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International evidence on tradables and nontradables inflation

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Abstract

Using 1970–85 sectoral data for the OECD we find that inflation in nontradable goods exceeds inflation in tradables. We identify a demand shift towards nontradables and faster growth of total factor productivity in the tradable goods sector as the prime causes of the differential inflation. In addition, disinflation attempts and the exchange rate regime appear to have exerted significant influence on the relative inflation rate.

Key words: Exchange rate regime; Productivity growth; Real exchange rate; Sectoral inflation

JEL classification: F41; F43

1. Introduction

The disinflation experiences of the 1970s and 1980s, both within the group of OECD countries and outside it, have highlighted the role of international markets. Inflation appears to behave differently across sectors.[1] Indeed, exchange rate-based stabilizations have been characterized by a higher rate

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[1] See, for example Kravis et al. (1983), Summers and Heston (1991), De Gregorio et al. (1993), and Micossi and Milesi-Ferretti (1993).

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of inflation in sectors sheltered from international competition. A difference in the behavior of inflation across sectors is also the defining feature of fluctuations in the real exchange rate (the relative price of nontradable goods[2]) in two-sector models of small open economies.[3] Hence, discussions of exchange-rate misalignment have to focus on sectoral inflation.

In this paper we take a closer look at the determinants of differentials in sectoral inflation rates. We examine the time-series and cross-sectional behavior of the relative price of nontradables in terms of tradables in a sample of 14 OECD countries during the period 1970–85. We begin with the traditionally dominant supply side explanations, resting on the assumption of faster productivity growth in the tradables sector (Balassa, 1964; Samuelson, 1964).[4] The supply side approach yields a negative correlation between relative prices and relative production across sectors. In contrast, we find that in most OECD countries the increase in the relative price of nontradable goods has been accompanied by an increase in the share of output produced in the nontradable goods sector. We hence consider demand side shifts as additional determinants of relative price movements. Finally, we compare the evidence for the quasi-fixed exchange rate regime in the core EMS and the managed flexible exchange rate system in non-core European and non-European economies to determine whether the exchange rate regime played a role in addition to the demand and supply side factors.

The paper is divided into seven sections. We begin in Section 2 by discussing the basic theoretical framework underlying our analysis. In Sections 3 and 4 we describe the data and propose a measure of tradability underlying our later empirical work. In Section 5 we discuss the time-series and cross-sectional properties of relative prices and their determinants. Section 6 reports regression results aimed at disentangling the supply, demand and macroeconomic determinants of the relative price of nontradable goods. Section 7 concludes.

2. A conceptual framework

Balassa (1964) and Samuelson (1964) formalized – see also Harrod (1939,

[2] For specificity, we will throughout the paper use the expression 'relative price of nontradables'. Nevertheless, it is useful to bear in mind that an increase in this relative price corresponds to a real appreciation.

[3] Developed originally by Salter (1959) and Swan (1960), and extended to incoroporate intertemporal effects by Dornbusch (1983), Edwards (1989), Frenkel and Razin (1992) and Rogoff (1992), among others.

[4] Kravis and Lipsey (1983) and Bhagwati (1984) present an alternative supply side view based on factor endowment differentials. The fairly narrow distribution of relative factor endowments across OECD economies renders this approach more relevant for discussion of relative price movements between LDCs and DCs than for the datasets underlying our analysis.

Ch. IV), for an earlier discussion of this idea – what has since become the benchmark model of real exchange rate determination: faster productivity growth in the tradable than in the nontradable goods sector leads, via wage equalization, to a decline in the relative price of tradables.

To illustrate their proposition, consider the following production functions for the two sectors:

$$Y_T = \theta_T L_T^{\alpha^T} K_T^{1-\alpha^T} \tag{1}$$

and

$$Y_N = \theta_N L_N^{\alpha^N} K_N^{1-\alpha^N}, \tag{2}$$

where the subscripts T and N denote tradable and nontradable goods, Y denotes output, L labor input, and K capital. Under perfect competition prices in each sector are derived by duality as

$$P_T = \frac{1}{\theta_T} W^{\alpha_T} R^{1-\alpha_T} \alpha_T^{-\alpha^T} (1-\alpha_T)^{-(1-\alpha_T)} \tag{3}$$

and

$$P_N = \frac{1}{\theta_N} W^{\alpha_N} R^{1-\alpha_N} \alpha_N^{-\alpha^N} (1-\alpha_N)^{-(1-\alpha_N)}, \tag{4}$$

where W is the unit cost of labor and R the rate of return on capital. Consider the case of a small open economy with perfect capital mobility, and express all prices in terms of the tradable goods (P_T is the numeraire). Perfect capital mobility and law of one price in the tradable goods sector ensures that the rate of return in tradables R is equal to its world value. Defining P as the relative price of nontradable goods, log-differentiating the expressions for prices, and then solving for the difference, it can be shown that

$$\hat{P} = \hat{\theta}_T - \hat{\theta}_N + (\alpha_N - \alpha_T)\hat{W}, \tag{5}$$

where the $\hat{}$ denotes the rate of change.

