

Capital Allocation and Productivity in South Europe

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Misallocation of capital in periphery?

① Empirical Evidence

- manufacturing sector, firm-level data on production and finance
- Increases over time in dispersion in capital's returns
- Increasing misallocation over time and low TFP

② Model

- pre-crisis: with financial frictions, interest rate decline generates misallocation of capital inflows and decreasing TFP
- post-crisis: additional role for tightening constraints and uncertainty

1 Dispersion, Misallocation, and TFP.

- Restuccia and Rogerson (2008, RED); Foster, Haltiwanger, and Syverson (2008, AER); Hsieh and Klenow (2009, QJE); Bartelsman, Haltiwanger, and Scarpetta (2013, AER); Oberfield (2013, RED); Asker, Collard-Wexler, and De Loecker (2014, JPE); Sandleris and Wright (2014, SJE).

2 Models of Financial Frictions and TFP.

- Banerjee and Duflo (2005, Handbook EG); Mendoza (2010, AER); Buera and Shin (2011, WP); Midrigan and Xu (2014, AER); Moll (2014, AER); Buera and Moll (Forthcoming, AEJ: Macro).

3 Misallocation in the Euro Area.

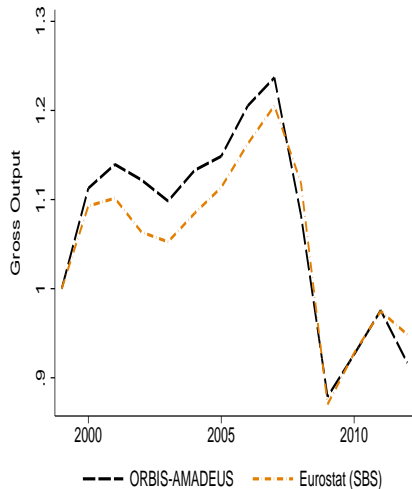
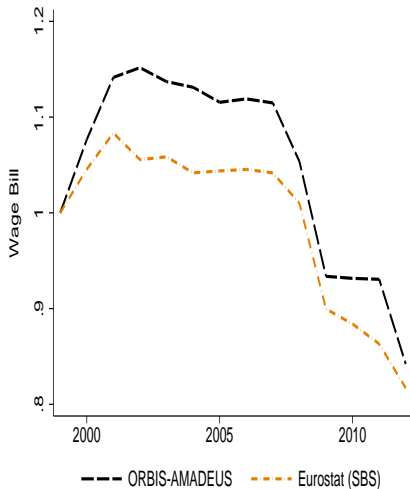
- Blanchard and Giavazzi (2002, Brookings); Blanchard (2007, PEJ); Reis (2013, Brookings); Benigno and Fornaro (2014, SJE); Dias, Marques, and Richmond (2014, WP); Garcia-Santana, Moral-Benito, Pijoan-Mas, and Ramos (2014, WP).

- 1 **Data**
- 2 Dispersion and Productivity in the Data
- 3 Model of Productivity, Dispersion, and Capital Flows (with Financial Frictions, Investment Risk and Adjustment Costs)
- 4 Micro Implications
- 5 Macro Implications
- 6 Evidence for other Countries
- 7 Conclusions

- ORBIS database provided by Bureau van Dijk (BvD), harmonized worldwide. Focus on AMADEUS, the European subset of ORBIS.
- Collected from official business registers, annual reports, and newswires.
- Focus on manufacturing industries. 4 digit NACE industry classification.
- Three main features of the data:
 - 1 Good coverage relative to Census as we merge across different vintages of data and across different disks.
 - 2 We have both balance sheets and income statements (advantage over Census).
 - 3 Our sample has many of small and private firms (advantage over Compustat/Worldscope).

Coverage Relative to Eurostat: Spain

	Employment	Wage Bill	Gross Output
1999	0.56	0.69	0.75
2000	0.58	0.71	0.76
2001	0.61	0.73	0.77
2002	0.65	0.75	0.79
2003	0.65	0.74	0.78
2004	0.66	0.75	0.78
2005	0.66	0.74	0.77
2006	0.67	0.74	0.77
2007	0.67	0.74	0.77
2008	0.65	0.72	0.72
2009	0.71	0.72	0.75
2010	0.68	0.73	0.74
2011	0.69	0.74	0.75
2012	0.65	0.71	0.72



		Employment	Wage Bill	Gross Output
ORBIS-AMADEUS	1-19 employees	0.24	0.18	0.14
	20-249 employees	0.50	0.47	0.42
	250+ employees	0.26	0.34	0.45
Eurostat (SBS)	0-19 employees	0.31	0.20	0.14
	20-249 employees	0.43	0.43	0.38
	250+ employees	0.26	0.37	0.49

- ① Data
- ② **Dispersion and Productivity in the Data**
- ③ Model of Productivity, Dispersion, and Capital Flows
- ④ Micro Implications
- ⑤ Macro Implications
- ⑥ Evidence from Other Euro Countries
- ⑦ Conclusions

- Total industry s output given by CES production function:

$$Y_{st} = \left[\sum_{i=1}^{N_{st}} D_{ist} (y_{ist})^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}},$$

- Firm i output given by a Cobb-Douglas production function:

$$y_{ist} = A_{ist} k_{ist}^{\alpha} l_{ist}^{1-\alpha},$$

- Profit maximization:

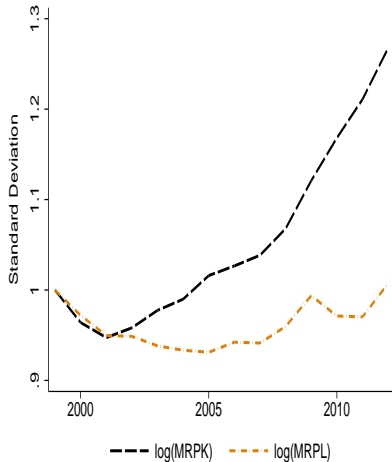
$$\max_{p_{ist}, k_{ist}, l_{ist}} (1 - \tau_{ist}^y) p(y_{ist}) y_{ist} - (1 + \tau_{ist}^k) (r_t + \delta_{st}) k_{ist} - w_{st} l_{ist}.$$

$$\text{MRPL}_{ist} := \left(\frac{1 - \alpha}{\mu} \right) \left(\frac{p_{ist} y_{ist}}{l_{ist}} \right) = \left(\frac{1}{1 - \tau_{ist}^y} \right) w_{st},$$

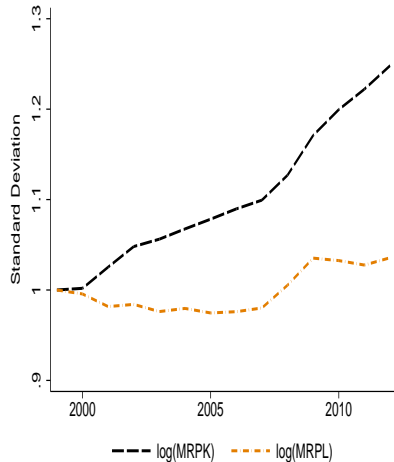
$$\text{MRPK}_{ist} := \left(\frac{\alpha}{\mu} \right) \left(\frac{p_{ist} y_{ist}}{k_{ist}} \right) = \left(\frac{1 + \tau_{ist}^k}{1 - \tau_{ist}^y} \right) (r_t + \delta_{st}),$$

Measurement

- $p_{ist}y_{ist}$ is nominal value added (gross output minus materials).
- y_{ist} is nominal value added divided by industry output price.
- k_{ist} is stock of tangibles and intangibles (book value) deflated with aggregate price of investment goods.
- l_{ist} is wage bill divided by industry output price.
- δ_{st} is sum of depreciation expenses divided by the aggregate book value of capital.
- r_t is nominal corporate lending rate to non-financial firms minus next year's expected inflation.
 - lending rate is from Eurostat and refers to loans with size less than 1 million euros that mature within 1 year
 - expected inflation is given by the fitted values from an estimated AR(1) process for CPI inflation



(a) Permanent Sample



(b) Full Sample

Notes: To aggregate across industries s we (i) compute dispersion within s at t and (ii) take weighted average across s using time-invariant value added shares as weights.

$$\text{TFPR}_{ist} := p_{ist} A_{ist} = \mu \left(\frac{\text{MRPK}_{ist}}{\alpha} \right)^\alpha \left(\frac{\text{MRPL}_{ist}}{1 - \alpha} \right)^{1 - \alpha}. \quad (1)$$

Equilibrium vs. Efficient TFP (at the aggregate (sector) level):

$$\text{TFP}_{st} = \frac{Y_{st}}{K_{st}^\alpha L_{st}^{1 - \alpha}} = \left[\sum_i \left(\underbrace{(D_{ist})^{\frac{\epsilon}{\epsilon - 1}} A_{ist}}_{Z_{ist}} \frac{\overline{\text{TFPR}}_{st}}{\text{TFPR}_{ist}} \right)^{\epsilon - 1} \right]^{\frac{1}{\epsilon - 1}}. \quad (2)$$

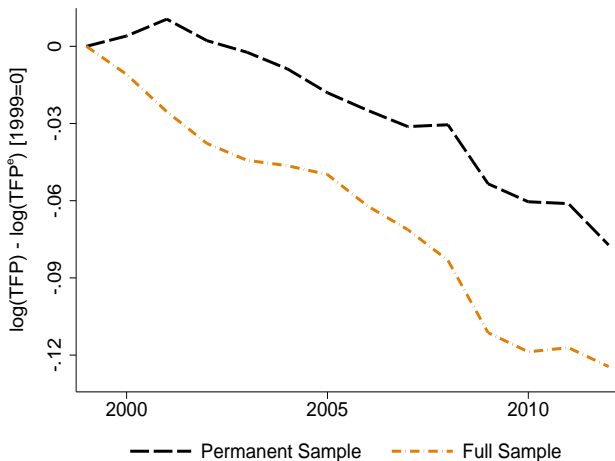
$$\text{TFP}_{st}^e = \text{TFP}_{st} (\text{TFPR}_{ist} = \overline{\text{TFPR}}_{st}) = \left[\sum_i Z_{ist}^{\epsilon - 1} \right]^{\frac{1}{\epsilon - 1}}. \quad (3)$$

Misallocation measure:

