Capital Allocation and Productivity in South Europe

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COMPNET Conference
June 2015

Imbalances in Euro Area

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

Related Literature

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

Data

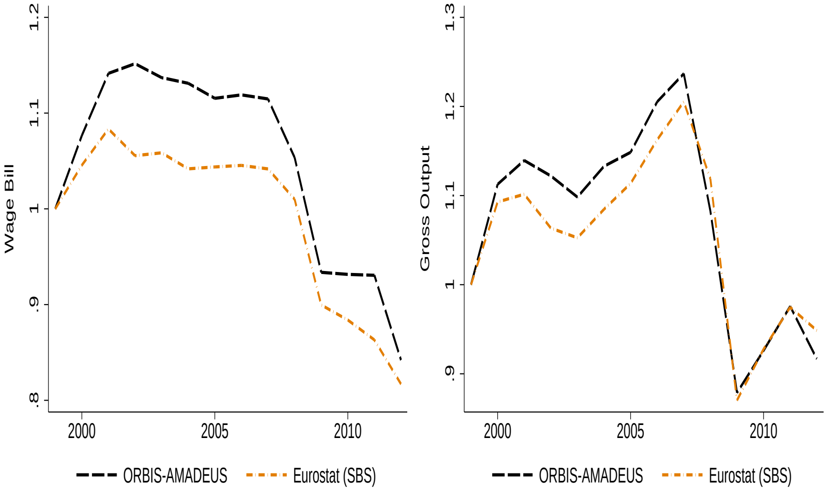
- ORBIS database provided by Bureau van Dijk (BvD), harmonized worldwide. Focus on AMADEUS, the European subset of ORBIS.
- Collected from official business registers, annual reports, and newswires.
- Focus on manufacturing industries. 4 digit NACE industry classification.
- Three main features of the 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

Aggregates Relative to Eurostat

▸ Labor Productivity



Size Distribution (2006): Spain

▸ Other Countries

		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
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- Total industry s output given by CES production function:

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

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

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

- Profit maximization:

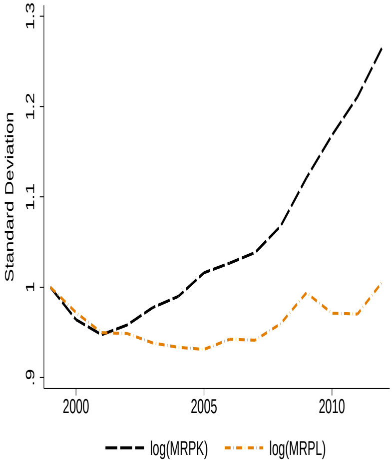
$$\max_{p_{ist}, k_{ist}, l_{ist}} \left(1 - \tau_{ist}^{y}\right) p\left(y_{ist}\right) y_{ist} - \left(1 + \tau_{ist}^{k}\right) \left(r_t + \delta_{st}\right) k_{ist} - w_{st} l_{ist}.$$

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

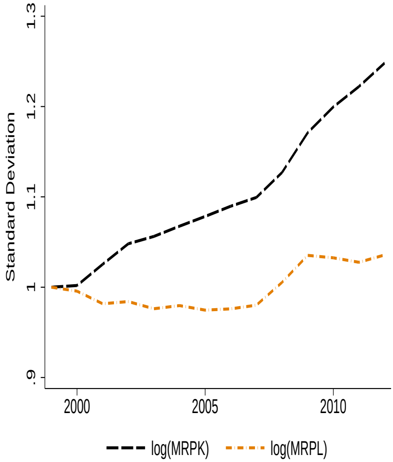
$$\text{MRPK}_{ist} := \left(\frac{\alpha}{\mu}\right) \left(\frac{p_{ist} y_{ist}}{k_{ist}}\right) = \left(\frac{1 + \tau_{ist}^{k}}{1 - \tau_{ist}^{y}}\right) \left(r_t + \delta_{st}\right),$$

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.

TFP Decomposition (Foster, Haltiwanger, Syverson; Hsieh and Klenow)

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

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

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

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

Misallocation measure:

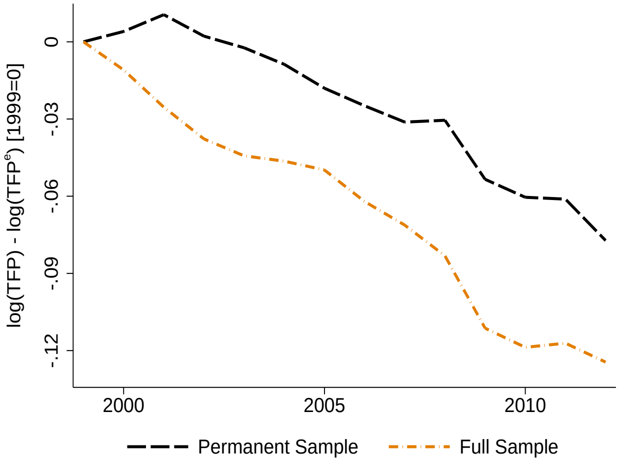
$$\begin{aligned} \text{Loss}_{st} &= \frac{1}{\varepsilon-1} \left[\log \left(\mathbb{E} Z_{ist}^{\varepsilon-1} \mathbb{E} \left(\frac{\overline{\text{TFPR}}}{\text{TFPR}_{ist}} \right)^{\varepsilon-1} + \text{Cov} \left(Z_{ist}^{\varepsilon-1}, \left(\frac{\overline{\text{TFPR}}}{\text{TFPR}_{ist}}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

- 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:

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

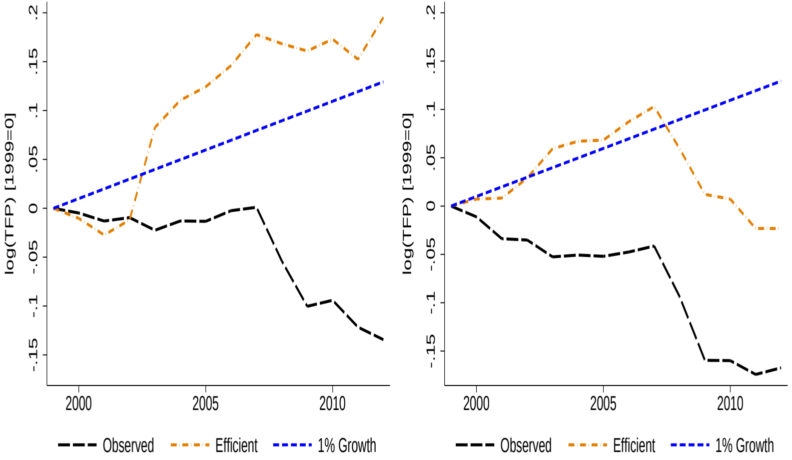
Trends in Misallocation

▸ OP ▸ Other Countries



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.

Trends in TFP ‣ MeanZ



(a) Permanent Sample (b) Full Sample

Notes: $\log(\text{TFP}_{st}) = \log\left(\sum_i y_{ist}\right) - \alpha \log\left(\sum_i k_{ist}\right) - (1-\alpha)\log\left(\sum_i l_{ist}\right)$. 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. $\log\left(\text{TFP}^e_{st}\right) = \left(\frac{1}{\varepsilon-1}\right)\left(\log\left(N_{st}\right) + \log\left(\mathbb{E}_i Z^{\varepsilon-1}_{ist}\right)\right)$.