Given R, Eq. (3) uniquely determines wages. Given both W and R, Eq. (4) then uniquely determines the price of nontradables. Hence, as Rogoff (1992) emphasizes, under the joint assumption of a small open economy and perfect capital mobility the relative price of nontradable goods is determined exclusively by technological conditions and is *independent of demand conditions.*

Log-differentiating Eq. (3) and substituting into expression (5) yields an expression for the change in the relative price of nontradable goods:[5]

[5] Rogoff (1992) obtains the same equation from the factor market equilibrium conditions. See also Obstfeld (1993).

$$\hat{P}=\frac{\alpha_N}{\alpha_T}\hat{\theta}_T-\hat{\theta}_N. \tag{6}$$

The intuition for the positive link between faster productivity growth in the tradable goods sector and the relative price of nontradable goods is straightforward: Imagine there is an increase in tradable goods productivity (θ_T) while nontradable goods productivity θ_N remains constant. Given the world real interest rate R and given the price of tradables P_T, the productivity increase is matched by a real wage increase that keeps the marginal cost of tradables constant but increases the marginal cost, and hence the price, of nontradables. In contrast, an increase in θ_N with θ_T constant does not affect wages (determined in the tradable goods sector) and hence leads to a fall in the relative price of nontradables.

While demand shifts have no effects on the relative price of nontradable goods, they do alter the composition of output. To analyze the demand side of the economy, we consider the case of a representative consumer maximizing the present discounted value of

$$u(C_N, C_T)=C_N^{\phi}(C_T-\bar{C})^{1-\phi}, \tag{7}$$

where C_N and C_T denote the consumption of nontradable and tradable goods, respectively. The parameter $\bar{C}$ represents the subsistence level of consumption of tradable goods, yielding a less than unitary income elasticity of the demand for tradable goods. For simplicity, the consumer is assumed to maximize utility on a period-by-period basis, subject to the budget constraint (expressed in terms of tradable goods)[6]

$$I=C_T+PC_N+PG, \tag{8}$$

where I is total income, and G is total government expenditure, falling entirely on nontradable goods and financed through lump sum taxation.

The corresponding demand functions are given by

$$C_T-\phi\bar{C}+(1-\phi)(I-PG) \tag{9}$$

and

$$C_N=\frac{\phi}{P}[I-PG-\bar{C}]. \tag{10}$$

If government expenditure is a constant fraction of total income, $PG=gI$,

[6] The assumption rules out the use of the current account to smooth consumption, and thus ignores the different response of the economy to transitory and permanent shocks. For an intertemporal analysis of the current account and its empirical implications in a similar framework to the one of this paper see Stockman and Tesar (1990) and Glick and Rogoff (1993).

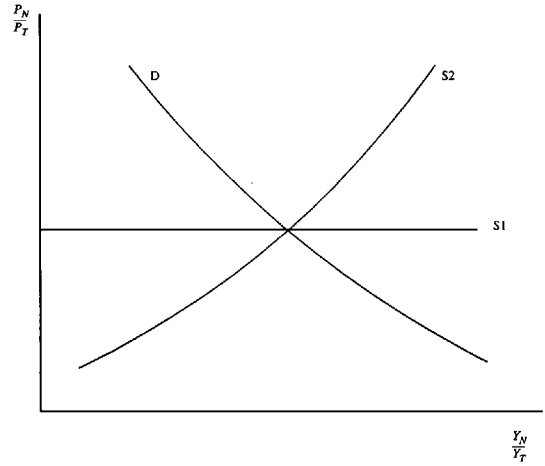

Fig. 1. Equilibrium relative price and production of nontradable goods.

the total demand (public and private) for tradable and nontradable goods equals

$$C_T=(1-\phi)(1-g)I+\phi\bar{C} \tag{11}$$

and

$$C_N+G=[\phi+(1-\phi)g]\frac{I}{P}-\frac{\phi\bar{C}}{P}. \tag{12}$$

Hence for $\bar{C}>0$ the income elasticity of demand for tradables falls short of unity while that for nontradables exceeds unity, thus an increase in income will result in an increase in the consumption share of non-tradables.[7]

