presented)	

(iii) Recent developments in the financial system

Historically, bank credit growth has not been a driver of inflation. But in recent years, the growth of bank assets has been higher than that of both overall GDP and non-oil GDP, which is a strong evidence that financial deepening of the economy is finally taking place. This implies that a future source of both consumer price inflation and asset price inflation might come from excess credit creation. Due to SAMA's prudent and highly conservative stance, Saudi banks were largely immune to the recent global financial crisis. They are modestly leveraged, well capitalised, highly liquid, adequately provisioned and sustainably profitable. In 2014, ROA and ROE were 1.9% and 14.2%, respectively. Bank capital and reserves have doubled in size since 2007 and they exceed the Basel III minimum requirements on all points. This positive view was endorsed by the IMF in June 2015, which pointed out that: "Saudi banks' strong capital, profitability and liquidity will help them weather a slowing in the pace of economic growth. SAMA continues to further strengthen its regulations and supervision of the financial sector, and this will support the continued development and stability of the financial system."

Compared to overall GDP, the provision of credit is low. The ratio is about 45%, below most emerging economies, but similar to other oil exporters, a reflection of the fact that the country's large oil sector does not need much borrowing. The ratio for the non-oil sector is much higher at around 80%. While lending to the private sector drives the banks' growth, their expansion nonetheless remains largely dependent on the oil price and government spending since many loans are to companies that rely on public contracts. This is true of the retail sector as well, which is dominated by lending to civil servants.

(iv) Prudential and macroprudential policy

SAMA has long relied on providing informal and formal guidance to the banks as a means of steering the availability of credit. SAMA's toolkit is set out in Table 2.

SAMA's macroprudential toolkit Table 2

Instrument	Regulatory Requirement
Capital Adequacy Ratio	Basel requirement of minimum 10%
Provisioning	General: 1% of total loans
	Specific: Minimum 100% of NPLs
Leverage Ratio	Deposits less than or equal to 15x Capital and Reserv
Cash Reserve Ratio	7% for Demand Deposits
	4% for Time/Savings Deposits
Loan to Value (LTV)	Mortgage loans at or below 70% of
	residential real estate value
Debt Service to Income (DTI)	Monthly repayments at or below 33% of employed
	salary and 25% of retired person
Statutory Liquidity Reserve	Liquid Assets at or below 20%
Liquidity Coverage Ratio (LCR)-Basel III	100% by 2019 (already fulfilled)
Net Stable Funding Ratio (NFSR)-Basel III	100% by 2019 (already fulfilled)
Counterparty Exposure	Individual Exposure at or below 25% of bank capital
	(in practice at 15%)
Foreign Exposure	SAMA approval needed before foreign
	lending (qualitative measure)

Note: *The Basel III metrics, the Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR) are designed to improve the liquidity of the banks and reduce the insolvency risk. Under the LCR, high-quality and highly liquid assets must be available to exceed the net cash outflows expected for the next thirty days. Similarly, the NSFR promotes banks' resiliency over a longer period. Banks' resources must exceed their long-term commitments.*

SAMA applies its own macroprudential measures as well as the standard ones.

Loan-to-value ratios (LTVs): Since November 2014, it has enforced a 70% LTV ratio designed to prevent leverage-enhanced speculation on domestic property.

Debt service-to-income ratios: These ratios also apply to individual borrowers dating back to 2005 when, to ensure that levels of household debt remained sustainable, SAMA capped the amounts that can be deducted from individuals' monthly salaries and paid as instalments to lenders.

Dynamic countercyclical loan loss provisions: After the global financial crisis, Saudi banks' total provisions against NPLs dipped below 100%. SAMA insisted that they should increase them, and by 2014 loan-loss provision rose to 170% of NPLs.

True macroprudential measures would go beyond individual banks to economy-wide rules. Their application in Saudi Arabia would not be straightforward:

- Credit to GDP is not as relevant for oil-reliant economies as it would be in more diversified economies, because overall GDP for oil economies tends to be more volatile. A better alternative for Saudi Arabia would be to target credit to non-oil GDP. But even this approach is problematic since the non-oil economy is still linked to the oil price. Furthermore, credit in the kingdom is growing naturally year-by-year due to the financial deepening of the Saudi economy, something that does not apply to the same extent in developed economies.

- Inflation in asset prices is especially difficult to manage as these can move for many reasons besides overheating in the financial system.
- The third idea under discussion, ie foreign exchange controls, is becoming more acceptable in the international monetary system, provided that controls are applied temporarily in order to smooth capital flows. But this runs contrary to the free market philosophy that SAMA has always nurtured.

In 2015, SAMA published its first *Financial Stability Report*, which analysed the state of the financial system and outlined the work that needed to be done, such as identifying systemically important financial institutions and monitoring whether the LTV ratio had slowed the build-up of credit risk in real estate. A shadow banking sector hardly exists in Saudi Arabia, but SAMA is keeping a particularly close watch on lending by the new real estate lending companies and on the new field of microfinance lending to small businesses.

SAMA also ran stress tests including one designed to see how the banks would respond to a rise in global interest rates. In fact, their profitability actually improved under this scenario because of their non-interest-bearing deposits, which means that when rates rise the banks' lending margins actually go up. The banks are also resilient to a drop in oil prices and would survive for at least one working week even if there was a run on their deposits. As well as these top-down tests, SAMA requires each bank to run its own stress tests twice a year and to report the results.

5. Conclusion

The oil price is at the root of the monetary and fiscal challenges facing Saudi Arabia. In the context of domestic inflation, high oil prices tend to lift import prices while at the same time leading to higher domestic government spending owing to higher oil revenues, and putting upward pressure on consumer prices. Food and housing/rental costs constitute over 40% of the total weight of the CPI basket. Since Saudi Arabia is a fiscally dominant economy and changes in exchange rates do not affect the volume of exports, monetary policy targets a stable exchange rate and this tends to stabilise domestic inflationary expectations.

Recent work has given policymakers a short-term inflation forecast tool but there is a lack of economic indicators that would give longer-term inflation expectation data.

While the tight relationship between net domestic government spending and the private sector balance of payments deficit dominates monetary expansion, credit creation by the banks is also a factor and will likely grow in importance in the future. SAMA will continue to strengthen prudential framework to help safeguard the banking system. SAMA's conservative approach, although criticised in the past, was amply vindicated in the aftermath of the global financial crisis.

The inflation process and expectations in Singapore

Choy Keen Meng[1]

Abstract

This country note discusses measures of inflation used in monetary policy formulation in Singapore, and assesses the relative influence of global and regional factors in determining domestic inflation dynamics. It is found that the regional factor has grown in importance as a source of external inflationary pressures, although domestic cost pressures and inflation expectations have continued to play significant roles. Indeed, the central bank's gauge of inflation expectations extracted from survey data provides the best forecasts of near-term inflation outcomes.

Keywords: Inflation, factor analysis, Phillips curve, forecasting, Singapore

JEL classification: E31, E37, E52

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1. Introduction

This country note addresses selective aspects of the inflation process and inflation expectations in Singapore – a small open economy that is also a major international financial centre. As such, factors related to increased global economic integration have continuously shaped domestic inflation dynamics and affected the formation of expectations. In addition, Singapore has maintained the same monetary regime for the last 35 years, based on an exchange rate-centred policy framework aimed at achieving price stability.[2] The note begins with a description of policy-relevant inflation measures in Singapore, followed by approaches to modelling inflation outcomes. It concludes by discussing a useful gauge of inflation expectations extracted from survey data.

2. Inflation measures

Although Singapore does not operate a formal inflation targeting regime, the Monetary Authority of Singapore (MAS) in its conduct of policy takes reference from two measures of inflation: the headline consumer price index (CPI-All Items inflation) and core inflation (MAS Core Inflation). In many countries, core inflation serves as a more reliable indicator of underlying price pressures in the economy, and is typically derived by excluding food and energy prices from the CPI. However, this would not be appropriate for Singapore given its heavy reliance on imported food and energy products, as well as the relative importance of these items in the consumption basket (with a collective weight of 27%).

Instead, MAS Core Inflation is derived from CPI-All Items inflation by excluding the costs of accommodation and private road transport, as these two components are highly volatile and significantly influenced by administrative policies.[3] The cost of private road transport is largely policy-driven, being jointly determined by the supply of, and demand for, new vehicle licences.[4] Similarly, government rebates such as those for Service & Conservancy Charges generate fluctuations in the cost of accommodation, depending on when they are disbursed.

A significant share of housing outlays in Singapore comprises imputed "owner-occupied accommodation" (OOA) cost, which is calculated based on the rental equivalence method, ie the expected rental the owner would have to pay if he or she

2 For an exposition of the characteristics of, and rationale behind, Singapore's exchange rate-centred monetary policy framework, which incorporates key features of the basket, band and crawl system, refer to Khor et al (2007).

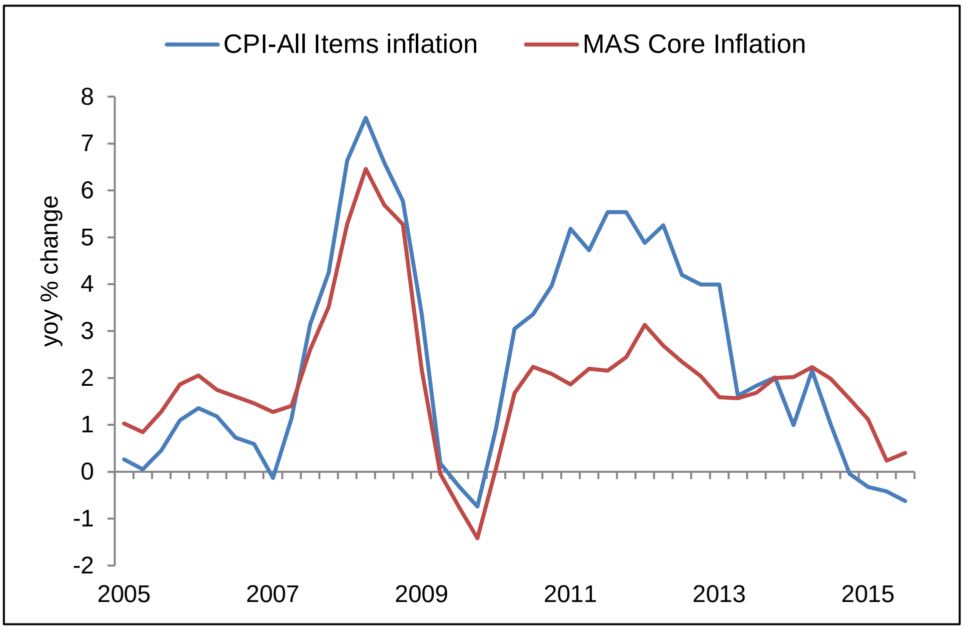
3 There are other items in the CPI basket the prices of which can be considered as government-administered, for example public school fees and government levies on foreign domestic maids. However, as these account for a very small proportion of the basket, there is no need to exclude them.

4 Singapore uses a quota system to regulate the supply of vehicle licences. Under this system, anyone purchasing a new vehicle must first obtain a Certificate of Entitlement (COE), which confers the ownership right for 10 years. The Land Transport Authority determines the number of COEs available based on a target growth rate of vehicles, while the market determines the prices of COEs in an open bidding process. Consequently, sharp fluctuations in COE premiums can lead to volatility in car prices.

were a tenant of the premises.[5] Due to the high home ownership rate, however, most households in Singapore do not actually incur rental expenditure and the corresponding fluctuations in imputed rentals should therefore not have any real impact on their cost of living. For this reason, the Department of Statistics compiles an alternative inflation indicator that excludes imputed rentals on OOA ("CPI-All Items inflation less imputed rentals on OOA").

As an exclusion-based measure, MAS Core Inflation abstracts from relative price movements that emanate from the housing and car markets. Therefore, it is meant to only capture generalised and more persistent price movements, making it less volatile than CPI-All Items inflation (Graph 1). For example, headline inflation rose to an average of 4.9% in 2011–12, largely on account of sharp increases in car and house prices amid scarce supply, before easing to 1.1% in 2013–15 following the policy of a modest and gradual appreciation of the Singapore dollar exchange rate, as well as measures to cool the vehicle and property markets. In comparison, MAS Core Inflation was relatively more stable, declining from 2.4% to 1.5% over these two periods as oil prices tumbled. Nevertheless, both measures of inflation track each other quite closely and tend to converge in the longer run.[6] Much as it does in many central banks around the world, the MAS Core Inflation measure plays a useful role in guiding the formulation of monetary policy in Singapore even as close attention is paid to the headline rate.

CPI-All Items and MAS Core Inflation, 2005–15 Graph 1



[5] Besides imputed rentals on OOA, actual rentals paid are included separately in CPI-All Items inflation. Monthly market rental data from tax returns are used as the pricing indicator for both types of rentals.

[6] See Ong et al (2011).

3. The inflation process

Over the last three decades, numerous efforts have been made at modelling the inflation process in Singapore by the MAS as well as academic economists. In the traditional approach, price formation is broken into two stages, whereby import prices are first determined by foreign prices and the exchange rate, incorporating the assumption of unitary pass-through elasticities given Singapore's price-taker status, and they in turn play a crucial role in determining consumer prices, in conjunction with domestic costs.[7] This intuitive procedure has been given formal expression in the so-called "Scandinavian model" of inflation and the closely related Balassa-Samuelson hypothesis. Functionally, the second step is effected by taking consumer prices to be a composite of the form $CPI = P_T^{\alpha} P_{NT}^{1-\alpha}$, where the subscripts denote the tradable and non-tradable sectors of the economy and α calibrates the relative importance of import prices in consumer price determination.[8] Essentially, studies in this mould find a substantial contribution from foreign prices, while the exchange rate acts as an efficacious filter for imported inflation.