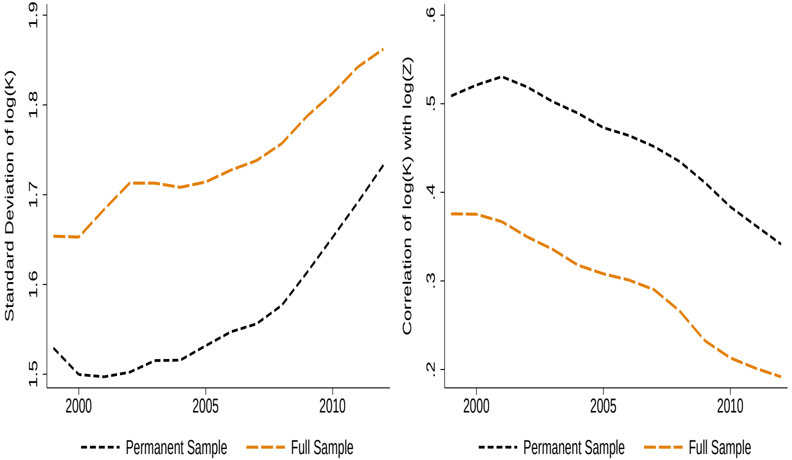
Dispersion in MRPK ▸ VarZ

- 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.

Data: Take Aways

- 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**
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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

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

$$c_{it} + x_{it} + (1 + r_t) b_{it} = p_{it} y_{it} - w_t l_{it} + b_{it+1} - \mathrm{AC}_{it}, \tag{6}$$

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

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

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

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

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

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

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

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

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

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

Capital Choice

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

χ_{it}: multiplier on collateral constraint

Firm Productivity (Combo of Productivity and Demand)

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

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

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

- 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:

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

Parameters (Initial Stationary Distribution) ▸ comparison

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:

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

Investment and Debt Decisions

Relation to Finance Literature

		Model				Data	
						Spain	Italy
		(1)	(2)	(3)	(4)	(5)	(6)
	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.

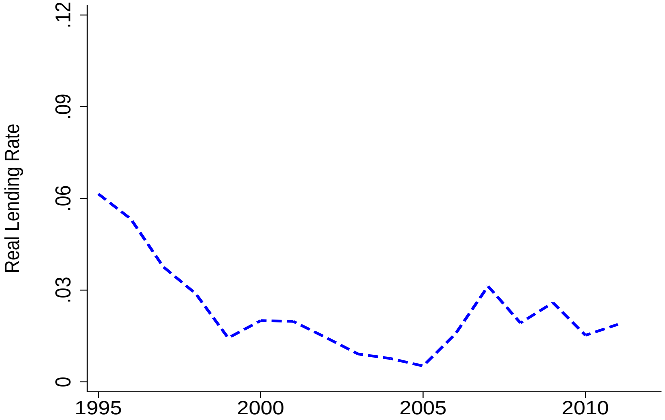
Leverage and Size

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

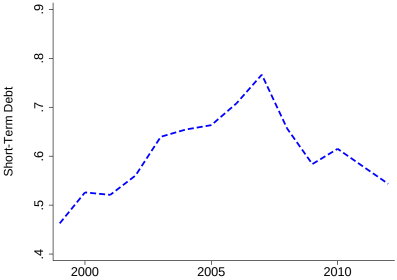
Notes: Regressions cover the period 1999-2007, in response to the transition from $r = 0.06$ to $r = 0.00$. All regressions include sector-year fixed effects. All coefficients in the data are significant at the 1 percent level. Data regressions control for long term liabilities less than assets. Data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

Real Interest Rate Decline

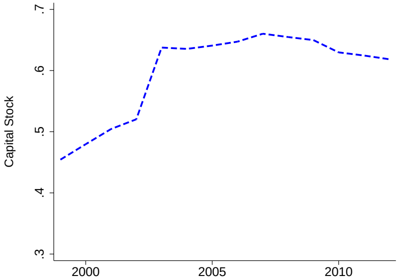


Notes: The real lending rate r_t is defined as the nominal corporate lending rate to non-financial firms minus next year's expected inflation. The lending rate is taken from Eurostat and refers to loans with size less than 1 million euros that mature within 1 year. Expected inflation is given by the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

Capital Flows

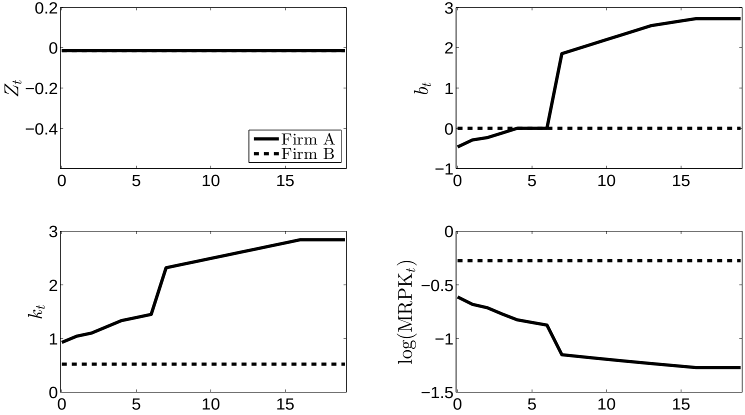


(c) Short Term Debt



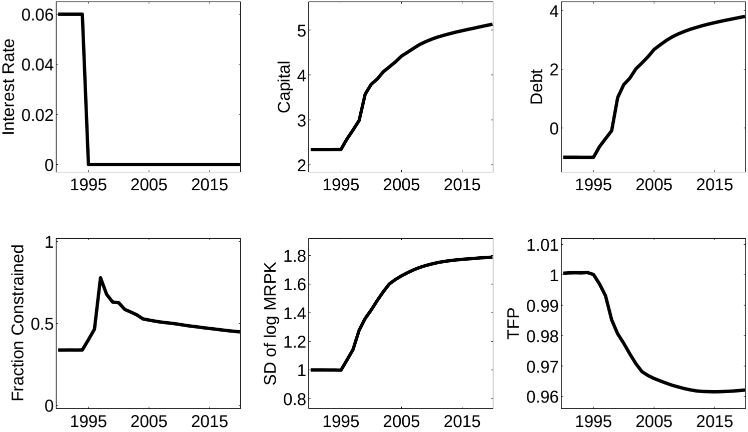
(d) Capital

Notes: Sample of continuing firms.