Fig. 1 illustrates the determination of relative prices and production as the intersection of the downward sloping relative demand for nontradable goods (the ratio of (12) and (11)) and the relative supply curve. Under the border case of perfect capital mobility the supply curve is horizontal (S1). While supply shocks affect both the equilibrium relative price P and the relative production levels of tradable goods, demand shifts only affect the compo-

[7] See Bergstrand (1991). Relative demands may also be shifted by changes in the preference parameter ϕ (De Gregorio et al., 1993). In this case, increased demand for nontradables is again reflected by an increase in both the relative price and relative production of nontradable goods.

sition of output, but not relative prices. A non-zero slope of the relative supply curve – obtained by relaxing the extreme assumptions of perfect competition in goods and factors markets, law of one price for tradable goods, and perfect capital mobility – is thus a necessary condition for an effect of demand factors on relative prices (S2).[8]

It is useful to further separate shifts in relative demands by origin, distinguishing shifts in the preferences of the private sector from changes in the size of the public sector. Government expenditure has two effects on sectoral demands. It directly produces a range of nontradable commodities, ranging from healthcare to public safety. In addition, the financing of increased expenditures reduces disposable private income, a reduction which, given the income elasticities derived above, falls more heavily on the nontradable sector. As the overall decline in private sector spending on nontradables falls short of the increase in government spending on nontradables, the net effect of an increased public sector share is a shift in relative production and consumption towards the nontradable sector.

3. Data

The empirical work is based on the OECD international sectoral database, comprising 14 countries[9] and 20 sectors.[10] The dataset includes output data in nominal and real terms, permitting the construction of sectoral deflators, as well as detailed input data, permitting the derivation of sectoral total factor productivity levels.

We augment the OECD database by data on inflation, total government expenditures, and government expenditures on goods and services, taken respectively from the IMF *International Financial Statistics*, the IMF *World Economic Outlook*, and the United Nations *Detailed National Account Statistics*. We also use data on per capita GDP from the IMF *World Economic Outlook*. Our classification of sectors according to their level of

[8] The last option has been followed by Rogoff (1992) to find an explicit solution for changes in the real exchange rate in a model without capital mobility across sectors. See also Froot and Rogoff (1991b) for additional discussion.

[9] Australia (AUS), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (GER), Italy (ITA), Japan (JPN), the Netherlands (NLD), Norway (NOR), Sweden (SWE), the United Kingdom (GBR) and the United States (USA).

[10] (1) Agriculture, (2) mining, (3) food, beverages, tobacco, (4) textiles, (5) wood and wood products, (6) paper, printing, publishing, (7) chemicals, (8) non-metallic mineral products, (9) basic metal products, (10) machinery, equipment, (11) other manufactured products, (12) electricity, gas, water, (13) constructions, (14) wholesale and retail trade, (15) restaurants, hotels, (16) transport, storage, communication, (17) finance, insurance, (18) real estate, (19) community, social and personal services and (20) government services.

tradability, discussed in the next section, is based on sectoral export data reported in the United Nations *Trade Statistics* for commodity exports, and in the IMF *Balance of Payment Statistics* for service exports.

4. Tradability

The theoretical literature on real exchange rates relies upon a neat division of commodities into 'tradables' and 'nontradables'. Unfortunately few real world commodities fall easily into the nontradable category. Indeed, as Roy Harrod pointed out, virtually all commodities are tradable within some area, with the extent of the area determined by transportation cost. Notwithstanding, most economists would argue that certain commodities are in some sense inherently 'less tradable' than others.

Shifting from theoretical to empirical work requires an operationalization of this prior. An obvious benchmark for tradability is the extent to which a particular good *is* actually traded. This benchmark implicitly underlies the shortcut adopted in most empirical work of labeling manufactures as 'tradables' and services as 'nontradables'. While historically quite accurate, the often cited globalization of service markets casts doubts on the continued validity of this simple dichotomy for recent years. We make the implicit assumption explicit and base our classification on the ratio of *total* exports across all 14 OECD economies to *total* production across all 14 countries for each sector. We define a sector as 'tradable' if more than 10 percent of total production is exported. While the measure remains subjective in the selection of the particular threshold, it has the virtues of being based on the sample data and being easily subjectable to sensitivity checks.

Table 1 reports the ratio of total exports across the 14 sample OECD countries to the total value of production, both converted into US dollars, for all sectors.[11] Among the four main sectors, manufacturing is seem to be most tradable under this definition, with exports amounting to 45.2 percent of production, following by mining with 31.5 percent, agriculture with 23.6 percent and services with 4.3 percent. All sectors experience a sizeable increase in tradedness between 1970 and 1985, with a particularly pronounced increase in manufactures. The table provides little support for rapidly increasing service exports suggested in some informal accounts. Rather, the aggregate results support the standard practice of treating manufactures as tradables and services as nontradables goods.