The approach outlined above provides only a reduced-form explanation of the inflation process in Singapore. Nonetheless, a deeper understanding of the structural determinants of foreign and domestic sources of inflation can be obtained through the estimation of factor models and a New Keynesian Phillips curve, respectively, as discussed next.

3.1 Factor models

In recent years, empirical research on inflation dynamics has turned to the issue of the shifting balance between domestic and foreign drivers of inflation, with the latter believed to have assumed greater importance as a result of globalisation. Proponents of this view argue that the integration of China and the eastern European economies into international markets and supply chains, coupled with increasing cross-border spillovers resulting from more extensive trade and financial linkages, have imparted disinflationary impulses to the world economy.[9]

Factor models have proven to be useful for shedding light on this question. For example, Ciccarelli and Mojon (2010) extract a common factor from the inflation rates of 22 OECD countries and show that it contains sufficient explanatory power to outperform forecasts from standard inflation models. Some results in the same vein are reported here for Singapore, allowing for a further separation of external inflation influences into global and regional components. A principal component analysis is used to obtain the global common factor as in Ciccarelli and Mojon (2010), and the

7 See Chew et al (2009) for an econometric analysis of the exchange rate pass-through that incorporates asymmetric transmission over the business cycle.

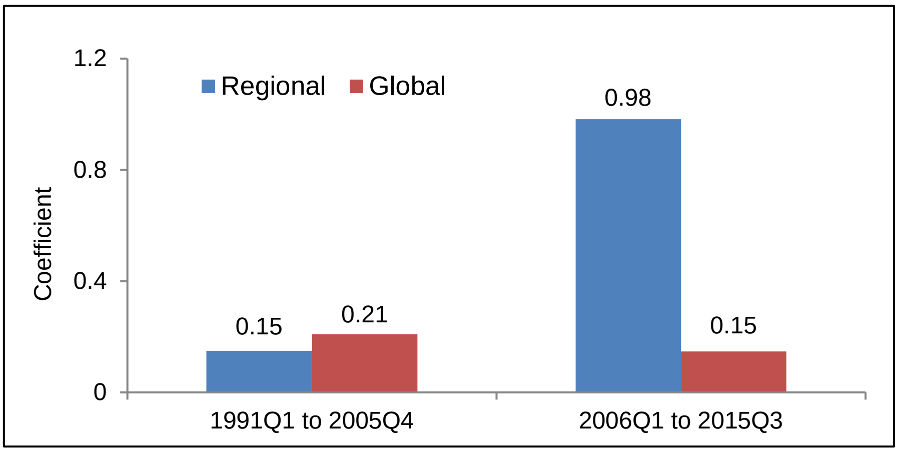
8 Using import prices and unit labour cost as proxies for P_T and P_{NT} respectively, Low (1994) and Abeysinghe and Choy (2007) estimate α to be in the range of 0.45–0.7. The more recent work cited in footnote 7 puts the estimate of α at 0.42.

9 See, for example, "The changing dynamics of inflation in EMEAP economies: the role of external shocks", background note for the 19th EMEAP Governors' Meeting, Bangkok, July 2014.

methodology is extended to 11 economies in Asia to derive a corresponding regional factor.[10]

When the global and regional factors are included in a regression equation for CPI-All Items inflation estimated over the period Q1 1991–Q3 2015, they are found to be jointly significant. Impact-wise, the global factor has a larger effect on CPI inflation. However, breaking the sample into earlier (Q1 1991–Q4 2005) and more recent (Q1 2006–Q3 2015) subperiods shows that the regional factor has grown in importance as a source of external inflationary pressures, with its estimated coefficient rising from 0.15 to 0.98 while that on the global factor declined (Graph 2). The proportion of domestic inflation variance accounted for by the foreign factors in the subsample regressions ranges from 54 to 74%, broadly in line with the reduced-form findings. The rising prominence of regional inflation drivers can be explained by several developments, including the greater synchronisation of business cycles within Asia, the prevalence of common commodity price shocks in the past decade, and the emergence of intraregional production networks.

Estimated coefficients on global and regional factors — Graph 2



3.2 New Keynesian Phillips curve

Alongside a larger role for global and regional factors in the determination of inflation at the national level, studies have found that the sensitivity of prices to domestic macroeconomic variables – in particular the output gap – has declined in many advanced economies. In noting this phenomenon of a "flattening" of the short-run Phillips curve since the 1980s, the BIS *84th Annual Report* attributed it to better anchored inflation expectations, the presence of global economic slack and swings in commodity prices driven by rising demand from emerging market economies.

[10] The Asian economies included are China, Chinese Taipei, Hong Kong SAR, India, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam (Japan and Korea are excluded as they are part of the OECD). The results are based on the first principal component, which by construction explains the largest proportion of variance in the data.

In Singapore's case, however, there is no evidence to suggest that the link between aggregate real activity and inflation has weakened. Indeed, MAS's research using a New Keynesian approach indicates that the empirical Phillips curve is alive and well. The theoretical model on which this conclusion rests is an open economy version of the formulation introduced by Galí and Gertler (1999), which augments the traditional specification with rational inflation expectations and replaces the output gap measure of slack with marginal cost.[11] In the open economy setting, marginal cost is decomposed into four terms: the relative wage (domestic wages relative to import prices, w_t), the terms-of-trade (domestic prices relative to import prices, tot_t), the labour share in GDP (s_t) and aggregate output (y_t). The additional relative wage and terms-of-trade variables are implied by a model of price-setting behaviour that allows firms to substitute intermediate imported inputs for labour in production.

Estimating the model over the sample period Q1 1994–Q1 2013 by employing the generalised method of moments (GMM) produces the following estimates (standard errors in parentheses):

$$\pi_t = \underset{(0.21)}{0.65} E_t \pi_{t+1} + \underset{(0.14)}{0.33} \pi_{t-1} + \underset{(0.06)}{0.18} s_t + \underset{(0.14)}{0.18} tot_t + \underset{(0.08)}{0.18} y_t - \underset{(0.11)}{0.18} w_t ,$$

$$\bar{R}^2 = 0.91$$

where π_t is annual CPI-All Items inflation. The results show that both forward- and backward-looking inflation expectations have statistically discernible roles in driving Singapore's inflation outcomes. The size of the estimated coefficient on future inflation expectations is in line with the literature and is twice that for the lagged inflation term – a proxy for inflation inertia. Further, the relative wage and terms-of-trade coefficients possess the right signs and are economically meaningful, even though they are not statistically significant at the conventional levels.

4. Inflation expectations and forecasting

The relevance of inflation expectations in determining actual inflation leads naturally to the issue of how they can be measured, as well as their potential use in forecasting. In practice, inflation expectations can be backed out from the forecasts of professional economists, surveys of households or the information embedded in financial markets, such as the market for inflation-indexed debt.[12] Only the first two of these sources can be availed of in Singapore, and the discussion that follows will focus on the *MAS Survey of Professional Forecasters* (SPF) conducted by the central bank.[13]

[11] Under the assumption of a Cobb-Douglas or CES production technology, it can be shown that the marginal cost is proportional to the output gap.

[12] Information on longer-term inflation expectations can also be gleaned from MAS Core Inflation, which is a good predictor of trend inflation.

[13] An online survey of 400 random households jointly administered by Singapore Management University and MasterCard, called SInDEx, was started in September 2011. It polls consumers on their perceived values of economic variables, including inflation, over the next one to five years.

The SPF was launched in the fourth quarter of 1999, with the aim of establishing a consistent benchmark for private sector forecasts of key economic variables. Around the middle of every quarter, the views of close to 30 respondents are collated on a host of indicators, the most important of which are real GDP growth, CPI-All Items inflation and the unemployment rate. The survey questionnaires are only sent to participants after official economic data are released to the public, so that forecasters are equipped with the requisite information set when making their projections. The survey confines the rolling forecasting horizon to one quarter, although it also asks forecasters for their evolving views on current full-year and one-year-ahead outturns.

Previous analyses of the SPF results suggest that survey participants appear, on the whole, to be rational, as their predictions were generally unbiased and efficient with regard to incorporating the latest information.[14] Moreover, shifts in forecasters' expectations of inflation have a bearing on the actual outcomes, consistent with the New Keynesian findings and further hinting that the information content of the survey may be superior to other inflation forecasts.[15]

Accordingly, a simple forecast competition is carried out to compare the accuracy of the SPF vis-à-vis the structural models discussed above as well as statistical benchmarks.[16] Initial experimentation suggests that Phillips curve models based on a single measure of economic slack – either the unemployment rate or its deviation from a long-term trend as captured by the Hodrick-Prescott filter – predicted inflation better, and so the results for these specifications are reported instead. All comparisons are performed using a pseudo out-of-sample forecasting methodology; that is, the models are estimated with data dated prior to the projection period of Q4 2009–Q3 2015. The two measures used for judging forecast accuracy are the root mean square forecast error (RMSE) and the mean absolute error (MAE).

Forecast errors of inflation models

In percentage points — Table 1

	SPF	AR(2)	Random walk	Phillips curve (level)	Phillips curve (gap)	Global factor	Regional factor
RMSE	0.364	1.102	1.000	1.100	1.044	0.951	0.934
MAE	0.281	0.911	0.753	0.926	0.863	0.739	0.753

Table 1 reports the RMSE and MAE statistics for the out-of-sample forecasts generated from the alternative models. The SPF aside, there is little to choose between these, though the factor models come out quite well, followed by the random walk forecasts. Rather surprisingly, the autoregressive benchmark, known to produce accurate predictions in the short run, is beaten by all the models save for the

[14] See Special Feature A in MAS (2007).

[15] See Box A in MAS (2014).

[16] Only the one-quarter-ahead forecast horizon is considered here, as the year-ahead predictions are in the nature of a fixed event forecast, which leaves too few observations for a formal evaluation to be undertaken.

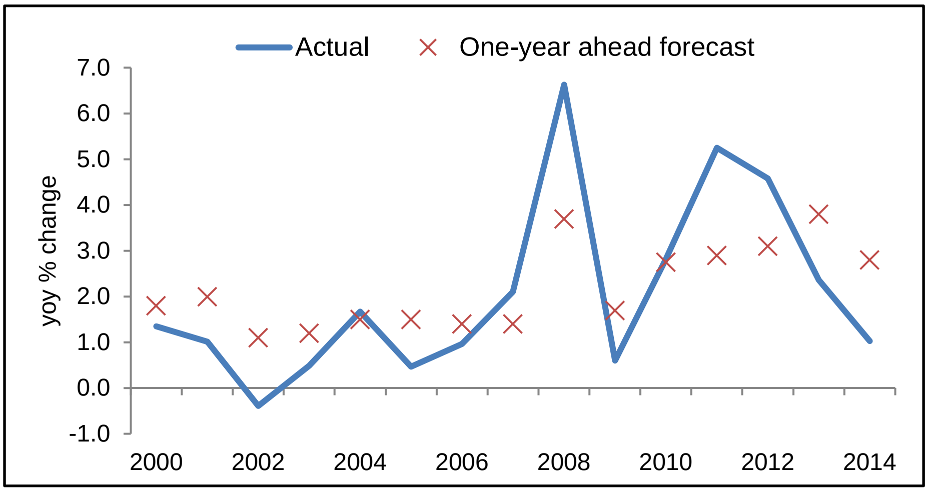
Phillips curve approach. The SPF clearly outperforms its rivals, with forecast errors that are about a third of the next best method.

To put this result in perspective, there is ample evidence that survey forecasts or market-based expectations are among the most accurate predictors of key macroeconomic variables in the short term, although they usually perform worse at long horizons (Giacomini (2015)). Some researchers have argued that survey participants do not necessarily possess deeper knowledge than a hypothetical econometrician of the dynamic forces driving the economy, but they are simply better at processing information in real time. More generally, the literature has shown that models which incorporate survey expectations can result in sizeable accuracy gains.

5. Implications for monetary policy

Two implications for monetary policy can be drawn from the foregoing short review of the inflation process and expectations in Singapore. First, the continuing importance of external factors in influencing inflation dynamics implies that policy should remain focused on managing a trade-weighted exchange rate basket. Indeed, the effectiveness of the exchange rate-centred framework in subduing inflation is demonstrated by the fact that domestic inflation has been relatively benign for the last 35 years, averaging 2% per annum from 1981 to 2015. Second, expectations of low inflation have also become more entrenched as a result of this good track record, as can be seen in the stability of the professional forecasts in Graph 3. This anchoring of expectations may explain why the short-term anticipations of survey respondents provide the best forecasts of near-term inflation outcomes.

Inflation expectations versus actual outcomes, 2000–14 Graph 3



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Inflation mechanisms, expectations and monetary policy

South African Reserve Bank

Abstract

This note identifies supply factors, particularly the exchange rate, as key drivers of inflation in South Africa. Demand factors play a negligible role, with a flat Phillips curve apparent since the inception of the country's inflation targeting regime. The Phillips curve flattened further with the Global Financial Crisis, which suggests that inflation is now even less responsive to demand factors. In addition, the note discusses the adaptive nature of the inflation expectations of price setters, which have eventually become well anchored towards the end of the sample, albeit at the upper bound of the official target band.

Keywords: Inflation, exchange rate pass-through, inflation expectations, Phillips curve

JEL classification: E31, E52, E58

South Africa follows a flexible inflation targeting (IT) monetary policy framework, with a dual mandate for price and financial stability in the interests of sustainable and balanced economic growth. As emerging market economies such as South Africa are largely dependent on imported capital goods to drive investment, inflation measurement is particularly affected by such economies' vulnerability to large exchange rate movements. Thus, the high level of dependency on imported goods feeds through to domestic price formation processes.