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 ($\psi = 3.5$, $\kappa = 2.3$)



Extensions

- 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

Conclusions

- 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)

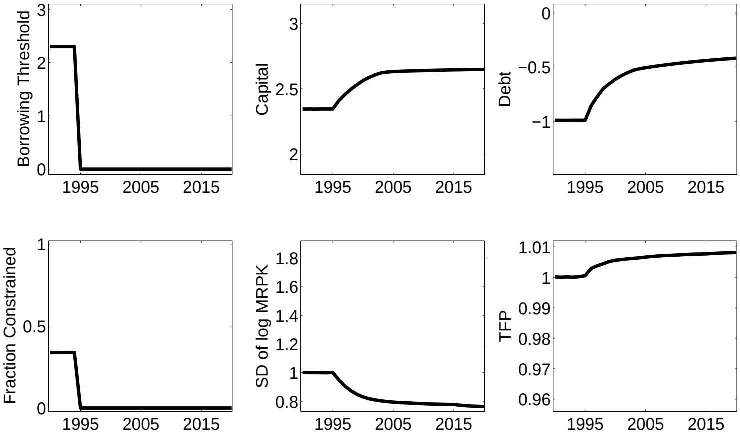
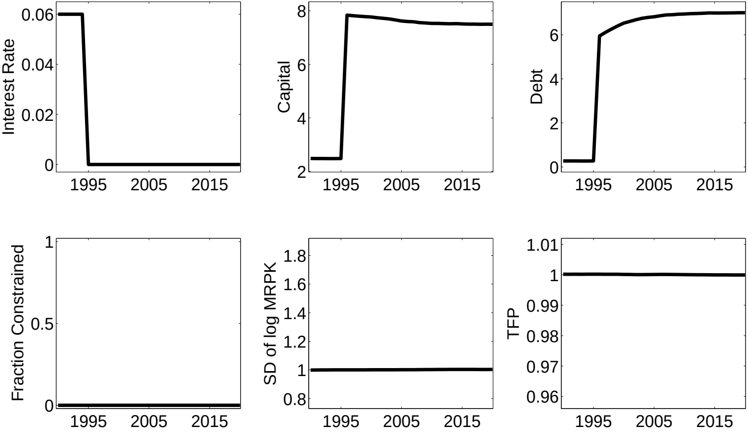

Borrowing Threshold
3
2
1
0
1995 2005 2015
Capital
3
2.5
2
1995 2005 2015
Debt
0
−0.5
−1
1995 2005 2015
Fraction Constrained
1
0.5
0
1995 2005 2015
SD of log MRPK
1.8
1.6
1.4
1.2
1
0.8
1995 2005 2015
TFP
1.01
1
0.99
0.98
0.97
0.96
1995 2005 2015

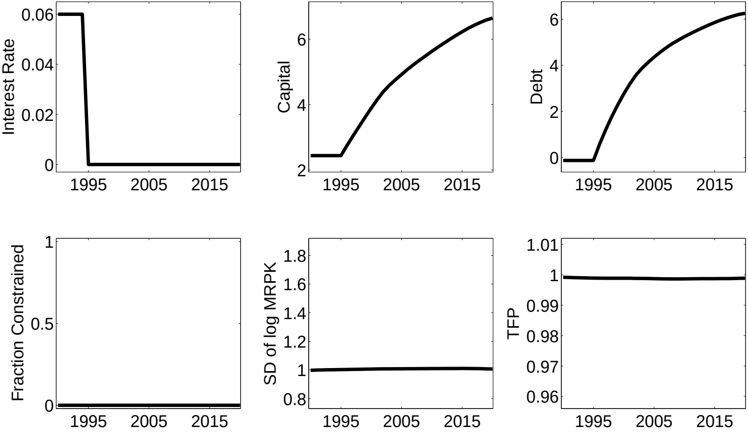
Table: Evidence Using Industry Variation

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

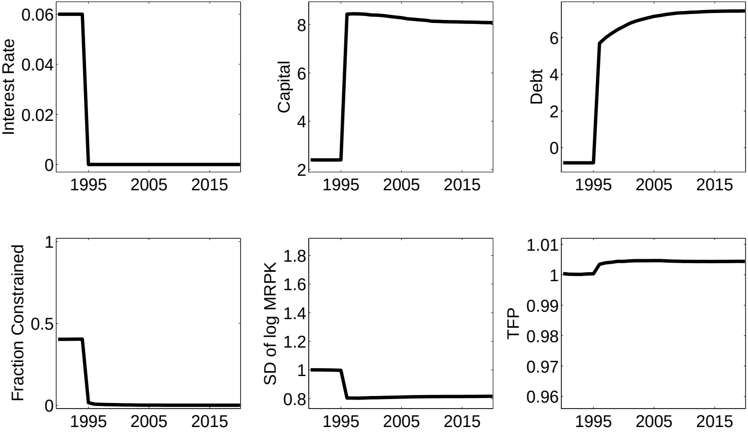
Decline in r ($\psi = 0.0$, $\kappa = 0.0$)



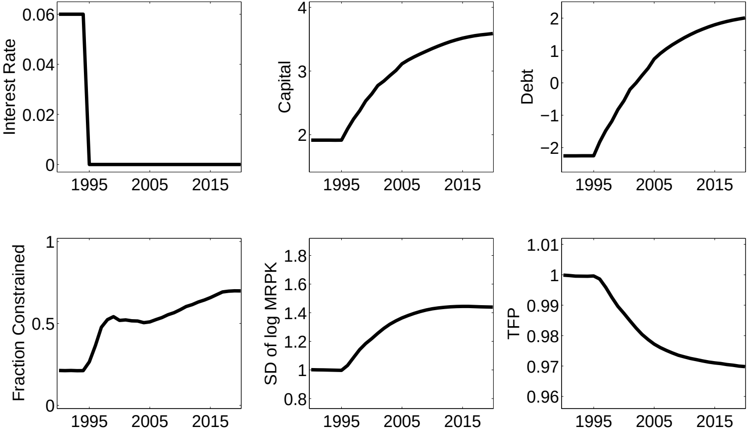
Decline in r ($\psi = 3.5$, $\kappa = 0.0$)



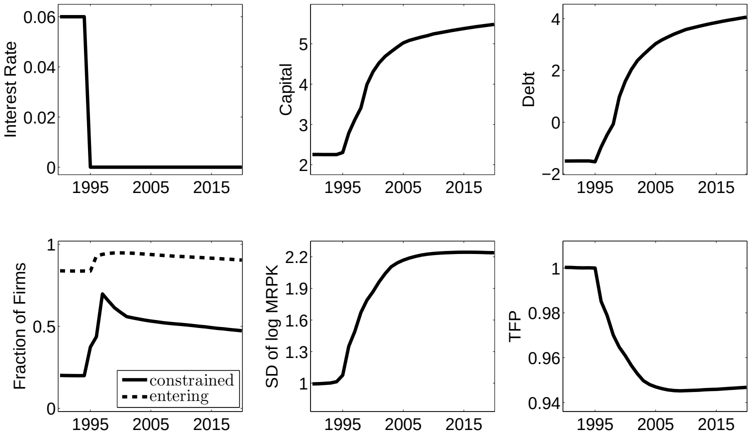
Decline in r ($\psi = 0.0$, $\kappa = 2.3$)



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

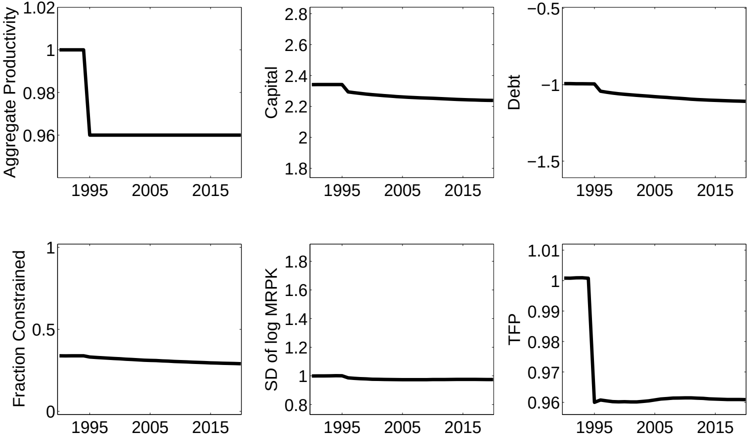


Changes in Productivity Process?