A look at more disaggregated data reveals substantial variation. Within manufacturing, export shares range from 60 percent for metal manufacturing

[11] As far as possible, missing observations were matched to avoid distortions.

Table 1
Tradedness[a]

	1970	1975	1980	1985	Mean	T/NT
Agriculture	17.3	24.3	28.1	24.7	23.6	T
Mining	29.6	36.9	27.9	31.4	31.5	T
Manufacturing	32.5	47.1	53.1	48.3	45.2	
Metal manufacturing	42.6	64.5	69.2	63.4	59.9	T
Chemicals	35.6	56.3	71.8	62.6	56.6	T
Basic metals	37.4	49.2	50.7	45.0	45.6	T
Textiles	31.7	42.4	42.5	41.3	39.5	T
Other manufactures	28.1	30.6	39.8	35.8	33.6	T
Paper & products	20.9	26.7	30.2	20.7	24.6	T
Food, bev., tobacco	16.7	24.1	29.9	25.2	24.0	T
Non-metallic minerals	10.3	12.7	16.4	15.4	13.7	T
Services	3.5	4.4	4.9	4.5	4.3	
Transportation	22.9	28.0	31.5	28.8	27.8	T
Other services	1.3	1.9	2.2	2.1	1.9	NT

[a]Export share in total production.

to a low 14 percent for non-metal minerals. Within services, the low overall tradedness contrasts sharply with the 28 percent of transportation services production being exported in 1985. Indeed, the export share of the transport sector, the only subcomponent of services for which reliable export data are available, exceeds the export of three manufacturing subsectors, paper products, food and non-metal mineral products.

Our classification is reported in the last column of Table 1. With a 10 percent threshold, agriculture and mining are classified as tradables, as is all of manufacturing and transportation. The remaining services, accounting for about 50–60 percent of GDP, are treated as nontradables.[12] The sizeable differences between sectoral shares provide our measure with some local robustness: cutting the threshold to 5 percent would have no effect, raising it to 20 percent would shift the quantitatively small non-metal mineral products from tradables to nontradables.

5. Sectoral inflation

Based on the classification derived above, we aggregated the sectoral deflators to obtain aggregate price indices for tradable and nontradable commodities. The same aggregation was used to construct time series on

[12] Our classification coincides with that used by Stockman and Tesar (1991).

Table 2
Change in P_N/P_T: 1970–85

OECD	Mean	St. Dev.
Australia	1.70	3.67
Belgium	2.47	2.02
Canada	−0.03	2.83
Denmark	0.81	2.12
Finland	1.05	2.67
France	1.97	1.63
Germany	1.34	1.75
Italy	1.73	3.25
Japan	3.35	2.42
Netherlands	1.45	3.73
Norway	1.37	4.52
Sweden	1.05	2.98
United Kingdom	1.37	5.04
United States	1.12	2.20

sectoral total factor productivities.[13] We begin our empirical discussion by examining the time-series and cross-sectional properties of these data.

Table 2 reports the mean and the standard deviation of the annual change in the relative price of nontradables to tradables. With the exception of Canada, the relative price of nontradables increased for all 14 OECD economies over the 1970 to 1985 period, at an average of more than 1 percent per year. The results are quite dispersed, ranging from less than zero for Canada to the sustained 3.3 percent higher inflation rate for nontradables in Japan. Differentiating the core EMS economies (those who started within the narrow band in 1979: Belgium, Denmark, France, Germany, the Netherlands) from the remaining OECD economies, however, reveals a substantially lower dispersion of relative inflation rates within the core, suggesting a possible relationship between relative inflation rate dispersion and the exchange rate regime.

Fig. 2 plots the change in the share of nontradables against the average annual change in the relative price of nontradables. The figure reveals a negative correlation: the larger the increase in the relative share of nontradables, the smaller the average annual increase in the relative price of nontradables. The figures furthermore reveal that eight of the 14 OECD economies experienced *both* an increase in the relative price of nontradables *and* an increase in the relative share of nontradables. Only Japan and Norway experienced an increase in the share of tradable goods above half of a percentage point. This positive comovement between relative price and

[13] Since the computations are sensitive to changes in the factor shares across time, we use the average factor share during 1970–85 for each sector and country.