The SARB's target measure of inflation is the monthly consumer price index (CPI) for all urban areas, which covers price changes in all of the major metropolitan areas as well as the largest towns in each of the nine provinces of South Africa. Although the quarterly GDP deflator is an alternative measure of inflation, it reflects the prices of domestically produced goods only. The CPI basket includes prices of imported goods, which also play an essential role in the inflation process in an open emerging market economy such as South Africa. In addition, the quarterly frequency of the GDP deflator, together with its more volatile nature (relative to CPI), limits its suitability for monetary policy purposes since it would inter alia complicate the communication surrounding the inflation process and developments. Since the target measure of inflation is the CPI, the SARB, in the main, focuses most of its attention on analysing changes in the CPI.

In addition to the headline CPI, Statistics South Africa also publishes a number of underlying measures of inflation, with the SARB's preferred underlying measure for analytical purposes being the headline CPI excluding food and non-alcoholic beverages (with a weight of 15.41%), petrol (with a weight of 5.68%) and electricity (with a weight of 4.13%). Administered prices (with a weight of 18.48% in the CPI basket) play an important role in overall CPI inflation outcomes in South Africa. Administered price inflation has generally been above overall CPI inflation in South Africa, thus adding to overall inflationary pressures in the economy. Exacerbated by a fairly rigid labour market (despite a persistent high unemployment rate), administered price inflation has on numerous occasions been advanced as one of the reasons for elevated wage demands in recent years, which in turn have added to inflationary pressures.

South Africa has a fairly large informal sector, employing about 2.7 million people. However, the purchasing power of the informal sector is fairly small, implying that the informal sector's influence on the CPI weights is relatively small. Statistics South Africa does survey prices at some informal traders in metropolitan areas, with the main products being sold by these informal traders being food products and second-hand clothing. Subsidised municipal services in large parts of the country could complicate the measurement of inflation and lead to a distortion in relative prices. Those consumers not subject to these fast-rising administered prices can more easily divert their spending power towards other goods and services, impacting demand and supply equilibrium in factor and product markets.

South Africa's high unemployment rate (25.5%) has led to continued urbanisation. Although urbanisation drives up land values in metropolitan areas, house and land price inflation is not directly captured in the CPI. The CPI measures actual rental prices (with a weight of 4.76%) as well as owners' equivalent rent (with a weight of 11.42%). The higher weighting allocated to owners' equivalent rent reflects South Africans' traditional preference of home ownership to renting. However, three of the largest South African commercial banks do compile independent house price indices, which are monitored by the SARB.

Since the adoption of the IT framework, the SARB has largely left the domestic currency to float freely. The flexible exchange rate regime has contributed towards the increased volatility of the rand owing to the fact that South Africa is a small and open economy. The rand has been responsive to both domestic and external shocks and in some regards also acts as a shock absorber. As in most emerging market economies, the exchange rate is one of the key drivers of inflation in South Africa. The transmission mechanism operates through import prices. Hence, the magnitude and the speed of the transmission depends largely on the first-stage and the second-stage pass-through. The first-stage pass-through refers to the impact of exchange rate movement on import prices, while the second-stage pass-through points subsequently to the effects of the latter prices on overall consumer prices.

Studies show that both the first-stage and the second-stage pass-through change over time. First, from 2000 to 2009, the long-term first-stage pass-through was almost complete, at around 90%.[1] The pass-through has dropped sharply since the financial crisis, reaching a minimum of 63% in 2011, before rebounding to 70% in 2014. The decline in the first-stage pass-through is mainly attributed to the weakness in global demand coupled with the decline in energy and global food prices. Second, the second-stage effects have plummeted since the adoption of the IT regime to a long-term level of 21%. It is worth mentioning that the second-stage pass-through depends largely on the state the economy. It increased, from 19% to 33%, during the boom phase between 2004 and 2007, and then declined marginally to 31%. It would appear that firms are reluctant to pass the cost on to consumers when the economy contracts, and prefer reducing their margins. This is in line with the recent observation that the massive depreciation of the rand has not translated into higher inflation. Currently, the overall pass-through to the CPI in the short term is estimated at 10%.

It is evident from surveys that the inflation expectations of economic agents are heterogeneous, with the expectations of financial analysts being well anchored within the official target band but those of price setters (trade unions and businesses) at levels slightly above the upper bound of the target band. Note that the expectations of price setters are the most relevant for policymakers because they influence inflation directly. There is a strong positive relationship between the expectations of trade unions and those of businesses. The two series depict a correlation coefficient of 95%. This relationship is expected since firms form their expectations based on information revealed by wage setters on the future path of wage inflation.

To reduce inflation to a level consistent with the monetary policy objective, ie within the band of 3–6%, the SARB should aim to favourably influence the expectations of trade unions or the perceived target of this group to fall within the official target band in order to ensure that realised inflation converges to within the official target band. In such an environment the expectations should be flat or, in other words, they should not react to small shocks to realised inflation.

The expectations of wage setters closely follow inflation outcomes with a lag. This implies that wage setters may not always be primarily influenced by the central bank's objective, but rather they are likely to react to shocks on realised inflation. These agents are somewhat backward-looking and their perceived inflation targets are above the SARB's official target. In addition, the relationship between actual

[1] The pass-through was estimated using the mark-up model (see Kabundi, A and Mbelu, A (2016). "Has the Exchange Rate Pass-Through changed in South Africa?" forthcoming South African Reserve Bank Working Paper).

inflation and inflation expectations seem to be asymmetric. Expectations tend to rise rapidly with an increase in actual inflation, but display downward rigidity. The downward rigidity is evident in Q4 2002 following a sharp decline in actual inflation. The same pattern is observed in Q3 2008 when inflation plunged after the Great Recession, whereas expectations declined slowly and remained high and close to the upper bound of the target. The credibility of the central bank is enhanced when the perceived target of price setters is in line with its objectives.

This un-anchoring of expectations can be attributed to the expectation trap hypothesis, where trade unions are leaders in a strategic game that develops with the central bank. They determine wages with little consideration of the objective set by the central bank and with the view that they will not get punished with higher interest rates. Instead, they expect that the central bank will accommodate their demand for higher wages due to its fears of causing a recession. This finding is somewhat confirmed by the absence of a correlation between wage inflation and employment. When faced with higher inflation, the central bank increases interest rates, which slows economic activity and hence reduces demand for higher wages. However, the second transmission channel, ie from employment to wages, seems very weak in South Africa. This lack of a relationship is due to wage rigidity and an inflexible labour market. The trade unions demand wages that are often substantially above the actual inflation rate and not always consistent with productivity. Unfortunately, their demands are usually met. In such an environment, inflation is likely to exceed the central bank objective. Reducing inflation to a level consistent with the official target would first require a very conservative central bank, involving the risk of considerable output loss. Second, it would entail a more flexible labour market and less powerful labour unions.

The backward-looking behaviour of price setters in turn translates into high inflation persistence. This tendency is observed in the data from 2002 to 2007 with a persistence coefficient of 0.86.[2] This coefficient has declined considerably since the financial crisis, reaching 0.66 in 2013, due partly to a rise in the credibility of monetary policy and also to positive supply shocks such as declines in the price of oil and international food prices. Interestingly, the decline in inflation persistence coincided with the period where all inflation expectations were stable around the upper bound of the official target band.

In South Africa, demand factors have not always been key determinants of inflation dynamics. This implies a flat Phillips curve. Nevertheless it is worth mentioning that the relationship between the inflation gap and the unemployment gap is not constant, but changes with the business cycle. In the boom phase, the expansion of economic activity exerts pressure on domestic prices. For example, the slope of the Phillips curve increased moderately, from 0.16 in 1996 to 0.19 in 2002. It then jumped to 0.27 in 2003 and remained constant until 2008. And finally, it declined slightly to the current level of 0.25. The implication for disinflation policy is that the sacrifice ratio, which captures the increase in unemployment above the natural rate due to each percentage point decline in inflation, is increasing. This suggests that the SARB should focus on anchoring inflation expectations rather than seek to exploit any trade-off between inflation and unemployment.

2 See Kabundi, A, Schaling, E, and Some, M (2016): "Estimating a Time-Varying Phillips Curve for South Africa," South African Reserve Bank Working Paper 1605.

Inflation dynamics and inflation expectations in Thailand

Wanicha Direkudomsak[1]

Abstract

Acting in parallel with changes in Thailand's inflation dynamics, the fall in inflation and inflation variability is a worldwide phenomenon that has coincided with accelerating globalisation. This paper explains that global factors have played an important role in changing the dynamics of inflation in Thailand. It also shows that the country's monetary policy has been effective in helping to keep inflation low and stable via well anchored long-run inflation expectations.

Keywords: Inflation dynamics; inflation expectations; inflation measurement; monetary policy; globalisation

JEL classification: E31, E52

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1. Introduction

Inflation in Thailand has remained remarkably low and stable since the Bank of Thailand adopted a flexible inflation targeting framework in May 2000. The average annual consumer price inflation has stayed at the level below 3%.

Low and stable inflation dynamics are a global phenomenon. Since the mid-1980s, the level and volatility of international inflation rates have significantly declined, especially in the advanced economies. Furthermore, the degree of co-movement in headline inflation dynamics worldwide has increased. The trend of globalisation is one of the key factors in explaining this "new normal" of inflation dynamics.

Nevertheless, a high correlation between inflation rates across countries is mainly applied to the headline figure, while core inflation rates are less subject to global factors and mostly influenced by domestic factors. Thus, some argue that low and stable inflation is, in part, a result of improvements in monetary policy effectiveness, which have helped to anchor public inflation expectations (Ball (2006); Mishkin (2008)).

To assess the changing dynamics of inflation, this paper analyses the extent to which inflation in Thailand is influenced by either global or domestic factors. The organisation of this note is as follows. After this introduction, Section 2 presents the measurement of Thai inflation. Section 3 describes the development of inflation dynamics in Thailand. Section 4 presents the role and characteristics of inflation expectations in Thailand. The last section concludes and outlines the monetary policy implications.

2. Measurement of Thai inflation

The Bank of Thailand has conducted its monetary policy under a flexible inflation targeting framework since May 2000. At the outset, the Bank targeted core inflation, a measurement that excludes transitory shocks from fresh foods and energy components. However, core inflation has increasingly lost its capacity to reflect the real cost of living as the dynamics of headline and core inflation increasingly diverge. This is due mainly to structural changes in energy price dynamics, and diminished cost pass-through effects as a result of price administration, increased retail competition and well anchored inflation expectations (Pongsapan and Mallikamas (2005)). Thus, in 2015, the Bank of Thailand altered its target for headline inflation to 2.5% with a tolerance band of ±1.5%. Since headline inflation better reflects the cost of living and public inflation expectations, this in turn should help enhance the effectiveness of monetary policy in anchoring inflation expectations.

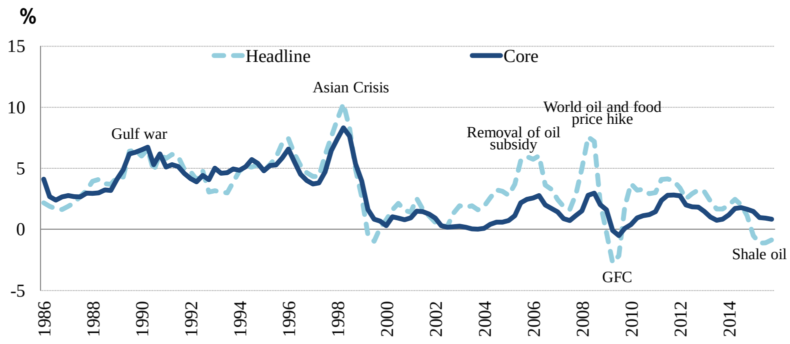
However, inflation dynamics are also affected by factors beyond the scope of monetary policy, such as transitory shocks, government measures and housing rent. For example, Thailand's inflation rate has been influenced by government measures aimed at easing the high cost of living, particularly in Q4 2008, and an increase in the excise tax on alcoholic beverages. Moreover, there is continued downward pressure from housing rent due to its high degree of price persistence and its dominant share, of 21%, in the core inflation basket.

The Bank of Thailand constantly monitors core inflation, excluding government measures and rent, as the key underlying inflation indicator. In addition, the Bank also uses other underlying inflation indicators, such as the symmetric trimmed mean, asymmetric trimmed mean and principal component, to help gauge real inflationary pressure.

3. Inflation dynamics in Thailand: changes and causes

Inflation in Thailand has been remarkably low and stable. As shown in Graph 1, Thailand's CPI headline and core inflation rates have slowed sharply since the early 2000s. Thailand's headline inflation averaged 2.6% in 2000–14, in welcome contrast to the average of 4.5% in 1986–1999. In addition, the volatility of core inflation, as measured by the standard deviations of annual inflation rates, fell from 1.6% in 1986–1999 to 0.9% after 2000.