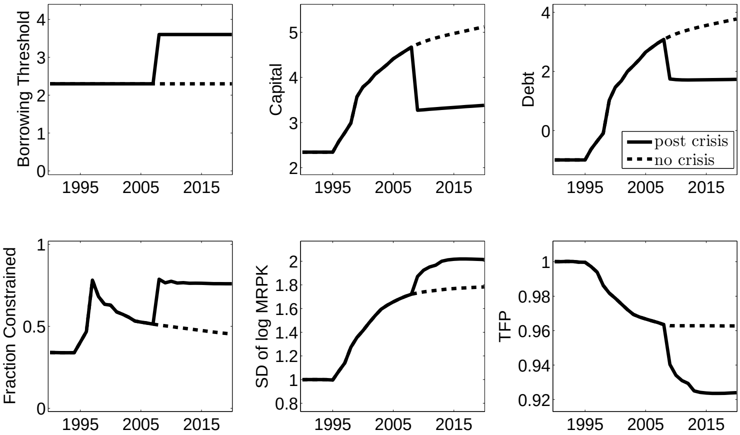
(e) Mean Productivity

(f) Std. Dev of Productivity

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


Aggregate Productivity
1.02
1
0.98
0.96
1995
2005
2015
Capital
2.8
2.6
2.4
2.2
2
1.8
Debt
−0.5
−1
−1.5
Fraction Constrained
1
0.5
0
SD of log MRPK
1.8
1.6
1.4
1.2
1
0.8
TFP
1.01
1
0.99
0.98
0.97
0.96

Post-Crisis: κ increase



Post-Crisis: σ^2 increase and Z decrease

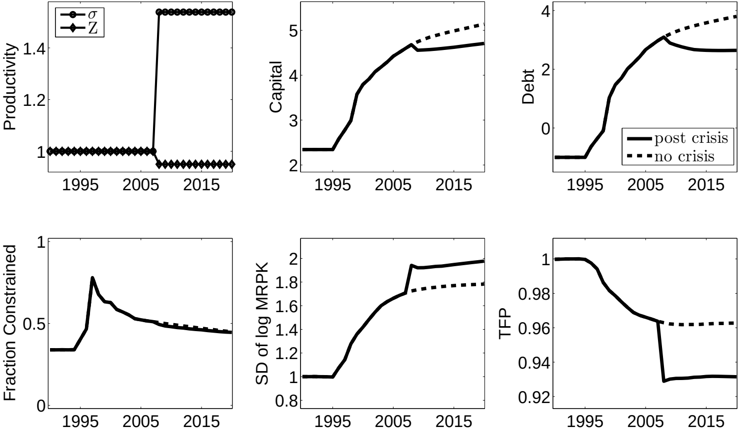


Table: Evidence Using Industry Variation

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

Evidence from Other Countries

Coverage Relative to Eurostat (Wage Bill)

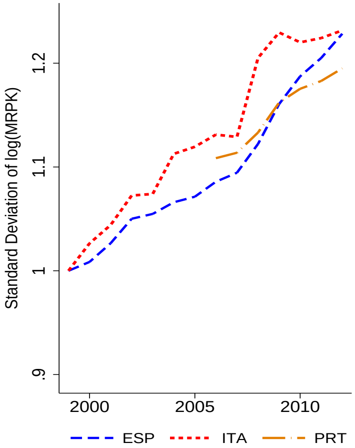
	Spain	Italy	Portugal	Germany	France	Norway
1999	0.69	0.59				
2000	0.71	0.63			0.70	
2001	0.73	0.62			0.72	
2002	0.75	0.69			0.75	
2003	0.74	0.68			0.73	
2004	0.75	0.71			0.71	0.66
2005	0.74	0.72			0.71	0.67
2006	0.74	0.73	0.91	0.34	0.72	0.71
2007	0.74	0.73	0.94	0.34	0.73	0.73
2008	0.72	0.84	0.97	0.28	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

Share of Total Wage Bill by Size Class (2006)

▸ other variables

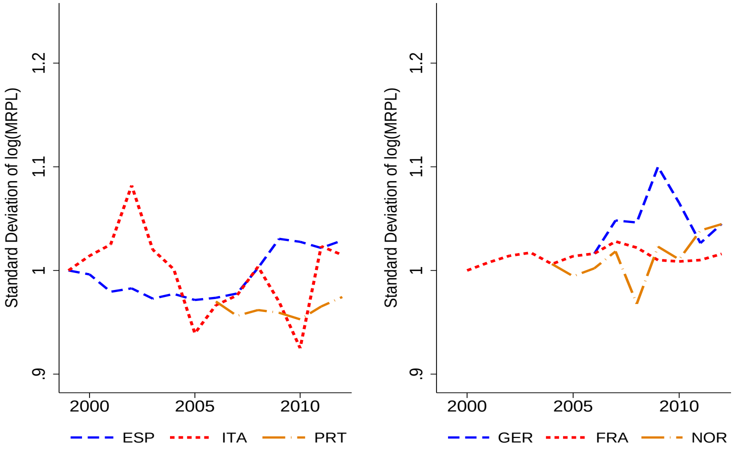
	Spain	Italy	Portugal	Germany	France	Norway
ORBIS-AMADEUS						
1-19 employees	0.19	0.11	0.18	0.01	0.08	0.14
20-249 employees	0.47	0.53	0.50	0.33	0.30	0.43
250+ employees	0.34	0.36	0.32	0.67	0.61	0.43
Eurostat (SBS)						
0-19 employees	0.20	0.22	0.21	0.07	0.14	0.15
20-249 employees	0.43	0.44	0.49	0.26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

MRPK Dispersion



Notes: $\text{MRPK}_{ist} := \frac{\alpha}{\mu}\frac{p_{ist}y_{ist}}{k_{ist}}$. 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 ▸ back



Notes: $\text{MRPL}_{ist} := \frac{1-\alpha}{\mu}\frac{p_{ist}y_{ist}}{l_{ist}}$. 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

	0-1 to 19			20 to 249			+250		
Country	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

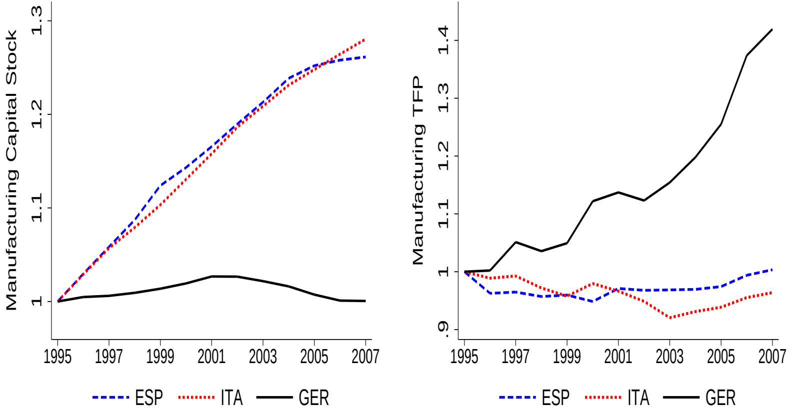
Notes: Each cell gives the share of number of firms of the corresponding size group in total economy from the relevant data source for the given year (%).

