

Macro II, MAGCEA

Primavera, 2005

R. Bergoeing

The Micro Sources of Aggregate Growth

Motivation

- There is a strong link between aggregate growth, aggregate productivity, and plant dynamics.
- Obstacles to reallocation and aggregate growth: they reduce the level of efficiency and speed at which efficiency gains are obtained.
 - Poverty
 - Stagnation
 - Catching up with world knowledge

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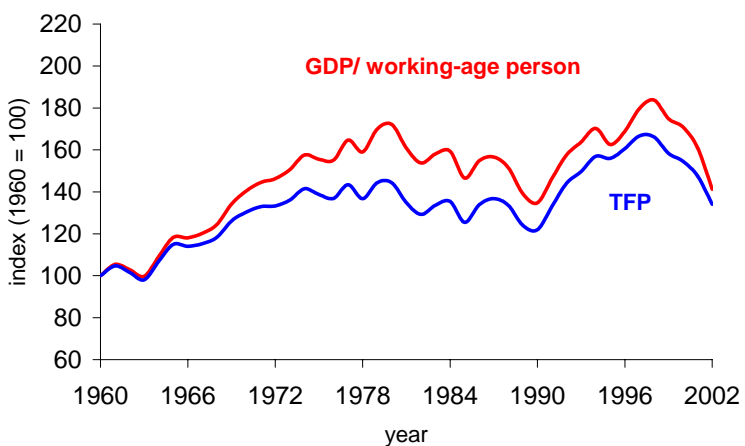
- Slow recoveries

- Reaping the benefits from market reforms

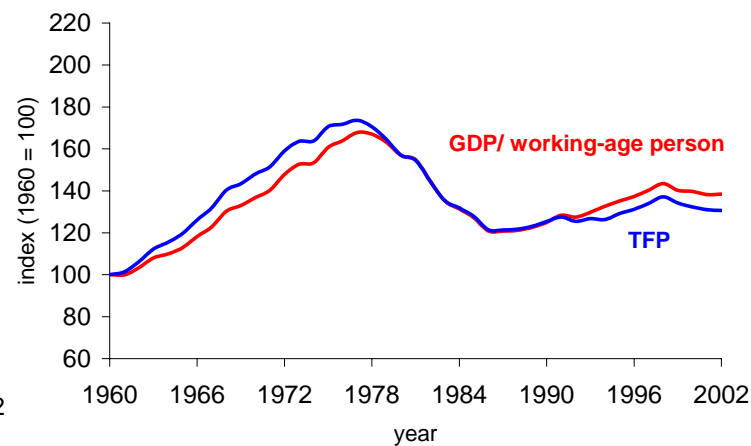
I. Evidence: The world and Chile

- High correlation between aggregate efficiency and growth (> 0.8)
- Reallocation accounts for a large fraction of efficiency gains ($> 50\%$). Entry-exit is key (most efficiency gains in Chile during the 1990s.)
- Distortions that alter plant dynamics reduce income and retard growth.

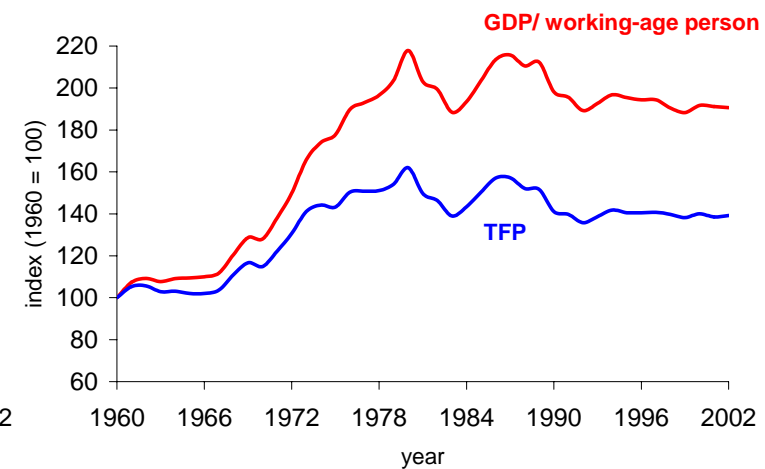
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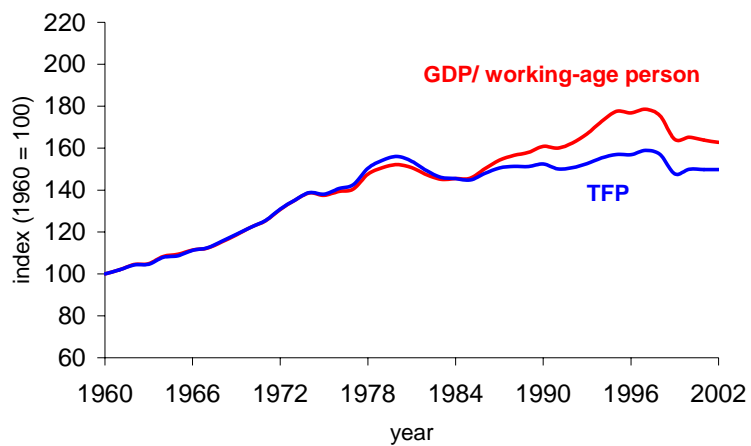
Bolivia



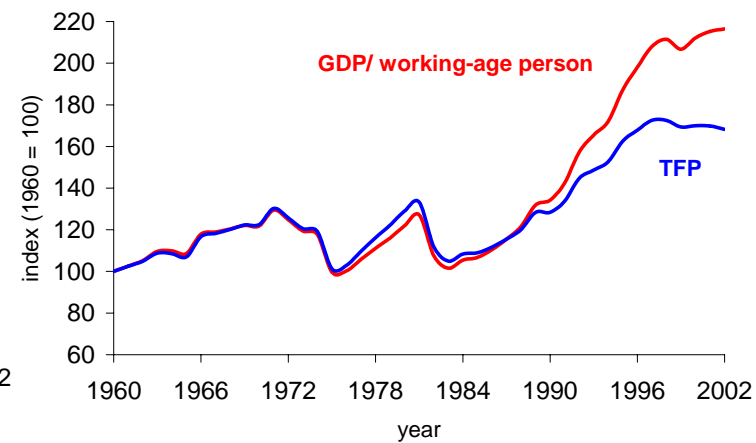
Brazil



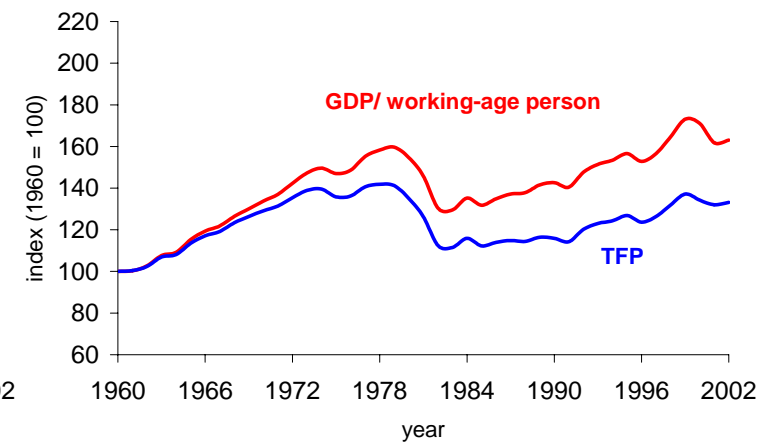
Colombia



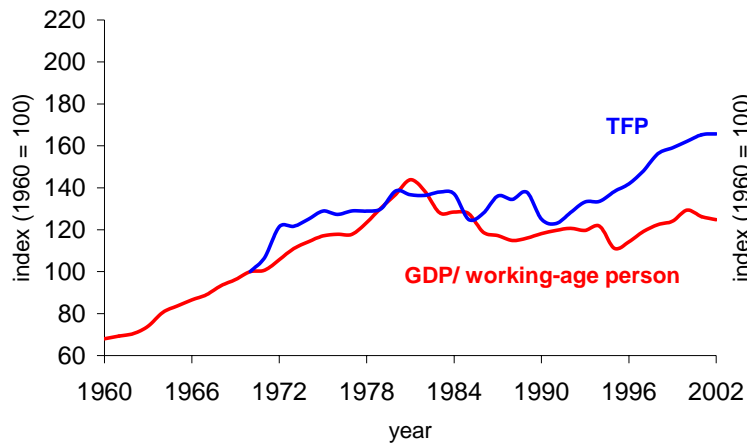
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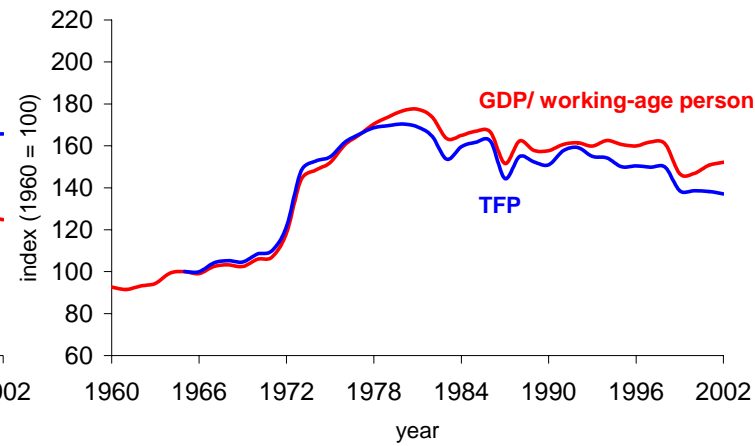
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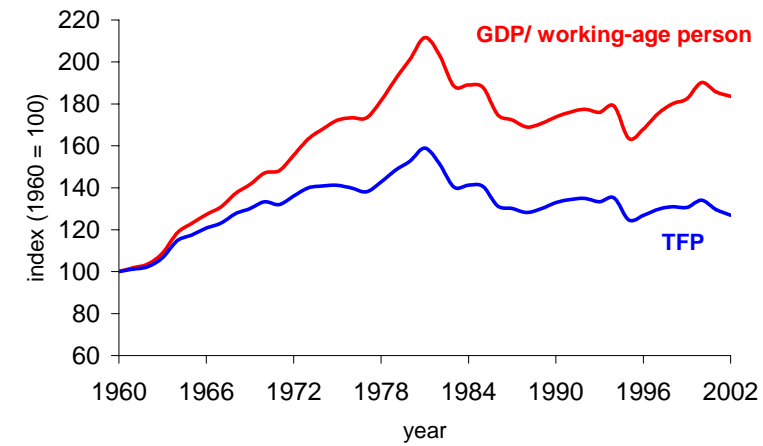
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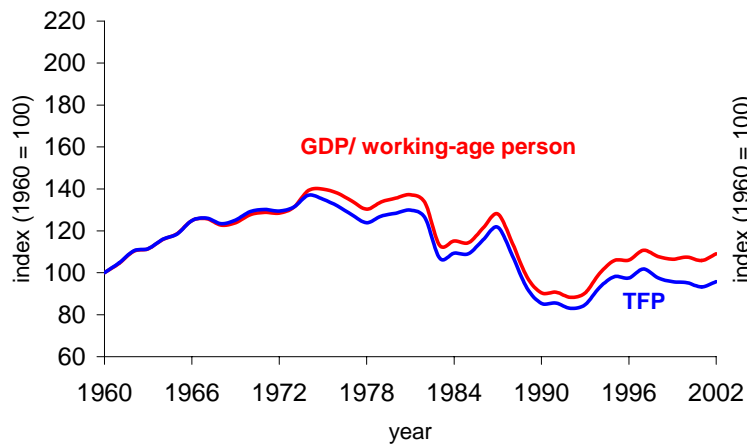
Ecuador