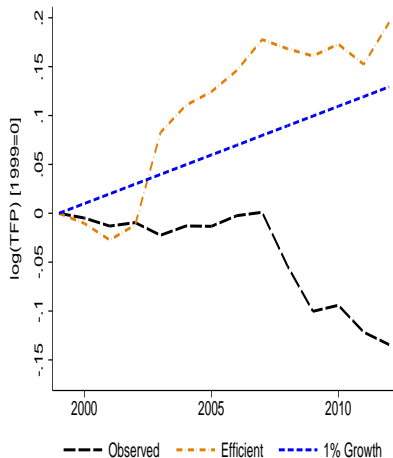
$$\begin{aligned} \text{Loss}_{st} = & \frac{1}{\epsilon - 1} \left[\log \left(\mathbb{E} Z_{ist}^{\epsilon - 1} \mathbb{E} \left(\frac{\overline{\text{TFPR}}}{\text{TFPR}_{ist}} \right)^{\epsilon - 1} + \text{Cov} \left(Z_{ist}^{\epsilon - 1}, \left(\frac{\overline{\text{TFPR}}}{\text{TFPR}_{ist}} \right)^{\epsilon - 1} \right) \right) \right] \\ & - \frac{1}{\epsilon - 1} \log \left(\mathbb{E} Z_{ist}^{\epsilon - 1} \right). \end{aligned} \quad (4)$$

- To construct the Loss_{st} measure of misallocation we need estimates of Z_{ist}
- Using same structural assumptions on demand and production used for the “Loss” equation, we estimate productivity as:

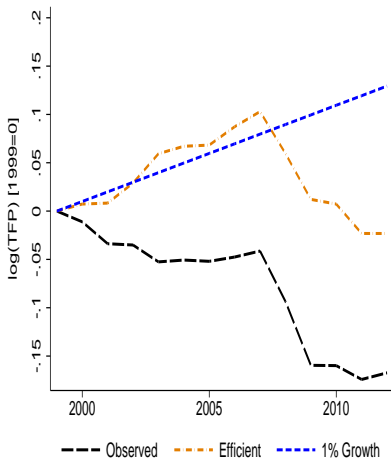
$$Z_{ist}^{\text{HK}} = \left(\frac{(P_{st} Y_{st})^{-\frac{1}{\varepsilon-1}}}{P_{st}} \right) \left(\frac{(p_{ist} y_{ist})^{\frac{\varepsilon-1}{\varepsilon}}}{k_{ist}^{\alpha} l_{ist}^{1-\alpha}} \right),$$



Notes: To aggregate across industries s we (i) compute dispersion within s at t and (ii) take weighted average across s using time-invariant value added shares as weights.



(a) Permanent Sample



(b) Full Sample

Notes: $\log(\text{TFP}_{st}) = \log(\sum_i y_{ist}) - \alpha \log(\sum_i k_{ist}) - (1 - \alpha) \log(\sum_i l_{ist})$. To aggregate across industries s we (i) compute dispersion within s at t and (ii) take weighted average across s using time-invariant value added shares as weights.

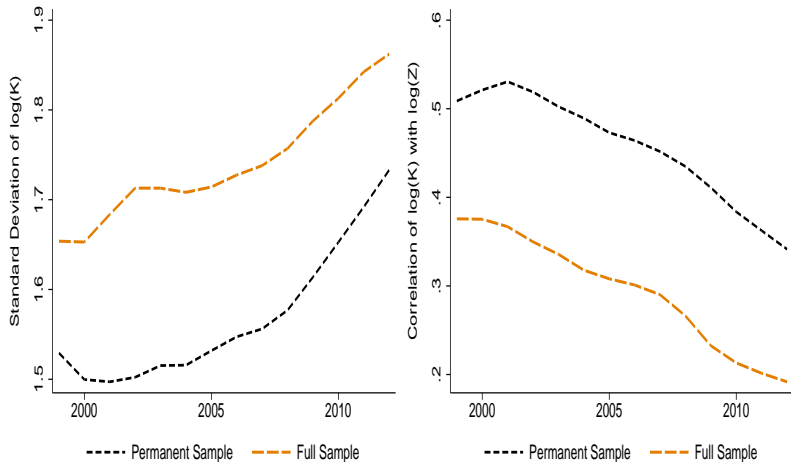
$$\log(\text{TFP}_{st}^e) = \left(\frac{1}{\varepsilon - 1}\right) \left(\log(N_{st}) + \log(\mathbb{E}_i Z_{ist}^{\varepsilon - 1})\right).$$

- To explain these trends in misallocation the model relates declines in interest rate to capital inflows that were directed to some unproductive firms.
- The correlation between productivity and capital declined over time: capital might have been allocated inefficiently to less productive firms.

$$\text{Var}(\log \text{MRPK}) = \gamma_1 \text{Var}(\log Z) + \gamma_2 \text{Var}(\log k) - \gamma_3 \text{Cov}(\log Z, \log k).$$

$$\gamma_1 = \left(\frac{\varepsilon - 1}{1 + \alpha(\varepsilon - 1)} \right)^2, \gamma_2 = \left(\frac{1}{1 + \alpha(\varepsilon - 1)} \right)^2, \gamma_3 = \frac{2(\varepsilon - 1)}{(1 + \alpha(\varepsilon - 1))^2}.$$

Trends in Capital



Notes: To aggregate across industries s we (i) compute dispersion within s at t and (ii) take weighted average across s using time-invariant value added shares as weights.

- Pre-crisis and Post-Crisis:
 - \uparrow MRPK dispersion
 - Stable MRPL dispersion
 - \uparrow TFP Losses from Misallocation
 - Decreasing correlation (+) over time between capital and productivity suggesting capital is allocated to less productive firms over time.

- Role of financial frictions?

- ① Data
- ② Dispersion and Productivity in the Data
- ③ **Model of Productivity, Dispersion, and Capital Flows**
- ④ Micro Implications
- ⑤ Macro Implications
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Key Elements

- 1 Partial equilibrium (exogenous r , w , and D).
- 2 Heterogeneous entrepreneurs hit by productivity shocks.
- 3 Monopolistic competition.
- 4 Capital accumulated and is risky (standard time-to-build).
- 5 Borrowing restrictions that depend on size.
- 6 Adjustment costs to expand capital.
- 7 Entry and exit (later).

Entrepreneurs' Problem

$$\max_{\{c_{it}, b_{it+1}, x_{it}, l_{it}, p_{it}\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{c_{it}^{1-\gamma} - 1}{1-\gamma}, \quad (5)$$

$$c_{it} + x_{it} + (1 + r_t)b_{it} = p_{it}y_{it} - w_t l_{it} + b_{it+1} - AC_{it}, \quad (6)$$

$$y_{it} = Z_{it} k_{it}^{\alpha} l_{it}^{1-\alpha}, \quad (7)$$

$$k_{it+1} = (1 - \delta)k_{it} + x_{it}, \quad (8)$$

$$b_{it+1} \leq \begin{cases} k_{it+1}, & \text{if } k_{it+1} > \kappa_t \\ 0, & \text{if } k_{it+1} \leq \kappa_t \end{cases}, \quad (9)$$

$$AC_{it} = \left[\frac{\psi}{2} \frac{(k_{it+1} - k_{it})^2}{k_{it}} \right] \mathbb{I}(k_{it+1} \geq k_{it}). \quad (10)$$

Recursive Formulation

We define net worth as $a := k - b \geq 0$.

$$V(a, k, Z, \mathbf{X}) = \max_{a', k', l, p} \{U(c) + \beta \mathbb{E} V(a', k', Z', \mathbf{X}')\}, \quad (11)$$

$$c + a' = p(y)y - wl - (r + \delta)k + (1 + r)a - AC, \quad (12)$$

$$y = Zk^\alpha l^{1-\alpha} = p^{-\varepsilon}, \quad (13)$$

$$k' \leq \begin{cases} \infty, & \text{if } k' > \kappa \\ a', & \text{if } k' \leq \kappa \end{cases}, \quad (14)$$

$$AC = \left[\frac{\psi}{2} \frac{(k' - k)^2}{k} \right] \mathbb{I}(k' \geq k). \quad (15)$$

$$\mathbb{E}_{it} \left[\frac{\beta U'(c_{it+1})}{U'(c_{it})} \right] \left[\text{MRPK}_{it+1} - R_{t+1} - \frac{\partial \text{AC}_{it+1}}{\partial k_{it+1}} \right] = \frac{\chi_{it}}{U'(c_{it})} + \frac{\partial \text{AC}_{it}}{\partial k_{it+1}}.$$

χ_{it} : multiplier on collateral constraint

Firm Productivity (Combo of Productivity and Demand)

$$Z_{it} = Z_t z_i^P \exp(z_{it}^T). \quad (16)$$

- z_i^P : permanent idiosyncratic effect with standard deviation ν
- z_{it}^T : temporary idiosyncratic effect:

$$z_{it}^T = -\frac{\sigma_t^2}{2(1+\rho)} + \rho z_{it-1}^T + \sigma_t u_{it}^z, \quad \text{with } u_{it}^z \sim N(0, 1). \quad (17)$$

- Measurement:

- 1 Z_{ist}^{WLP} with Wooldridge extension of Levinsohn and Petrin. [Go](#)
- 2 Combine structure of demand and production (Hsieh and Klenow)
- 3 Cost shares

We estimate:

$$\log(Z_{ist}) = d_i + d_{st} + \rho \log(Z_{ist-1}) + u_{ist}^z \quad (18)$$

Parameter	Value	Parameter	Value	Parameter	Value
ρ	0.63	σ	0.13	ν	0.00
ψ	3.50	κ	2.30	Z	1.00
r	0.06	β	0.93	γ	2.00
D	1.00	ε	3.00	N	100,000
α	0.35	δ	0.06	w	1.00

- The adjustment cost parameter (ψ) and the threshold parameter (κ) are picked to match the response of firm capital growth to changes in productivity and net worth observed in the data.
- We regress:

$$\frac{k_{ist+1} - k_{ist}}{k_{ist}} = d_i + d_{st} + \beta_z \log(Z_{ist}) + \beta_a \log(a_{ist}) + \beta_k \log(k_{ist}) + u_{ist}^k$$

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		Model				Data	
		(1)	(2)	(3)	(4)	Spain	Italy
	Adjustment Cost ψ	0.0	0.0	3.5	3.5		
	Borrowing Threshold κ	0.0	2.3	0.0	2.3		
$(k_{it+1} - k_{it})/k_{it}$	Z_{it}	1.54	1.04	0.08	0.11	0.13	0.08
	$\log a_{it}$	0.01	0.00	0.01	0.07	0.09	0.04
	$\log k_{it}$	-1.08	-0.96	-0.20	-0.20	-0.61	-0.54
$(b_{it+1} - b_{it})/k_{it}$	Z_{it}	1.44	0.93	-0.05	-0.12	-0.44	-0.77
	$\log a_{it}$	0.02	0.01	0.02	0.15	0.13	0.16
	$\log k_{it}$	-1.10	-0.98	-0.28	-0.31	-0.51	-0.89

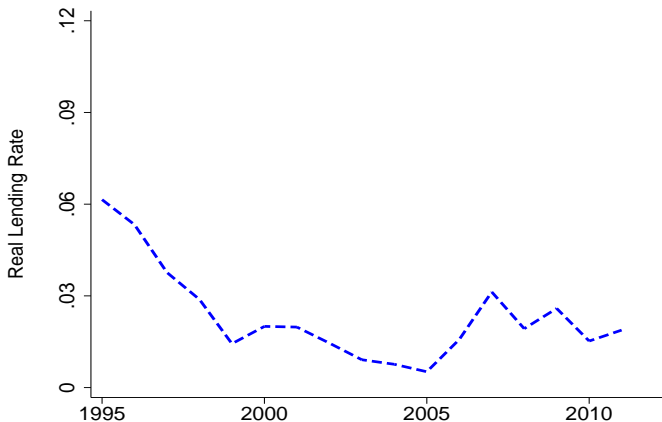
Notes: Regressions cover the period 1999-2007, in response to the transition from $r = 0.06$ to $r = 0.00$. All regressions include firm and sector-year fixed effects. All coefficients in the data are significant at the 1 percent level.

