RESEARCH

Small and Vulnerable: SME Productivity in the Great Productivity Slowdown

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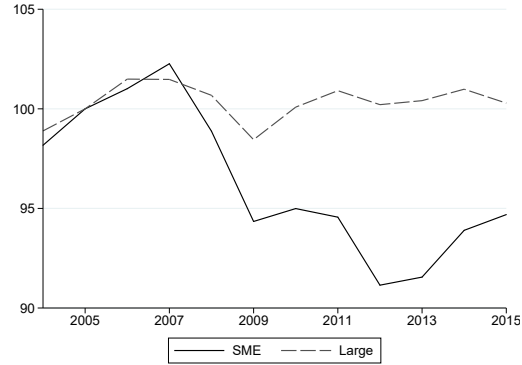
Motivations

- Do financial crises hinder the productivity growth of SMEs more so than that of large firms?
- A resounding YES
  - New evidence from close to half a million SMEs in Europe
  - We call it the *"SME productivity gap"*
- Why do we care?
  - Key to understanding Europe's post-crisis productivity slowdown
  - ... and supporting business dynamics



Notes: Figure plots the average firm-level TFP for SMEs and large firms. TFP in 2005 normalized to 100.
Source: Orbis

Theoretical predictions and empirical questions

Ambiguous predictions on financial crises and SME productivity gap

- Schumpeterian reorganization view:
  - The gap may improve if SMEs can reorganize more effectively than large firms.
- Credit multiplier view:
  - The gap depends on how credit constraints affect production efficiency.
- Cyclical investment composition view:
  - The gap depends on the relative reduction in productivity-enhancing investment.

Three key questions

- Is there an SME productivity gap after the GFC?
- Can the gap be explained by tight credit market conditions during the crisis?
- Is productivity-enhancing investment a driver of the gap?

Empirical strategies

Diff-in-diff model

- Compare the pre- and post-crisis TFP growth differential of SMEs relative to large firms
- Use credit supply shock following the collapse of Lehman Brothers as a natural experiment
- Control for industry-country FE and an extensive set of firm-level characteristics

Overcoming the data hurdle

- Collect comprehensive firm-level data
  - with input-output, balance sheet, creditor relationship
- A sample of $\sim$400K firms in 6 EU countries
- Extensive coverage of SMEs

Contributions to the literature

One of the first to study the existence and drivers of SME productivity gap after the GFC

- The literature has focused on output, employment, and capital.
  - Gertler and Gilchrist 1994; Chari, Christinao, and Kehoe 2013; Moscarini and Postel-Vinay 2013; Chodorow-Reich 2013; Siemer 2019
- None can inform TFP.

Offer evidence from a cross-country dataset with extensive coverage of SMEs

- Extensive coverage facilitates inference of aggregate implications

One of the first to quantify the role of intangible capital in SME productivity at the firm-level

Key findings

A large and very robust *SME productivity gap*

- SME indicators are more robust and powerful than other indicators for productivity growth vulnerability.
- The gap was driven by an interaction between tight credit conditions and SMEs' vulnerabilities in the credit market.

The role of intangible investment: *SME intangible investment gap*

- SMEs reduce intangible investment more than large firms
- ... which explains 13% of the SME productivity gap

Data and measurement

Firm-level data: Orbis

Bank-firm relationships: AMADEUS

- Lists up to five of the most important credit banks for each Orbis firm
- Name match to:
  - Bank balance sheet data from Fitch Connect
  - 5-year CDS spreads from Markit

Sample: 6 EU countries Data Coverage Summary Statistics

- Denmark, France, Germany, Netherlands, Spain, and UK
- SME definition: Transition Matrix

Company category	Employees	Turnover OR Balance sheet total
Medium	< 250	$\leq$ €50 million OR $\leq$ €43 million
Small	< 50	$\leq$ €10 million OR $\leq$ €10 million
Micro	< 10	$\leq$ €2 million OR $\leq$ €2 million