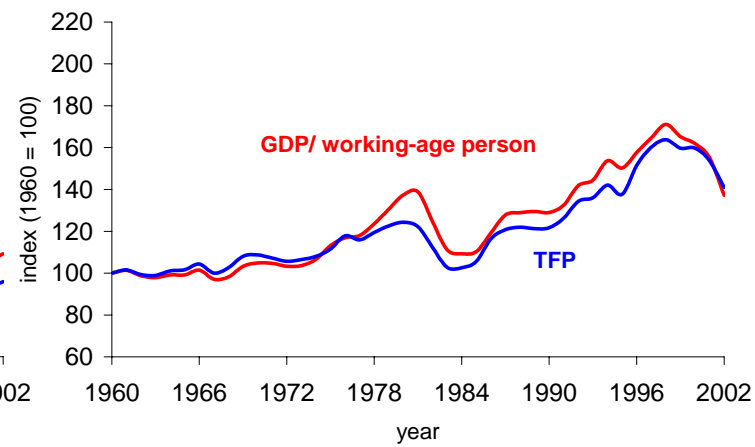
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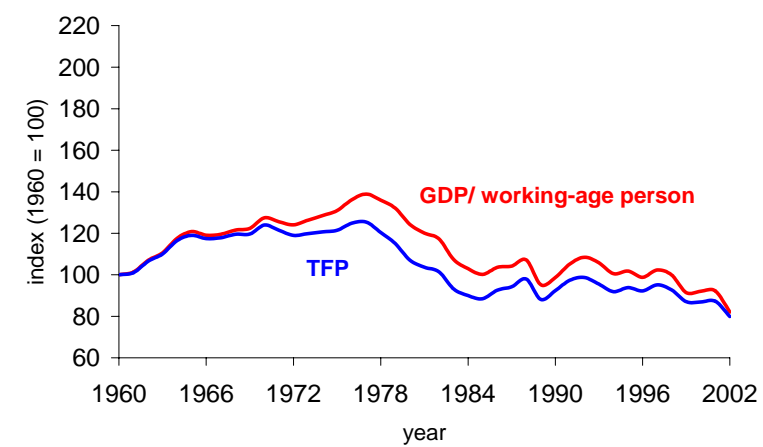
Peru



Uruguay



Venezuela



Reallocation of output and inputs across individual producers accounts for a large fraction of total efficiency gains.

- Nicoletti and Scarpetta (2003): OECD > 50%
- Bergoeing, Hernando and Repetto (2004): Chile > 70%. Most gains result from the entry-exit margin.
- Haltiwanger et al. (2004): Colombia > 90%

The dynamics of plant-level productivity in Chile

The data (ENIA)

- Annual Census of Manufacturing (1980-01)
- Data at 4 digit ISIC level
- All continuing and newly created plants with total employment of at least ten employees
- 50% of total industrial employment

Stylized facts in Chile

- Simultaneous creation and destruction (13.2% and 12.8% for labor, and 10.3% and 7.3% for capital).
- Correlation between creation and destruction:
 - 1980-1999: - 0.75
 - 1984-1996: - 0.39
- Total factor productivity:
 - Within-sector wide differences in levels.
 - Upward trend and procyclical growth.
 - Incumbents are more productive than startups and shutdowns in most (but not all) sectors.

TFP and Value added (all sectors)

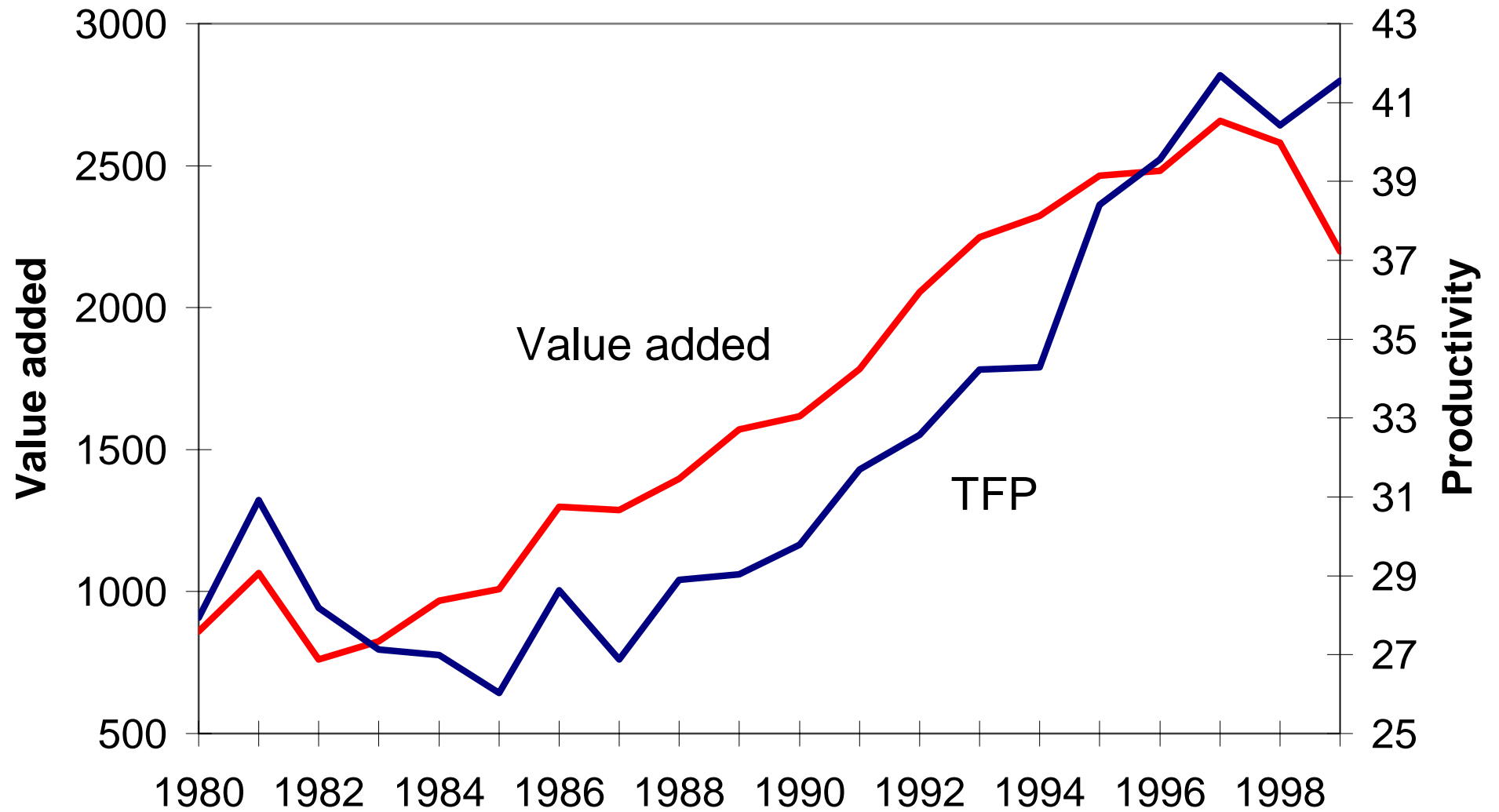
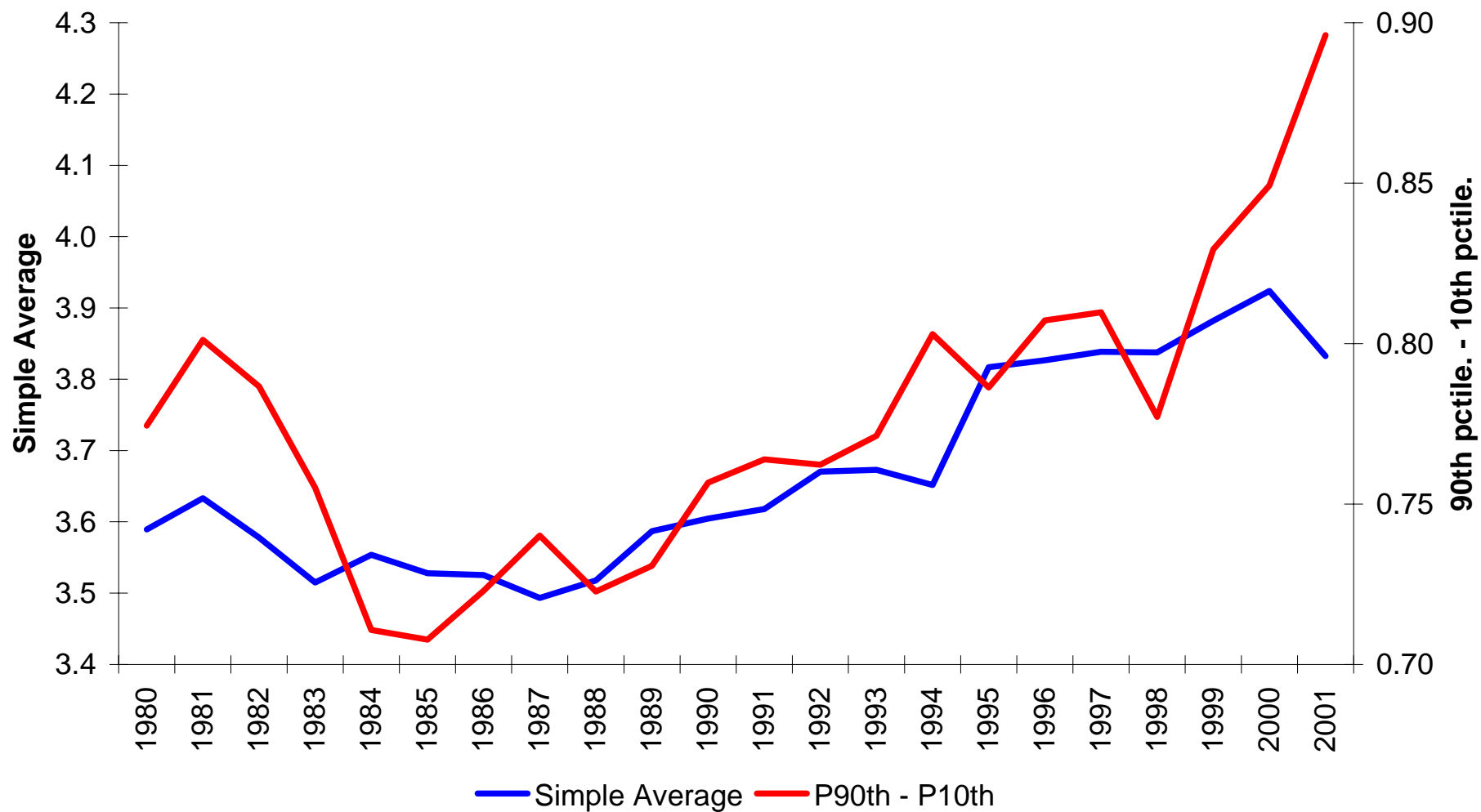
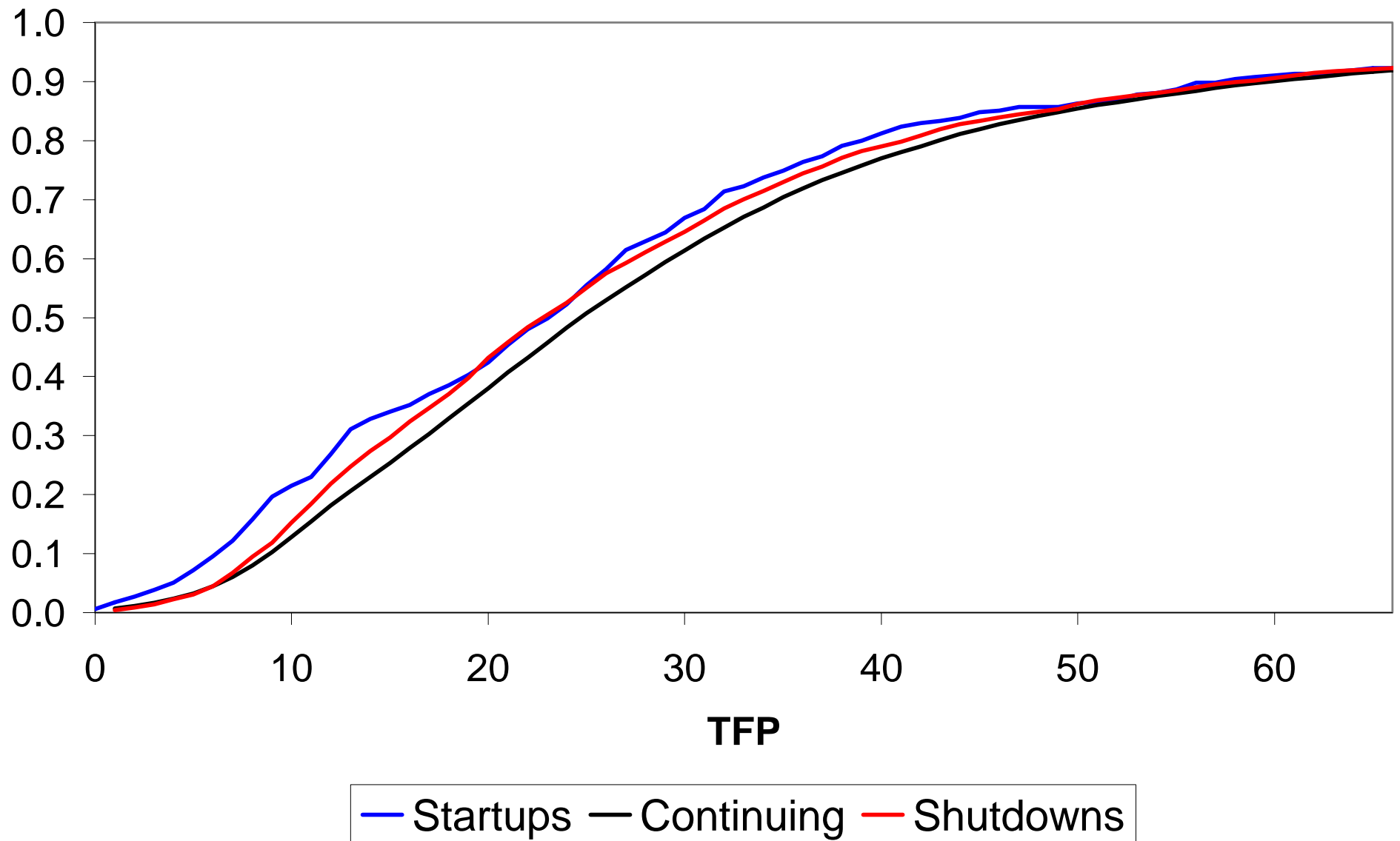