Regression of b_{it}/k_{it} on $\log k_{it}$.

	Model (ψ, κ)				Data	
Firm Fixed Effects	(0.0, 0.0)	(0.0, 2.3)	(3.5, 0.0)	(3.5, 2.3)	Spain	Italy
	(1)	(2)	(3)	(4)	(5)	(6)
No	-0.08	-0.09	-0.68	0.47	0.22	0.12
Yes	0.06	0.14	-0.45	0.91	0.59	0.53

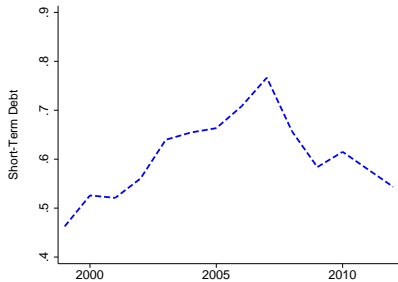
Notes: Regressions cover the period 1999-2007, in response to the transition from $r = 0.06$ to $r = 0.00$. All regressions include sector-year fixed effects. All coefficients in the data are significant at the 1 percent level. Data regressions control for long term liabilities less than assets. Data regressions without firm fixed effects additionally control for firm age.

Real Interest Rate Decline

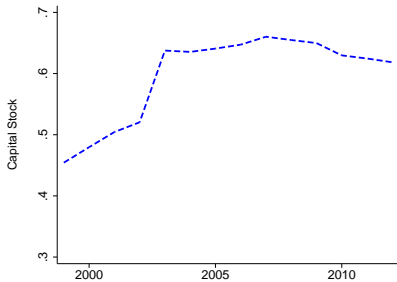


Notes: The real lending rate r_t is defined as the nominal corporate lending rate to non-financial firms minus next year's expected inflation. The lending rate is taken from Eurostat and refers to loans with size less than 1 million euros that mature within 1 year. Expected inflation is given by the fitted values from an estimated AR(1) process for CPI inflation.

Capital Flows



(c) Short Term Debt

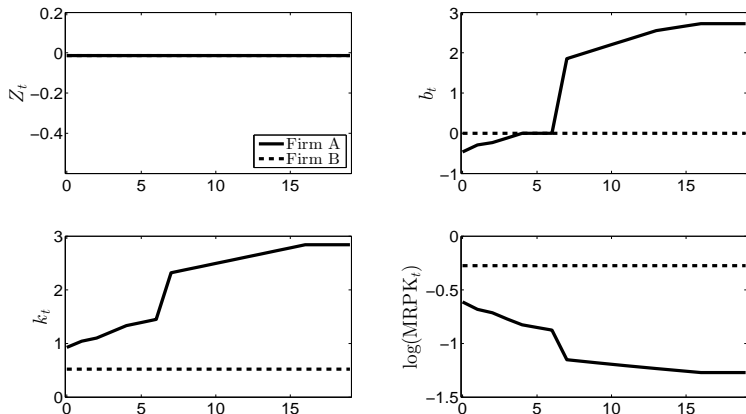


(d) Capital

Notes: Sample of continuing firms.

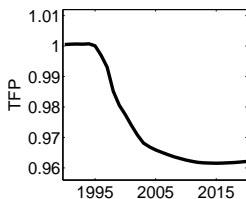
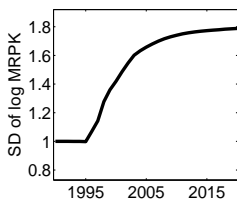
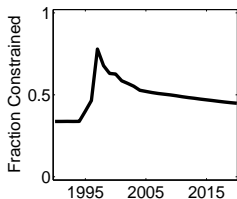
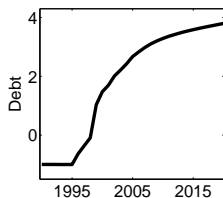
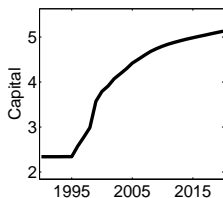
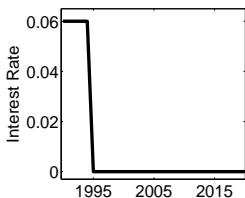
Interest Rate and Misallocation Example

► Negative Z Shock



Notes: The figure shows paths for two hypothetical firms following an unexpected and permanent change from $r = 0.06$ to $r = 0.00$. The initial values k_0 and a_0 are drawn from their joint stationary distribution when $r = 0.06$.

Decline in r ($\psi = 3.5$, $\kappa = 2.3$)



- Endogenous entry-exit
- Permanent firm productivity differences
- Different borrowing constraint/easing borrowing constraint
- Changes in firm productivity process
- MRPL dispersion
- Post crisis
- Other countries
- Correlations of Size, Z, and TFPR
 - Size and Z is positively correlated in cross section
 - Size and TFPR, MRPK are negatively correlated in cross section

- Lower real interest rates, large capital inflows and low productivity in South.
- Measure of misallocation increase over time.
 - Driven by capital
 - No evidence of an increase in misallocation of labor.
- Lower borrowing costs + financial frictions generate misallocation of resources and lower productivity.
- Differences in facts for South (Spain, Italy, Portugal) and North (France, Norway, Germany)

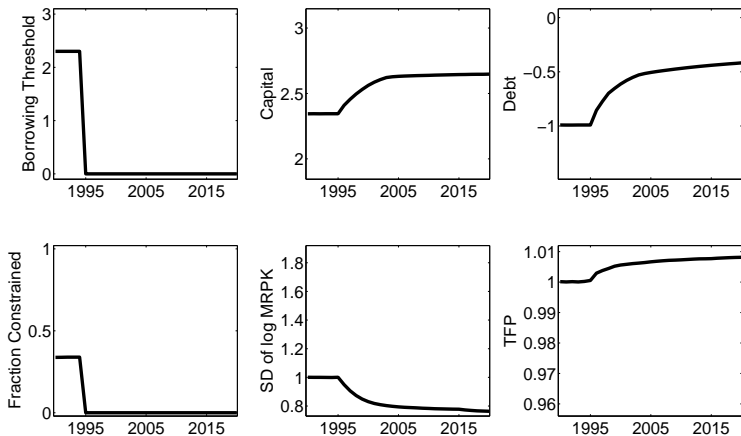
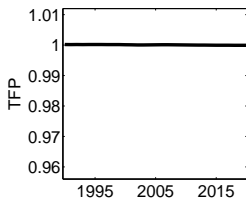
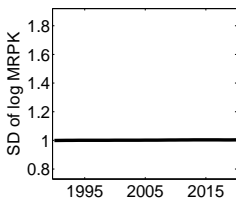
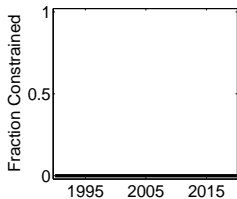
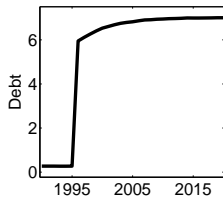
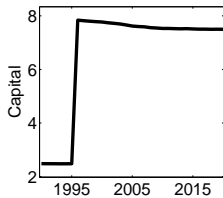
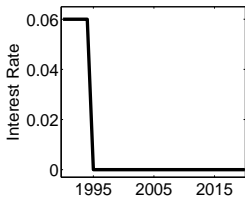


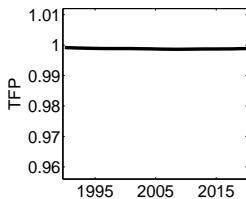
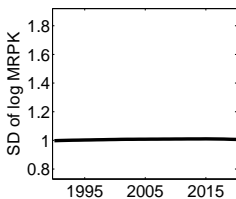
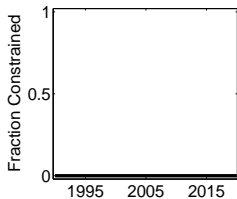
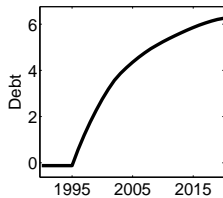
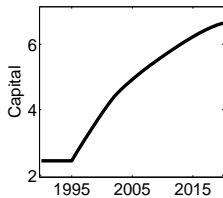
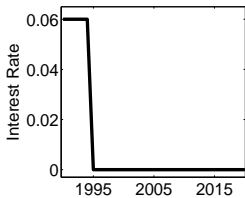
Table: Evidence Using Industry Variation

$\Delta(\text{sd}(\log(\text{MRPK}_s)))$	1999-2007
EFD _s	0.049** (0.019)
$\Delta\sigma_s$	0.190 (0.176)
ΔZ_s	-0.132 (0.123)
Observations	422

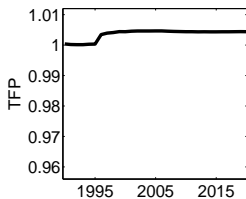
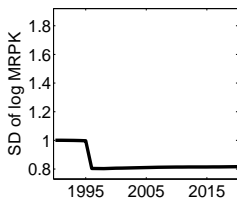
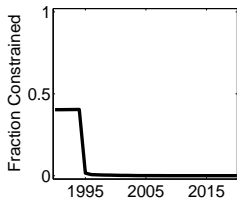
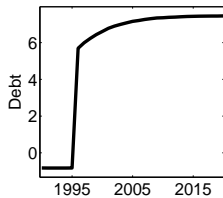
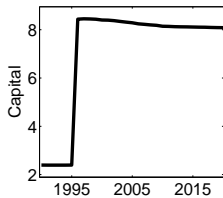
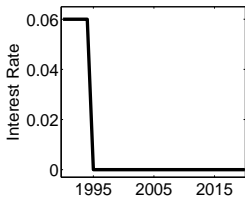
Decline in r ($\psi = 0.0$, $\kappa = 0.0$)