Table 4
Nontradable inflation: Correlations

	JP	CA	US	AU	NO	IT	FI	SW	GB	FR	GE	NL	BE	DN
JPN	1													
CAN	−0.14	1												
USA	−0.15	0.26	1											
AUS	0.55	0.38	−0.01	1										
NOR	0.55	0.33	0.25	0.69	1									
ITA	0.33	−0.15	0.36	0.15	0.61	1								
FIN	0.30	0.49	0.28	0.70	0.87	0.52	1							
SWE	0.44	0.17	0.24	0.44	0.83	0.69	0.83	1						
GBR	0.29	0.07	0.57	0.33	0.70	0.90	0.66	0.77	1					
FRA	0.51	−0.01	0.24	0.41	0.81	0.86	0.73	0.89	0.81	1				
GER	0.66	0.05	0.01	0.53	0.84	0.74	0.69	0.77	0.68	0.86	1			
NLD	0.63	0.08	0.16	0.43	0.87	0.76	0.73	0.83	0.71	0.90	0.94	1		
BEL	0.69	0.02	0.09	0.43	0.83	0.74	0.72	0.88	0.69	0.90	0.91	0.97	1	
DEN	0.68	0.14	0.00	0.54	0.83	0.65	0.74	0.81	0.58	0.87	0.93	0.94	0.95	1

relative purchasing power parity, the correlation would approach unity. In line with a sizeable previous literature, PPP in this simple sense is rejected for the overall sample. Looking separately at the EMS, core, however, reveals a fairly close correspondence: the correlation of the German tradables inflation rate with France amounts to 0.89, with the Netherlands to 0.94, with Belgium to 0.93 and with Denmark to 0.94. In contrast, the correlation with European non-EMS economies and non-European countries is significantly lower, with a zero correlation with the US and a negative correlation with Canada. The data thus suggest a fair degree of comovements of tradable prices within quasi-fixed exchange rate blocs, with fairly small correlations between countries linked by flexible exchange rates.[14]

Interestingly, both the same pattern and – more strikingly – almost the same numerical values are observed for the correlations of nontradable goods inflation rates (Table 4). Again, the average correlation between core countries, at 0.92, substantially exceeds both the average correlation within non-core countries (0.74) and the average correlation across the entire sample (0.53).

The close comovements of both tradable and nontradables prices across the core admits two explanations under the framework laid out above. First, productivity shocks to both the tradable and nontradable sectors could be more similar within the core compared to between core and non-core. Second, demand side shocks, such as fiscal shifts and income growth, could be more correlated within the core. Moving beyond the narrow confines of

[14] This is consistent with the findings of Mussa (1986).

Table 5
Average correlations

Variable	European countries		Non-Eur.	OECD
	Core EMS countires	Non-core sample		
1971–85				
Tradable goods inflation	0.93	0.76	0.46	0.62
Nontradable goods inflation	0.94	0.79	0.36	0.58
Tradable productivity growth	0.59	0.37	0.61	0.44
Nontradable productivity growth	0.42	0.28	0.28	0.29
Income growth	0.65	0.34	0.60	0.46
Fiscal expenditure growth	0.46	0.29	0.43	0.36

the model, the striking differences between the subgroups of economies operating under fixed and under flexible exchange rates suggests that the exchange rate system may have played an additional independent role.

Table 5 reports the summary of the correlations of demand and supply factors across several groups of countries for the entire 1971–85 period. Among European countries we separate out the core EMS economies (Belgium, Denmark, France, Germany, Netherlands). We also report the average correlations for the subset of non-European countries and the total sample of 14 countries.

The data reveal a moderately positive correlation of both supply side and demand side shocks for the entire sample. Separating the European economies into core and non-core shows a substantially higher correlation of demand and supply shifts within the core. A comparison of European and non-European economies reveals a higher correlation of demand and supply shifts relative to inflation rates for the former, with reverse results for the non-European economies.

The results are suggestive of an additional determinant of inflation correlations in Europe. While the exchange rate regime provides an obvious candidate, the possibility of reverse causation must be taken into account: the higher correlations of sectoral inflation rates and their determinants within the core-EMS countries may precede the creation of the EMS and may indeed have been the reason leading these countries to join the EMS. To control for possible reverse causation we divide the sample period into pre-EMS (1971–78) and post-EMS (1979–85). The results are shown in Table 6. While inflation correlations have increased uniformly across Europe, the correlations of demand and supply side factors have increased for the non-core but decreased for the core economies. The marked difference between core and non-core over the two subsamples is suggestive of an additional role of the exchange rate system in bringing about the higher correlation of inflation rates.