Figure 1. Mean TFP and TFP Dispersion



The Distribution of TFP by Plant Status



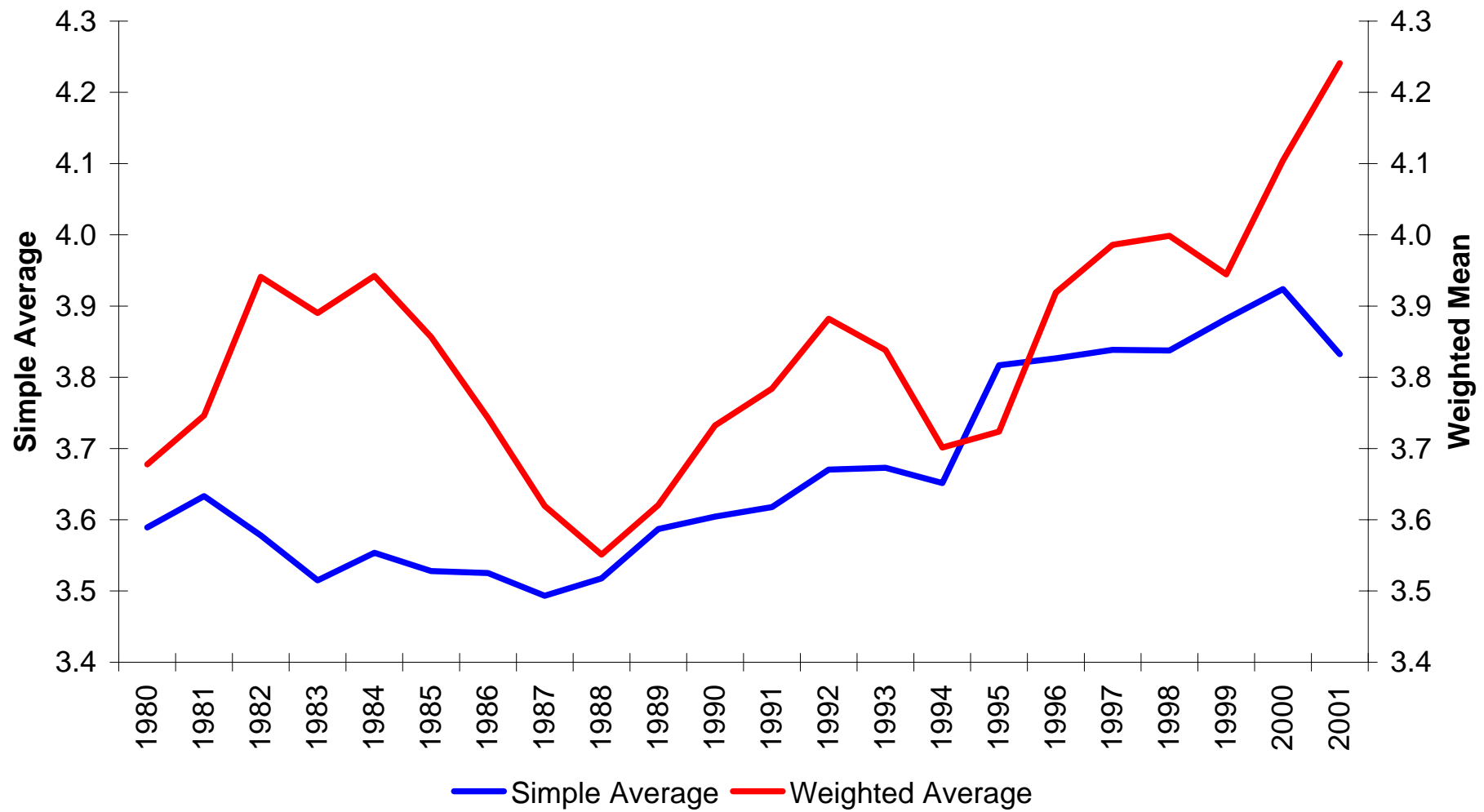
Reallocation and efficiency gains

$$prod_t^s = \sum_{j \in S} f_{jt} prod_{jt}$$

$$prod_t^s = \overline{prod_t^s} + \sum_{j \in S} (f_{jt} - \overline{f_t})(prod_{jt} - \overline{prod_t^s})$$

$$\ln prod_{jt}^s = \alpha_s + \beta * \ln X_{st} + \delta * trend_t + \varepsilon_{st}$$

Figure 2. TFP Evolution: Simple and Weighted Averages



Sources of TFP changes?

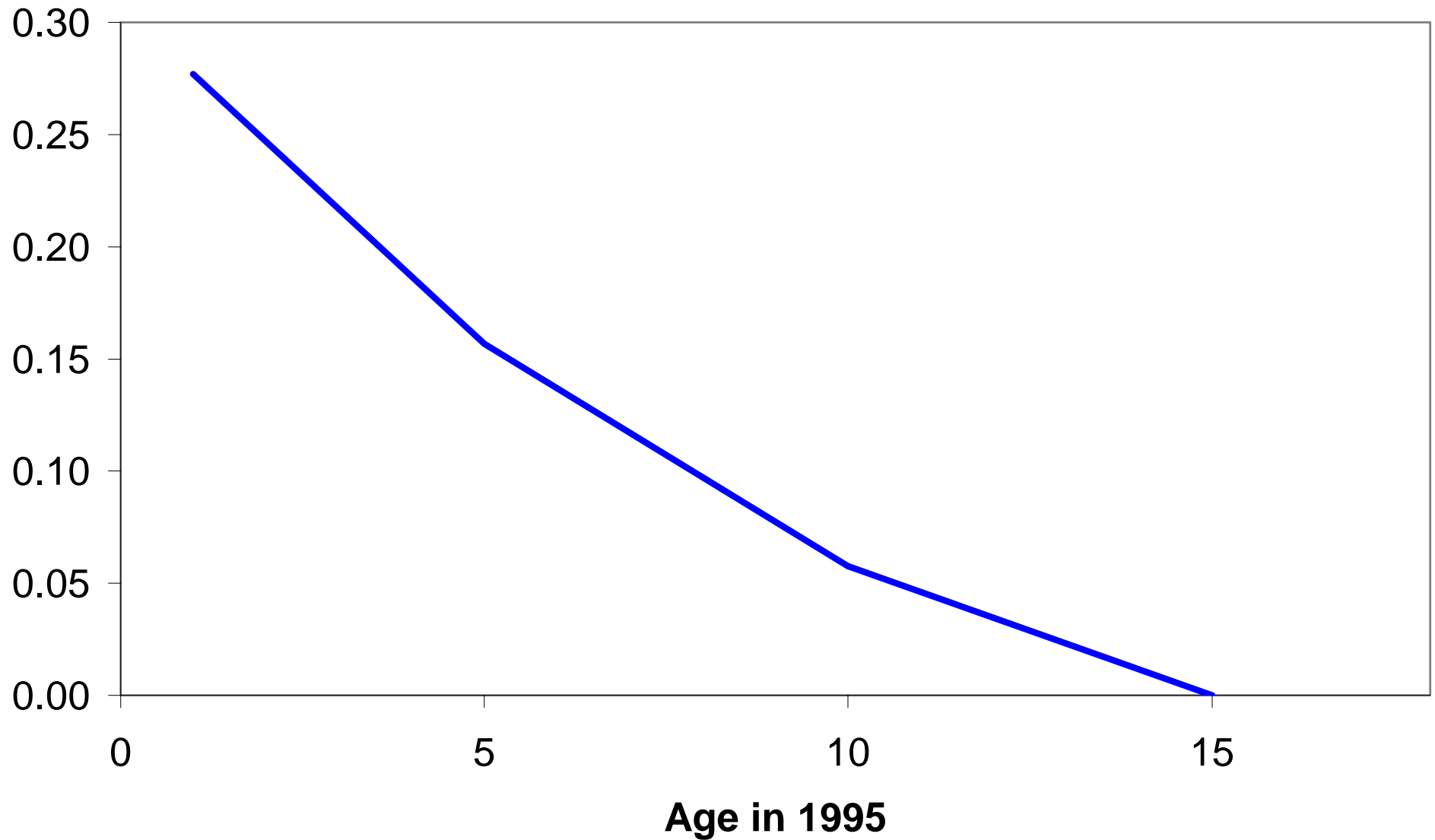
Decomposition 1:

- Age and cohorts
- Business cycle

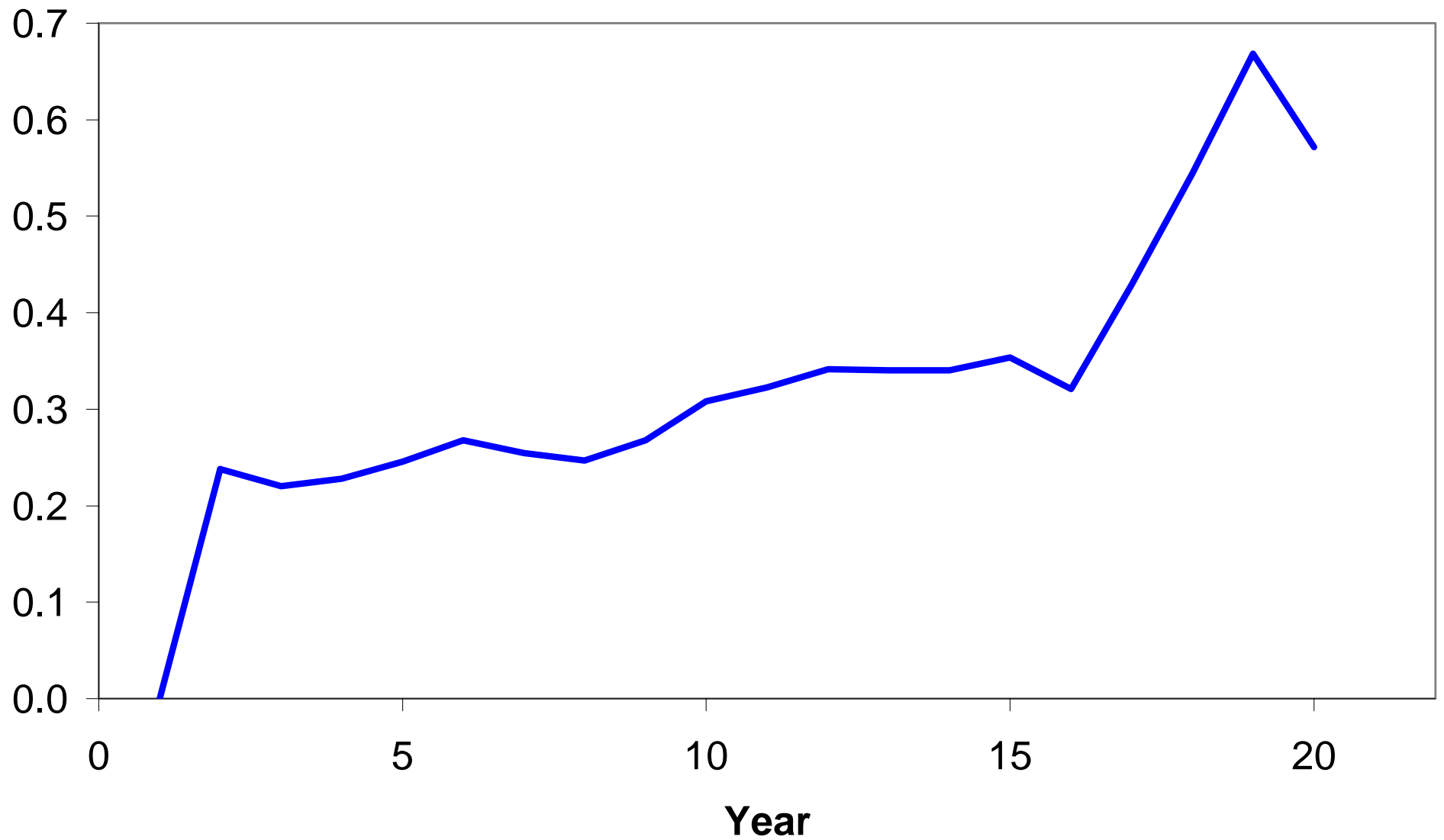
Decomposition 2:

- Within
- Reallocation

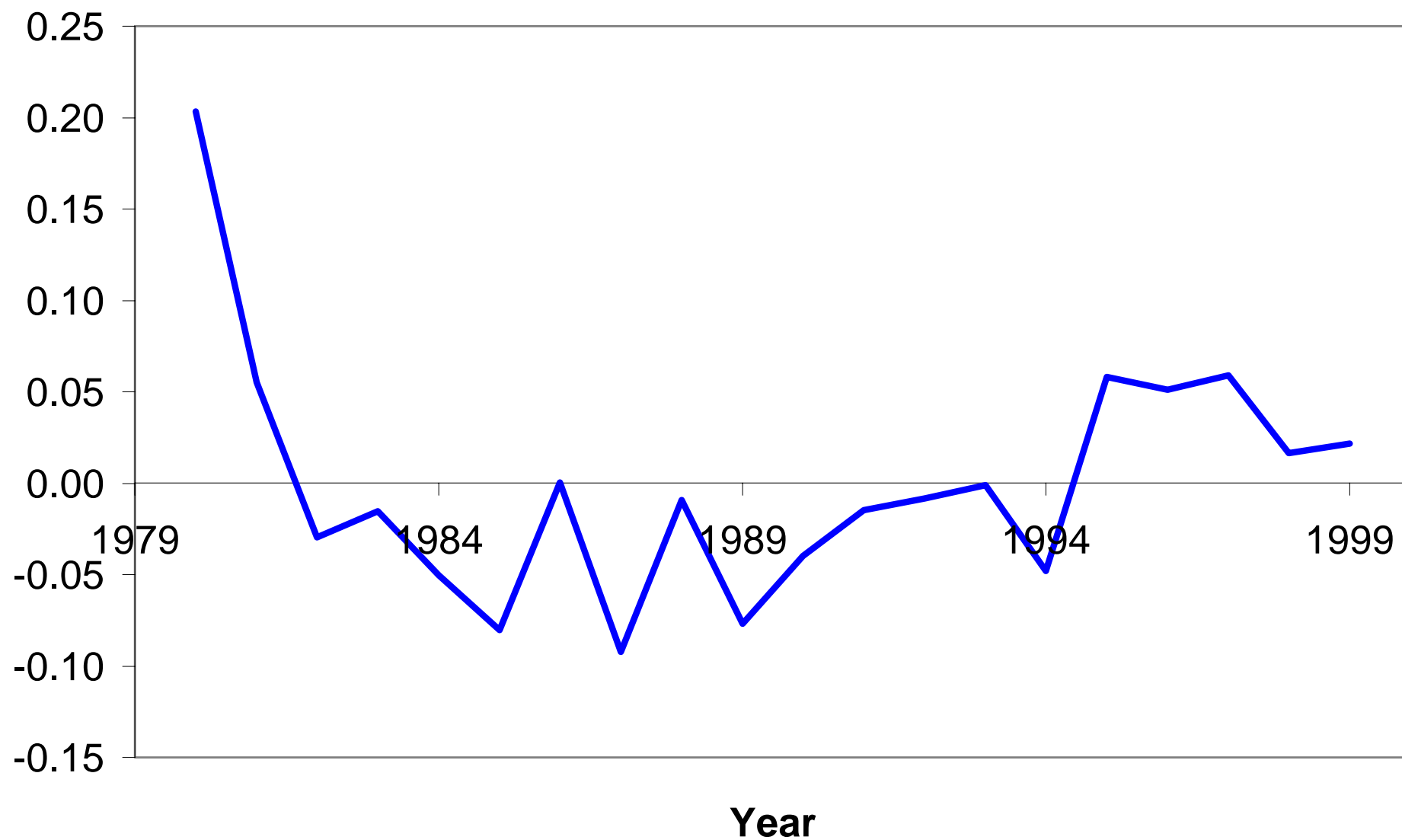
TFP Decomposition: Cohort Effects



TFP Decomposition: Age Effects



TFP Decomposition: Year Effects



The micro sources of aggregate TFP gains

- Within plants
- Reallocation from net entry and among incumbents

$$\Delta P_t = P_t - P_{t-k} =$$

$$\sum_{i \in C} \theta_{it-k} \Delta p_{it} + \sum_{i \in C} \Delta \theta_{it} (p_{it} - P_{t-k}) + \sum_{i \in N} \theta_{it} (p_{it} - P_{t-k}) - \sum_{i \in X} \theta_{it-k} (p_{it-k} - P_{t-k})$$

TFP Decomposition

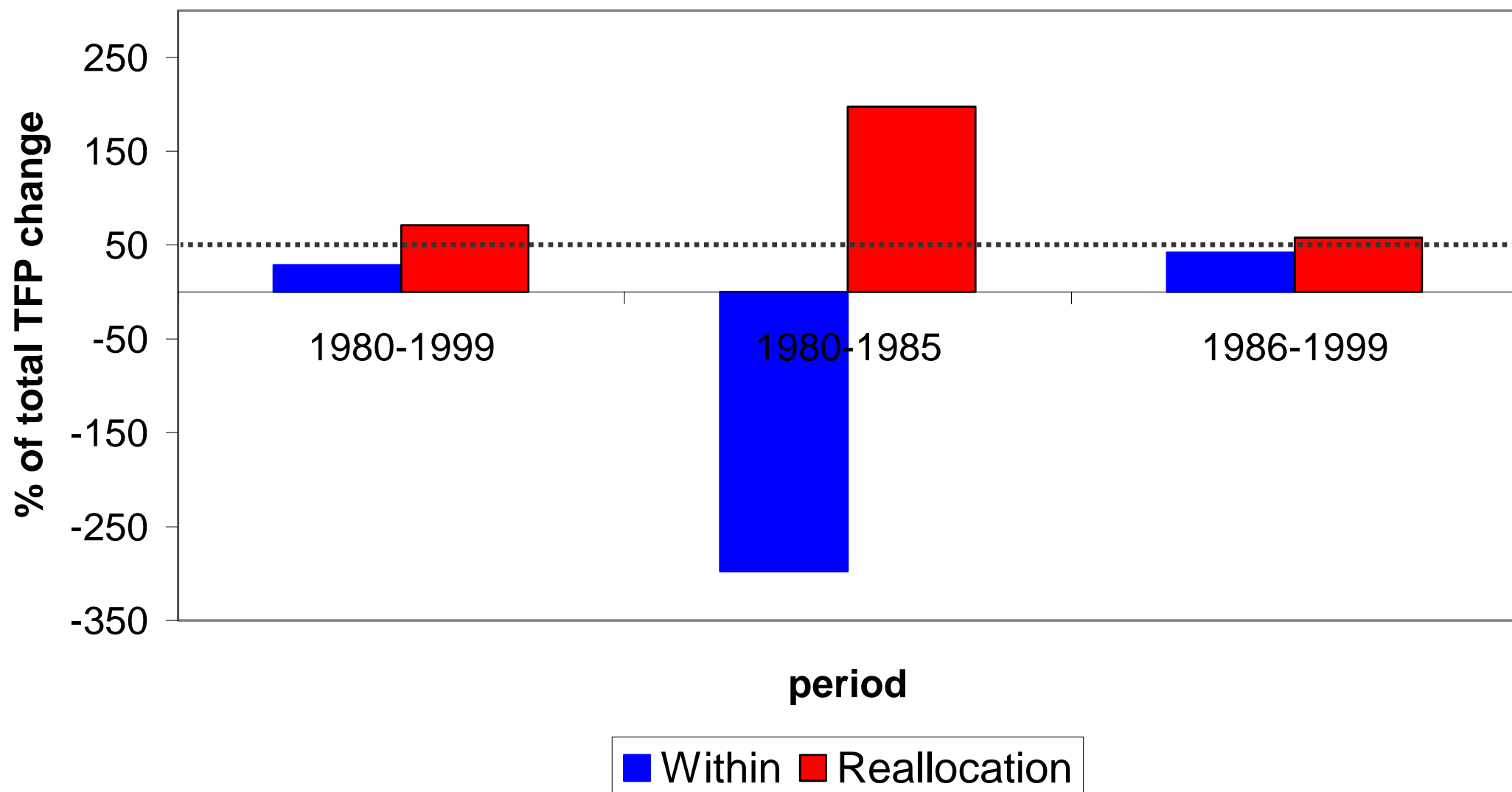


Table 7. Decomposition of Aggregate TFP Gains

	1980-1990	1990-2001
TFP gain	0.151	0.460
Within	0.132	0.246
Reallocation among incumbents	0.014	-0.031
Entry	0.054	0.502
Exit	0.049	0.257
Net entry	0.005	0.245
Share of TFP gain	100.00	100.00
Within	87.16	53.46
Reallocation among incumbents	9.27	-6.77
Entry	35.78	109.29
Exit	32.21	55.98
Net entry	3.57	53.31