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

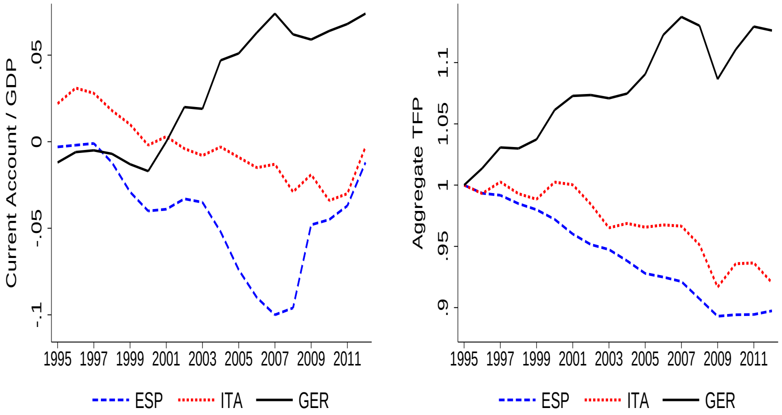
▸ Back



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

Capital Flows and Productivity in Euro Area

Back



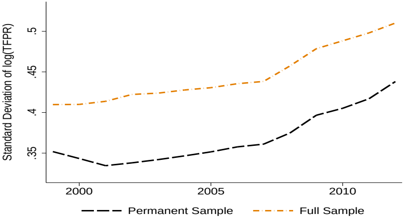
Sources: CA/GDP from IFS, IMF. Aggregate TFP from TED, Conference Board.

MRPK vs. MRPL Dispersion with CD Production

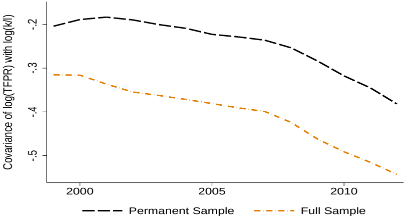
Back

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

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



(k) Standard Deviation of log(TFPR)



(l) Covariance of log(TFPR) and log(k/l)

Figure: TFPR Moments

Share of Total Gross Output by Size Class (2006)

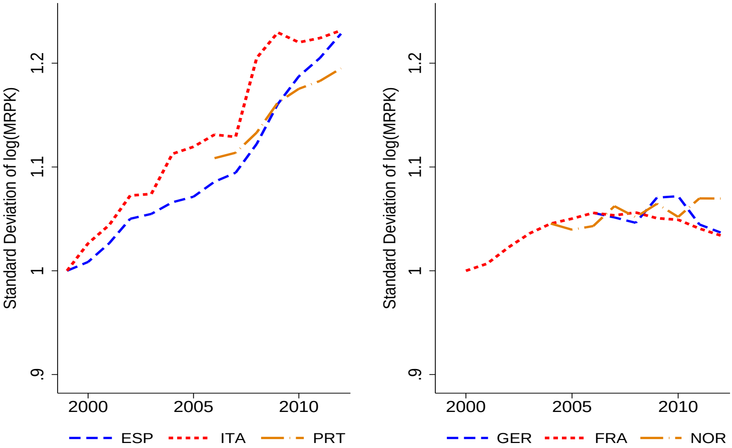
▸ Back

	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

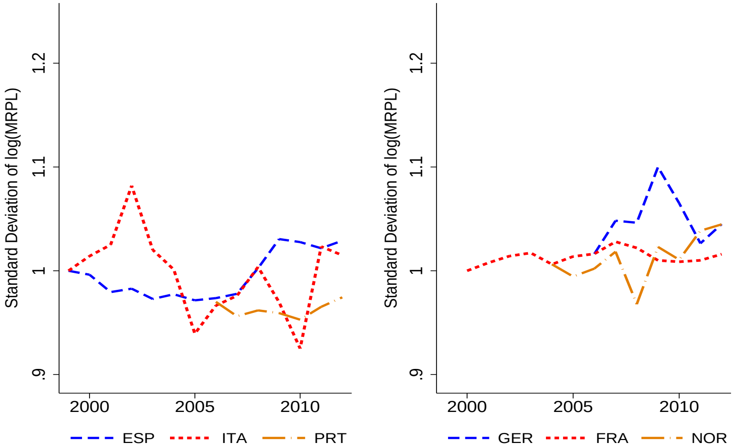
	Spain	Italy	Portugal	Germany	France	Norway
ORBIS-AMADEUS						
1-19 employees	0.24	0.13	0.25	0.05	0.10	0.18
20-249 employees	0.50	0.55	0.53	0.32	0.35	0.47
250+ employees	0.26	0.32	0.22	0.63	0.56	0.35
Eurostat (SBS)						
0-19 employees	0.31	0.41	0.32	0.15	0.19	0.20
20-249 employees	0.43	0.38	0.49	0.32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



Notes: $\text{MRPK}_{ist} := \frac{\alpha}{\mu}\frac{p_{ist}y_{ist}}{k_{ist}}$. 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

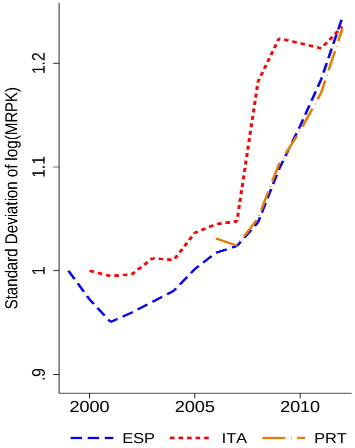
Back

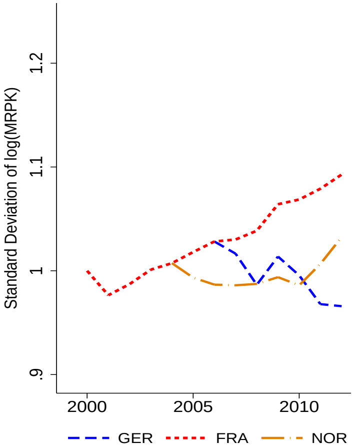


Notes: $\text{MRPL}_{ist} := \frac{1-\alpha}{\mu} \frac{p_{ist} y_{ist}}{l_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t; (2) weighted average across s using time-invariant value added shares as weights.