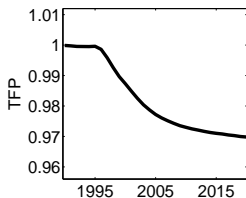
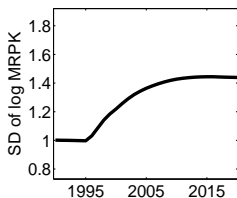
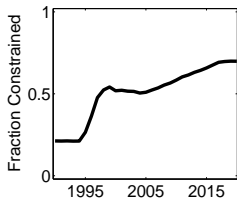
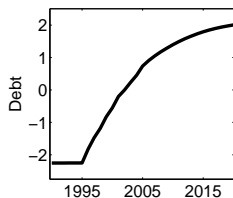
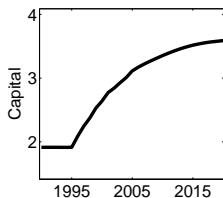
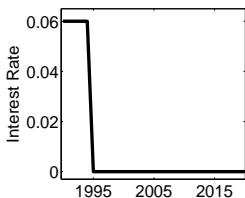
Decline in r ($\psi = 3.5, \kappa = 0.0$)



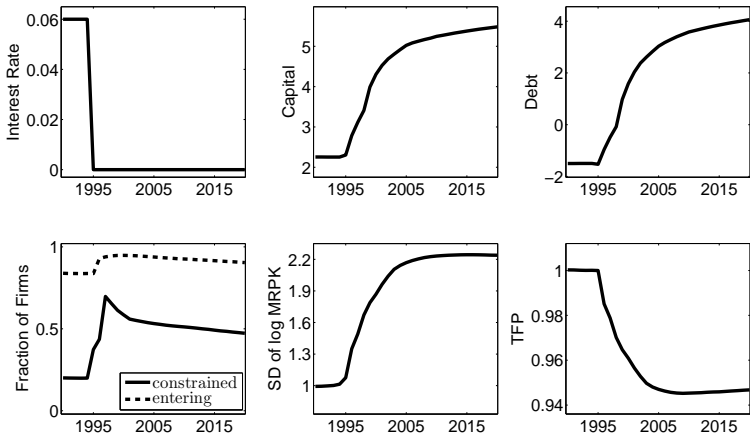
Decline in r ($\psi = 0.0$, $\kappa = 2.3$)



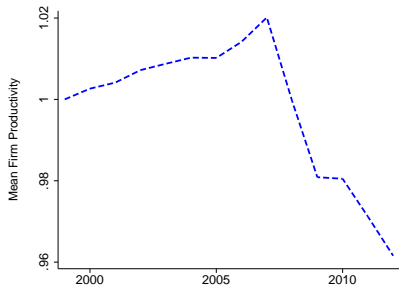
Decline in r with $\nu = 0.35$ ($\psi = 5.5, \kappa = 3.7$)



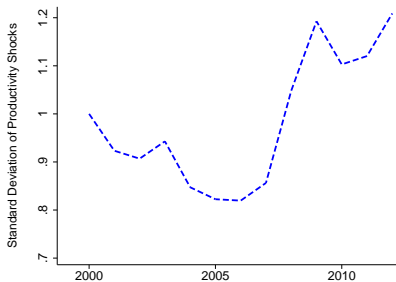
Decline in r with entry ($\psi = 3.5, \kappa = 2.3$) [▶ details](#)



Changes in Productivity Process?

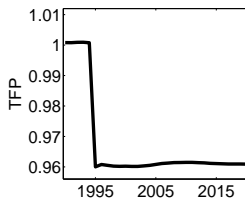
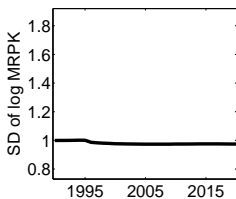
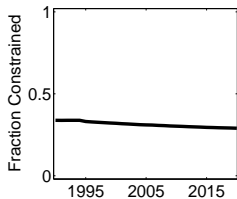
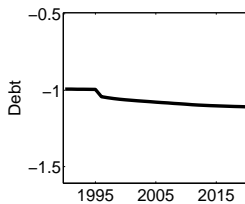
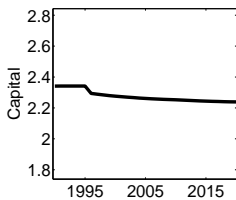
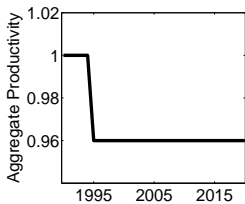


(e) Mean Productivity

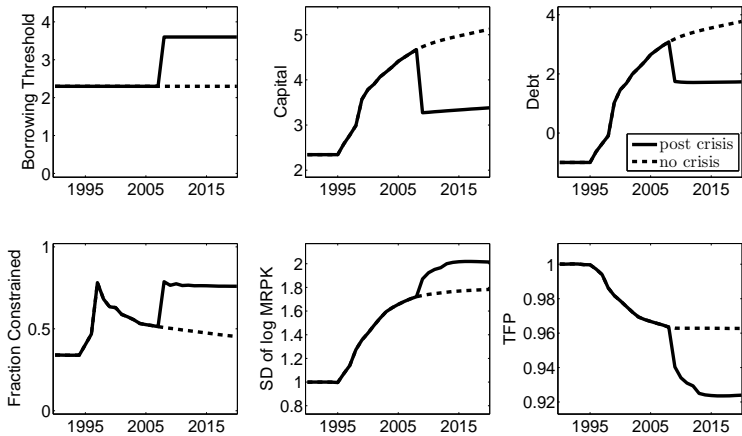


(f) Std. Dev of Productivity

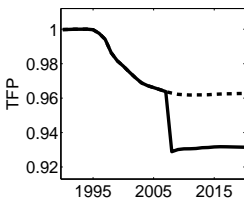
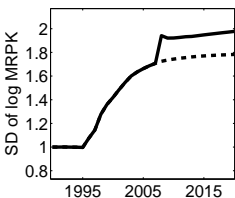
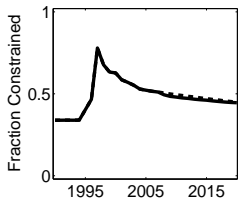
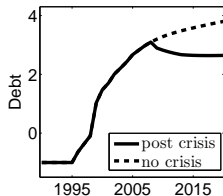
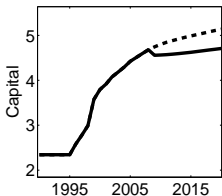
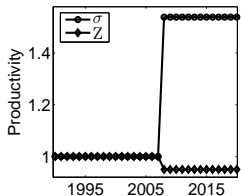
Notes: Productivity measure is Z^{WLP} . Sample of continuing firms.



Post-Crisis: κ increase



Post-Crisis: σ^2 increase and Z decrease



Evidence Using Cross-Industry Variation

Table: Evidence Using Industry Variation

$\Delta (\text{sd} (\log (\text{MRPK}_s)))$	1999-2007	2008-2012
EFD_s	0.049** (0.019)	0.020 (0.023)
$\Delta \sigma_s$	0.190 (0.176)	0.681** (0.205)
ΔZ_s	-0.132 (0.123)	-0.196 (0.158)
Observations	422	413

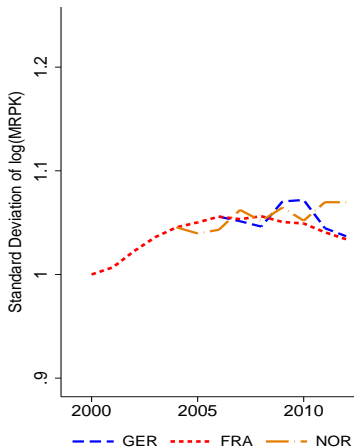
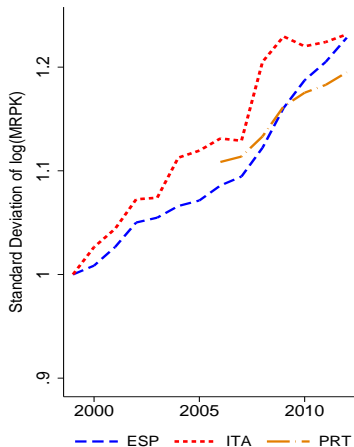
Evidence from Other Countries

Coverage Relative to Eurostat (Wage Bill)

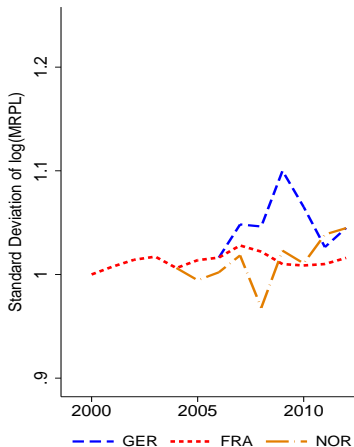
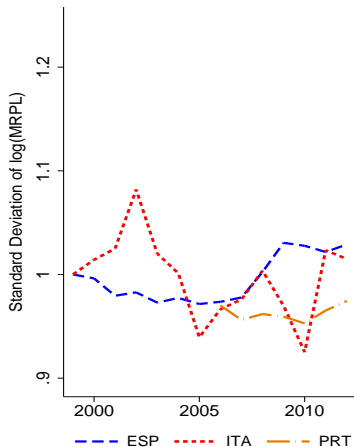
	Spain	Italy	Portugal	Germany	France	Norway
1999	0.69	0.59				
2000	0.71	0.63			0.70	
2001	0.73	0.62			0.72	
2002	0.75	0.69			0.75	
2003	0.74	0.68			0.73	
2004	0.75	0.71			0.71	0.66
2005	0.74	0.72			0.71	0.67
2006	0.74	0.73	0.91	0.34	0.72	0.71
2007	0.74	0.73	0.94	0.34	0.73	0.73
2008	0.72	0.84	0.97	0.28	N/A	0.65
2009	0.72	0.81	0.96	0.28	0.71	0.85
2010	0.73	0.83	0.96	0.30	0.73	0.82
2011	0.74	0.86	0.97	0.28	0.75	0.82
2012	0.71	0.85	0.96	0.25	0.73	0.87

	Spain	Italy	Portugal	Germany	France	Norway
ORBIS-AMADEUS						
1-19 employees	0.19	0.11	0.18	0.01	0.08	0.14
20-249 employees	0.47	0.53	0.50	0.33	0.30	0.43
250+ employees	0.34	0.36	0.32	0.67	0.61	0.43
Eurostat (SBS)						
0-19 employees	0.20	0.22	0.21	0.07	0.14	0.15
20-249 employees	0.43	0.44	0.49	0.26	0.31	0.41
250+ employees	0.37	0.34	0.30	0.67	0.55	0.44

MRPK Dispersion



Notes: $MRPK_{ist} := \frac{\alpha}{\mu} \frac{P_{ist} Y_{ist}}{k_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t ; (2) weighted average across s using time-invariant value added shares as weights.