The role of exports

- Most of the increase in exports came from larger and highly intensive new exporters (96.7%; and 63.3% by net entry), rather than from increasing export intensity at existing exporters.
- Exports and productivity co-move over the Chilean export boom.
- Export expansion associated to reallocation of resources towards more efficient plants.

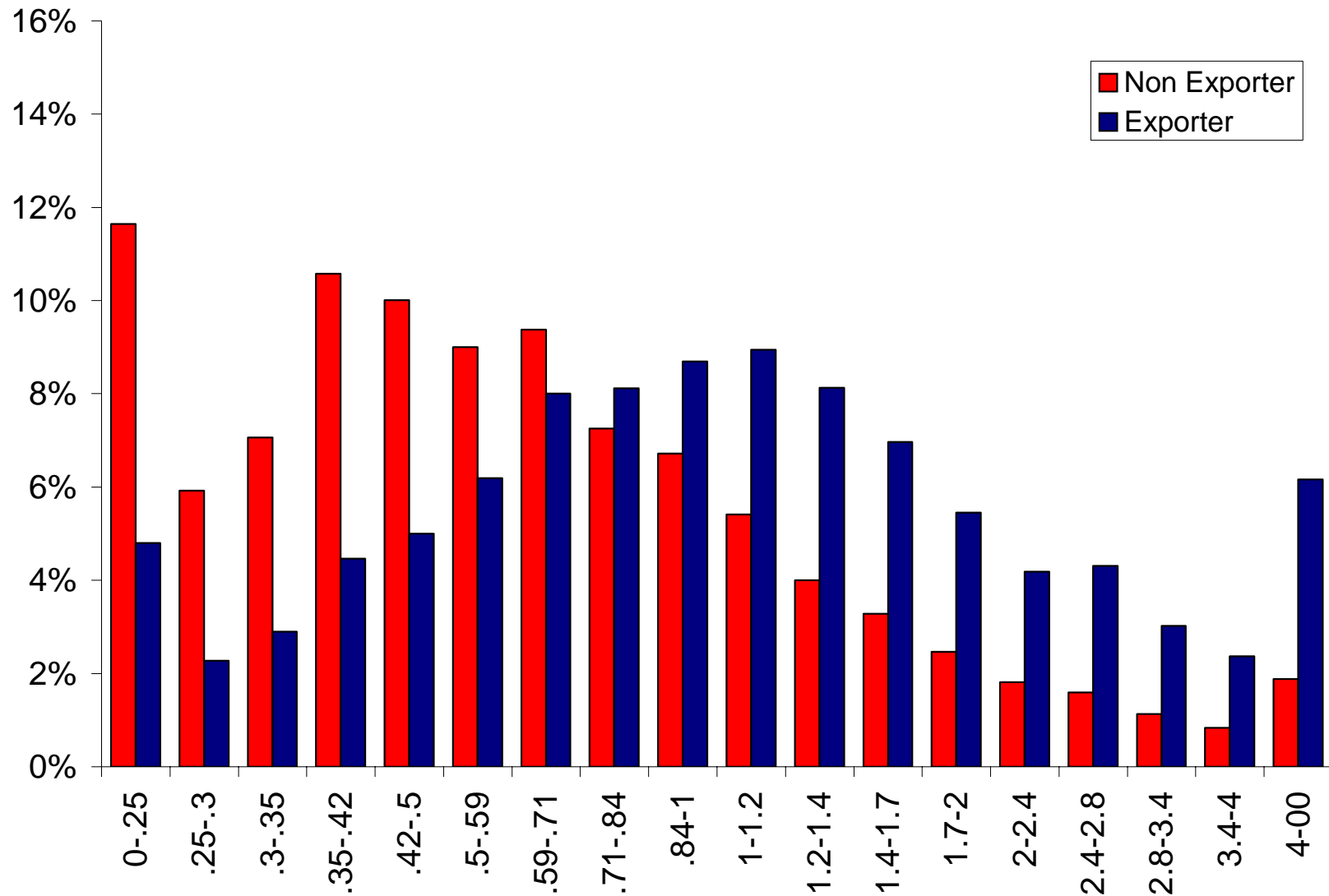
Plant-Level Export Facts in Chile during the 1990 - 2001 period

Sectors	Plants	Labor Productivity Relative to	Capital per emp. Sector Simple	Labor Share Average	Size Employees (3dig ISIC)
No Exports	79.2%	-12%	-21%	1.02	-25%
Positive Exports	20.8%	45%	82%	0.93	93%

Export Intensity of Exporters (percent)	% of Exporting	Relative to Sector Simple Average			
0 to 10	47.7%	46%	61%	0.91	84%
10 to 20	11.1%	37%	67%	0.94	93%
20 to 30	5.7%	40%	80%	0.95	94%
30 to 40	4.6%	35%	84%	1.00	90%
40 to 50	4.0%	49%	104%	0.91	105%
50 to 60	3.9%	44%	106%	0.97	117%
60 to 70	3.9%	43%	111%	0.98	111%
70 to 80	4.2%	46%	125%	0.94	117%
80 to 90	5.5%	54%	125%	0.89	118%
90 to 100	9.3%	47%	111%	0.98	98%

Authors' calculation

Distribution of Plant-Level Productivity



Growth in exports due to growth of continuers (36.7%), to growth in the average size of entrants respect to exiters (53.7%), and to more firms entering than exiting (9.6%)

$$\Delta X_{90-01} = \left(\frac{X_{c,01}}{C} - \frac{X_{c,90}}{C} \right) C + \left(\frac{X_{EN}}{EN} - \frac{X_{EX}}{EX} \right) EN + \frac{X_{EX}}{EX} (EN - EX)$$

Growth in exports due to increasing intensity (17.4%) and increasing sales (19.3%) of continuers, and to higher intensity of entrants (63.3% = 96.7% - 33.4%)

$$\Delta X_{90-01} = \left(\frac{X_{c,01}}{S_{c,01}} - \frac{X_{c,90}}{S_{c,90}} \right) S_{90} + \left(\frac{X_{c,01}}{S_{c,01}} \right) (S_{c,01} - S_{c,90}) + \left(\frac{X_{EN}}{S_{EN}} \right) S_{EN} - \left(\frac{X_{EX}}{S_{EX}} \right) S_{EX}$$

Market reforms and micro level efficiency

- Competition facilitates the adoption of new technologies and know-how
- Flexibility facilitates reallocation. Entry and exit costs are quantitatively relevant.

The role of policy

- Plant dynamics (and heterogeneity):
 - How much of inputs reallocation and entry-exit of plants and their variation over time are induced by the fluctuating tastes of economic policymakers?
- Slow recoveries and barriers to riches:
 - How relevant is the incentive to remain inefficient, either by misallocating resources or by not adopting new technologies?

The effect of policy

- Static inefficiencies (across industries):
 - Input reallocation (inside PPF).
 - Technology adoption (lower PPF).
- Dynamic inefficiencies (over time):
 - Entry-exit process enhances previous effects.
- Mapping between policy and equilibrium:
 - Policy reduces the cut-off level of productivity.

Evidence of specific policies

- Pymes: US\$ 500 millions in 1980s by Corfo but only US\$ 100 millions back.
- Barriers to entry: Chile 10 times higher than Canada and the US.
- Labor flexibility: Korea and Chile.
- TFP estimated from the Enia
 - Probability of exit is a decreasing function of subsidies.

Empirical evidence on Obstacles to reallocation and aggregate growth: 76 countries.

- We build a regulation index based on information on:
 - Tax burdens, Labor regulation, Financial restrictions, Trade barriers, Entry costs, Bureaucratic red tape, Bankruptcy procedures
- Recession severity: downward GDP deviations from trend.