Thailand's inflation rates — Graph 1



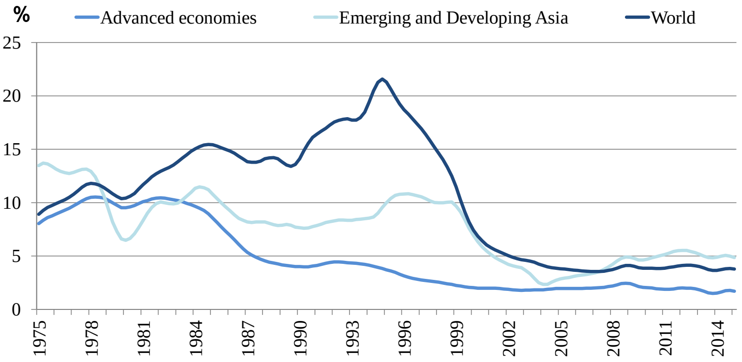
Source: Ministry of Commerce

In part, at least, Thailand's experience echoes inflation dynamics around the world. Graph 2 shows that the mean of worldwide headline inflation rates had fallen drastically by the year 2000, led first by a group of advanced economies in the late 1980s and followed by developing countries from 2000 onwards.

The significant fall in worldwide inflation rates in 2000 in fact coincided with the drastic rise in economic integration or globalisation, particularly the growing integration of emerging countries into the global supply chain. Thus, the global factors underlying the process of globalisation have considerable weight in explaining the inflation dynamics of many countries.

Worldwide headline inflation mean

Graph 2



Note: Using five-year rolling window
Source: IMF International Financial Statistics Database

Global factors

Influences from globalisation

As Thailand is a small and highly open economy, with its degree of trade openness rising continuously since the 1990s and currently exceeding 100%, the country's inflation dynamics have been influenced by globalisation, which has helped to keep inflation low through various channels.

The entry of lower-cost producers to the global trading system enhances price competition, making consumer price markups more difficult (Binici et al (2012)). Pongsapan and Mallikamas (2005) and Manopimoke and Direkudomsak (2015) show some evidence for increasing competition in Thailand's consumer product markets. Firms' profit margins have been on a declining trend as the degree of trade openness has increased. Moreover, the widespread adoption of technology from global integration tends to increase productivity and lower production costs and good prices.

Many studies use the global output gap to control for these global influences on domestic inflation dynamics. Manopimoke and Direkudomsak (2015) find that the global output gap is responsible for Thailand's inflation dynamics and those of its top trading partners. The global output gap has gained more importance in explaining Thailand's inflation dynamics, while the influence of the domestic output gap has declined over time. This phenomenon is also well documented by the flattening of the Phillips curve in the wake of globalisation in 2000.

Role of commodity prices

Movements in global commodity prices have a significant impact on Thai inflation. The main effect is through oil prices as Thailand is a net energy importer. The weight of the energy component in Thailand's CPI basket is significant, accounting for 11.4%.

Despite their transitory impact, global commodity prices have played a major role in explaining overall price movements since 2000. Prime examples include the large swings in commodity prices during the global financial crisis in 2008–09 and the recent collapse in global oil prices.

Globalisation, especially since 2000, has led to greater co-movements of worldwide headline inflation rates, and has amplified global commodity price cycles. Inflation in Asian developing countries has been heavily influenced by swings in global commodity price cycles, particularly those of food and oil (Jongwanich and Park (2008)). Khemangkorn et al (2008) explain that changing world commodity prices have important implications for Thai inflation dynamics. Furthermore, Manopimoke and Direkudomsak (2015) find that the oil price movement has been a dominant driver of Thai inflation since 2007.

Government measures have also influenced retail oil prices in Thailand. An oil fund levy and fuel excise taxes have been used as instruments to stabilise domestic oil prices. However, in some episodes, such adjustments have led to a large fluctuation in retail oil prices, as was the case with a sudden large increase in the oil fund levy following an oil price freeze in 2005. Recently, the government has attempted to restructure domestic fuel pricing by reducing price subsidies as well as setting energy prices to better reflect actual costs. This has caused domestic oil prices to move more closely with global prices.

Domestic factors

Role of monetary policy

Carney (2015) states that, although the commodity super-cycle has increased correlation between headline inflation rates across countries, core inflation dynamics have become more dispersed. In other words, domestic economic conditions, which can be influenced by domestic monetary policy, still matter. In Thailand, Khemangkorn et al (2008) and Manopimoke and Direkudomsak (2015) suggest that globalisation might have helped exert inflationary pressure, but disciplined and well anchored monetary policy has also played an important role in keeping the inflation trend low and stable.

An evident and important shift in the policy framework first observed in advanced economies since 1990s is the adoption of inflation targets, which helped ease the high inflationary pressures of the 1970s. Based on the success of advanced economies in achieving low and stable inflation, many developing countries including Thailand adopted the same type of framework in the early 2000s.

Inflation expectations in Thailand have been stable during the inflation targeting regime, particularly with respect to long-term expected inflation. The country's inflation dynamics have also become more resilient to supply and demand price pressures originating both domestically and abroad because well anchored inflation expectations help control the second-round effect from excessive swings in commodity prices and lower inflation persistence (Chantanahom et al (2008), Manopimoke and Direkudomsak (2015)). This limited second-round effect implies that a temporary shock to the price level disappears rather quickly, so that the effects of global commodity price shocks on core inflation have significantly declined.

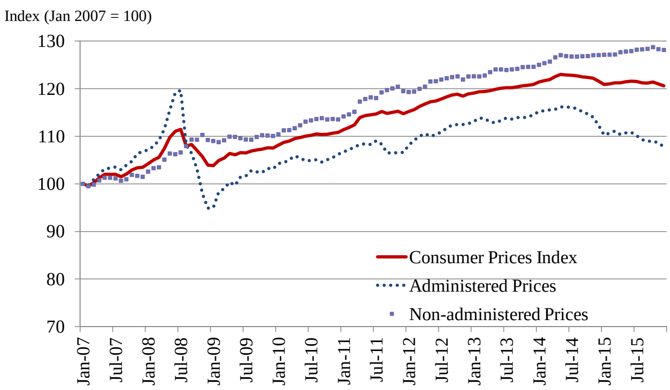
Price administration

In addition to monetary policy, government measures to influence the cost of living have partly contributed to Thailand's low and stable inflation. Overall, goods and services for which prices are administered by the government to varying degrees account for approximately 35% of the CPI basket. The most prominent administered items are in the energy and public transportation categories, accounting for 13% of the CPI basket. That said, most of the administered prices are not under the total control of the government, although they are constantly monitored.[2.]

Graph 3 shows that administered prices played a part in cushioning living costs and thus curbing inflation during the implementation of the six government measures to lessen the impact of the spike in global oil prices in Q4 2008.[3]

Administered prices

Graph 3



Sources: Ministry of Commerce, Calculated by the Bank of Thailand

Exchange rate pass-through

A number of studies find that the degree of exchange rate pass-through is very low in many countries (White (2008); Dramane and Kempf (2010); Devereux and Yetman (2014)). This also holds true for Thailand. Generally, exchange rate movements directly and principally affect Thai consumer prices through retail oil prices, which account for 7.5% of the CPI basket. Indirectly, they affect other goods in the CPI basket through the costs of imported inputs for domestic production, given that the import content in accounts for 16% of the CPI.[4]

2 The government classifies administered goods and services into three main categories. They are "watch list", "priority watch list", and "sensitivity list" in which prices of goods and serviced are monitored every two weeks, twice a week and every day respectively.

3 These measures include reducing oil excise tax rates, free fares for third-class trains and buses, subsidising electricity and water fees, and preventing increases in household LPG prices.

4 Using the 2005 Input-Output table compiled by Office of the National Economic and Social Development Board (NESDB).

An empirical study shows that a 1 percentage point fall in the exchange rate increases headline inflation by 0.06%. This change in headline inflation breaks down into a 0.04% component mostly via changes in retail oil prices, while the remaining 0.02% is attributable to core inflation. Further analysis also suggests that the exchange rate pass-through is not symmetrical for Thailand, having a larger effect when the currency depreciates. Previous studies have found that the degree of exchange rate pass-though is lower when (i) domestic competition is high; (ii) inflationary pressures are low; and (iii) monetary policy gives due weight to price stability (Buddhari and Chensavasdijai (2003); Styrin and Zamulin (2012); Ito and Sato (2007)).

Recently, the 5.3% depreciation in the annual average exchange rate in 2015 increased Thailand's headline CPI by about 0.2%. However, this amount could not offset the impact of the large fall in global oil prices, resulting in overall negative inflation of –0.9% in 2015.

4. Inflation expectations in Thailand

Former Federal Reserve Chairman Paul Volcker said "Inflation feeds in part on itself". This means that public inflation fears may become self-fulfilling if inflation expectations become unanchored. The effectiveness of monetary policy in anchoring inflation expectations is the key concern of most inflation targeting central banks.

Stylised facts about inflation expectations

The Bank of Thailand closely monitors inflation expectations from various sources, such as the survey-based inflation expectations from the Business Sentiment Survey and Consensus Economics forecasts. However, market-implied inflation expectations from inflation-linked bonds (ILB) are not yet a reliable indicator, as the inflation-linked bond market is still relatively illiquid. Therefore, the Bank extracts inflation expectations from a macrofinancial term structure model based on a new Keynesian macroeconomic framework and an arbitrage-free affine term structure model (see Table 1).

Inflation expectations used by the Bank of Thailand — Table 1

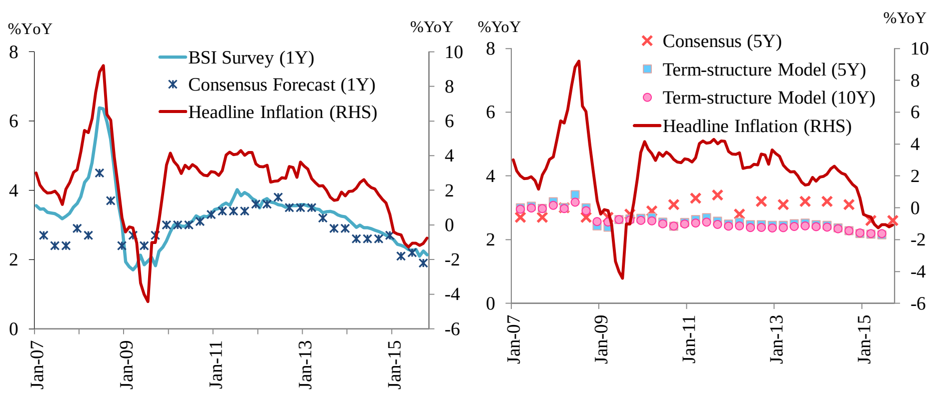
Inflation expectations	Conducted by	Data sources	Expectation horizon		Data frequency
			Short-term	Long-term	
Consensus Economics	Asia Pacific consensus forecast	Professional forecasters	Yes	Yes	ST: quarterly since 2004/ LT: every Apr. and Oct. since 2001
Business Sentiment Survey (BSI)	Bank of Thailand	Business enterprises	Yes	Yes	ST: monthly since 2007/ LT: quarterly since 2014[1]
Term-structure model	Bank of Thailand	Model-based	–	Yes	LT: quarterly since 2011

[1] The BSI long-term inflation expectations model is in an early stage of development.

Short-term inflation expectations are more volatile due to transitory supply or demand shocks, such as the global oil and food prices hike in 2008, the post-GFC collapse in global oil prices, and the six government measures to lower the cost of living in Q4 2008. Short-term inflation expectations were unaffected by most of the one-time and expected shocks, such as the rise in excise tax for diesel oil fuel in 2005 and an increase in minimum wages in 2013. Graph 4 (left panel) shows the relationship between short-term inflation expectations and headline inflation.

Inflation expectations and actual inflation

Graph 4



Source: Ministry of Commerce, Consensus Economics, Business Sentiment Survey and BOT's Calculations

For long-term inflation expectations, the year-on-year change in headline inflation and five-to-ten-years inflation expectations from survey-based and model-based sources are plotted in Graph 4 (right-hand panel). These rates are less volatile, despite the massive supply or demand shocks in 2008, the flood crisis in 2011, and political unrest in 2014. Remarkably, even after the recent oil price shocks occurred, driving Thai headline inflation into negative territory in 2015, long-term inflation expectations have hovered at around 2.5%, the mid-point of the official inflation target. As well as the credibility of the monetary policy framework, this reflects the public's awareness that the recent global oil price shock was transitory.

The role of inflation expectations and their anchoring

To understand ***the role of inflation expectations in inflation dynamics***, the Phillips curve is used to find the relationship between Thailand's inflation[5] and its drivers, which include cost, economic slack and inflation expectations. Using long-term (five-to-ten-years) inflation expectations from the term-structure model and short-term (one-year) inflation expectations from Economics Consensus, Table 3 shows that inflation expectations could partially explain the domestic inflation process. These results are in line with the theoretical evidence that inflation expectations should play a role in contemporaneous price-setting through the public's perceptions of future inflation.

[5] Using headline inflation excluding government measures and quarterly data from Q3 2001 to Q3 2015.

Thai inflation determinants

Table 3

Determinants	Model 1	Model 2	Model 3
Lag of inflation	0.34*** (0.09)	0.35*** (0.08)	0.37*** (0.08)
Farm prices	0.05*** (0.16)	0.05*** (0.14)	0.05*** (0.14)
Dubai oil prices	0.04*** (0.004)	0.04*** (0.004)	0.03*** (0.003)
Exchange rate	0.06* (0.02)	0.06** (0.02)	0.06** (0.02)
Domestic output gap[1]	0.00 (0.0003)	0.00 (0.0002)	0.00 (0.0002)
Inflation expectations			
– One-year ahead	0.001** (0.0003)		
– Five-year ahead		0.001** (0.0003)	
– Ten-year ahead			0.001** (0.0003)
Adjusted R^2	0.76	0.77	0.76
DW	2.3	2.3	2.3

Note: The values in parenthesis are standard deviations.

*, **, *** denote significance at 10%, 5% and 1%, respectively.