Notes: $MRPL_{ist} := \frac{1-\alpha}{\mu} \frac{p_{ist} Y_{ist}}{l_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t ; (2) weighted average across s using time-invariant value added shares as weights.

EXTRA SLIDES

Comparison to Compnet

Table: SIZE DISTRIBUTION: BvD vs. OECD AND COMPNET
BASED ON EMPLOYMENT

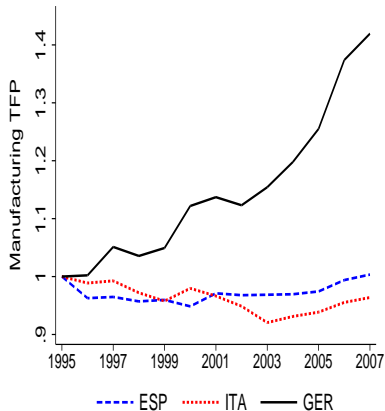
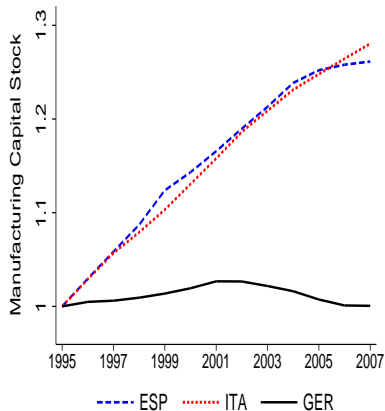
COUNTRY	0-1 TO 19			20 TO 249			+250		
	BvD	ES	CN	BvD	ES	CN	BvD	ES	CN
Belgium 08	87.6	95.1	89.5	11.5	4.6	9.9	0.9	0.3	0.7
Estonia 07	86.4	91	89.4	12.9	8.6	10.3	0.7	0.4	0.4
Finland 07	86.4	95.9	92.2	12.4	3.7	7.2	0.1	0.3	0.6
France 09	87.8	96.3	66	11.1	3.4	31.8	0.1	0.2	2.2
Germany 08	81.0	92.8	20.8	17.4	6.7	65.9	0.6	0.5	13.4
Italy 08	85.0	97.6	83.5	14.1	2.3	15.8	0.8	0.1	0.7
Latvia 07	83.5	89.3	71.1	15.2	10.3	27	0.3	0.4	1.9
Spain 08	86.7	96.5	90.7	12.6	3.4	9	0.6	0.1	0.3

NOTES: Each cell gives the share of number of firms of the corresponding size group in total economy from the relevant data source for the given year (%).

Table: ORBIS-AMADEUS TO WRDS, 2006, MANUFACTURING, SPAIN

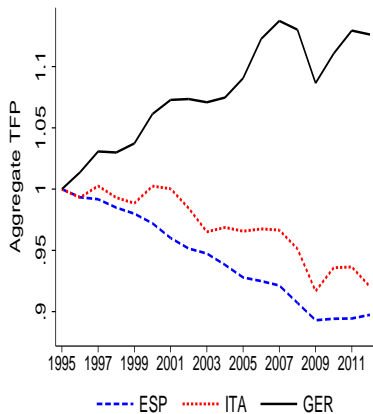
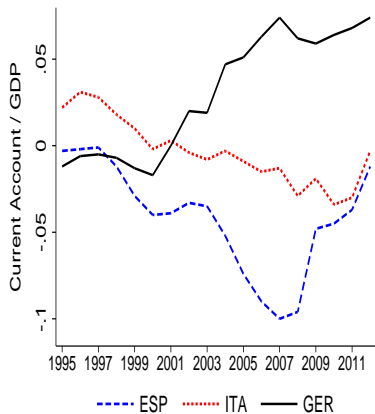
	TFP Sample	Download TFP Sample
Panel A: Employment		
1-19	24.2%	0.6%
20-249	49.7%	50.1%
250+	26.1%	49.3%
Panel B: Wage Bill		
1-19	19.2%	0.6%
20-249	47.0%	44.4%
250+	33.8%	53.4%
Panel C: Output		
1-19	13.6%	1.2%
20-249	41.5%	42.6%
250+	44.8%	54.4%

Capital and Productivity in Euro Manufacturing



Source: EU KLEMS. Capital is real non-residential capital stock.

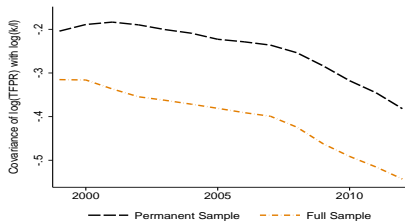
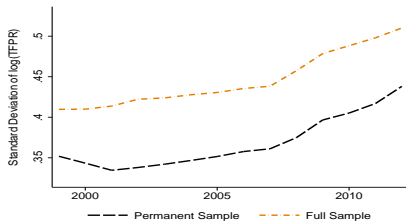
Capital Flows and Productivity in Euro Area

[▶ Back](#)

Sources: CA/GDP from IFS, IMF. Aggregate TFP from TED, Conference Board.

$$\begin{aligned}\text{Var}(\log(\text{MRPK})) &= \text{Var}(\log(\text{TFPR})) + (1 - \alpha)^2 \text{Var}\left(\log\left(\frac{K}{L}\right)\right) \\ &\quad - 2(1 - \alpha) \text{Cov}\left(\log(\text{TFPR}), \log\left(\frac{K}{L}\right)\right)\end{aligned}$$

$$\begin{aligned}\text{Var}(\log(\text{MRPL})) &= \text{Var}(\log(\text{TFPR})) + \alpha^2 \text{Var}\left(\log\left(\frac{K}{L}\right)\right) \\ &\quad + 2\alpha \text{Cov}\left(\log(\text{TFPR}), \log\left(\frac{K}{L}\right)\right)\end{aligned}$$



(k) Standard Deviation of $\log(\text{TFPR})$ (l) Covariance of $\log(\text{TFPR})$ and $\log(k/l)$

Figure: TFPR Moments

Share of Total Gross Output by Size Class (2006)

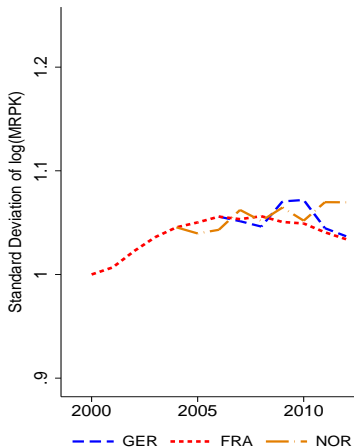
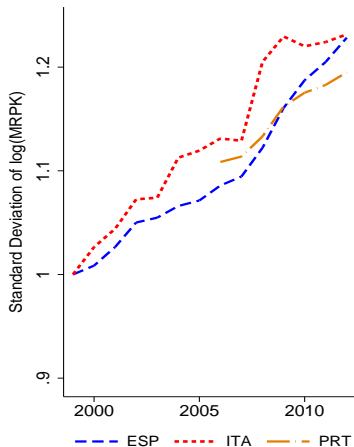
[▶ Back](#)

	Spain	Italy	Portugal	Germany	France	Norway
ORBIS-AMADEUS						
1-19 employees	0.14	0.12	0.12	0.06	0.05	0.11
20-249 employees	0.42	0.49	0.43	0.27	0.23	0.40
250+ employees	0.45	0.40	0.46	0.67	0.72	0.49
Eurostat (SBS)						
0-19 employees	0.14	0.20	0.14	0.06	0.09	0.13
20-249 employees	0.38	0.41	0.42	0.22	0.27	0.36
250+ employees	0.49	0.39	0.43	0.72	0.64	0.51

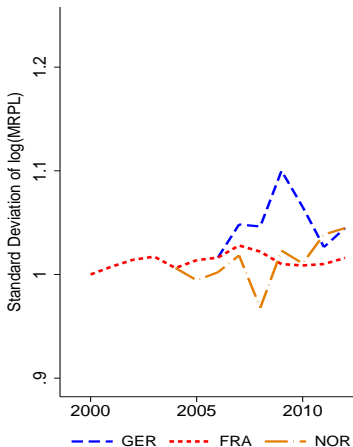
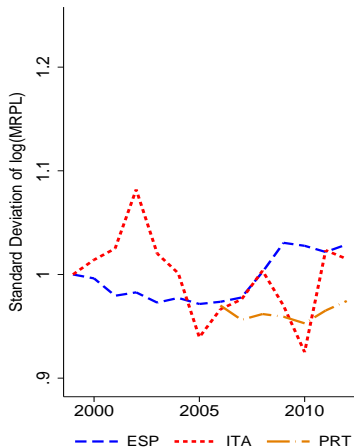
Share of Total Employment by Size Class (2006)

[▶ Back](#)

	Spain	Italy	Portugal	Germany	France	Norway
ORBIS-AMADEUS						
1-19 employees	0.24	0.13	0.25	0.05	0.10	0.18
20-249 employees	0.50	0.55	0.53	0.32	0.35	0.47
250+ employees	0.26	0.32	0.22	0.63	0.56	0.35
Eurostat (SBS)						
0-19 employees	0.31	0.41	0.32	0.15	0.19	0.20
20-249 employees	0.43	0.38	0.49	0.32	0.34	0.42
250+ employees	0.26	0.22	0.19	0.53	0.47	0.38

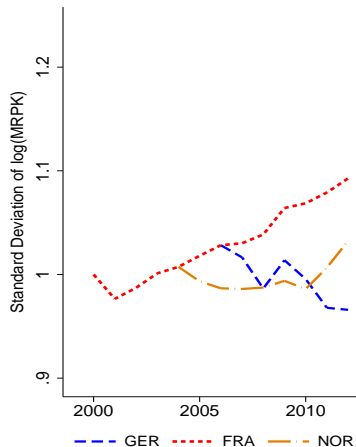
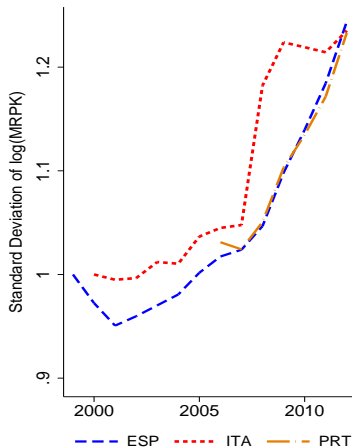


Notes: $MRPK_{ist} := \frac{\alpha}{\mu} \frac{P_{ist} Y_{ist}}{k_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t ; (2) weighted average across s using time-invariant value added shares as weights.