MRPK Dispersion in Continuing Sample

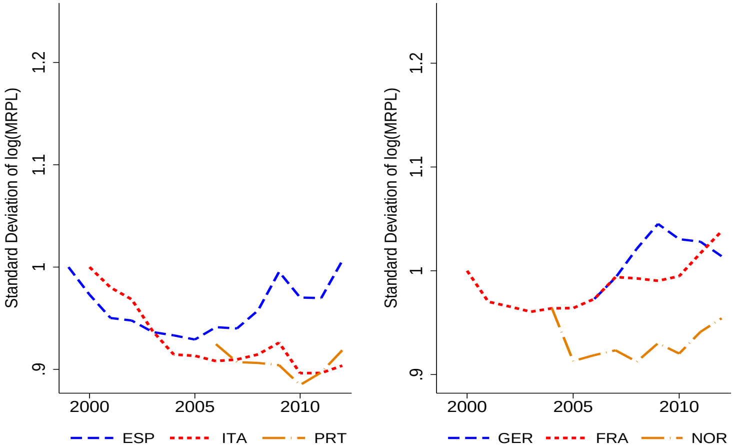
Back





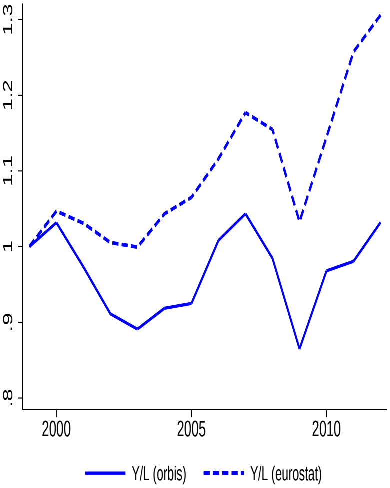
Notes: $\text{MRPK}_{ist} := \frac{\alpha}{\mu}\frac{p_{ist}y_{ist}}{k_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t; (2) weighted average across s using time-invariant value added shares as weights.

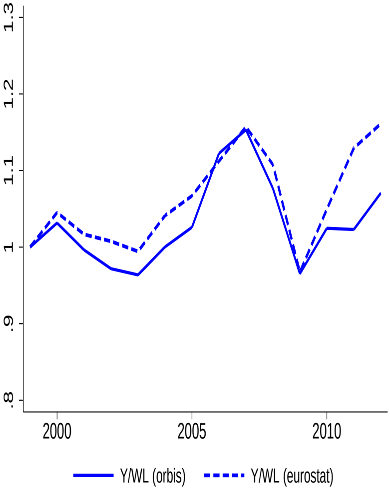
MRPL Dispersion in Continuing Sample ▸ Back



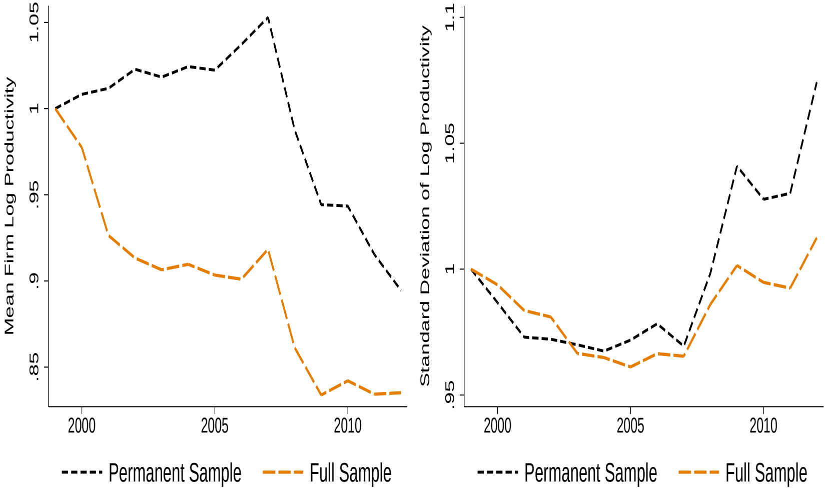
Notes: $\text{MRPL}_{ist} := \frac{1-\alpha}{\mu} \frac{p_{ist} y_{ist}}{l_{ist}}$. Aggregation: (1) compute dispersion within industries s at time t; (2) weighted average across s using time-invariant value added shares as weights.

Aggregates Relative to Eurostat II ▸ Back





Mean and Var Z ‣ Back



Olley and Pakes (1996) Decomposition in Spain

Back

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

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

Olley and Pakes (1996) Decomposition in Italy ▸ Back

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

Notes: We use $\theta_{ist} = \frac{p_{ist} y_{ist}}{P_{st} Y_{st}}$ and $\omega_{ist} = Z^{\text{WLP}}_{ist}$.

Olley and Pakes (1996) Decomposition in Portugal

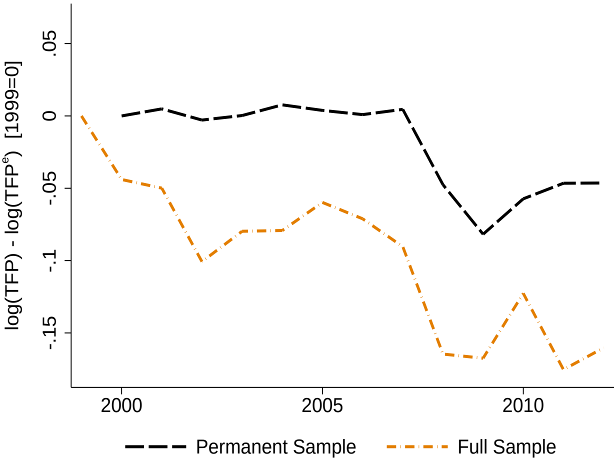
Back

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

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

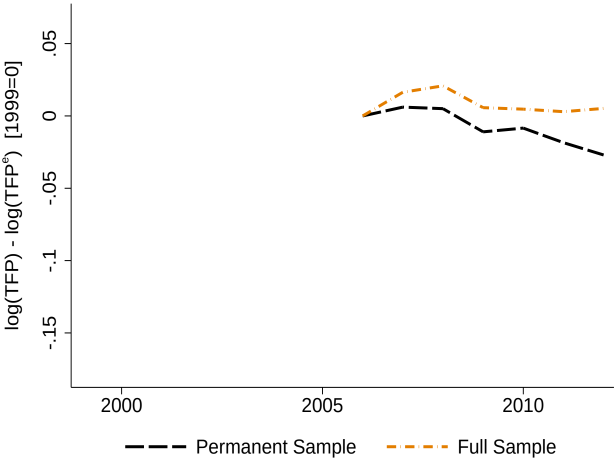
Trends in Misallocation in Italy

Back



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.

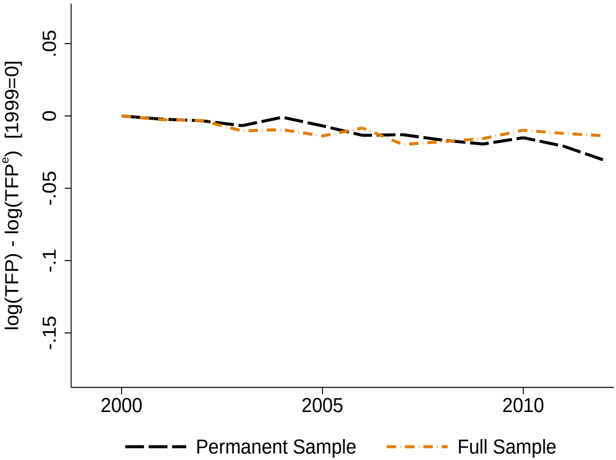
Trends in Misallocation in Portugal ▸ Back



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.