Measuring TFP: Wooldridge 2009 approach Details TFP level path

Question 1: SME productivity gap

Diff-in-Diff model:

$$\Delta TFPgrowth_{ijc} = \alpha_{jc} + \beta_1 Micro_i + \beta_2 Small_i + \beta_3 Medium_i + \gamma X_i + \varepsilon_{ijc} \quad (1)$$

- Firm i, (4-digit) industry j, country c
- $\Delta TFPgrowth_{ijc}$: Post − pre-crisis average TFP growth
- Pre–crisis: 2004–2007, post–crisis: 2008–2011
- $Micro_i, Small_i, Medium_i$: Set of micro, small, and medium firm dummies
- α_{jc}: Industry × country fixed effects
- X_i: Firm-level controls
  - Firm age (linear and quadratic terms)
  - Balance sheet vulnerabilities (debt maturity, leverage, liquidity, earnings)
  - Level of pre-crisis TFP
- Standard errors clustered at industry × country level

Results: SME productivity gap

$$\Delta TFPgrowth_{ijc} = \alpha_{jc} + \beta_1 Micro_i + \beta_2 Small_i + \beta_3 Medium_i + \gamma X_i + \varepsilon_{ijc} \quad (1)$$

	(1) Full Sample	(2) Private	(3) Manufacturing	(4) Non-manufacturing
Micro	-0.0205***	-0.0196***	-0.0164***	-0.0220***
	(0.0027)	(0.0027)	(0.0049)	(0.0032)
Small	-0.0182***	-0.0174***	-0.0148***	-0.0196***
	(0.0027)	(0.0027)	(0.0047)	(0.0032)
Medium	-0.0114***	-0.0106***	-0.0085*	-0.0127***
	(0.0025)	(0.0025)	(0.0047)	(0.0030)
Observations	399,503	398,809	71,086	328,417
R^2	0.05	0.05	0.07	0.04
Mean dep var	-0.04	-0.04	-0.04	-0.04
Lag TFP control	No	No	No	No
Balance sheet controls	No	No	No	No
Industry × Country FEs	Yes	Yes	Yes	Yes
Micro = Small (p-val)	0.14	0.14	0.34	0.19
Small = Medium (p-val)	0.00	0.00	0.01	0.00

SME as a distinct and powerful vulnerability indicator

	(1)	(2)	(3)
Micro	-0.0227***		-0.0616***
	(0.0027)		(0.0034)
Small	-0.0188***		-0.0363***
	(0.0026)		(0.0029)
Medium	-0.0126***		-0.0145***
	(0.0025)		(0.0021)
Age		-0.0003***	-0.0006***
		(0.0001)	(0.0000)
Leverage		0.0340***	0.0268***
		(0.0020)	(0.0021)
Debt Maturity		-0.0038***	-0.0030***
		(0.0009)	(0.0009)
Cash Flow		-0.0722***	-0.0384***
		(0.0090)	(0.0104)
Liquidity		-0.0014***	-0.0012***
		(0.0003)	(0.0002)
Observations	378,586	378,586	378,586
R^2	0.05	0.60	0.60
Lag TFP control	No	Yes	Yes
Industry × Country FEs	Yes	Yes	Yes
Micro = Small (p-val)	0.01		0.00
Small = Medium (p-val)	0.00		0.00

Question 2: The credit market channel of SME productivity gap

Diff-in-Diff model:

$$\Delta TFPgrowth_{ijc} = \alpha_{jc} + \beta_1 Micro_i + \beta_2 Small_i + \beta_3 Medium_i + \delta_1 Micro_i \times \Delta CDS + \delta_2 Small_i \times \Delta CDS + \delta_3 Medium_i \times \Delta CDS + \gamma X_i + \varepsilon_{ijc} \quad (2)$$

Two measures of credit market exposure ΔCDS

- ΔCDS_c: Change in the average CDS spread of domestic banks in country c
  - Time window: Between September 7 and September 28, 2008 Figure
- ΔCDS_i: Change in the average CDS spread of the firm i's main creditor banks