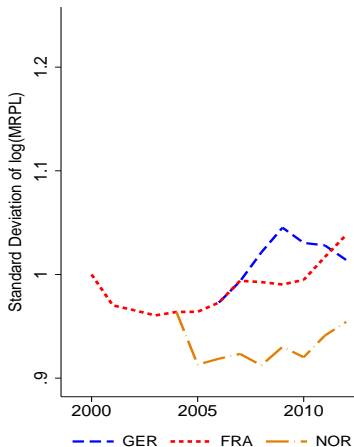
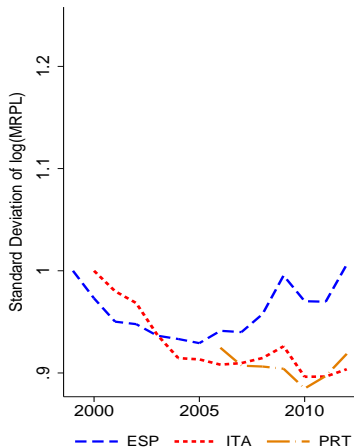
Notes: $MRPL_{ist} := \frac{1-\alpha}{\mu} \frac{p_{ist} Y_{ist}}{l_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t ; (2) weighted average across s using time-invariant value added shares as weights.

MRPK Dispersion in Continuing Sample

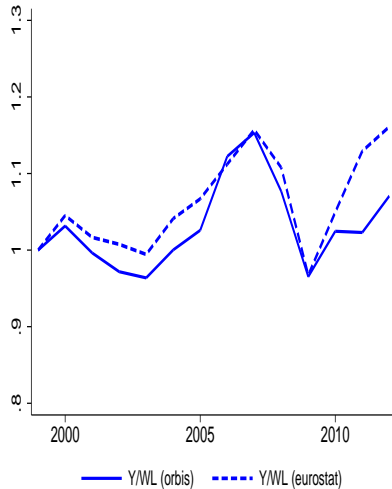
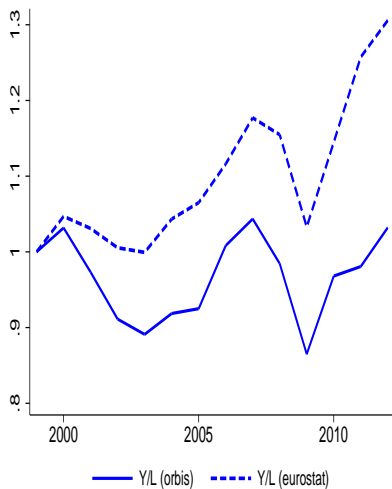
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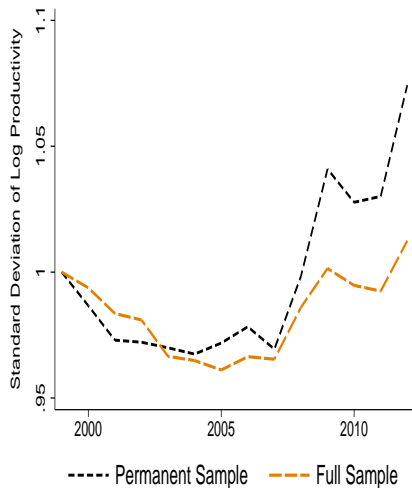
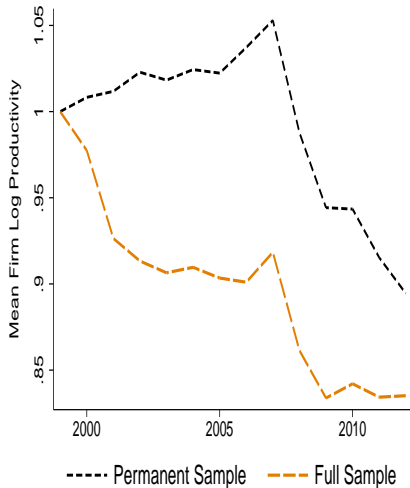
Notes: $MRPK_{ist} := \frac{\alpha}{\mu} \frac{P_{ist} Y_{ist}}{k_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t ; (2) weighted average across s using time-invariant value added shares as weights.

MRPL Dispersion in Continuing Sample

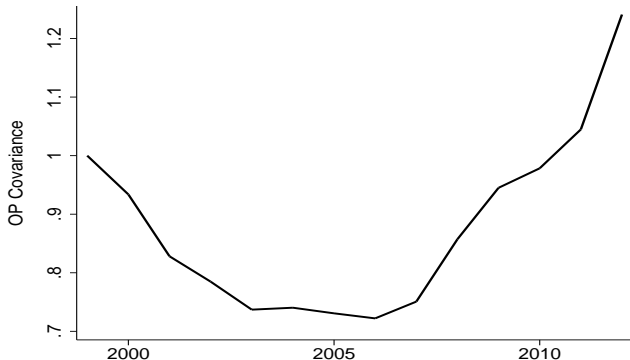
[▶ Back](#)

Notes: $MRPL_{ist} := \frac{1-\alpha}{\mu} \frac{p_{ist} Y_{ist}}{l_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t ; (2) weighted average across s using time-invariant value added shares as weights.





$$\Omega_{st} = \sum_i \theta_{ist} \omega_{ist} = \underbrace{\bar{\omega}_{ist}}_{\text{unweighted average}} + \underbrace{\sum_i (\theta_{ist} - \bar{\theta}_{st}) (\omega_{ist} - \bar{\omega}_{st})}_{\text{OP covariance}},$$



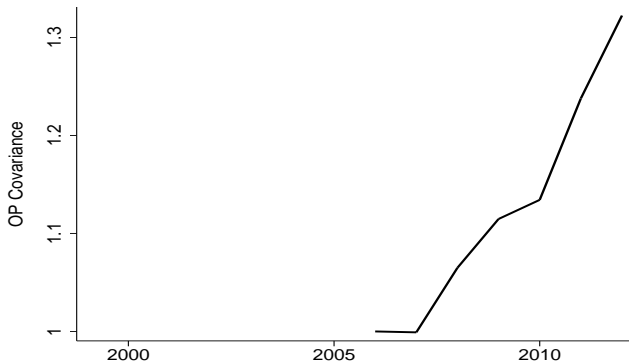
Notes: We use $\theta_{ist} = \frac{P_{ist} Y_{ist}}{P_{st} Y_{st}}$ and $\omega_{ist} = Z_{ist}^{WLP}$.

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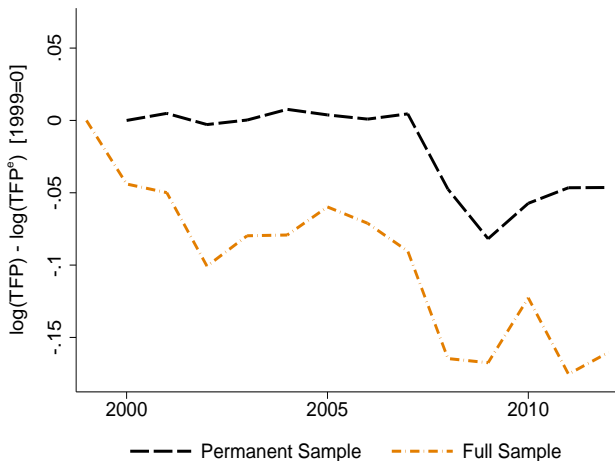


Notes: We use $\theta_{ist} = \frac{P_{ist} Y_{ist}}{P_{st} Y_{st}}$ and $\omega_{ist} = Z_{ist}^{WLP}$.

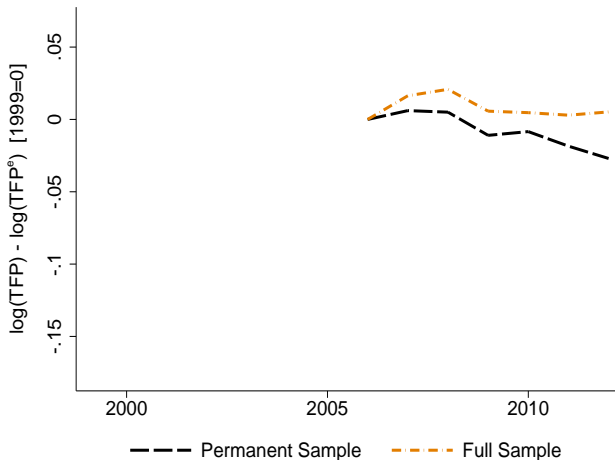
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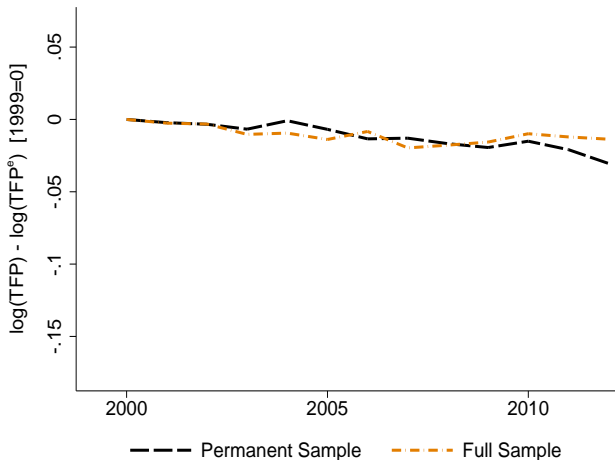
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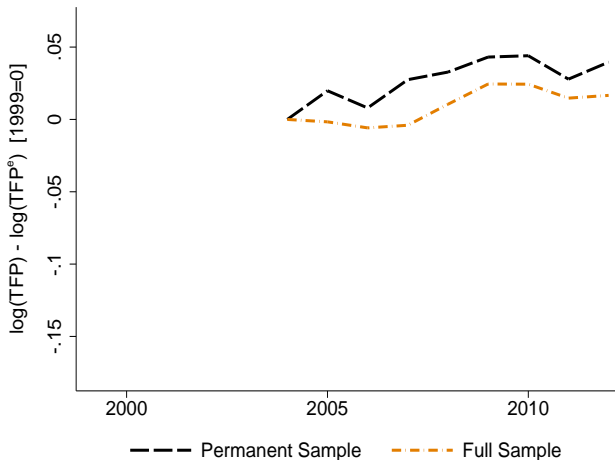
Notes: To aggregate across industries s we (i) compute dispersion within s at t and (ii) take weighted average across s using time-invariant value added shares as weights.