Figure 1. Regulation Index by Region

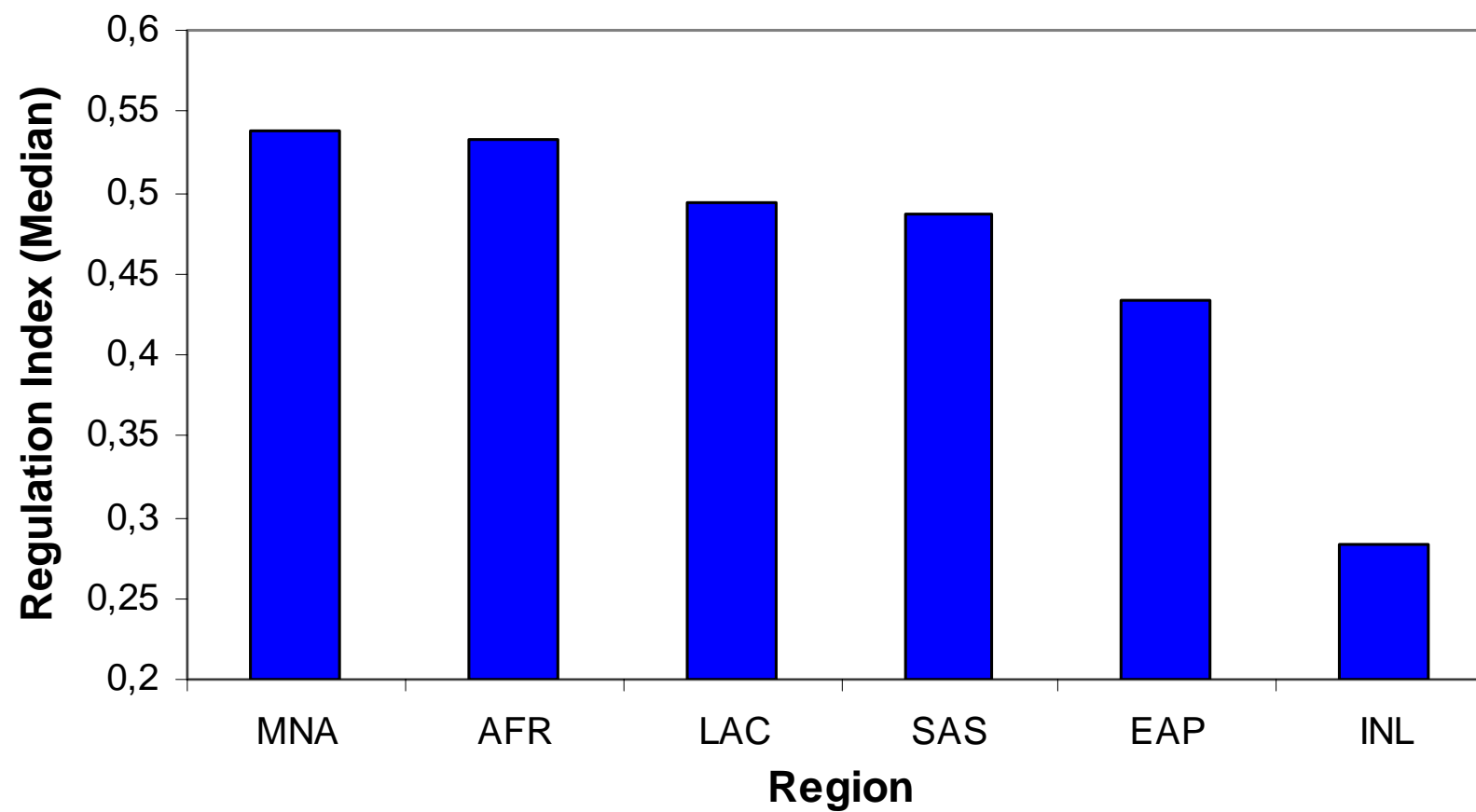
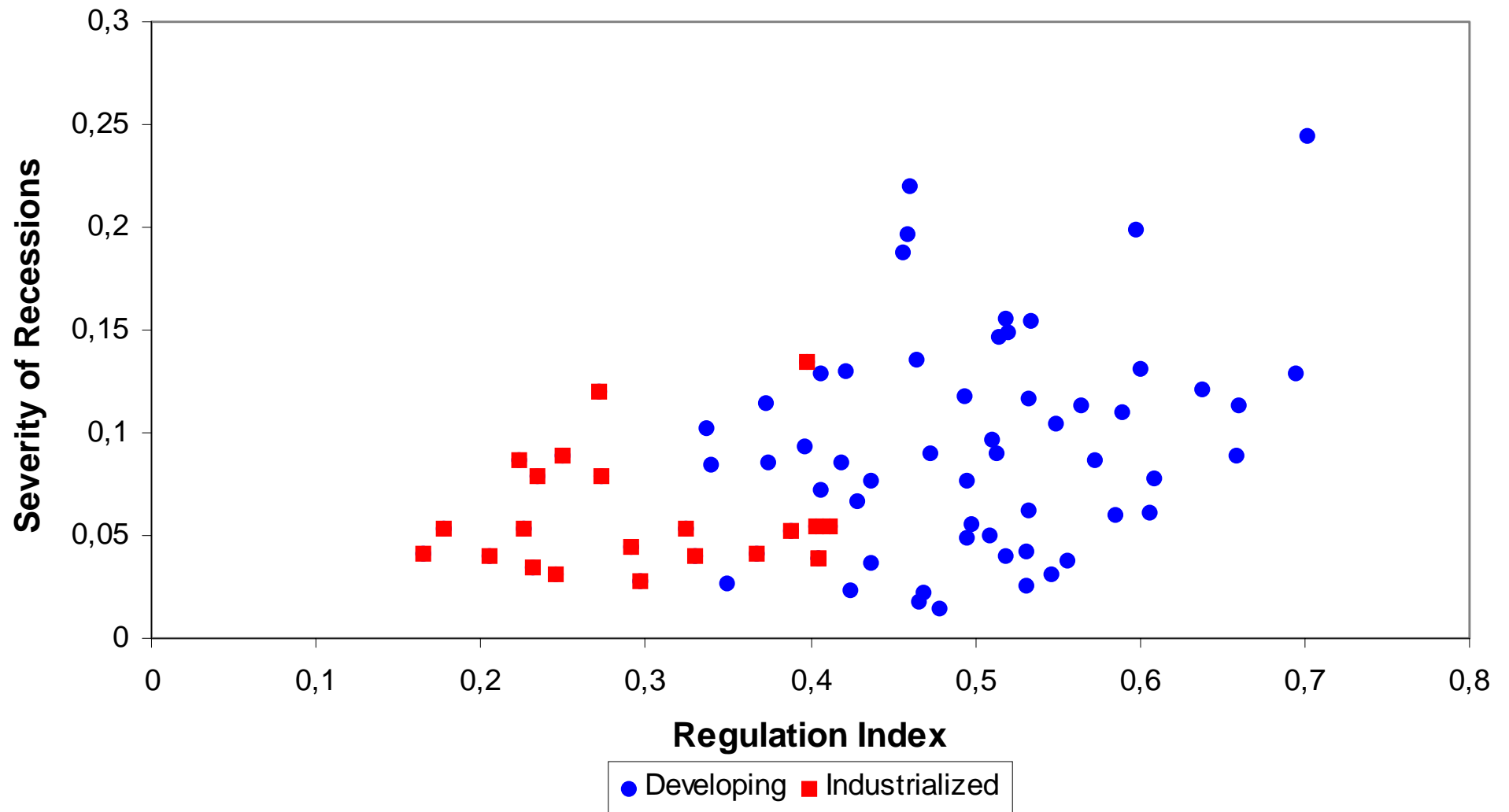


Figure 2. Severity of Recessions and Regulatory Burden
(Correlation: 0.36)



II. Theory: A GE model with distortions

We build a stochastic GE model with firms' level heterogeneity

We find that protecting incumbents reduces volatility at the expense of

- More time needed to recover after facing negative aggregate shocks
- More time needed to materialize gains from aggregate market reforms

⇒ Output losses are large

Model

- Standard one good economy with heterogeneous plants

Production

- Labor and capital are needed for production
- Capital embodies different levels of technology
- Aggregate production function:

$$Y_t = e^{\lambda_t} N_t^\alpha \left[\int_{-\infty}^{+\infty} e^{\theta_t} k_t(\theta_t) d\theta_t \right]^{1-\alpha}$$

- At the end of the period, capital is either scrapped, with salvage value s , or it undergoes a random change in productivity:

$$\theta_{t+1} = \theta_t + \varepsilon_{t+1}^{\theta}, \varepsilon^{\theta} \sim N(0, \sigma_{\theta}^2)$$

- A newly created unit of capital operates in $t+1$ and draws its initial level of technology from:

$$\theta_{t+1} \sim N(z_t, \sigma^2)$$

- The leading edge technology evolves according to

$$z_t = \mu_z + z_{t-1} + \varepsilon_t^z, \varepsilon^z \sim N(0, \sigma_z^2)$$

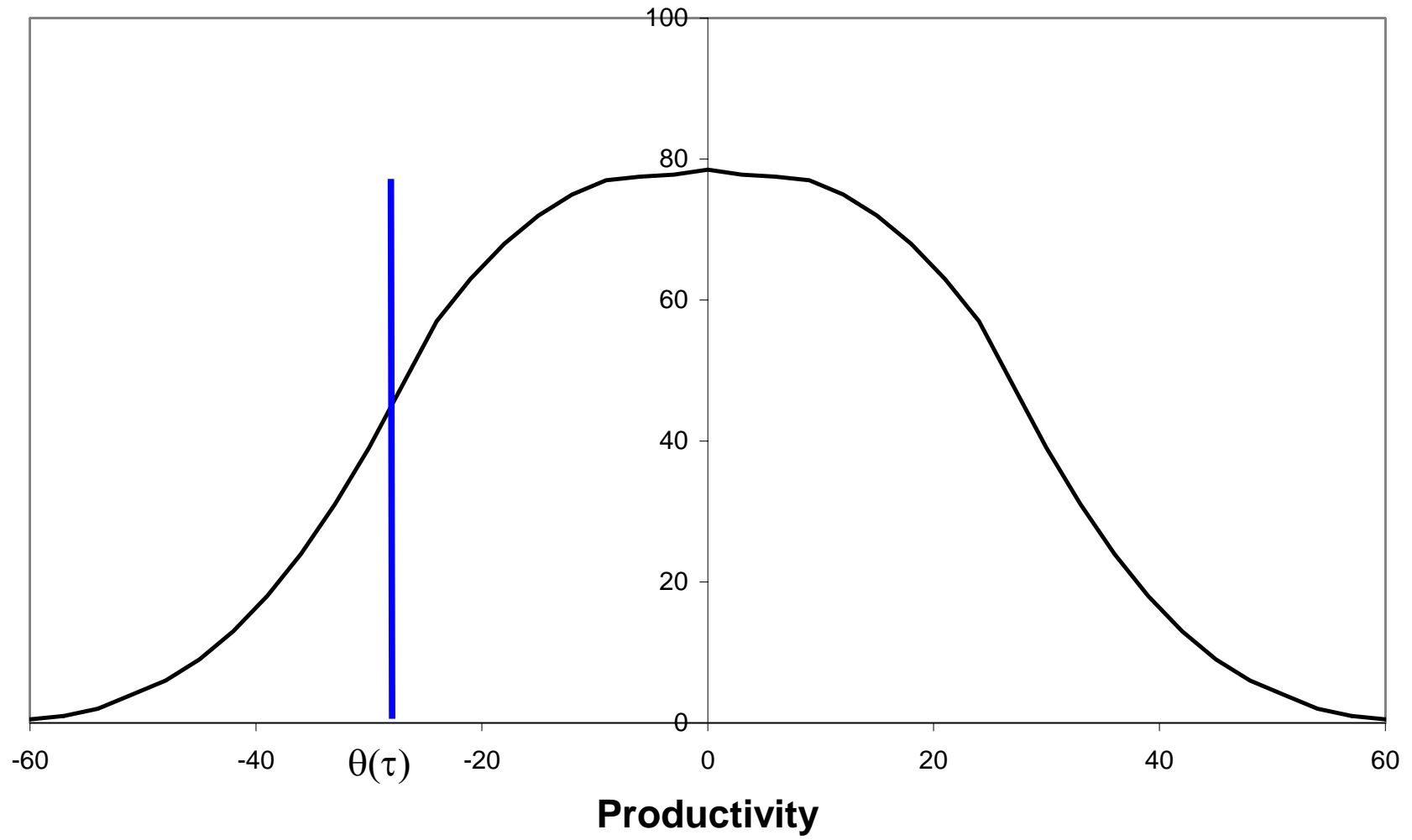
- Capital by state of productivity evolves according to

$$k_{t+1}^0(\theta_{t+1}) = \int_{-\infty}^{\infty} \frac{1}{\sigma_\theta} \phi\left(\frac{\theta_{t+1} - \theta_t}{\sigma_\theta}\right) k_t^1(\theta_t) d\theta_t + \phi\left(\frac{\theta_{t+1} - z_t}{\sigma}\right) I_t^c$$

- Exit determined by exogenous cut-off

$$s = q_t^1(\overline{\theta_t})$$

Distribution of Plants



Consumption

$$\max \quad E_0 \left[\sum_{t=0}^{\infty} \beta^t \{ \log(c_t) + \gamma(1 - n_t) \} \right] \quad \text{s.t.}$$

$$c_t + I_t^c q_t^{li} + \int_{-\infty}^{\infty} q_t^1(\theta_t) k_t^1(\theta_t) d\theta = \omega_t n_t + \int_{-\infty}^{\infty} q_t^0(\theta_t) k_t^0(\theta_t) d\theta$$