Results: Credit supply shock

	Country-level exposure		Firm-level exposure	
	(1)	(2)	(3)	(4)
Micro	-0.0122***	-0.0474***	-0.0258***	-0.0554***
	(0.0026)	(0.0026)	(0.0032)	(0.0033)
Micro $\times$ ΔCDS	-0.0181***	-0.0199***	-0.0070**	-0.0063**
	(0.0027)	(0.0029)	(0.0029)	(0.0029)
Small	-0.0141***	-0.0261***	-0.0188***	-0.0303***
	(0.0024)	(0.0022)	(0.0030)	(0.0028)
Small $\times$ ΔCDS	-0.0099***	-0.0170***	0.0015	-0.0031
	(0.0026)	(0.0023)	(0.0027)	(0.0024)
Medium	-0.0106***	-0.0113***	-0.0119***	-0.0124***
	(0.0025)	(0.0018)	(0.0029)	(0.0022)
Medium $\times$ ΔCDS	-0.0045*	-0.0094***	0.0005	-0.0044**
	(0.0027)	(0.0019)	(0.0029)	(0.0021)
Observations	201,887	201,887	69,863	69,863
R^2	0.06	0.62	0.08	0.63
Lag TFP control	No	Yes	No	Yes
Balance sheet controls	No	Yes	No	Yes
Industry $\times$ Country FEs	Yes	Yes	Yes	Yes

Results: Bank strength

	Bank strength: Bank capital		Bank strength: CDS presence	
	(1)	(2)	(3)	(4)
Micro	-0.0534***	-0.0821***	-0.0299***	-0.0665***
	(0.0063)	(0.0073)	(0.0042)	(0.0043)
Micro × Bank strength	0.0419*	0.0397**	0.0114**	0.0145***
	(0.0227)	(0.0194)	(0.0049)	(0.0049)
Small	-0.0380***	-0.0541***	-0.0243***	-0.0425***
	(0.0066)	(0.0062)	(0.0041)	(0.0036)
Small × Bank strength	0.0259*	0.0370***	0.0106**	0.0160***
	(0.0143)	(0.0116)	(0.0048)	(0.0041)
Medium	-0.0221***	-0.0241***	-0.0148***	-0.0197***
	(0.0068)	(0.0054)	(0.0041)	(0.0030)
Medium × Bank strength	0.0091	0.0216**	0.0051	0.0090**
	(0.0122)	(0.0091)	(0.0051)	(0.0037)
Observations	25,057	25,057	201,887	201,887
R^2	0.08	0.62	0.06	0.62
Lag TFP control	No	Yes	No	Yes
Balance sheet controls	No	Yes	No	Yes
Industry × Country FEs	Yes	Yes	Yes	Yes

Question 3: Intangible investment as a driver

Diff-in-Diff model:

$$\Delta Investment_{ijc} = \alpha_{jc} + \beta_1 Micro_i + \beta_2 Small_i + \beta_3 Medium_i + \gamma X_i + \varepsilon_{ijc} \quad (4)$$

Three measures of *Investment*:

- Total investment: Physical + intangible investment
- Intangible investment share: Share of intangible investment in total investment
- Patent applications: Average number of annual patent applications
  - Worldwide Patent Statistical Database (PATSTAT)

Results: Intangible investment

$$\Delta Investment_{ijc} = \alpha_{jc} + \beta_1 Micro_i + \beta_2 Small_i + \beta_3 Medium_i + \gamma X_i + \varepsilon_{ijc} \quad (4)$$

	Δ Total investment		Δ Intangible investment share		Δ Patent applications	
	(1)	(2)	(3)	(4)	(5)	(6)
Micro	-0.0159***	-0.0283***	-0.0431***	-0.0237***	-0.3876***	-0.2618***
	(0.0023)	(0.0052)	(0.0046)	(0.0047)	(0.0447)	(0.0563)
Small	-0.0079***	-0.0148***	-0.0303***	-0.0187***	-0.3218***	-0.2049***
	(0.0021)	(0.0038)	(0.0043)	(0.0047)	(0.0373)	(0.0434)
Medium	-0.0030	-0.0053*	-0.0215***	-0.0179***	-0.2794***	-0.1835***
	(0.0021)	(0.0029)	(0.0042)	(0.0044)	(0.0336)	(0.0344)
Observations	552,863	552,863	450,914	450,914	7,152	7,152
R^2	0.59	0.59	0.25	0.25	0.48	0.49
Mean dep var	-0.093	-0.093	-0.011	-0.011	0.001	0.001
Lag dep var	No	Yes	No	Yes	No	Yes
Balance sheet controls	No	Yes	No	Yes	No	Yes
Industry × Country FEs	Yes	Yes	Yes	Yes	Yes	Yes