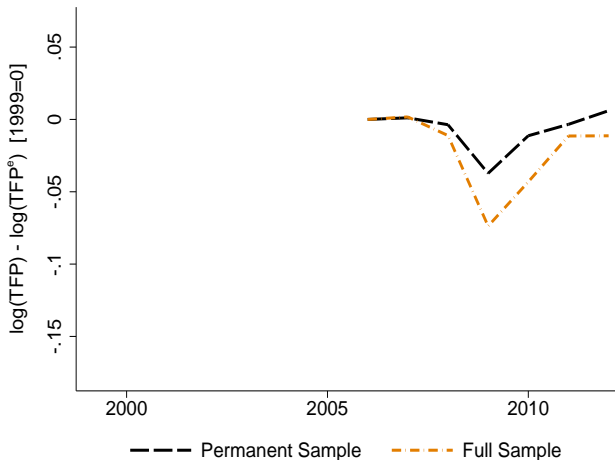
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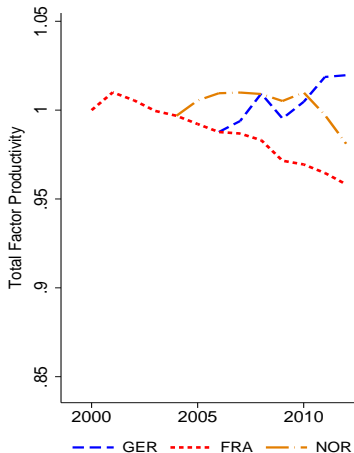
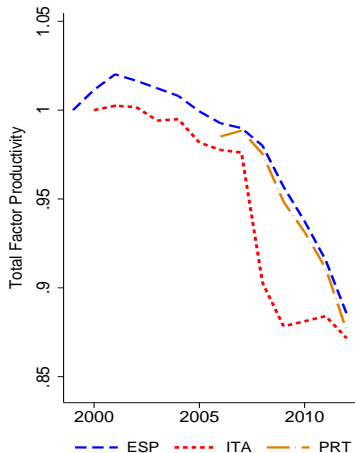


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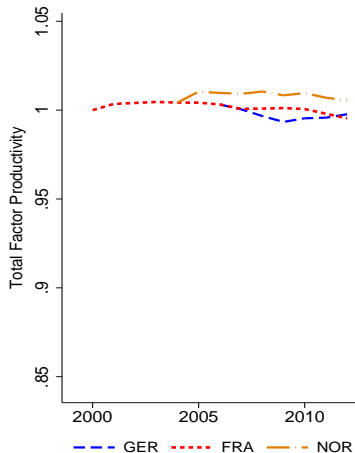
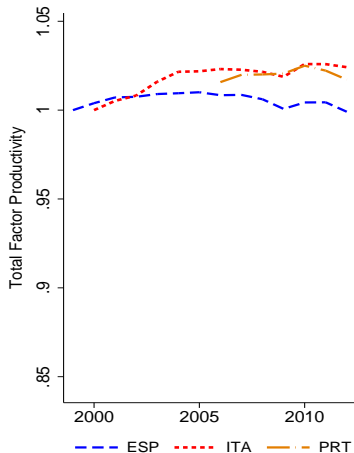
Notes: To aggregate across industries s we (i) compute dispersion within s at t and (ii) take weighted average across s using time-invariant value added shares as weights.

Hypothetical TFP (MRPK) in Continuing Sample [▶ Back](#)



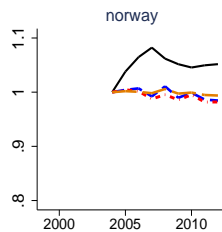
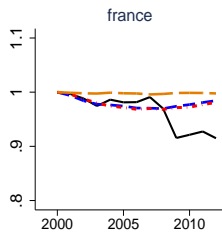
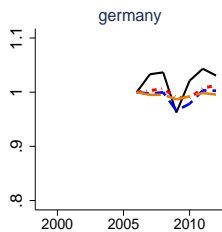
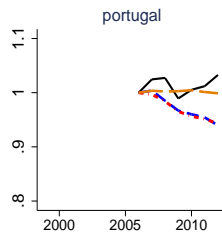
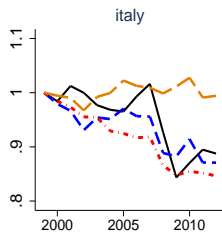
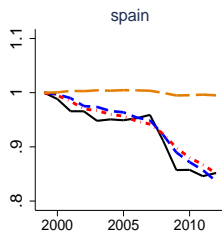
Notes: $\Delta \log \left(TFP_t^K \right) = - \left(\frac{\alpha(\epsilon\alpha+1-\alpha)}{2} \right) \Delta \text{Var} \left(\log \left(MRPK_{ist} \right) \right)$ with $\alpha = 0.35$ and $\epsilon = 3$.

Hypothetical TFP (MRPL) in Continuing Sample [▶ Back](#)



Notes: $\Delta \log \left(TFP_t^L \right) = - \left(\frac{(1-\alpha)(\epsilon(1-\alpha)+\alpha)}{2} \right) \Delta \text{Var} \left(\log \left(MRPL_{ist} \right) \right)$ with $\alpha = 0.35$ and $\epsilon = 3$.

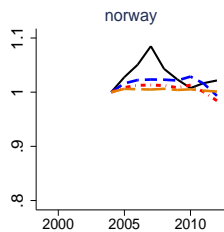
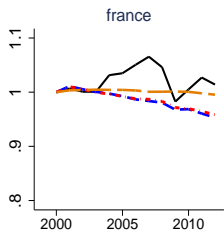
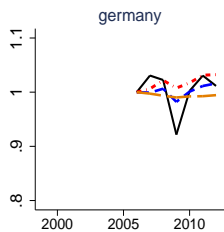
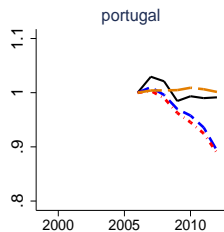
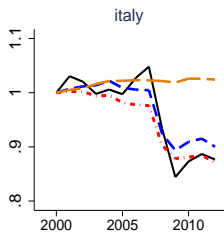
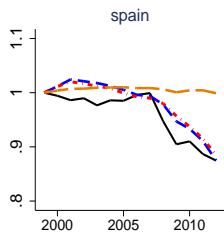
Time Series of TFP in the Model vs. Data

[▶ Back](#)

— TFP (Data) - - - TFP (TFPR)
· · · · · TFP (MRPK) - - - TFP (MRPL)

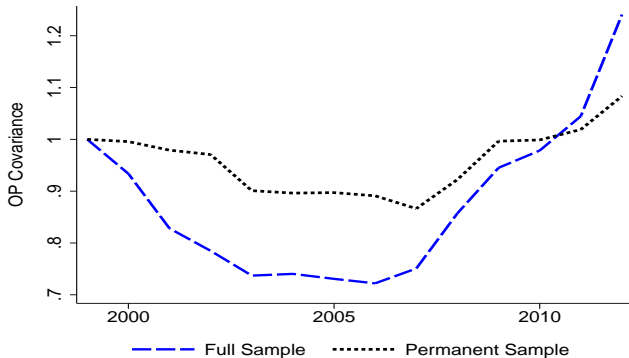
TFP in the Model vs. Data in Continuing Sample

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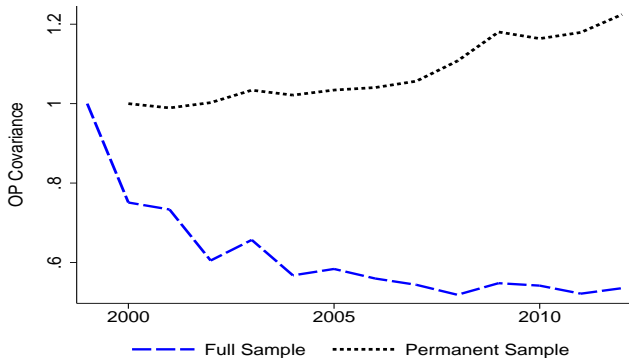
— TFP (Data) - - - TFP (TFPR)
- . - . - . TFP (MRPK) - - - TFP (MRPL)

$$\Omega_{st} = \sum_i \theta_{ist} \omega_{ist} = \underbrace{\bar{\omega}_{ist}}_{\text{unweighted average}} + \underbrace{\sum_i (\theta_{ist} - \bar{\theta}_{st}) (\omega_{ist} - \bar{\omega}_{st})}_{\text{OP covariance}},$$



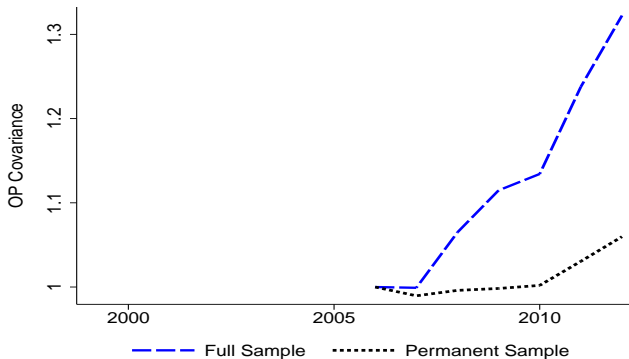
Notes: We use $\theta_{ist} = \frac{P_{ist} Y_{ist}}{P_{st} Y_{st}}$ and $\omega_{ist} = Z_{ist}^{WLP}$.

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Notes: We use $\theta_{ist} = \frac{P_{ist} Y_{ist}}{P_{st} Y_{st}}$ and $\omega_{ist} = Z_{ist}^{WLP}$.