Market clearing

$$C_t + I_t = Y_t + S_t$$

Definition of the equilibrium: A *Competitive Equilibrium* in this economy is a set of contingent plans $\{c_t, I_t, Y_t, \bar{K}_t, N_t, S_t\}_{t=0}^{\infty}$, and contingent prices $\{w_t, q_t^1, q_t^0, q_t^{li}\}_{t=0}^{\infty}$ of labor, plants at the beginning of the period, plants at the end of the period, and construction projects, and a vector $\{\bar{\theta}_t\}_{t=0}^{\infty}$ such that, given contingent prices, the transfer T_t , and production and government stochastic processes $\{z_t, \theta_t, \lambda_t, \tau_t\}$, at each period t :

1) The representative consumer solves

$$E_0 \left[\sum_{t=0}^{\infty} \log(c_t) + \gamma(1 - n_t) \right]$$

$$c_t + I_t^c q_t^{li} + (1 - \tau_t) \int_{-\infty}^{\infty} q_t^1(\theta_t) k_t^1(\theta_t) d\theta = w_t n_t + \int_{-\infty}^{\infty} q_t^0(\theta_t) k_t^0(\theta_t) d\theta - T_t$$

$$k_{t+1}^0(\theta_{t+1}) = \int_{-\infty}^{\infty} \frac{1}{\sigma_{\theta}} \phi\left(\frac{\theta_{t+1} - \theta_t}{\sigma_{\theta}}\right) k_t^1(\theta_t) d\theta_t + \phi\left(\frac{\theta_{t+1} - z_t}{\sigma}\right) I_t^c$$

2) The intermediary satisfies

$$I_t^i = q_t^{li} I_t^c$$

3) The producer of the consumption good satisfies

$$n_t(\theta) = N_t^\alpha e^{\theta_t} / \bar{K}_t$$

$$w_t = \alpha e^{\lambda_t} \left(\frac{\bar{K}_t}{N_t} \right)^{1-\alpha}$$

$$q_t^1(\bar{\theta}_t) = s$$

$$q_t^0(\theta_t) = (1-\alpha) \left(\frac{\bar{K}_t}{N_t} \right)^{-\alpha} e^{\theta_t} + (1-\delta) \left[1\{\theta_t < \bar{\theta}_t\} s + 1\{\theta_t > \bar{\theta}_t\} q_t^1(\theta_t) \right]$$

4) The government satisfies

$$\tau_t \int_{-\infty}^{\infty} q_t^1(\theta_t) k_t^1(\theta_t) d\theta = T_t$$

5) The market clearing restriction is satisfied

$$c_t + I_t = Y_t + S_t$$

Obstacles to reallocation: some examples

1. Incumbent subsidies

$$c_t + I_t^c q_t^{1i} + (1 - \tau_t) \int_{-\infty}^{\infty} q_t^1(\theta_t) k_t^1(\theta_t) d\theta = \omega_t n_t + \int_{-\infty}^{\infty} q_t^0(\theta_t) k_t^0(\theta_t) d\theta - T_t$$

2. Severance payments

$$V(n_{-1}, k, \lambda, \theta) = \max_{n, k \geq 0} \{ \Pi(k, n) - \tau \max(n_{-1} - n, 0) + \beta \int \int V(n', k', \lambda', \theta') d\lambda' d\theta' \}$$

3. Other: entry costs, bankruptcy costs,

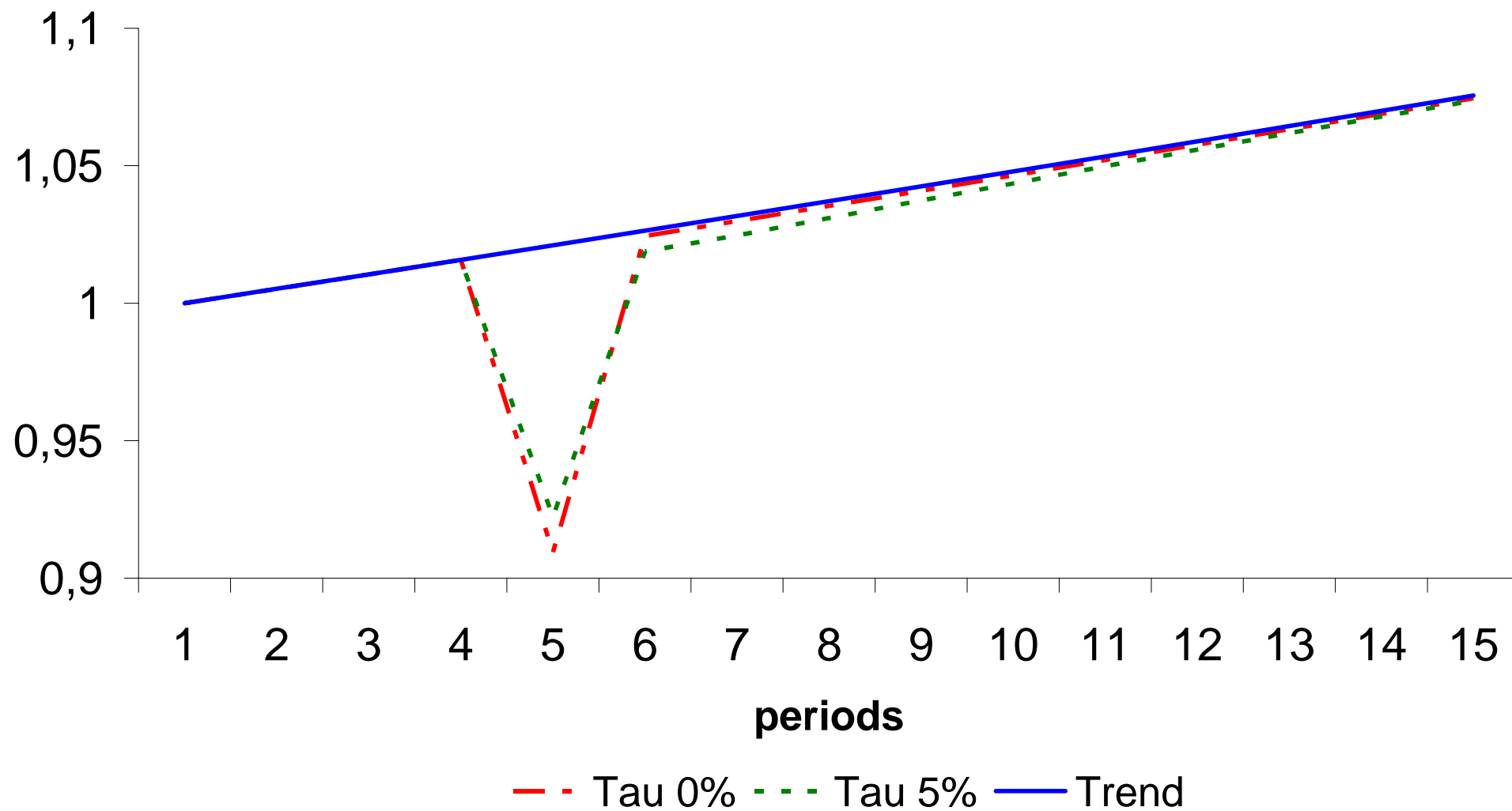
III. Applications

1: “Slow recoveries”

Two economies that face the same aggregate shock (-5% of aggregate TFP with no persistence)

- Benchmark: Undistorted economy.
- Exercise: Pre-existing production subsidy to incumbents.

Slow Recovery (normalized output level)



Simulated Slow Recovery Indicators

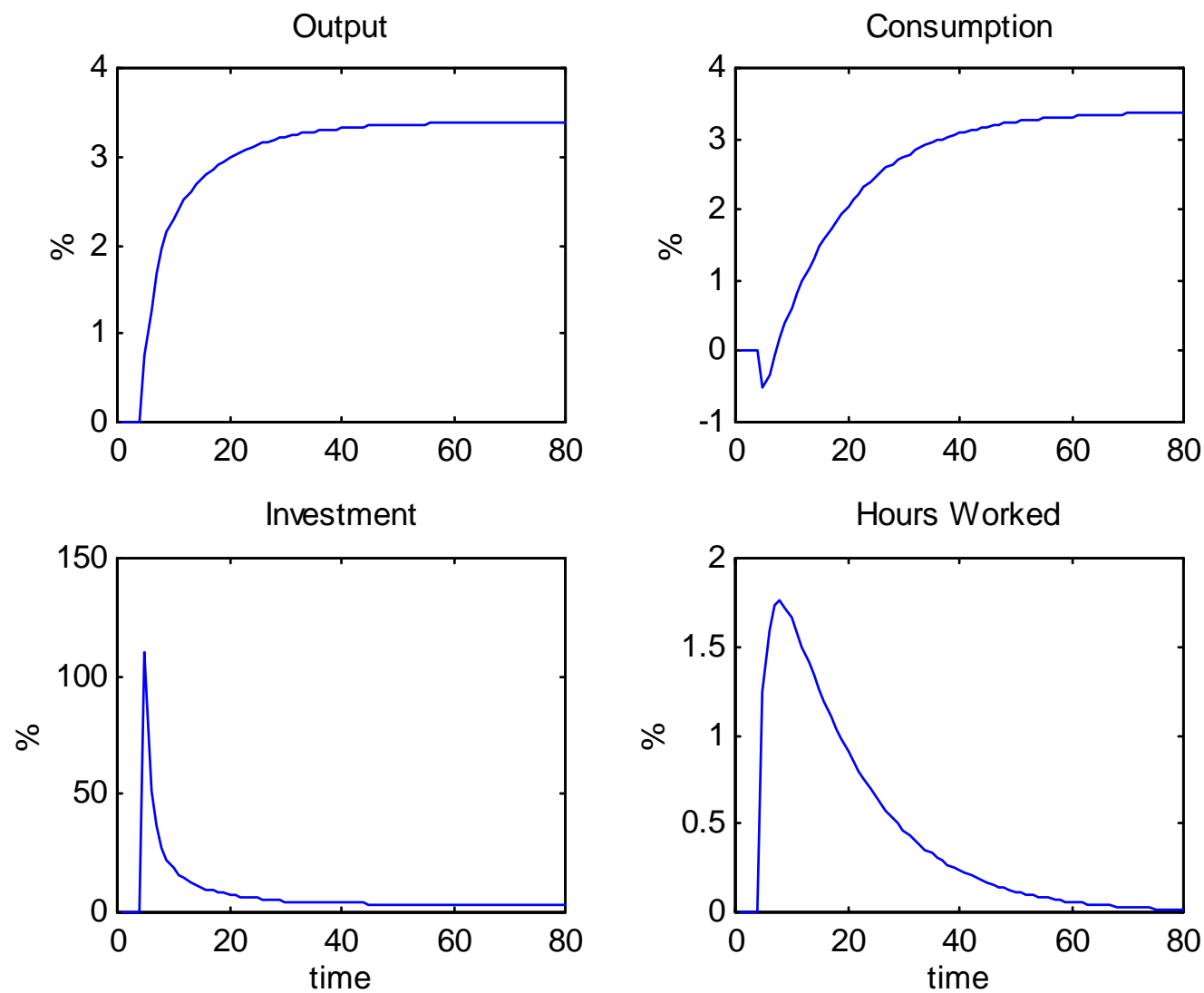
Pre-existing distortion		Subsidy (%)	
		0	5
Loss (% of pre-shock GDP)		13,1	14,2
Catching up with the trend (quarters)	0,2%	1	9
	0,5%	1	2
% of the loss realized in	1 quarter	84,2	72,3
	5 quarters	91,1	88,7
	10 quarters	94,5	94,9
	20 quarters	97,8	98,9
	30 quarters	99,1	99,8