Quantifying the role of intangible investment

Compare TFP estimates from two forms of production functions

- Solow (as in our baseline) model: $VA = AK^{\beta_k} L^{\beta_l}$
- Intangible-augmented model: $VA = A'(IK)^{\beta_{ik}} K^{\beta_k} L^{\beta_l}$

An intuitive relationship between the two:

- Solow measure attributes the contributions of intangible capital growth to output growth as contributions of TFP growth.
- It also affects the estimated contributions of physical capital and labor.

Quantifying the role of intangible investment (cont.)

Details

	SME Productivity gap	L gap	K gap	IK gap	Estimation adjustment in L	Estimation adjustment in K
Conventional (Solow) model (% of VA gap)	43.9%	54.9%	-1.2%	**3.6%**	**3.7%**	**-1.5%**
Intangible-augmented model (% of VA gap)	43.2%	54.4%	-1.2%	3.6%		
IK contribution in intangible-augmented model	8.2%					
% of SME productivity gap in conventional model explained by IK (IK gap plus estimation adjustment in L and K)	**13.4%**					

Notes:

- SME productivity gap defined as $\Delta TFPgrowth_{Large} - \Delta TFPgrowth_{SME}$
  - First calculate the difference in average TFP growth between the pre- and post-crisis periods for large firms and SMEs, respectively, then take their differences.
- SME labor gap (L gap), physical capital gap (K gap), and intangible capital gap (IK gap) similarly defined.

Robustness and extensions

Placebo test using 2000 recession:

- Post-recession TFP growth not associated with *SME* and *SME* × *BankCapital* ▸ Table

Robustness

- Creditor strength from each firm's top bank only ▸ Table
- Credit supply shocks using ECB's Bank Lending Survey (BLS) ▸ Table
- SME vs. leader–laggard indicators: Controlling for markups ▸ Details ▸ Cobb-Douglas ▸ Translog
- Results allowing entry and exit ▸ Productivity ▸ Investment

Conclusion

- We document an *SME productivity gap* in a large and representative sample of EU firms.
  - SME indicators are more robust and powerful than other indicators for productivity growth vulnerability.
- Evidence supports the role of limited credit market access among SMEs in aggravating the impact of the crisis
- Accounting for the SME intangible investment gap explains 13% of the baseline SME productivity gap.