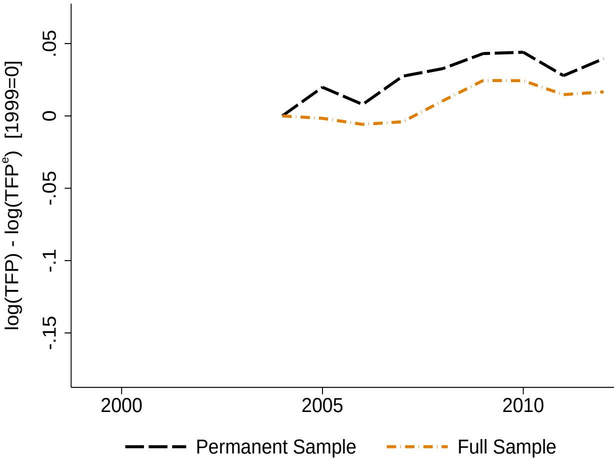
Trends in Misallocation in France

▸ Back



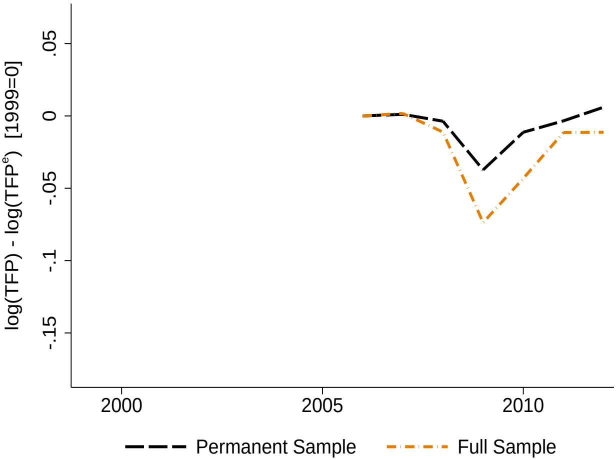
Notes: To aggregate across industries s we (i) compute dispersion within s at t and (ii) take weighted average across s using time-invariant value added shares as weights.

Trends in Misallocation in Norway ▸ Back



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.

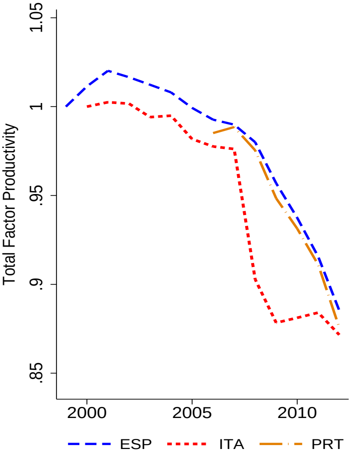
Trends in Misallocation in Germany ▸ Back



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

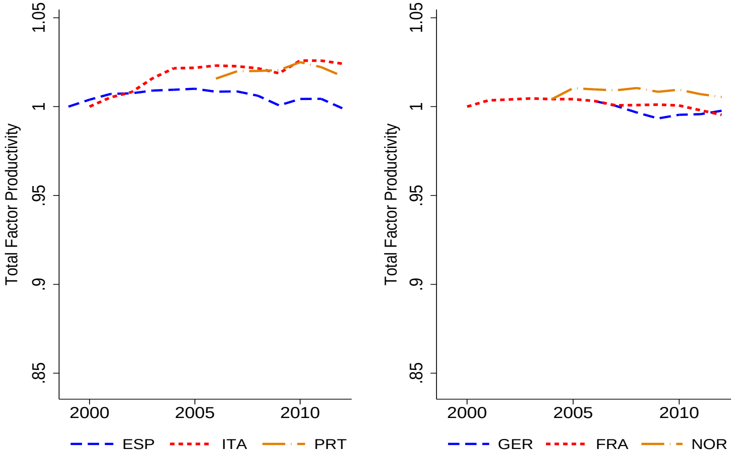
Back



Notes: $\Delta \log \left(\mathrm{TFP}_t^{\mathrm{K}}\right) = -\left(\frac{\alpha(\varepsilon\alpha+1-\alpha)}{2}\right) \Delta \mathrm{Var}\left(\log\left(\mathrm{MRPK}_{ist}\right)\right)$ with $\alpha = 0.35$ and $\epsilon = 3$.

Hypothetical TFP (MRPL) in Continuing Sample

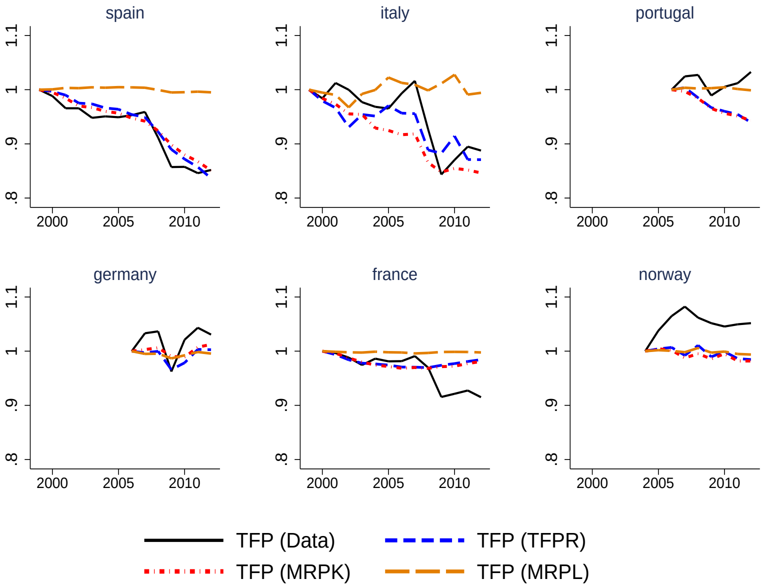
Back



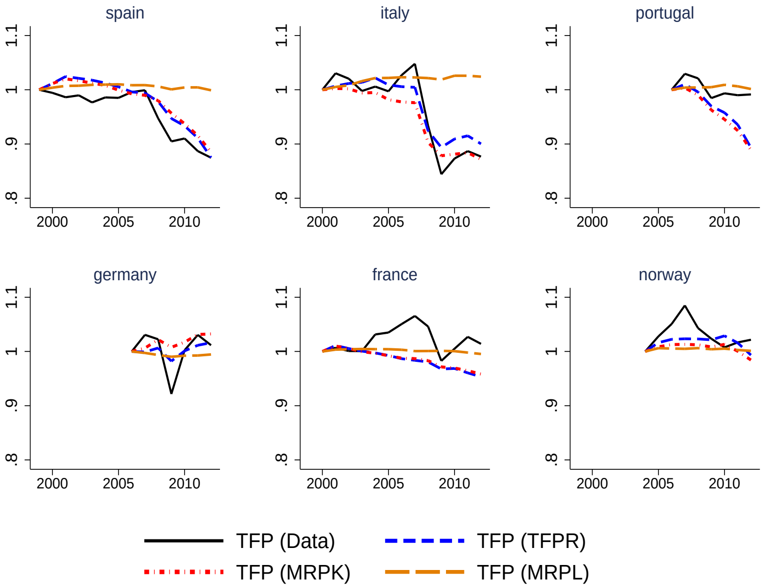
Notes: $\Delta \log \left(\mathrm{TFP}_t^L\right) = -\left(\frac{(1-\alpha)(\varepsilon(1-\alpha)+\alpha)}{2}\right) \Delta \mathrm{Var}\left(\log\left(\mathrm{MRPL}_{ist}\right)\right)$ with $\alpha = 0.35$ and $\epsilon = 3$.