Table 6
Average correlations in European countries: Subperiods

Variable	Core EMS	Non-core	All
1971–78			
Tradable goods inflation	0.86	0.50	0.61
Nontradable goods inflation	0.86	0.60	0.68
Tradable productivity growth	0.70	0.33	0.49
Nontradable productivity growth	0.55	0.25	0.43
Income growth	0.77	0.20	0.45
Fiscal expenditure growth	0.60	0.28	0.41
1979–85			
Tradable goods inflation	0.92	0.92	0.88
Nontradable goods inflation	0.95	0.91	0.87
Tradable productivity growth	0.47	0.36	0.45
Nontradable productivity growth	0.14	0.29	0.19
Income growth	0.40	0.52	0.50
Fiscal expenditure growth	0.32	0.29	0.35

To summarize, our initial exploration of the data has yielded a number of interesting results:

- The relative price of nontradables has increased almost uniformly across the 14 OECD economies over the 1970 to 1985 period.
- Most countries experienced both an increase in the relative size of the nontradables sector and an increase in the relative price of nontradables. The change in relative size and in relative price of nontradables were negatively correlated.
- The correlation of inflation rates, productivity growth rates, income growth and fiscal growth rates has been substantially higher within the quasi-fixed exchange rate bloc of the EMS core compared to non-core countries. For the core economies, the correlation of demand and supply side shifts fall short of the inflation correlations. While the correlation of inflation rates has increased for all European countries in the period 1979–85 compared to the period 1971–78, the correlation of demand and supply side shocks over the same periods increased for the non-core but decreased for the core economies.

6. Determinants of the relative price of nontradables

As a first pass at examining the Harrod–Balassa–Samuelson (HBS) hypothesis, Fig. 3 plots Eq. (6), the weighted relative productivity growth against the change in relative prices. Total factor productivity growth is seen to be higher in the tradable goods sector (corrected by factor shares) for all

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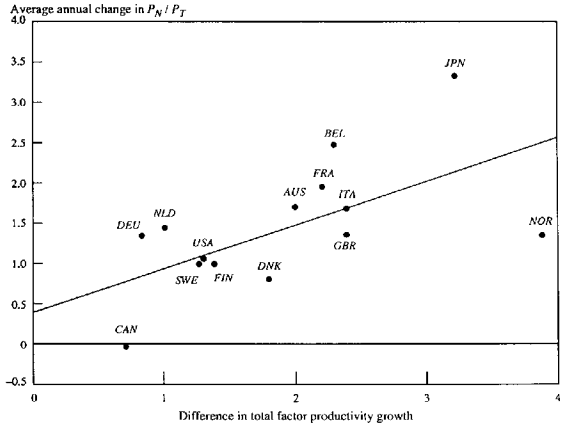

Fig. 3. Differential factor productivity growth and relative price of nontradables (1970–85, percentage).

the sample countries, as suggested by the original HBS hypothesis.[15] Furthermore, the figure reveals the positive correlation between the productivity growth differential and the increase in the relative price of nontradable goods suggested by HBS.

Taken in conjunction with the finding in Fig. 2 of a negative relationship between the relative change in the price of nontradables and the increase in the share of nontradables, a first glance at the data thus suggest a significant role of supply side factors. However, the simultaneous increase in both the relative price and the relative share of nontradables for a sizeable subset of countries suggests that demand side factors also matter. We next turn to econometric analysis to disentangle the relative contribution of the two effects.[16] To distinguish the two effects, we add demand side factors to the right-hand side of the integral of Eq. (6) and estimate the reduced form equation (13):

[15] This result is (empirically) not driven by the correction α_N/α_T, it holds when both shares are assumed to be the same.

[16] For related empirical evidence on determinants of the real exchange rate see Hsieh (1982), Marston (1987), Froot and Rogoff (1991a, b), Bergstrand (1991), De Gregorio et al. (1993), and Wolf (1993).

$$\log P_{i,t}=\beta_{0i}+\beta_1\theta_{i,t}+\beta_2 g_{i,t}+\beta_3 \log y_{i,t}+\beta_4 \Delta\pi_{i,t}, \tag{13}$$

where θ corresponds to the difference of total factor productivity across sectors corrected by the labor shares ($\theta=(\alpha_N/\alpha_T)\log\theta_T-\log\theta_N$), the subscripts i and t indicate country and time, g is government expenditure over GDP (both in real terms), y is per capita income, and $\Delta\pi$ is the first difference of the rate of inflation.