Summary statistics

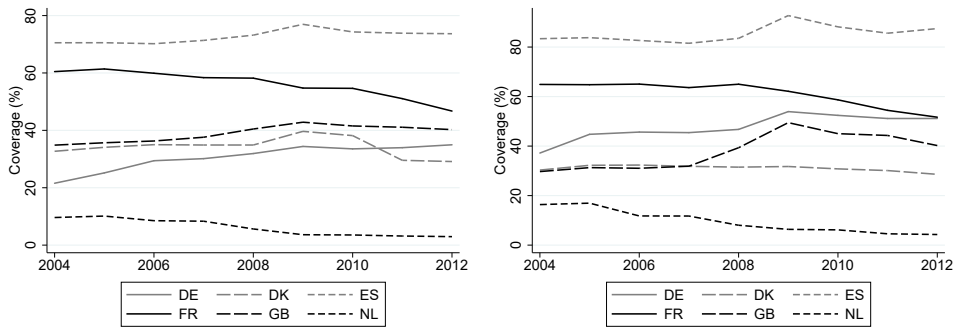
Return

	Obs	Mean	St. Dev.	Min	Median	Max
ΔTFP growth	399,503	-0.04	0.20	-1.64	-0.03	1.17
TFP	399,503	0.01	0.12	-0.66	0.01	1.16
$\Delta TFP'$ growth	155,745	-0.03	0.18	-1.55	-0.02	1.03
TFP'	155,745	0.01	0.11	-0.57	0.01	1.16
Age	399,503	17.97	11.60	5.00	15.00	194.00
Micro	399,503	0.60	0.49	0.00	1.00	1.00
Small	399,503	0.30	0.46	0.00	0.00	1.00
Medium	399,503	0.08	0.27	0.00	0.00	1.00
Leverage	378,586	0.62	0.24	0.04	0.64	7.20
Debt Maturity	378,586	0.46	0.79	0.00	0.28	16.39
Cash Flow	378,586	0.11	0.09	-0.20	0.09	1.69
Liquidity	378,586	2.04	2.53	0.18	1.39	21.14
Profitability	378,586	11.39	1.69	-0.63	11.26	19.16
Markup (Cobb-Douglas)	362,660	1.32	0.75	0.73	1.09	7.44
Markup (Translog)	362,660	1.13	0.80	-0.24	0.96	6.51
ΔCDS (Country-level)	6	0.19	0.05	0.15	0.18	0.27
ΔCDS (Firm-level)	70,010	0.31	0.18	-0.06	0.30	1.51
Tier 1 Capital Ratio	25,357	12.13	13.16	6.09	9.81	107.32
CDS Presence	201,954	0.27	0.42	0.00	0.00	1.00
ΔTotal investment	553,248	-0.09	0.31	-2.47	-0.06	1.76
Total investment	553,248	0.06	0.23	-0.60	0.01	2.17
ΔIntangible investment share	467,886	-0.02	0.30	-1.00	0.00	1.00
Intangible investment share	451,318	0.10	0.27	-1.00	0.00	1.00
ΔPatent applications	7,596	0.01	0.92	-2.00	0.00	2.50
Patent applications	7,596	0.46	0.66	0.00	0.00	3.00

Orbis dataset sample coverage

Return

(a) Employment, manufacturing (% of Eurostat) (b) Gross output, manufacturing (% of Eurostat)



Notes: This figure plots the coverage of Orbis data in our sample of countries relative to Eurostat Structural Business Statistics (SBS). The Orbis sample is restricted to firms that report data on employment, gross output, tangible fixed assets, and materials.

Transition Matrix

Return

Transition matrix: Frequency

Pre/Post Crisis	Micro	Small	Medium	Large	Total
Micro	226,323	13,769	72	7	240,171
Small	16,042	99,647	4,570	27	120,286
Medium	116	3,808	25,617	1,178	30,719
Large	16	28	727	7,556	8,327
Total	242,497	117,252	30,986	8,768	399,503

Transition matrix: Probability

Pre/Post Crisis	Micro	Small	Medium	Large	Total
Micro	94.2%	5.7%	0.0%	0.0%	100.0%
Small	13.3%	82.8%	3.8%	0.0%	100.0%
Medium	0.4%	12.4%	83.4%	3.8%	100.0%
Large	0.2%	0.3%	8.7%	90.7%	100.0%
Total	60.7%	29.3%	7.8%	2.2%	100.0%

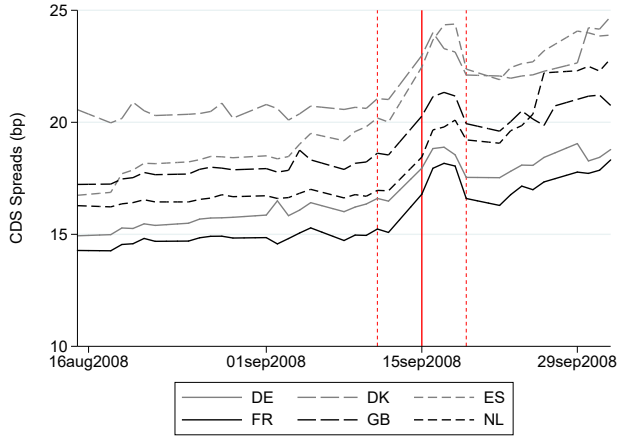
Notes: This table shows the frequency (top panel) and probability (bottom panel) of a firm switching between the micro/small/medium/large classification pre (rows) and post (columns) crisis.