- Olley and Pakes (1996, ECMA), Levinsohn and Petrin (2003, RESTUD), and Wooldridge (2009, EL). Production function:

$$\log(y_{it}) = \beta_0 + \beta_l \log(l_{it}) + \beta_k \log(k_{it}) + \log(Z_{it}) + u_{it}.$$

- A problem is that inputs are endogenous to Z_{it} .
- Let m_{it} be some proxy (e.g. intermediate inputs or investment) such that $Z_{it} = g(k_{it}, m_{it})$. Idea is to use g as a control function.
- Assume that u_{it} is orthogonal to all current and past values of (l_{it}, k_{it}, m_{it}) and that Z_{it} is first-order Markov.
- Estimate jointly the system of equations:

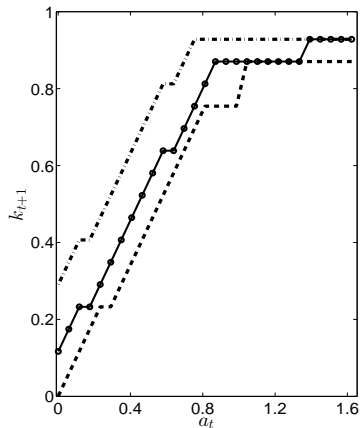
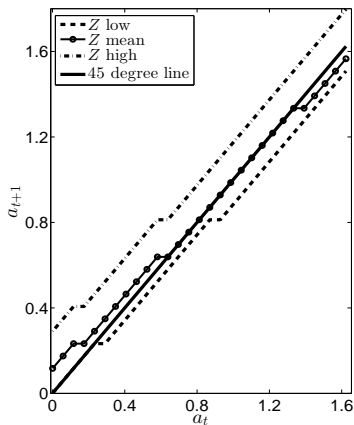
$$\log(y_{it}) = \beta_0 + \beta_l \log(l_{it}) + \beta_k \log(k_{it}) + g(m_{it}, k_{it}) + u_{it}^1.$$

$$\log(y_{it}) = \beta_0 + \beta_l \log(l_{it}) + \beta_k \log(k_{it}) + f(g(m_{it-1}, k_{it-1})) + u_{it}^2.$$

Estimates of Output Elasticities (24 2-digit industries)

	Spain	Italy	Portugal
Mean of Sum of Elasticities	0.81	0.71	0.78
Median of Sum of Elasticities	0.80	0.70	0.77
Max of Sum of Elasticities	0.91	0.81	0.88
Min of Sum of Elasticities	0.76	0.58	0.57
SD of Sum of Elasticities	0.04	0.05	0.06
Fraction of Negative Elasticities	0.02	0.00	0.09

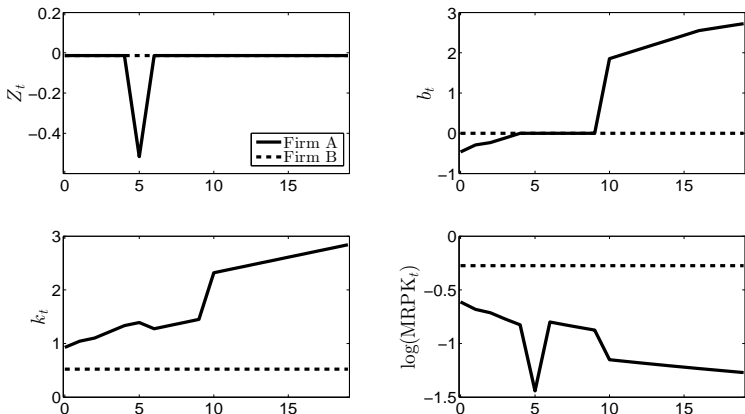
Saving and Investment Policies ($r = 0.06$)

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Paper	ρ	σ	ν	Country
This (WLP)	0.63	0.13	0.35	Spain and Italy
This (HK)	0.72	0.22	0.56	Spain and Italy
ACWDL (2014, JPE)	0.41	0.30	0.41	U.S.
MX (2014, AER)	0.25	0.50	1.47	Korea

Dependent Variable	Regressors	Country	
		Spain	Italy
$(k_{it+1} - k_{it})/k_{it}$	Z_{it}	0.13	0.08
	$\log a_{it}$	0.09	0.04
	$\log k_{it}$	-0.61	-0.54
$(k_{it+1} - k_{it})/k_{it}$	$\log(\text{Sales}_{it}/k_{it})$	0.14	0.08
	$(\text{Cash Flow})_{it}/k_{it}$	0.06	0.03
	$\log k_{it}$	-0.45	-0.45

Notes: All regressions include firm, year, and sector-year fixed effects. All coefficients are significant at the 1 percent level.



Notes: The figure shows paths for two hypothetical firms following an unexpected and permanent change from $r = 0.06$ to $r = 0.00$. The initial values k_0 and a_0 are drawn from their joint stationary distribution when $r = 0.06$.

Midrigan and Xu (2014, AER), Moll (2014, AER), Buera and Moll (Forthcoming, AEJ Macro)

- Budget constraint:

$$c + a' = AZk^\eta/\eta + (1+r)a - Rk.$$

- Size-independent borrowing constraint:

$$k \leq \theta a.$$

- One year-ahead perfect foresight about productivity:

$$k = \min \left\{ \theta a, (AZ)^{\frac{1}{1-\eta}} R^{-\frac{1}{1-\eta}} \right\}.$$

- MRPK and cutoff:

$$\log(\text{MRPK}) = \begin{cases} \log(R), & \text{if } Z \leq Z^* \\ \log(AZ\theta^{\eta-1}a^{\eta-1}), & \text{if } Z > Z^* \end{cases}$$
$$Z^* = (\theta a)^{1-\eta} R/A.$$

MRPK Dispersion: Interest Rate

$$\frac{\partial \text{Var}(\log(\text{MRPK}))}{\partial R} = \left(\frac{2}{R}\right) (\log R - \mathbb{E} \log(\text{MRPK})) \int_a F(Z^*|a) g(a) da \leq 0.$$

Variance does not change locally when initially:

- 1 everyone is unconstrained: $\log R = \mathbb{E} \log(\text{MRPK})$
- 2 everyone is constrained: $F(Z^*|a) = 0$

Intuition:

- constrained firms have higher $\log(\text{MRPK})$ than unconstrained
- $\downarrow R \implies \downarrow \log(\text{MRPK})$ for unconstrained, opening $\log(\text{MRPK})$ gap
- changes in cutoff Z^* have second-order effects

$$\frac{\partial \text{Var}(\log(\text{MRPK}))}{\partial \theta} = \left(\frac{2(\eta - 1)}{\theta} \right) \int_a \mathbb{E}(\log(\text{MRPK}) | Z > Z^*, a) (1 - F(Z^* | a)) g(a) da - \int_a \mathbb{E} \log(\text{MRPK} | a) (1 - F(Z^* | a)) g(a) da \leq 0.$$

Variance does not change locally when initially:

- 1 everyone is unconstrained: $F(Z^* | a) = 1$
- 2 everyone is constrained: $\mathbb{E}(\log(\text{MRPK}) | Z > Z^*) = \mathbb{E}(\log(\text{MRPK}))$

Intuition:

- constrained firms have higher $\log(\text{MRPK})$ than unconstrained
- $\uparrow \theta \implies \downarrow \log(\text{MRPK})$ for constrained, closing $\log(\text{MRPK})$ gap
- changes in cutoff Z^* have second-order effects

$$\frac{\partial \text{Var}(\log(\text{MRPK}))}{\partial A} = \left(\frac{2}{A}\right) \int_a \mathbb{E}(\log(\text{MRPK}) | Z > Z^*, a) (1 - F(Z^* | a)) g(a) da - \int_a \mathbb{E} \log(\text{MRPK} | a) (1 - F(Z^* | a)) g(a) da \geq 0.$$

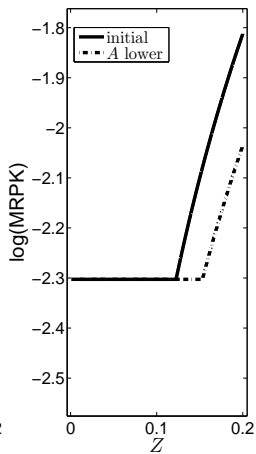
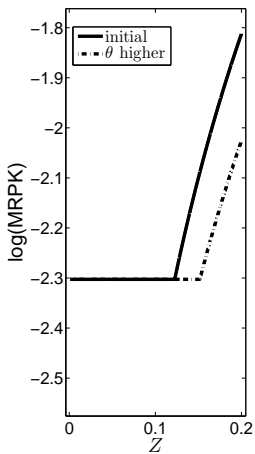
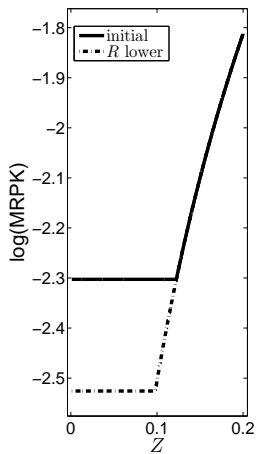
Variance does not change locally when initially:

- 1 everyone is unconstrained: $F(Z^* | a) = 1$
- 2 everyone is constrained: $\mathbb{E}(\log(\text{MRPK}) | Z > Z^*) = \mathbb{E}(\log(\text{MRPK}))$

Intuition:

- constrained firms have higher $\log(\text{MRPK})$ than unconstrained
- $\downarrow A \implies \downarrow \log(\text{MRPK})$ for constrained, closing $\log(\text{MRPK})$ gap
- changes in cutoff Z^* have second-order effects

MRPK Dispersion in Simpler Model



$m_t = \{0, 1\}$ denotes exit from and entry to manufacturing.

- For $m_{it} = 1$ and $m_{it+1} = 1$:

$$c_{it} + k_{it+1} + (1 + r_t)b_{it} = \pi_{it} - AC_{it} + (1 - \delta)k_{it} + b_{it+1}$$

- For $m_{it} = 1$ and $m_{it+1} = 0$:

$$c_{it} + (1 + r_t)b_{it} = \pi_{it} + (1 - \delta)k_{it} + b_{it+1}$$

- For $m_{it} = 0$ and $m_{it+1} = 0$:

$$c_{it} + (1 + r_t)b_{it} = h_t + b_{it+1}$$

- For $m_{it} = 0$ and $m_{it+1} = 1$:

$$c_{it} + k_{it+1} + (1 + r_t)b_{it} = h_t - \zeta(k_{it+1}) + b_{it}$$

$$V(a, k, m, Z, \mathbf{X}) = \max_{a', k', m', l, p} \{U(c) + \beta \mathbb{E} V(a', k', m', Z', \mathbf{X}')\},$$

$$c + a' = m(\pi - (r + \delta)k - m'AC) + (1 - m)(h - m'\zeta(k')) + (1 + r)a,$$

$$\pi = p(y)y - wl,$$

$$y = Zk^\alpha l^{1-\alpha} = D^\varepsilon p^{-\varepsilon},$$

$$AC = \left[\frac{\psi}{2} \frac{(k' - k)^2}{k} \right] \mathbb{I}(k' \geq k) \quad \text{and} \quad \zeta(k') = (\bar{\zeta}/2)(k')^2,$$

$$0 \leq k' \leq \begin{cases} \infty, & \text{if } k' > \kappa \\ a', & \text{if } k' \leq \kappa \end{cases}$$