The coefficient β_1 measures the impact of productivity growth as suggested by HBS with an expected positive sign. The next two variables (g and y) proxy demand shifts. While in general the coefficients depend on both supply and demand side factors, for the specific case of a flat supply curve β_2 and β_3 will be zero. Significant coefficients on income and fiscal growth are thus sufficient to rule out the flat supply curve assumption underlying the pure HBS model. With a positively sloped supply curve, both variables are expected to enter positively. Finally, relaxing the assumption of instantaneous price adjustment in the nontradable sector, we include the first difference of inflation to capture the possibility of transitory dynamics. If price adjustment in the nontradable sector is more sluggish, an attempt to bring about disinflation via exchange rate appreciation leads to a temporary increase in the relative price of nontradables and a temporary expansion of relative tradables production, leading to a predicted negative sign on β_4. For example, De Gregorio et al. (1993) discuss the effects of unwarranted wage increases reflecting e.g. lacking credibility of macroeconomic policy(makers). With the law of one price holding in tradables, the wage pressure will be manifested solely in the nontradable sector, resulting in an increase in the relative price of nontradable goods and a reduction in the relative output of tradables.

Because of the high persistence of the explanatory variables as well as of the residuals in the level equation, all regressions were run in first differences using seemingly unrelated regression with common coefficients across countries. The results are presented in Table 7.[17] Estimation by SUR in first differences eliminates the constant.[18] All regressions but 3 and 4 use total

[17] To test for robustness, all regressions reported in this section and the evidence presented in the previous section were performed with two alternative classifications. The first one excluded electricity, gas and water, production of government services, and other services from the nontradable goods sector, and included transportation, storage and communication services as nontradable goods. The second alternative classification looked at a narrower set of sectors, by including only manufacturing as tradable goods; and wholesale and retail trade, restaurants, hotels, transport, storage, communication, finance, insurance, real estate, and community, social and personal services as nontradables. Overall, the results were robust to this change of classification, indicating that our results are not stemming from some specific sector misclassified.

[18] To capture potential country specific effects, the regressions were also estimated with country specific intercepts, and the results did not change significantly.

Table 7
Regression results[a]

Regression no.	β_1	β_2	β_3	β_4	No. of obs.
1	0.234	1.974	0.281		210
	(0.018)	(0.119)	(0.030)		
2	0.234	1.846	0.272	−0.045	210
	(0.015)	(0.104)	(0.025)	(0.010)	
3	0.208	2.015	0.292		180
	(0.019)	(0.119)	(0.024)		
4	0.246	0.428	0.169		180
	(0.032)	(0.291)	(0.042)		
5	0.375	1.496			210
	(0.015)	(0.099)			
6	0.267		0.092		210
	(0.023)		(0.027)		
7	0.328				210
	(0.013)				
8	0.235	1.936	0.296	−0.037	210
	(0.017)	(0.113)	(0.027)	(0.011)	

[a]All regressions were estimated using SUR for the first differences of (13). Regressions 3 and 4 uses a narrower measure of government expenditure (see text). Regression 8 includes two dummy variables for the oil shocks (see text).

government expenditure in GDP, with a sample average of 19.4 percent. Regression 3 excludes from government spending the sub-category 'total purchases of goods and services', with a sample average of 5.2 percent, to obtain a closer approximation of spending on nontradables. The remaining government expenditure comprises mostly employment compensations, amounting to roughly three quarters of total government expenditure. Regression 4 uses, instead, only purchases of goods and services. The number of observations in regressions 3 and 4 declines because data are not available for Belgium and Italy.

The coefficients on total factor productivity differentials have the expected value in all the specifications and are statistically significant. The average coefficient estimate of 0.23 (in regressions 1–4) implies that a 3 percentage points faster productivity growth in the tradable goods sector results in a 0.7 percent increase in the relative price of nontradables. The coefficient on total factor productivity differentials increases somewhat when income growth or changes in government expenditure are omitted from the regressions (see 5–7). The highest point estimate is 0.38.

The coefficient on total government expenditure over GDP (regressions 1–

2 and 5–8) is always positive and significant, with point estimates ranging between 1.5 and 2.0, suggesting that an increase of one percentage point in the share of government expenditure increases the relative price of nontradable goods by 1.5 to 2 percent. Regression 3, which uses employment compensations, shows no significant differences with 1. However, regression 4, which uses only the subcategory of purchases of goods and services, yields an insignificant coefficient, lending credence to the use of the compensation variable as a better measure of government nontradables spending.

The second demand variable, income growth, enters positively as expected, and in most cases significantly, with a coefficient in the order of 0.24 and 0.29 (except in regressions 4 and 6, where the exclusion of the relevant component of government expenditure reduces the point estimate to 0.17 and 0.09, respectively) suggesting that a five percent income growth would be matched by a 1 percent increase in the relative price of nontradables. Several authors have interpreted the positive correlation between the relative price of nontradables as an indication of the importance of productivity differentials (e.g., Kravis et al., 1983). Implicitly, these authors thus associate income growth solely with supply rather than demand factors. The regressions, however, reveal an effect of income growth on the relative price of nontradable goods even after controlling for productivity differentials, justifying its interpretation as an indicator of demand.