CDS spreads around the Lehman collapse

Return

"Shock": September 15, 2008
Lehman Brothers collapse

- Sharp *unanticipated* tightening of credit supply in a *narrow* window



Notes: Figure plots the average 5-year CDS spread of all domestic banks in each country around the collapse of Lehman Brothers (Sep 15, 2008). Source: Markit CDS data

Placebo test using the 2000 recession

Return

	(1)	(2)	(3)	(4)
Micro	-0.0242	0.0083	-0.0123	0.0048
	(0.0313)	(0.0349)	(0.0378)	(0.0364)
Micro × Bank strength			-0.1586	-0.0202
			(0.0995)	(0.0894)
Small	-0.0079	0.0138	-0.0026	0.0091
	(0.0305)	(0.0307)	(0.0368)	(0.0343)
Small × Bank strength			-0.0228	0.0493
			(0.0650)	(0.0681)
Medium	0.0075	0.0024	0.0120	0.0047
	(0.0333)	(0.0244)	(0.0418)	(0.0306)
Medium × Bank strength			-0.0160	-0.0572
			(0.0562)	(0.0618)
Observations	844	844	844	844
R^2	0.13	0.73	0.14	0.74
Lag TFP control	No	Yes	No	Yes
Balance sheet controls	No	Yes	No	Yes
Industry × Country FEs	Yes	Yes	Yes	Yes

SMEs defined based on employment (Eurostat definition)

Return

	(1) Full Sample	(2) Private	(3) Manufacturing	(4) Non-manufacturing
Micro	-0.0267***	-0.0263***	-0.0210***	-0.0287***
	(0.0027)	(0.0027)	(0.0048)	(0.0032)
Small	-0.0197***	-0.0192***	-0.0164***	-0.0211***
	(0.0026)	(0.0026)	(0.0047)	(0.0030)
Medium	-0.0100***	-0.0098***	-0.0090*	-0.0104***
	(0.0023)	(0.0023)	(0.0046)	(0.0026)
Observations	399,503	398,809	71,086	328,417
R^2	0.05	0.05	0.07	0.04
Mean dep var	-0.04	-0.04	-0.04	-0.04
Lag TFP control	No	No	No	No
Balance sheet controls	No	No	No	No
Industry × Country FEs	Yes	Yes	Yes	Yes
Micro = Small (p-val)	0.00	0.00	0.01	0.00
Small = Medium (p-val)	0.00	0.00	0.00	0.00

The role of creditor strength: Using the top bank only

Return

	Bank strength: Bank capital		Bank strength: CDS presence	
	(1)	(2)	(3)	(4)
Micro	-0.0539***	-0.0822***	-0.0283***	-0.0660***
	(0.0063)	(0.0073)	(0.0039)	(0.0042)
Micro × Bank strength	0.0481**	0.0396**	0.0089**	0.0146***
	(0.0216)	(0.0193)	(0.0044)	(0.0046)
Small	-0.0385***	-0.0543***	-0.0229***	-0.0420***
	(0.0066)	(0.0062)	(0.0037)	(0.0035)
Small × Bank strength	0.0269*	0.0357***	0.0087**	0.0162***
	(0.0144)	(0.0117)	(0.0043)	(0.0038)
Medium	-0.0227***	-0.0244***	-0.0138***	-0.0189***
	(0.0067)	(0.0054)	(0.0037)	(0.0028)
Medium × Bank strength	0.0114	0.0222**	0.0040	0.0084**
	(0.0118)	(0.0088)	(0.0046)	(0.0033)
Observations	25,057	25,057	201,887	201,887
R^2	0.08	0.62	0.06	0.62
Lag TFP control	No	Yes	No	Yes
Balance sheet controls	No	Yes	No	Yes
Industry × Country FEs	Yes	Yes	Yes	Yes