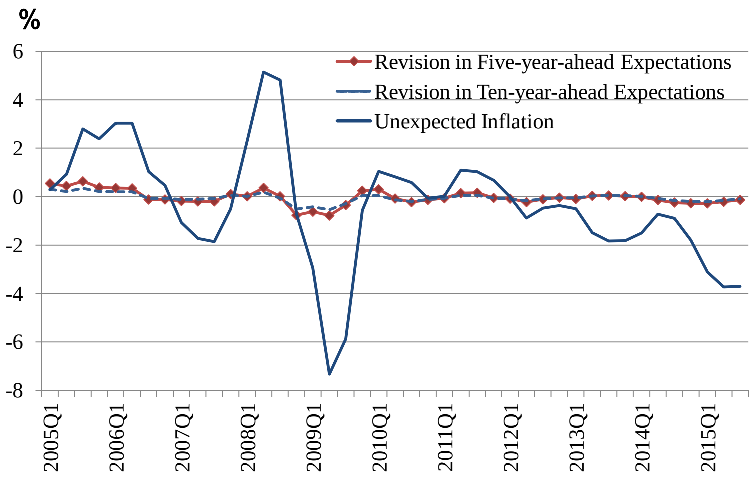
1 Empirical results showing insignificant domestic output gap is consistent with a number of previous studies. They report that the sensitivity of inflation to the domestic output gap declines, whereas that to the foreign output gap is higher (IMF (2006); Pain et al (2008); Manopimoke (2015)). The results are robust even after excluding inflation expectations variables. In addition to the globalisation impact, Roberts (2006) and Mishkin (2007) argue that the changing relationship might also be due to the endogenous outcome of effective monetary policy that has become more focused on the control of inflation.

In order to show how well ***inflation expectations were being anchored in Thailand***, this note calculates the sensitivity of expected inflation to current shocks or inflation. If expectations are well anchored, the current shock effect should be small. As mentioned above, movements in current inflation or short-term expected inflation may be affected by a number of factors irrelevant to monetary policy. Thus, one should focus on long-run inflation expectations, which are less affected by short-run transitory shocks, to measure the anchoring of expected inflation. Long-run inflation expectations should coincide with the inflation policy framework and monetary policy actions.

Manopimoke and Direkudomsak (2015) find that the shift to an inflation targeting regime significantly reduces the level and volatility of long-term inflation expectations. Long-term inflation expectations have been stable at around 2.4% since 2001, consistent with the mid-point of the Bank of Thailand's current inflation target. Moreover, Pongsak et al (2015) apply inflation expectations computed by a market-based approach, and find that monetary policy actions affect short-term as well as long-term inflation expectations.

Following the methodology of Davis (2012), Graph 5 shows unexpected components and revision in five-to-ten-years inflation expectations derived from a term-structure model.[6] The changes in revision series have been minimal despite the significant changes in unexpected components, possibly reflecting the anchoring ability. Moreover, the smaller revision in inflation expectations over time might indicate that the capacity of monetary policy to anchor long-term inflation expectations has improved.

Long-run inflation expectations and unexpected shocks Graph 5



Source: Author's Calculations

5. Monetary policy implications

The implementation of Thailand's inflation targeting framework has successfully lowered and stabilised inflation, as is reflected by well anchored long-term inflation expectations since 2000. Currently, even with negative headline inflation and downside risk factors to the inflation outlook, the Bank of Thailand assesses deflationary risks to be low, as negative headline inflation is primarily caused by supply side factors, especially plunging oil prices. Meanwhile, core inflation remains positive throughout the forecast period, while inflation expectations remain close to the inflation target. This anchoring ability is very important in shielding the economy against shocks and avoiding any downward price spirals.

Global disinflation is a concern in many countries. The persistent decline in world energy prices amidst the weak and uncertain global economic recovery adds to the downward pressure on inflation. Central banks thus face challenges in achieving their policy targets.

It is vital that long-term inflation expectations remain anchored if price stability is to be maintained. Although key measures suggest that Thailand's long-term

6 Unexpected components are calculated as the difference between the actual inflation rates over the past year and one-year-ahead expected inflation rate one year earlier. Revision to long-run inflation expectations is the difference between five- or 10-year inflation expectations at particular time and five- or 10-year expected inflation one year earlier.

inflation expectations are still well anchored at around 2.5%, the Bank of Thailand is closely monitoring developments in inflation dynamics and the global oil price structure.

Targeting headline inflation should be more in tune with the general public's understanding of what constitutes the cost of living, which should help improve the efficiency of the Bank of Thailand's communications to the public as well as the anchoring of inflation expectations. Maintaining the credibility of the policy target is still a focal challenge for central banks, particularly in today's volatile global environment.

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Twin stability problem: joint issue of high current account deficit and high inflation

Mustafa Kılınç, Cengiz Tunç and Mehmet Yörükoğlu[1]

Abstract

The low level of global interest rates and the high liquidity resulting from the quantitative easing policies adopted by advanced countries in the wake of the global financial crisis of 2007–09 bolstered capital flows to emerging market economies. However, the uncertainties relating to the future path of global monetary policies and the prospects for economic recovery led to high volatility in risk appetite, capital flows and exchange rates. In the process, emerging market economies with higher current account deficits faced larger currency depreciations and, consequently, higher cumulative increases in consumer prices. High current account deficits combined with strong inflationary pressures created a twin problem of financial and price stability. Exchange rate pass-through turned out to be an important parameter of this twin problem with a high degree of pass-through amplifying the relationship between current account deficits and inflationary pressures. Moreover, the twin problem created significant constraints for monetary policy and necessitated the use of complementary macroprudential (and other) policy tools.

Keywords: Financial stability, price stability, current account balance, inflation, exchange rate pass-through

JEL classification: E31; E44; F32

[1] Central Bank of the Republic of Turkey.

1. Introduction

The global financial crisis (GFC) of 2007–09 led to a volatile pattern of economic growth for the world economy. Recovery from the crisis was initially brisk for most countries but growth slowed down significantly afterwards, creating concerns about whether this slowdown was permanent or temporary.[2] In the process advanced economy (AE) central banks brought down their policy rates to levels close to zero and began to implement unconventional monetary policies (UMPs) involving quantitative easing to support the recovery. The global liquidity thus generated bolstered capital flows to emerging market economies (EMEs). However, those flows also exhibited a highly volatile pattern given the uncertainties regarding world economic growth and monetary policies.

These volatilities exerted depreciation pressures on most EME currencies and those pressures were strongest for countries with high current account deficits. Since the uncertainties regarding the interest rates and balance sheets of AE central banks tend to have important implications for capital flows to EMEs, concerns about the financing of high current account deficit in some EMEs implied that such economies faced higher depreciations of their currencies. Given the exchange rate pass-through to prices, higher depreciations generated upside pressures on inflation. This created a twin stability problem: a financial stability problem due to high current account deficits and a price stability one due to high inflationary pressures. Such a relationship imposed significant constraints on monetary policy in reaching price stability. It also showed the need for coordinated policies to handle the concurrent financial stability problem.

In the following section of this paper, we document the possible relationships between current account balances, exchange rates and inflation for 12 countries over the period ranging from October 2010 to October 2015. Then in the third section, we estimate exchange rate pass-through in Turkey and Indonesia (two countries with large to moderate current account deficits), and in Mexico and Korea (a country with a moderate current account deficit and a country with a high current account surplus) to quantify the possible inflationary effects of current account balances. We show that pass-through is higher in Turkey and Indonesia, possibly amplifying the inflationary pressures resulting from the current account deficits. The last section concludes.

2. Twin stability problem: possible relationship between high current account deficits and high inflation

In this section, we begin by ascertaining whether there is a statistical relationship between current account balances, exchange rate movements and inflation in a group of 12 countries for the period that followed the GFC, specifically from October 2010 to October 2015, and afterwards. We then try to look at whether there is any possible economic relationship between financial and price stability. We chose end-2010 as our starting period because the recovery from the GFC was by then complete in most countries and economic growth was starting to slow down. The Federal Reserve

2 See, for example, Teulings and Baldwin (eds) (2014).

launched the second phase of its quantitative easing programme in support of economic recovery and some EMEs began to implement new policies to handle problems created by ample global liquidity and low interest rates. In the period covered by our analysis, a number of developments caused significant movements in risk appetite, capital flows and exchange rates, including the European debt crisis of 2011–12, the third installment of the quantitative easing programme pursued by the Federal Reserve in November 2012, signals that the Federal Reserve would begin to taper its policy of quantitative easing in May 2013 and the introduction of forward guidance by Federal Reserve relating to a lift-off of interest rates in 2015.

Table 1 summarises current account, exchange rate and inflation data for our sample. Countries are ordered from those with the highest current account deficit to those with the highest current account surplus (all relative to GDP). This ordering illustrate a wide dispersion of countries' current account balances. Then, in the second column, we show the cumulative change in exchange rates against the US dollar over our selected reference period. Those numbers also show a wide dispersion with a cumulative depreciation of 130% in Brazil to no change in Korea. In the third column, we look at the cumulative change in the price level. We see that consumer prices increased by about 50% in Turkey and India but rose by only 10% in Thailand, Korea and Malaysia. The last column of Table 1 presents information on average inflation levels over the reference period.

Current account balances, exchange rates and consumer price inflation in selected countries (October 2010 to October 2015) Table 1

	Current account balance (average over period; % of GDP)	Cumulative exchange rate change (relative to USD end/beginning period)	Cumulative consumer price change (ratio of CPI end/beginning period)	Consumer price inflation (average over period, in %)
Turkey	–7.1	2.1	1.5	7.8
S. Africa	–4.7	2.0	1.3	5.3
Colombia	–3.7	1.6	1.2	3.2
India	–3.0	1.5	1.5	8.3
Brazil	–2.9	2.3	1.4	6.5
Indonesia	–1.8	1.5	1.3	5.8
Chile	–1.7	1.4	1.2	3.0
Mexico	–1.5	1.3	1.2	3.7
Thailand	1.8	1.2	1.1	2.1
Philippines	3.3	1.1	1.2	3.4
Korea	4.5	1.0	1.1	2.0
Malaysia	6.8	1.4	1.1	2.4

Source: Bloomberg and authors' calculations.

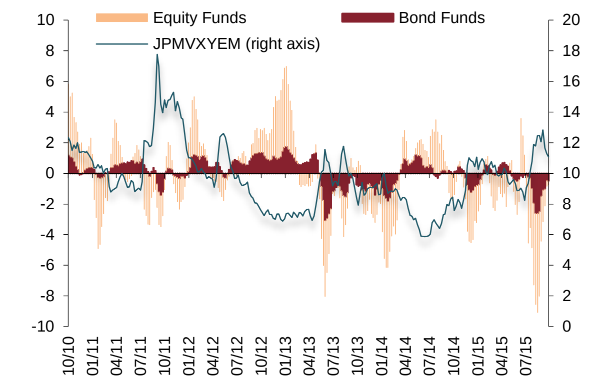
In Graph 1, we set portfolio flows to EMEs in relation to a widely used index of exchange rate volatility for those countries. We see that with the start of the European debt problems in mid-2011, there is a jump of exchange rate volatility in EMEs. In 2012, financial markets and exchange rates stabilise somewhat, and, with the start of the third phase of quantitative easing by the Federal Reserve in October 2012, we see the emergence of a global "risk-on" period characterised by significant portfolio flows to EMEs. However, with the tapering signal emanating from the Federal Reserve in May 2013, a "risk-off" period ensues with large portfolio outflows from EMEs and renewed currency volatility. There is some stabilisation of portfolio flows and exchange rate movements in mid-2014 but concerns about a lift-off of interest rates by the Federal Reserve lead again to portfolio outflows and higher currency volatility that last until 2015. These developments show the significant volatility of EME portfolio flows and exchange rates after the GFC.

Graph 1 shows the evolution of exchange rates in the post-crisis period of volatile global financial markets. We partition our countries into two sub-groups to see whether there are any patterns between exchange rate changes and current account balances. Group 1 includes the countries in the upper half of the current account balance distribution (ie those with deficits). Group 2 comprises countries in the lower half of the distribution (those with lower deficits and surpluses). Graph 1 shows that both the exchange rate cycles and the extent of currency depreciation differed significantly between the two groups. In the case of Group 1, exchange rates depreciated significantly and permanently in three cycles (from the European debt crisis of mid-2011, the tapering signal of May 2013 through to the low volatility period that began in mid-2014). By contrast, for Group 2 the depreciation of currencies was temporary in the first two cycles. At the end of the period, cumulative depreciation amounted to 80% for Group 1 while it was only 20% for Group 2.

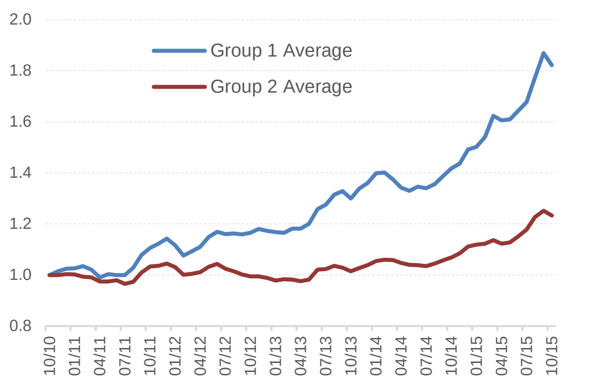
Portfolio flows to EMEs
(Four-week moving average; USD bn) and currency volatility index (JPMVXYEM; in %)

Sub-group averages exchange rates
(Against USD; Oct. 2010 =1)

Graph 1



Source: EPFR, Bloomberg.