Time Series of TFP in the Model vs. Data

Back



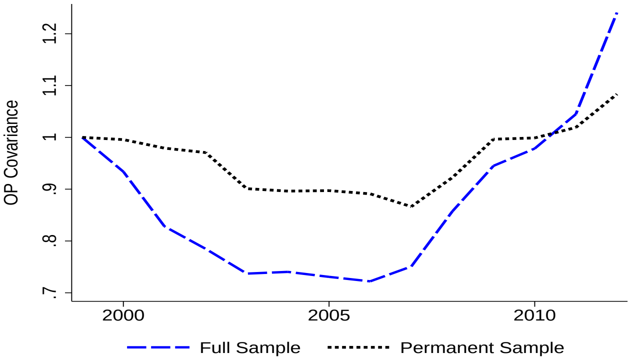
TFP in the Model vs. Data in Continuing Sample



Olley and Pakes (1996) Decomposition in Spain

Back

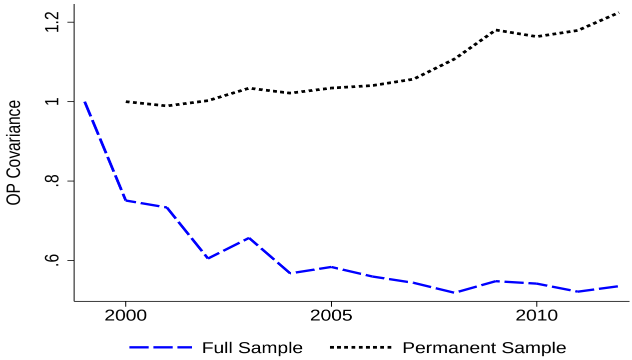
$$\Omega_{st} = \sum_i \theta_{ist}\omega_{ist} = \underbrace{\bar{\omega}_{ist}}_{\text{unweighted average}} + \underbrace{\sum_i \left(\theta_{ist} - \bar{\theta}_{st}\right)\left(\omega_{ist} - \bar{\omega}_{st}\right)}_{\text{OP covariance}},$$



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

Olley and Pakes (1996) Decomposition in Italy ▸ Back

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

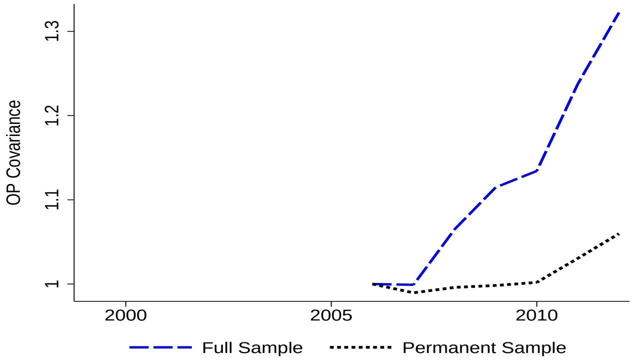


Notes: We use $\theta_{ist} = \frac{p_{ist} y_{ist}}{P_{st} Y_{st}}$ and $\omega_{ist} = Z_{ist}^{\text{WLP}}$.

Olley and Pakes (1996) Decomposition in Portugal

Back

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



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

Firm Productivity Estimation

Back

- 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:

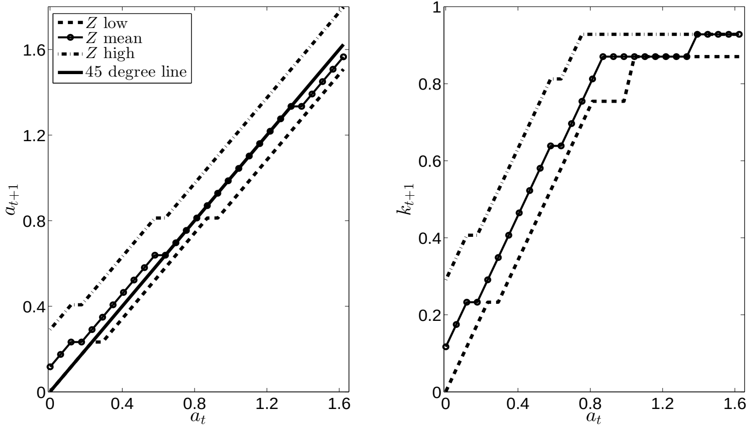
$$\log(y_{it}) = \beta_0 + \beta_l \log(l_{it}) + \beta_k \log(k_{it}) + g(m_{it}, k_{it}) + u_{it}^1.$$

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

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 ($r = 0.06$) ▸ Back



Productivity Process Estimates

Back

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

Relation to Finance Literature

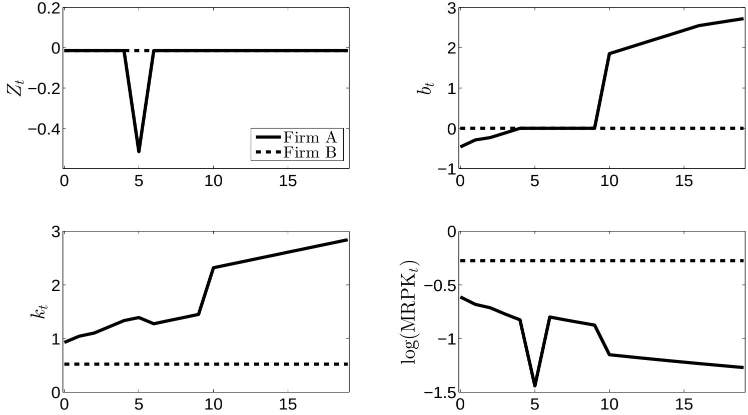
Back

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.

Interest Rate and Misallocation Example

Back



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 $r = 0.06$.

Simpler Model ▸ Back

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:

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

$$Z^* = (\theta a)^{1-\eta} R/A.$$

MRPK Dispersion: Interest Rate

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

Variance does not change locally when initially:

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

Intuition:

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

MRPK Dispersion: Financial Frictions

Back

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

Variance does not change locally when initially:

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

Intuition:

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

MRPK Dispersion: Productivity Back

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

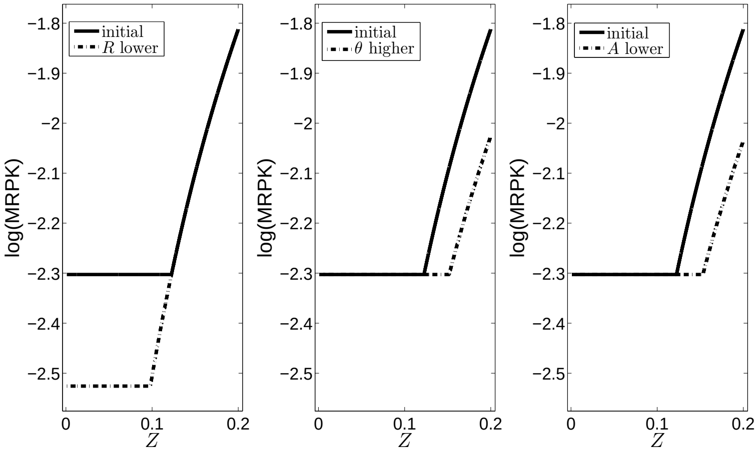
Variance does not change locally when initially:

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

Intuition:

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

MRPK Dispersion in Simpler Model



Entry

Back

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

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

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

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

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

Recursive Formulation with Entry

Back

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

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

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

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

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

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