The role of credit supply shock: Bank Lending Survey

Return

	Credit Condition: ΔNet Percentage		Credit Condition: ΔDiffusion Index	
	(1)	(2)	(3)	(4)
Micro	-0.0432***	-0.0822***	-0.0423***	-0.0814***
	(0.0046)	(0.0049)	(0.0046)	(0.0049)
Micro × Credit Condition	-0.1448***	-0.1386***	-0.2155***	-0.2063***
	(0.0185)	(0.0200)	(0.0279)	(0.0307)
Small	-0.0312***	-0.0560***	-0.0302***	-0.0551***
	(0.0046)	(0.0040)	(0.0045)	(0.0040)
Small × Credit Condition	-0.0902***	-0.1215***	-0.1318***	-0.1798***
	(0.0184)	(0.0167)	(0.0276)	(0.0257)
Medium	-0.0189***	-0.0282***	-0.0180***	-0.0271***
	(0.0048)	(0.0035)	(0.0047)	(0.0035)
Medium × Credit Condition	-0.0532***	-0.0795***	-0.0755***	-0.1136***
	(0.0195)	(0.0146)	(0.0291)	(0.0224)
Observations	192,907	192,907	192,907	192,907
R^2	0.06	0.62	0.06	0.62
Lag TFP control	No	Yes	No	Yes
Balance sheet controls	No	Yes	No	Yes
Industry × Country FEs	Yes	Yes	Yes	Yes

Horse races: Markups (Cobb-Douglas)

Return

	(1) Full Sample	(2) Private	(3) Manufacturing	(4) Non-manufacturing
Micro	-0.0634***	-0.0630***	-0.0942***	-0.0548***
	(0.0060)	(0.0059)	(0.0071)	(0.0058)
Small	-0.0629***	-0.0626***	-0.0923***	-0.0547***
	(0.0058)	(0.0057)	(0.0072)	(0.0057)
Medium	-0.0499***	-0.0497***	-0.0749***	-0.0428***
	(0.0052)	(0.0052)	(0.0067)	(0.0051)
Markup (Cobb-Douglas)	-0.0399***	-0.0399***	-0.0470***	-0.0393***
	(0.0042)	(0.0042)	(0.0028)	(0.0046)
Observations	362,616	362,148	68,895	293,721
R^2	0.07	0.07	0.09	0.06
Lag TFP control	No	No	No	No
Balance sheet controls	No	No	No	No
Industry × Country FEs	Yes	Yes	Yes	Yes
Micro = Small (p-val)	0.77	0.78	0.27	0.93
Small = Medium (p-val)	0.00	0.00	0.00	0.00

Horse races: Markups (Translog)

Return

	(1) Full Sample	(2) Private	(3) Manufacturing	(4) Non-manufacturing
Micro	-0.0932***	-0.0928***	-0.1093***	-0.0847***
	(0.0046)	(0.0047)	(0.0072)	(0.0052)
Small	-0.0854***	-0.0850***	-0.1010***	-0.0769***
	(0.0040)	(0.0040)	(0.0072)	(0.0044)
Medium	-0.0648***	-0.0645***	-0.0767***	-0.0580***
	(0.0035)	(0.0035)	(0.0065)	(0.0039)
Markup (Translog)	-0.0527***	-0.0528***	-0.0486***	-0.0541***
	(0.0018)	(0.0018)	(0.0026)	(0.0022)
Observations	362,616	362,148	68,895	293,721
R^2	0.06	0.06	0.09	0.06
Lag TFP control	No	No	No	No
Balance sheet controls	No	No	No	No
Industry × Country FEs	Yes	Yes	Yes	Yes
Micro = Small (p-val)	0.00	0.00	0.00	0.00
Small = Medium (p-val)	0.00	0.00	0.00	0.00

Results: SME productivity gap allowing for entry and exit

Return

$$\Delta TFPgrowth_{ijc} = \alpha_{jc} + \beta_1 Micro_i + \beta_2 Small_i + \beta_3 Medium_i + \gamma X_i + \varepsilon_{ijc} \quad (1)$$