Regressions 2 and 8 reveal some evidence for differential price adjustment speeds across sectors: in the sample, disinflation is associated with an increase in the relative price of nontradables, suggesting more flexible tradable goods prices in line with the discussion of Section 2. The finding is consistent with the real appreciation typically observed in the aftermath of exchange rate stabilizations. Interestingly, the effect appears to be common across exchange rate regimes: including a dummy variable interacting with the acceleration of inflation for core EMS economies versus non-EMS yielded an insignificant coefficient.

Finally, we examine the potential role of the two oil price shocks falling within our sample. By inducing a simultaneous decline in both income and the relative price of nontradables, an oil price increase potentially enhances the negative correlation illustrated earlier. Regression 8 includes two dummy variables for the oil shocks, taking values of one in 1974–75 and in 1979–80 respectively. However, little evidence for a major role emerges: the dummies were marginally significant, and the parameter estimates remain almost unchanged. Including measures of the real price of oil likewise does not suggest that the two oil price shocks contributed significantly to the stylized facts presented above.

The results presented so far suggest a rather more important role for demand side movements than suggested by the previous literature. To some degree, our results may, however, depend on the use of relatively high

Table 8
Actual and explained changes in P_N/P_T. Full OECD sample

	Actual	Productivity differential	Government expenditure	Income growth	Residual
Short run	1.31	0.42	0.10	0.61	0.18
Long run	1.31	1.24	0.00	0.07	0.00

frequency data, potentially concealing long-run trends. While our results reject the notion of a short-run flat supply curve, it may be more reasonable to think of perfect capital mobility as holding over the long run, and thus of the supply curve becoming flatter as the observation frequency declines. To allow for this possibility we estimate regression (13) using the average rate of growth of the variables during the period 1970–85:[19]

$$\Delta \log P_i = \underset{(0.278)}{0.741}\,\Delta\theta_i - \underset{(0.074)}{0.002}\,\Delta g_i + \underset{(0.238)}{0.032}\,\Delta \log y_i, \qquad (14)$$

$R^2 = 0.31$, and No. of obs. = 14.

The coefficient on total factor productivity differentials increases and becomes insignificantly different from unity. In contrast, the coefficients on the share of government expenditure and per capita income become insignificantly different from zero, indicating an increased importance of supply and a diminishing importance of demand factors in the long run.

In order to disentangle the relative importance of demand and supply factors in the rising trend of the relative price of nontradables, Table 8 uses the estimated short- (regression 1 in Table 7) and long-run (Eq. (14)) regression equations to decompose the average annual increase in the relative price of nontradables into the contribution made by the faster growth of total factor productivity in the tradable goods sector, the contribution made by increasing government expenditures and income, and a residual. While the high correlation among the explanatory variables suggests some caution in interpreting the table, the results indicate that in the short run demand side factors, in particular income growth, rather than relative productivity growth differentials were the dominant determinant of relative price changes over the sample period. Government spending plays a fairly secondary role, reflecting the small overall change in the share of government spending during the sample period (see also De Gregorio et al., 1993). In the long run, as reflected in the coefficients of Eq. (14), most of the increase in the relative price of nontradables can be explained by the faster increase of total factor productivity in the tradable goods sector.

[19] Since we are interested in trend movements, we exclude the temporary effects from changes in inflation.

7. Concluding remarks

The failure of high inflation countries in the OECD to converge towards their better performing partners has been often attributed to lacking credibility arising from the strategic interactions among unions, employers, and policymakers. The results of this paper suggest that more fundamental factors may also be to blame.

Examining sectoral data for 14 OECD countries we find that inflation over the 1970 to 1985 period has been driven predominantly by the nontradables sector. Examining the determinants of relative inflation rates we find empirical support for several effects. First, through its impact on the composition of demand, trend growth in income (and to a lesser extent government spending) has contributed to the increase in the relative price of nontradables. Second, higher trend growth of total factor productivity in tradables has operated in the same direction, suggesting that efforts to raise productivity growth in the nontradables sector, for example by stimulating increased competition, may provide a promising avenue towards disinflation. Third, we also find that the relative price of nontradables decreases as inflation accelerates, suggesting differential adjustment speeds across sectors.

The data reveal a substantially higher correlation between demand and supply shifts, and hence of relative price movements for the EMS-core countries. Moreover, sectoral inflation rates are substantially more correlated among the EMS core than are the demand and supply factors. These findings sugget a potential effect of the exchange rate regime on relative price movements.

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