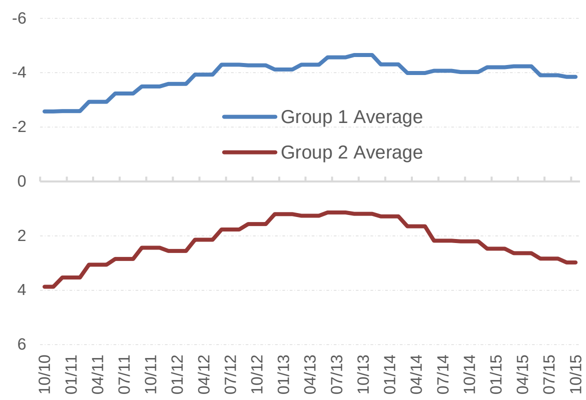
Source: Bloomberg.

The two sub-groups are based on averages of the current account balance/GDP numbers shown Table 1. As explained in the text, Group 1 comprises the first half of countries and Group 2 the second. Group 1 includes Turkey, South Africa, Colombia, India, Brazil and Indonesia. Group 2 includes Chile, Mexico, Thailand, Philippines, Korea and Malaysia.

Graphs 2 shows the average current account balance to GDP ratio (left-hand side) and average inflation (right-hand side) for our two sub-groups. The left-hand panel of Graph 2 shows that gGroup 1 countries had a relatively stable average current account deficit to GDP ratio of 4%. Group 2 countries had an average current account balance of 2% with some improvement towards the end of period. In the right-hand panel, one can see a difference in inflation levels that is comparable to the difference in exchange rates shown in Graph 1. In other words, the first group of relatively high current account deficit countries had persistently higher inflation levels over the period than the second group of low current account deficit or surplus countries.

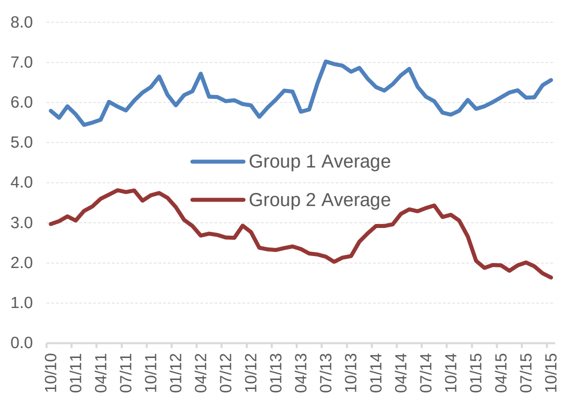
Current account balance

(as a % of GDP)



Consumer price inflation

(%) Graph 2



Source: Bloomberg and authors' calculations.

The two sub-groups are based on averages of the current account balance/GDP numbers shown Table 1. As explained in the text, Group 1 comprises the first half of countries and group 2 the second. Group 1 includes Turkey, South Africa, Colombia, India, Brazil and Indonesia. Group 2 includes Chile, Mexico, Thailand, Philippines, Korea and Malaysia.

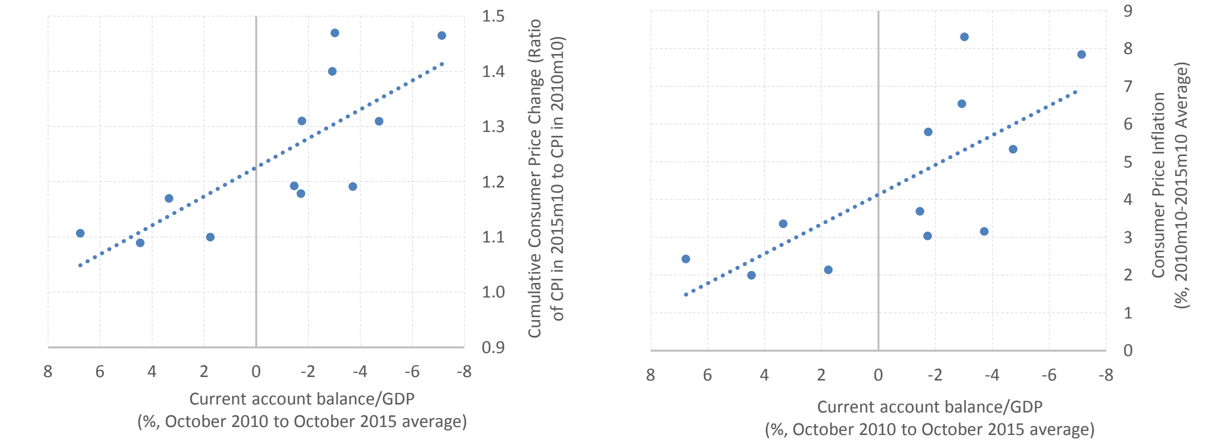
In Graph 3, we look at similar statistical relationships on a country-by-country basis rather than on an average basis for our sub-groups. The left-hand panel of Graph 3 shows the relationship between average current account balance for each country and the cumulative change in the consumer price level after the onset of the GFC. We see that a higher current account deficit is associated with a higher increase in the cumulative price level. In the right-hand panel of Graph 3, the same data on current account deficits is coupled with data on inflation levels. Again, we find that countries with higher current account deficits also have higher average inflation levels.

This statistical relationship between the current account balance and inflation in Graph 3 does not necessarily imply an economic relationship. But as noted earlier and observed in Graph 1, differences in exchange rates developments across countries could provide a possible economic mechanism from current account deficits to inflationary pressures. Graph 4 shows the relationship between current account balances and cumulative exchange rate changes in the relevant period. We see that, similar to Graph 1, countries with higher current account deficits experience higher cumulative exchange rate depreciations. After the GFC, low interest rates and high global liquidity generated by quantitative easing policies supported capital flows to EMEs. But with the uncertainties attached to conventional and unconventional policies, capital flows demonstrated a volatile pattern. During the risk-off periods, exchange rate depreciations were larger in high current account deficit countries as concerns regarding the financing of such deficit were exacerbated.

Current account balance as a percentage of GDP and cumulative consumer price change

Current account balance as a percentage of GDP and consumer price inflation level

Graph 3



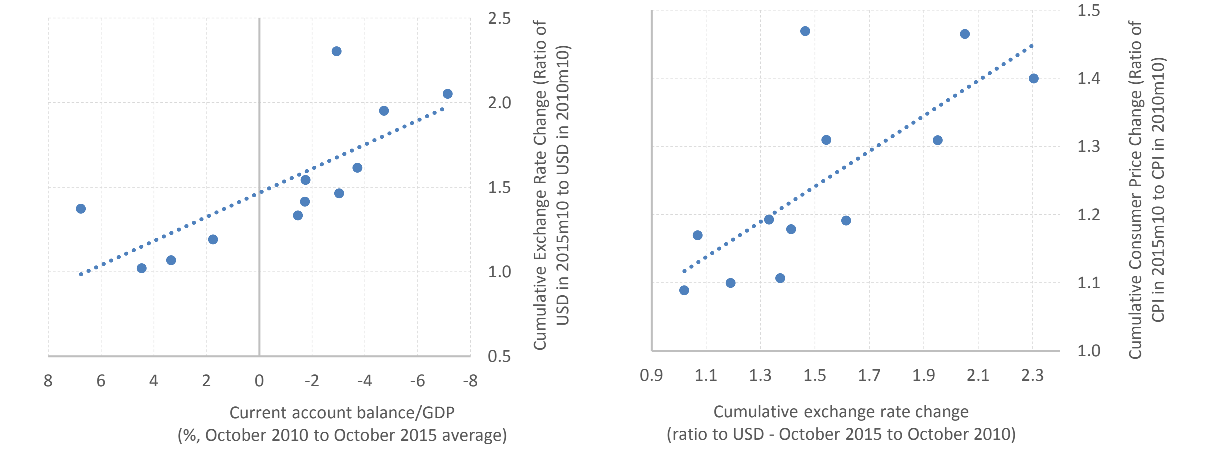
Source: Bloomberg and authors' calculations.

As high current account deficit countries experienced larger depreciations of their currencies, such larger depreciation would be expected to feed into domestic prices. In Graph 4, we see that countries with higher cumulative exchange rate depreciations also had also higher cumulative consumer price changes. That graph illustrates what are mainly statistical relationships. It may well be the case that some countries facing higher currency depreciations, experienced higher consumer price changes resulting from to other factors. Therefore it is crucial to show that exchange rate changes actually fed into inflationary pressures. To show and quantify this channel, we estimate in the next section the exchange rate pass-through for Turkey and Indonesia (two countries with current account deficits from the first group) and Mexico and Korea (a moderate current account deficit country and a large current account surplus county from the second group).

Current account balance/GDP (%) and cumulative exchange rate change

Cumulative exchange rate change and cumulative consumer price change

Graph 4



Source: Bloomberg.

3. Exchange rate pass-through: Turkish, Indonesian, Mexican and Korean cases

We estimate the exchange rate pass-through using a comprehensive structural VAR model borrowed from Kılınç and Tunç (2014). An important feature of the model is the block exogeneity assumption which differentiates the external variables from the domestic ones for small open economies, and prevents the domestic variables from influencing the external ones either contemporaneously or in lag forms. The block exogeneity feature is widely used for small open economies (Cushman and Zha (1997), Canova (2005), Mackowiak (2007), Giordani (2004), Franken et al (2006), and Hoffmaister and Roldos (2001)).

We define the true structure of the economy by the following model:

$$\Gamma(\mathrm{L})y(t) = e(t)$$

and the reduced-form equation as:

$$y(t) = B(L)y(t) + u(t).$$

If we define $\Gamma(\mathrm{L}) = \Gamma_0 + \Gamma^0(L)$, where Γ_0 is the contemporaneous coefficient matrix in the structural form and $\Gamma^0(L)$ is the coefficient in $\Gamma(L)$ without the contemporaneous coefficient, then $B(L) = -\Gamma_0^{-1}\Gamma^0(L)$. And the disturbances in the structural form equation are related to the residuals in the reduced form in the following way:

$$e(t) = \Gamma_0 u(t).$$

Using the block exogeneity feature, we can decompose the SVAR model into external (y_e) and domestic (y_d) blocks as follows:

$$y(t) = \begin{pmatrix} y_d(t) \\ y_e(t) \end{pmatrix}, \quad B(L) = \begin{pmatrix} B_{11}(L) & B_{12}(L) \\ B_{21}(L) & B_{22}(L) \end{pmatrix}, \quad u(t) = \begin{pmatrix} u_d(t) \\ u_e(t) \end{pmatrix}, and\ \Gamma_0 = \begin{pmatrix} \Gamma_{0,11} & \Gamma_{0,12} \\ \Gamma_{0,21} & \Gamma_{0,22} \end{pmatrix}$$

and impose that both $B_{21}(L)$ and $\Gamma_{0,21}$ are set to zero so that the domestic variables have neither contemporaneous nor lagged effect on the external variables. We employ the following identification structure for the contemporaneous relationship between the disturbances in the structural form equation and the residuals in the reduced form model ($e(t) = \Gamma_0 u(t)$):

$$\begin{pmatrix} e_{ip}(t) \\ e_{cpi}(t) \\ e_{m3}(t) \\ e_{ner}(t) \\ e_{embi}(t) \\ e_i(t) \\ e_{wcpi}(t) \\ e_{wipi}(t) \\ e_{ffr}(t) \end{pmatrix} = \begin{pmatrix} a_{1,1}^0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{2,2}^0 & 0 & a_{2,4}^0 & 0 & 0 & a_{2,7}^0 & 0 & 0 \\ 0 & 0 & a_{3,3}^0 & 0 & 0 & a_{3,6}^0 & 0 & 0 & 0 \\ a_{4,1}^0 & a_{4,2}^0 & a_{4,3}^0 & a_{4,4}^0 & a_{4,5}^0 & a_{4,6}^0 & a_{4,7}^0 & a_{4,8}^0 & a_{4,9}^0 \\ a_{5,1}^0 & a_{5,2}^0 & 0 & a_{5,4}^0 & a_{5,5}^0 & a_{5,6}^0 & 0 & 0 & a_{5,9}^0 \\ 0 & 0 & 0 & a_{6,4}^0 & a_{6,5}^0 & a_{6,6}^0 & 0 & 0 & a_{6,98}^0 \\ 0 & 0 & 0 & 0 & 0 & 0 & a_{7,7}^0 & a_{7,8}^0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & a_{8,8}^0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & a_{9,7}^0 & a_{9,8}^0 & a_{9,9}^0 \end{pmatrix} + \begin{pmatrix} u_{ip}(t) \\ u_{cpi}(t) \\ u_{m3}(t) \\ u_{ner}(t) \\ u_{embi}(t) \\ u_i(t) \\ u_{wcpi}(t) \\ u_{wipi}(t) \\ u_{ffr}(t) \end{pmatrix}$$

In our model, we use as external variables the world energy price index ($wcpi$) from the World Bank, the world industrial production index ($wipi$) from CPB Netherlands Bureau for Economic Policy Analysis and the federal funds rate (ffr) from the Federal Reserve. We use as domestic variables the country-level industrial production index (ip), the core consumer price index (cpi), the monetary aggregate ($m3$), the nominal exchange rate as units of local currency for one unit of US dollar (ner), the EMBI as country risk premium ($embi$) and the domestic interest rate (i). All domestic data are sourced from Bloomberg. We take the natural logarithms of ($wcpi$), ($wipi$), (ip), (cpi), ($m3$) and (ner) and use a Hodrick–Prescott filter to decompose these variables into trend and cyclical components. We then use the cyclical component for the analysis. For the other variables, namely (ffr), ($embi$) and (i), we simply take first differences.