2: “Reaping the benefits”

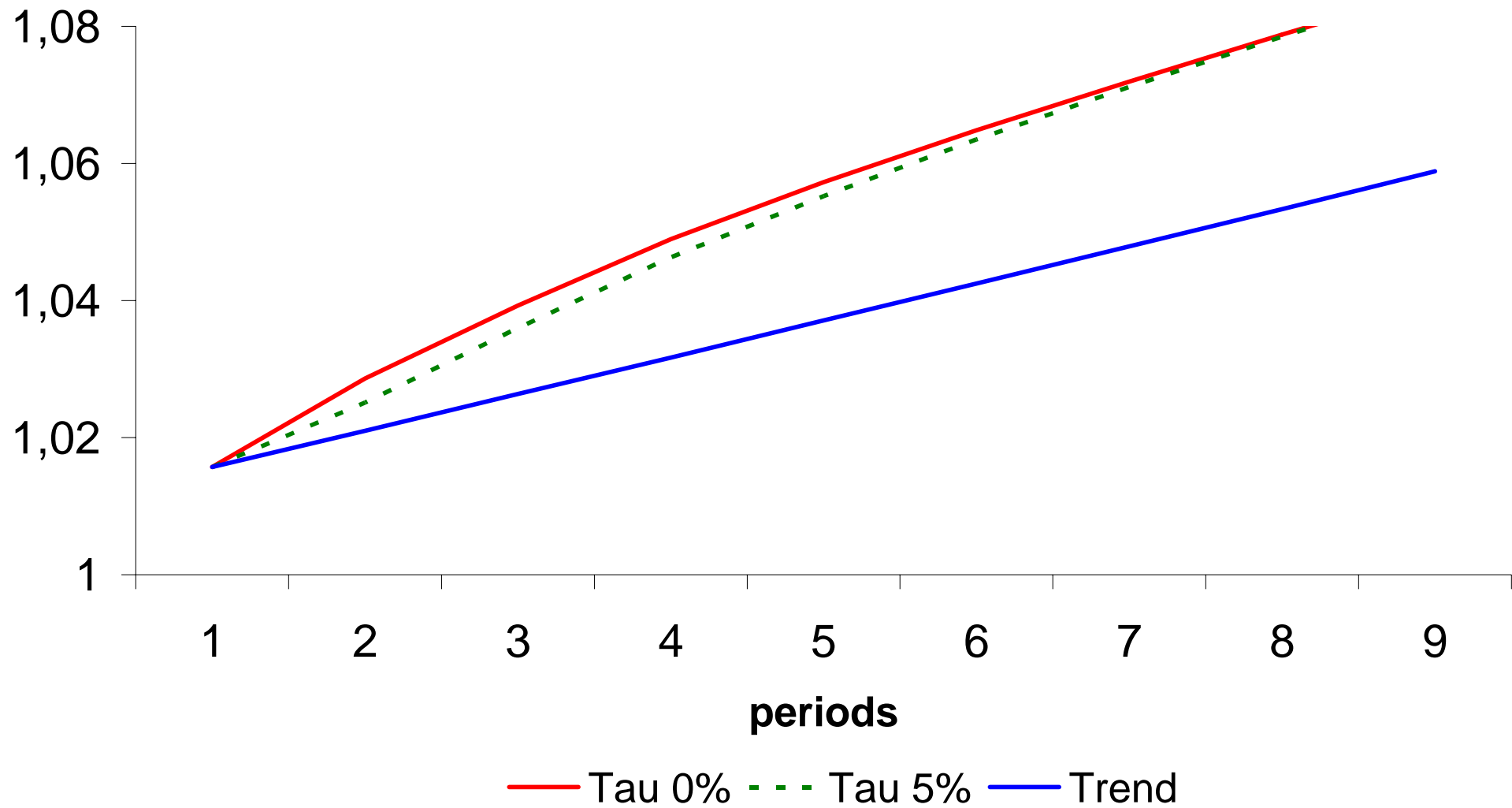
Two economies that face the same efficiency shock (+5% of leading technology TFP – permanent).

- Benchmark: Undistorted economy.
- Exercise: Pre-existing production subsidy to incumbents.

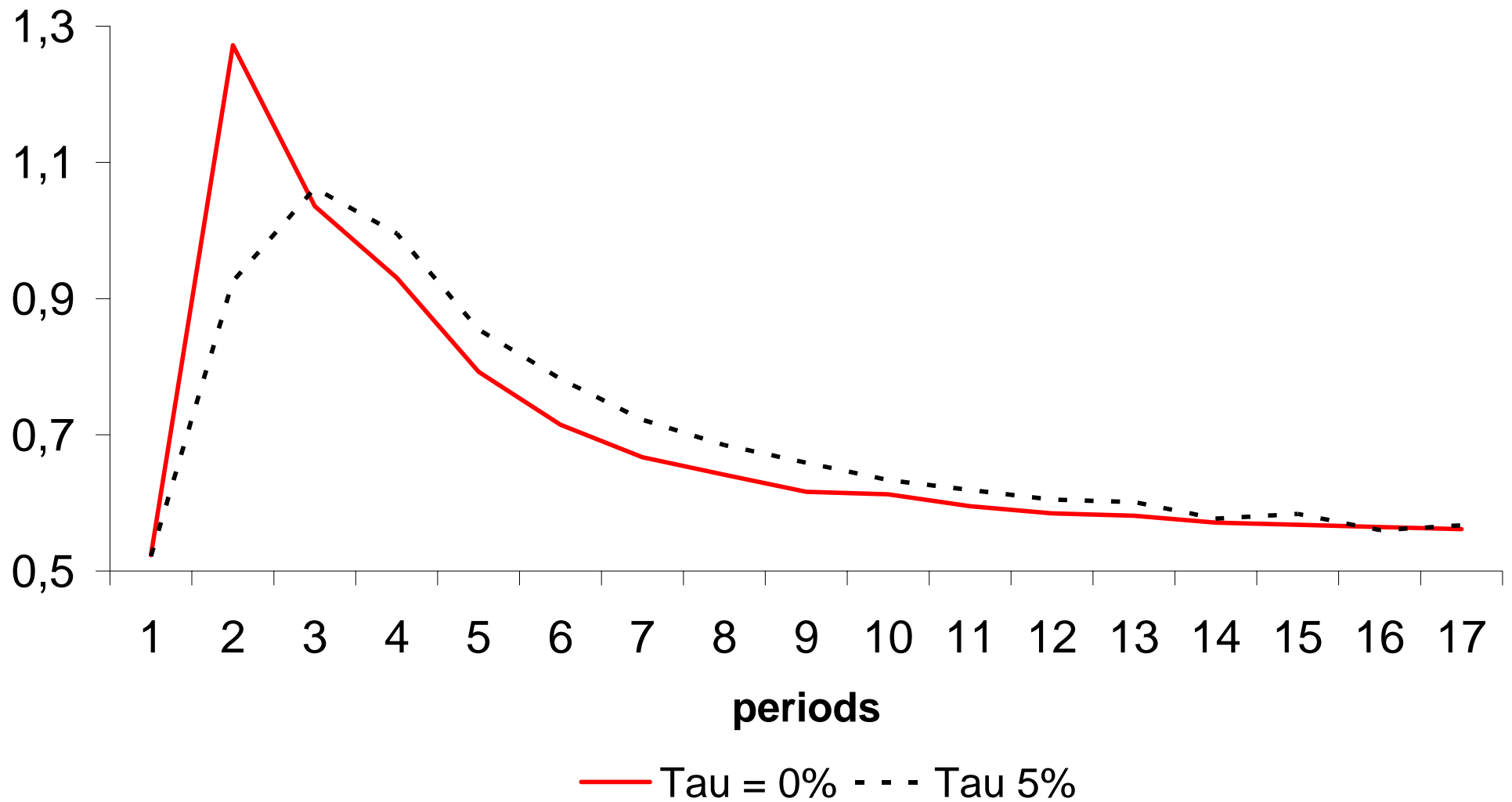
The benchmark economy



Reaping the benefits (normalized output level)



Reaping the benefits (growth rates)



Summarizing

Market reforms, micro level efficiency, and aggregate growth:

- Slow recoveries
- Reaping the benefits from market reforms

⇒ Microeconomic distortions explain stagnation and retard gains from market reforms.

3: The effects of market reforms on actual TFP gains

- Trade liberalization (new exporters are key)
- Credit market liberalization

Other possible channels:

- Privatization
- Knowledge revolution: ICTs

Table 5. Trade Orientation and Within-Plant TFP Gains

	Full period		Pre and Post 1990	
	OLS	F. Effects	OLS	F. Effects
Export oriented	3.934 (0.040)	2.398 (0.055)	3.815 (0.040)	2.319 (0.055)
Import competing	3.200 (0.050)	2.425 (0.070)	3.104 (0.049)	2.345 (0.071)
Other tradables	2.468 (0.035)	3.226 (0.053)	2.299 (0.035)	3.105 (0.053)
Export oriented - Post 1990			0.187 (0.012)	0.127 (0.010)
Import competing - Post 1990			0.151 (0.013)	0.093 (0.010)
Other tradables - Post 1990			0.278 (0.013)	0.198 (0.010)
Post 1990			0.160 (0.016)	0.173 (0.012)
Sector effects			Yes	Yes
Year effects			Yes	Yes
Overall R ²	0.89		0.89	0.88
N Observations	84912	84912	84912	84912
N Firms		10279		10279

Standard errors in parentheses.

Table 8. Trade Orientation and TFP Gains

	Total TFP Gain	Within	Reallocation	Entry	Exit
Export oriented - Post 1990	0.635 (0.189)	0.228 (0.123)	0.098 (0.114)	0.300 (0.079)	-0.010 (0.031)
Import competing - Post 1990	0.242 (0.221)	0.019 (0.145)	0.100 (0.137)	0.066 (0.084)	-0.057 (0.035)
Other tradables - Post 1990	0.645 (0.189)	0.221 (0.122)	0.277 (0.129)	0.129 (0.112)	-0.019 (0.041)
Sector effects	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes
R ²	0.80	0.65	0.62	0.71	0.75
N	48	48	48	48	48

Standard errors in parentheses. Regressions also include trade orientation dummies and a post-1990 period dummy equal to one in years 1990-2001.

Table 6. Ownership and Within-Plant TFP Gains

	Full Period		Pre and Post 1990	
	OLS	F. Effects	OLS	F. Effects
Individually Owned	-0.061 (0.012)	-0.024 (0.014)	-0.090 (0.013)	-0.036 (0.015)
Limited Liability Corporations	0.020 (0.011)	0.009 (0.012)	0.008 (0.013)	0.000 (0.013)
Stock Corporations	0.033 (0.012)	0.001 (0.014)	0.050 (0.014)	0.029 (0.014)
Individually Owned - Post 1990			0.070 (0.027)	0.048 (0.019)
Limited Liability Corporations - Post 1990			0.032 (0.026)	0.021 (0.018)
Stock Corporations - Post 1990			-0.013 (0.027)	-0.032 (0.018)
Post 1990			0.364 (0.029)	0.346 (0.020)
Sector effects	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes
Overall R ²	0.89		0.89	0.88
N Observations	83648		83648	84912
N Firms				10279

Standard errors in parentheses.

Algunas referencias

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