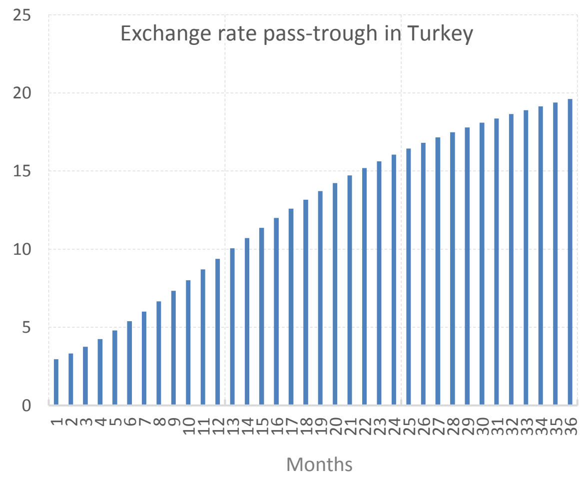
We make the standard assumption of the existing literature that all domestic and external variables have a contemporaneous impact on the nominal exchange rate given that the nominal exchange rate reacts immediately to all innovations. We also assume that consumer prices internalise any news relating to exchange rate and world commodity price developments contemporaneously while the effects of other variables materialise in the subsequent periods.

Employing the above model, we estimate the exchange rate pass-through in Indonesia, Korea, Mexico and Turkey using data for the period ranging from January 2006 to October 2015. Graph 5 shows the cumulative pass-through in Turkey and Mexico. Over a one year horizon, pass-through is close to 10% in Turkey and around 3.5% in Mexico. Over a two year horizon, pass-through is 16% in Turkey and 6.5% in Mexico.[3] These numbers mean that a 10% depreciation of the domestic currency generates 1% and 1.6% in additional inflation in one year and two years respectively in Turkey. These numbers are 0.35% and 0.65% respectively for Mexico.

Graph 5

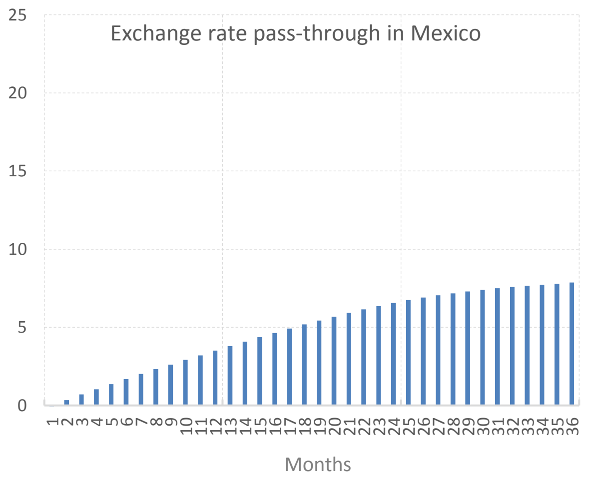
Cumulative exchange rate pass-through to core consumer prices in Turkey

(%; January 2006 to October 2015)



Cumulative exchange rate pass-through to core consumer prices in Mexico

(%; January 2006 to October 2015)

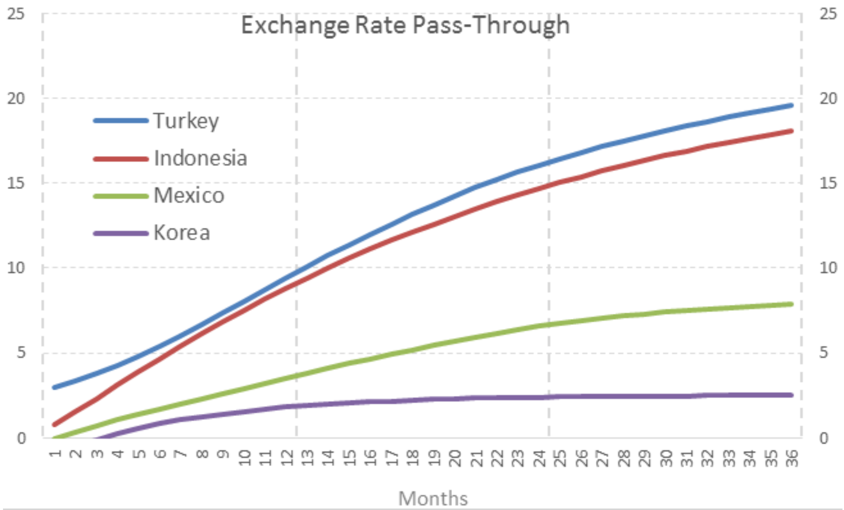


[3] These numbers are consistent with the findings of the literature. For Turkey, see Kilinç and Tunç (2014) and Kara and Ogunc (2012). For Mexico, see Peon and Brindis (2014).

In Graph 6, we add the exchange rate pass-throughs for Indonesia and Korea to those of Turkey and Mexico. In one year, pass-through is close to 9% in Indonesia and around 2% in Korea. Over a two year horizon, pass-through is around 15% in Indonesia and 3% in Korea.[4] These numbers mean that a 10% depreciation of the domestic currency generates 0.9% and 1.5% in additional inflation over one year and two years respectively in Indonesia. These numbers are 0.2% and 0.3% respectively for Korea.

Cumulative exchange rate pass-through to consumer prices in Turkey, Indonesia, Mexico and Korea

(%; January 2006 to October 2015) Graph 6



Graphs 4, 5 and 6 present stark differences in the exchange rate effects on inflation in Turkey and Indonesia, on the one hand, and Mexico and Korea on the other. For the same amount of currency movement, inflationary pressures in Turkey and Indonesia are much stronger. Moreover, Turkey and Indonesia experienced much stronger depreciations over the October 2010 to October 2015 period, around 105% and 55% respectively. Over the same period, Mexico experienced a 33% depreciation while it was only 2% in Korea. Even though differences in current account balances do not necessarily account for all of the differences in exchange rate movements, it seems that differences in current account positions could be an important determinant of inflation. Combined with a high pass-through parameter, exchange rate changes exerted significant pressures on domestic prices in Turkey and Indonesia. However, exchange rate effects in Mexico and Korea could be

4 These numbers are also consistent with the findings of the literature. For Turkey, see Kilinç and Tunç (2014), and Kara and Ogunc (2012). For Mexico, see Guillermo Peón and Rodríguez Brindis (2014). For Indonesia and Korea, see Prasertnukul et al (2010).

characterised as moderate to non-existent in comparison.[5] This could be taken to illustrate that high current account deficits could lead to higher inflationary pressures in some EMEs. When combined with a high exchange rate pass-through, this effect could be further amplified. Overall, countries with high current account deficits can face a twin stability problem: financial stability issues relating to the current account and price stability issues relating to inflationary pressures (themselves resulting from exchange rate movements). The relationship we found from the current account deficit to inflation imposes significant constraints on monetary policy, especially if the current account deficit is partly related to structural factors, credit dynamics and/or terms of trade movements. In these cases, the optimal policy mix would require the use of complementary macroprudential policies or other policies.

4. Conclusion

The world economy followed a very volatile path after the GFC. EMEs, in particular, witnessed boom-bust cycles in capital flows and exchange rates. Some EMEs with high current account deficits faced strong downward movements of their exchange rates which put upward pressures on their domestic prices. The combination of high current account deficits and inflation posed a twin stability problem for those economies, resulting in significant constraints on monetary policy and the necessity of adopting complementary policy tools. The exchange rate pass-through is an important parameter of the twin stability problem with a high pass-through amplifying the relationship between current account deficit and inflation.

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5 A simple quantitative analysis shows that in Turkey a 105% depreciation and a 16% pass-through coefficient imply total increase of 17% of inflation; in Mexico a 33% depreciation and a 6.5% pass-through coefficient imply 2% of additional inflation. Given the cumulative consumer price changes shown in Table 1, these pass-through-generated rises in inflation account for around 11% of the cumulative price change in Mexico and around 37% of the cumulative price change in Turkey.

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Inflation in the United Arab Emirates

Central Bank of the United Arab Emirates

1. Introduction

The United Arab Emirates (UAE), as a small economy with an open capital account and pegged foreign exchange rate regime, has limited scope for exerting an independent monetary policy. More specifically, given that its key policy objective is to maintain a stable peg with US dollar, domestic short-term interest rates generally follow US interest rates and therefore, the Central Bank of the UAE (CBUAE) does not anchor the inflation target. Moreover, inflation in the UAE moves for the most part in response to other forces that are not under the direct control of the central bank. Specifically, non-tradables account for 63% of the CPI basket, of which housing accounts for 39% of the total. Further, inflation of tradables (37% of the CPI basket) moves with developments in the nominal effective exchange rate (NEER), largely attributed to bilateral movements in the US dollar with respect to major trading partners.

While there is no explicit inflation target in the UAE, inflation is an important economic indicator which the CBUAE closely monitors.[1] The following discusses the various inflation measurements and assesses the challenges involved in capturing underlying inflation.

2. Inflation measurements

Inflation measures how quickly prices of a basket of goods and services rise in a given period of time. In other words, it measures the general price level, where a positive figure implies an increase in the cost of living and a fall in the purchasing power of money. In general, the prices of a basket of goods and services that are representative of the economy are collected; then the cost of this basket is collated to generate a consumer price index (CPI), which is also called headline inflation. In the UAE, headline inflation measures the price level of a basket of 334 different categories of goods and services, collected by the Federal Competitiveness and Statistics Authority (FCSA). This CPI is calculated by using a Young index, which assumes expenditure weights are constant over time.[2]

1 The CBUAE has developed a collection of other operational and regulatory policy tools, such as liquidity management and macroprudential measures, to complement the traditional monetary policy tools in the absence of independence to set the policy interest rate. These tools play a significant role in better monitoring monetary conditions (including inflation) and safeguarding overall economic and financial stability in the UAE.

2 The Young index differs from the Lowe index, where quantities are constant over time and expenditure shares are price-updated every month. In general, the Young index tends to underestimate price movements relative to the Lowe index.

Nonetheless, headline inflation measures total inflation, including energy and food, which tends to exhibit high volatility. For example, food consumption is dominated by imports, which move with the exchange rate of the US dollar with respect to major trading partners, mostly non-dollarised. Therefore, the published CPI does not always present an accurate picture of an economy's underlying trend change in prices, as sector-specific inflation shocks are unlikely to persist. In line with other central banks and statistical agencies, the CBUAE has designed multiple measures to analyse inflationary trends, which are more likely to assess underlying trends in prices and provide more useful leading indicators of where prices are heading. Such measures include exclusion-based and statistical methods, such as trimmed mean and volatility-weighted measures.

Different price indices are used by the CBUAE to gauge inflation. More specifically, based on the features of the UAE's basket of goods and services, the CBUAE tracks the prices of different goods and services using the following inflation measurements. Examples are provided in Section 3:

i. *Headline inflation (CPI):* FCSA started publishing the CPI on a monthly basis in January 2008. However, temporary shocks, along with other measurement issues, introduce noise into this measure of inflation.

ii. *CPI excluding rent:* As the rent component accounts for 33.8% of the total CPI basket, it is important to examine the price level of rent and non-rent items separately.

iii. *CPI excluding food:* This method excludes food items as they are mostly imported from abroad and have volatile prices. Thus, their temporary price shocks can diverge from the overall trend of inflation.

iv. *Tradable CPI vs non-tradable CPI:* As a small open economy with trade contributing significantly to the economy, the analysis of tradable and non-tradable inflation could provide valuable information on whether inflationary pressures are generated domestically or imported from overseas. Tradable and non-tradable goods represent 37% and 63% of the total CPI basket, respectively.

v. *Trimmed CPI:* This statistical method removes the most volatile items in a given month. The remaining items are re-weighted and the trimmed CPI is calculated. Analysis of the CPI components in the UAE suggests trimming the top 5% and bottom 5% of items is optimal in terms of both volatility and the ability to predict future inflation, though the effect of seasonality needs to be further examined.

vi. Volatility-weighted inflation: This statistical method re-weights the items in the CPI basket by assigning weights based on the inverse of relative volatility, where the most volatile constituents get assigned the smallest weights. However, this methodology has little theoretical underpinning and reduces the impact of major constituents of the basket, such as the rent component.

vii. Apart from various consumer price indices, the NBS published an annual *Producer Price Index (PPI)*, but it only covers the period 2008–11.

Although the CBUAE considers various measures of inflation to better understand and monitor the true underlying inflation trends, due to the limitations in sampling methods in the design and implementation of the consumer expenditure surveys, there are unavoidably measurement biases, such as substitution bias, quality adjustment bias, new products and products attrition bias etc, in the inflation measurement. On top of that, given the relatively short history of the data and the limited information on the sampling techniques, there are no quantitative measurements to measure the magnitude of these biases yet.

Another challenge is that many items in the CPI basket have administered and/or regulated prices. The prices of these goods and services are currently being treated in the same way as other products, and no adjustment has been made accordingly. Further investigation and specific treatment for these administered and regulated goods is needed.

Moreover, there can be potentially large measurement biases for key drivers of headline inflation such as the rent component, which accounts for nearly 34% of the CPI basket. In particular, one has to consider, among other things, whether owner-occupied homes have been included; whether any change in the neighbourhood quality has been taken into consideration; or whether new and old rental contracts have been adjusted properly. A sophisticated and consistent rental measurement method needs to be developed and deployed.

With respect to the role of wage growth and unemployment in shaping inflation, data limitations imply that quantifying such impacts is not possible in the case of the UAE, so far. Such information would be helpful to assess the impact of demand on rental increases and CPI inflation.

3. The inflation process

By examining the subcategories that make up headline CPI, it is clear that the various measurements of inflation differ significantly owing to the different causes of inflation. Therefore, it is important to identify whether a given change in inflation is due to temporary or permanent shocks, so as to identify the underlying inflationary trends. A close examination of UAE inflation measurements follows.

After the 2008 financial crisis, headline CPI in the UAE gradually lifted starting in early 2012, in parallel with the recovery of economic activity, and persisted through 2015. As shown in Table 1, in average terms headline CPI increased by 4.12% in 2015 (year to end-July), while year-on-year CPI increased to 4.43% in July 2015, from 3.1% in December 2014, mainly due to the acceleration in the prices of non-tradable goods and services.

By component, much of the inflation is largely attributable to housing costs, which increased 9.95% year on year in July 2015. The upward housing cost pressure mainly comes from rising rent, along with water and electricity subsidies reform. Other service sector components, such as "Education", "Restaurant and Hotels", and "Transportation", also made notable contributions to headline CPI through 2015. However, prices of imports, such as "Textiles, Clothing and Footwear", were weighed down by the rising nominal effective exchange rate, weak trading partner inflation and falling commodity prices (Table 1).

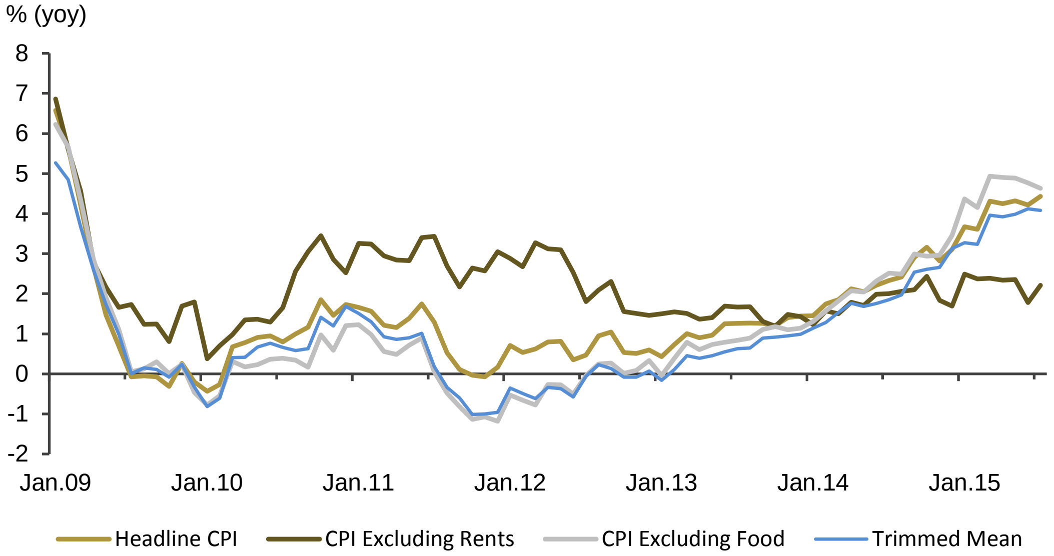
The impact of the rent component on headline CPI inflation becomes evident once we exclude from the latter its most volatile constituents. In 2015, there was upward pressure on overall headline CPI, while CPI excluding rents was well contained. In July, CPI excluding rents increased only 2.2% year on year, compared with 4.43% headline CPI. This reflects the significant contribution of rent to consumer price inflation. Unsurprisingly, other measures of underlying inflation (including the rent component) also displayed an upward trend. Reflecting this, trimmed mean inflation went up 4.08% year on year, while CPI excluding food increased 4.63% year on year in July 2015, surpassing headline inflation (Graph 1).

UAE headline CPI and components (July 2015) Table 1

	Yoy change, %	Year to July average change, %	% weighting
Total	**4.43**	**4.12**	**100**
Food and Soft Drinks	3.4	1.32	13.94
Beverages and Tobacco	–0.92	2.41	0.22
Textiles, Clothing and Footwear	–3.03	–2.00	7.58
Housing	9.95	8.97	39.33
Furniture and Household Goods	1.73	3.14	4.21
Medical Care	–0.05	0.68	1.12
Transportation	0.16	1.15	9.94
Communications	–0.07	0.28	6.93
Recreation and Culture	–0.03	0.11	3.07
Education	3.93	3.96	4.00
Restaurants and Hotels	3.26	2.29	4.35
Miscellaneous Goods and Services	0.35	3.12	5.31

Sources: FCSA and CBUAE

Underlying inflation measurements Graph 1

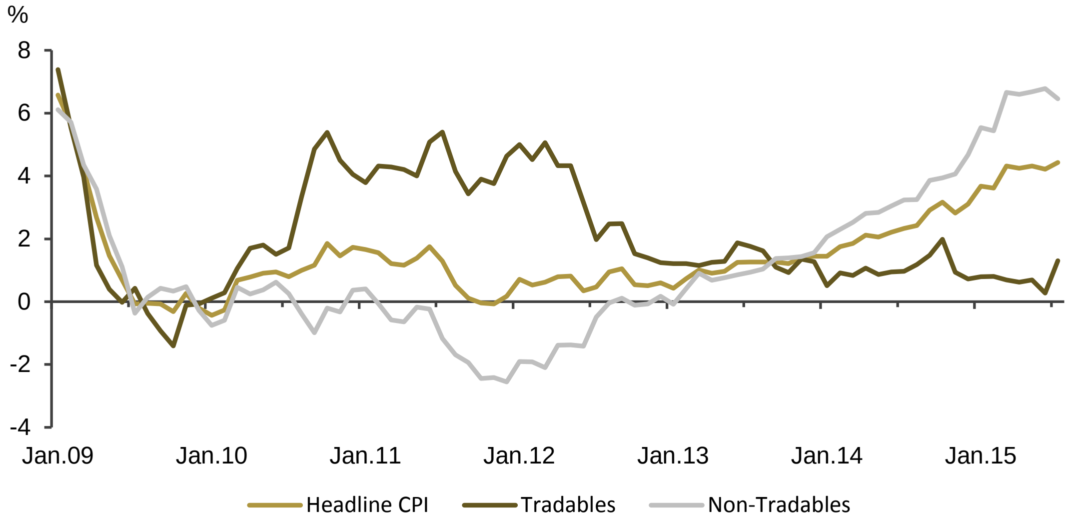


Sources: FCSA and CBUAE

As Graph 2 shows, the acceleration of inflation was largely attributable to domestic factors in 2015. Non-tradable inflation, representing 63% of the total CPI basket, increased 6.5% year on year in July 2015. This is mainly due to the increase in rent prices and the government's decision to remove energy subsidies, while the prices of other non-tradable goods and services were well contained. Non-tradable inflation excluding rent, which accounts for around one third of the CPI basket, increased 3.4% year on year.

Non-tradable inflation and tradable Inflation

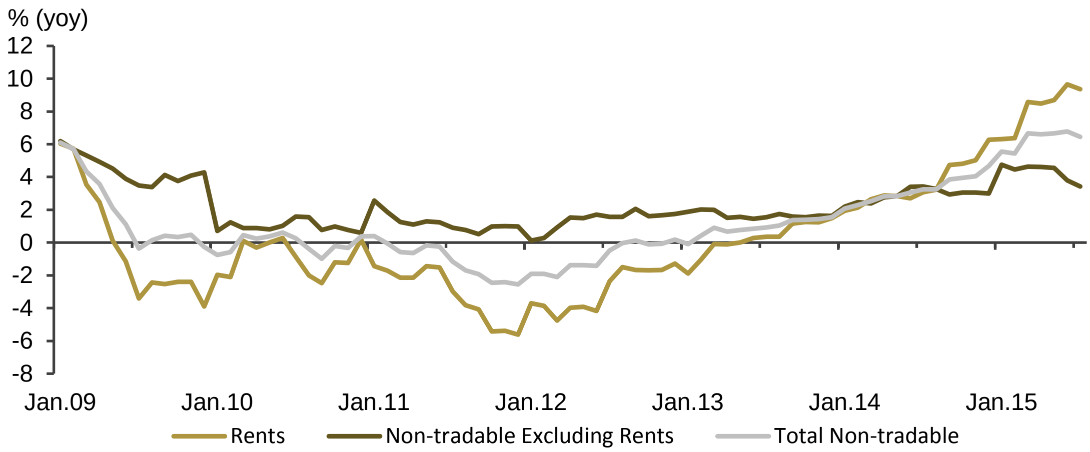
Graph 2



Sources: FCSA and CBUAE

Non-tradable inflation

Graph 3

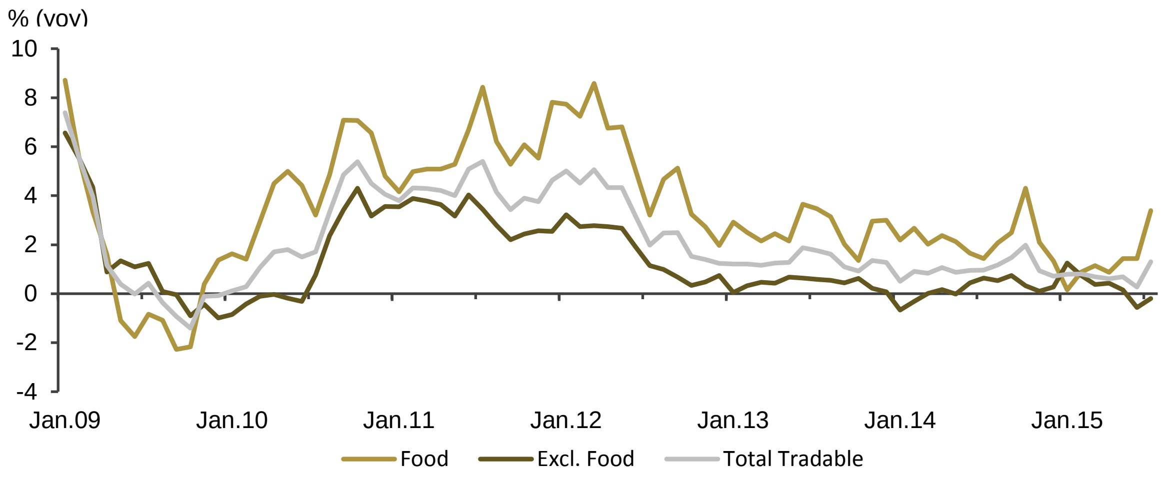


Sources: FCSA and CBUAE.

In contrast to non-tradable inflation, inflation of tradables, which account for 37% of the CPI basket, was relatively subdued, with a year-on-year increase of 1.3% in July 2015. As tradable goods are either import- or export-competing, their prices tend to be influenced by movements in the NEER), mostly on account of bilateral movements in the dollar exchange rate with non-dollarised trading partners, global commodity prices and trading partners' inflation. For a small open economy such as the UAE, exchange rate movements of the domestic currency relative to those of the respective major trading partners play a significant role in the inflation process. Therefore, the strong NEER due to the strengthening US dollar contributed to the low tradable inflation, which increased just 0.74% in average terms (year to end-July). Moreover, low inflation in key trading partners also helped contain tradable inflation.

Tradable inflation

Graph 4



Sources: FCSA and CBUAE.

The overall analysis reveals that much of the weakness in tradable inflation was attributed to non-food items, which accounts for around 23% of the CPI basket. Tradable inflation excluding food decreased 0.2% year on year in July 2015. For food items, weakening global prices of soft commodities saw low food price inflation in the first half of 2015 in addition to the appreciation of the dirham. However, a significant pickup in food prices was observed in July, mainly due to the Eid holiday. Although the increase in food prices pushed up tradable inflation that month, its impact is considered transitory and does not alter the trend of the underlying tradable inflation.

Accounting for the movements of the different CPI subcomponents, it is projected that headline CPI will ease gradually owing to falling commodity prices, weaker inflation registered by the UAE's trading partners, a strong NEER and moderate rent prices slowly feeding into CPI.

4. Inflation expectations

Currently, there are no surveys of inflation expectations available in the UAE. In addition, due to the relatively less developed bond market, no market-based measures of inflation expectations (such as inflation-linked government bonds and inflation swaps) have been formed yet.

List of participants

Central banks

Central Bank of Argentina	**Lucas Llach** Deputy Governor
Central Bank of Brazil	**Tony Volpon** Deputy Governor
Central Bank of Chile	**Joaquín Vial** Member of the Board
People's Bank of China	**Yong Yin** Assistant Governor **Ye Liu** (B) Director, International Department **Wangxin Hu** (B) Secretary to Assistant Governor
Bank of the Republic (Colombia)	**Hernando Vargas Herrera** Deputy Governor
Czech National Bank	**Vladimír Tomšik** Vice Governor and Member of the Board
Hong Kong Monetary Authority	**Lillian Cheung** Executive Director (Research)
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Bank Indonesia	**Hendar** Deputy Governor **Agung Bayu Purwoko** (B) Assistant Director **Ferry Kurniawan** (B) Manager, Economic and Monetary Policy Department
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Bank of Korea	**Min Chang** Director General of the Research Department
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National Bank of Poland	**Andrzej Raczko** Member of the NBP Management Board
Saudi Arabian Monetary Agency	**Tareq Al-Sadhan** Deputy Governor for Supervision
Monetary Authority of Singapore	**Keen Meng Choy** Principal Economist and the Head of Economic Analysis
South African Reserve Bank	**Kuben Naidoo** Deputy Governor
Bank of Thailand	**Jaturong Jantarangs** Assistant Governor, Monetary Policy Group
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