	(1) Full Sample	(2) Private	(3) Manufacturing	(4) Non-manufacturing
Micro	-0.0422***	-0.0419***	-0.0292***	-0.0466***
	(0.0031)	(0.0032)	(0.0060)	(0.0036)
Small	-0.0232***	-0.0227***	-0.0146**	-0.0266***
	(0.0033)	(0.0033)	(0.0058)	(0.0039)
Medium	-0.0155***	-0.0153***	-0.0098*	-0.0179***
	(0.0029)	(0.0029)	(0.0056)	(0.0035)
Observations	706,179	705,194	112,840	593,339
R^2	0.04	0.04	0.05	0.03
Mean dep var	-0.07	-0.07	-0.07	-0.07
Lag TFP control	No	No	No	No
Balance sheet controls	No	No	No	No
Industry × Country FEs	Yes	Yes	Yes	Yes
Micro = Small (p-val)	0.00	0.00	0.00	0.00
Small = Medium (p-val)	0.00	0.00	0.09	0.00

Intangible investment allowing for entry and exit

Return

$$\Delta Investment_{ijc} = \alpha_{jc} + \beta_1 Micro_i + \beta_2 Small_i + \beta_3 Medium_i + \gamma X_i + \varepsilon_{ijc} \quad (4)$$

	Δ Total investment		Δ Intangible investment share		Δ Patent applications	
	(1)	(2)	(3)	(4)	(5)	(6)
Micro	-0.0078***	-0.0318***	-0.0407***	-0.0217***	-0.3246***	-0.2259***
	(0.0022)	(0.0046)	(0.0041)	(0.0042)	(0.0384)	(0.0509)
Small	-0.0036*	-0.0166***	-0.0285***	-0.0169***	-0.2854***	-0.1948***
	(0.0019)	(0.0034)	(0.0038)	(0.0040)	(0.0304)	(0.0367)
Medium	-0.0004	-0.0047*	-0.0194***	-0.0155***	-0.2439***	-0.1750***
	(0.0019)	(0.0026)	(0.0036)	(0.0037)	(0.0255)	(0.0261)
Observations	669,381	669,381	544,853	544,853	9,387	9,387
R^2	0.65	0.65	0.25	0.25	0.47	0.47
Mean dep var	-0.109	-0.109	-0.009	-0.009	0.005	0.005
Lag dep var	No	Yes	No	Yes	No	Yes
Balance sheet controls	No	Yes	No	Yes	No	Yes
Industry × Country FEs	Yes	Yes	Yes	Yes	Yes	Yes

SME productivity gap from industry splits

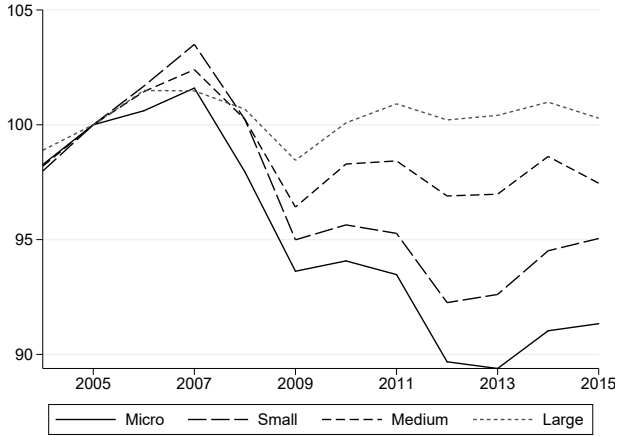
Return

$$\Delta TFPgrowth_{ijc} = \alpha_{jc} + \beta SME_i + \delta(SME_i \times IndustryIntensity_{jc}) + \gamma X_i + \varepsilon_{ijc} \quad (5)$$

	High Intangible share		High Patent applications		Finance intensive	
	(1)	(2)	(3)	(4)	(5)	(6)
Micro	-0.0140***	-0.0446***	-0.0074*	-0.0459***	-0.0205***	-0.0564***
	(0.0040)	(0.0063)	(0.0039)	(0.0044)	(0.0041)	(0.0037)
Micro × Industry Intensity	-0.0144***	-0.0272***	-0.0299***	-0.0422***	-0.0042	-0.0064
	(0.0054)	(0.0074)	(0.0073)	(0.0091)	(0.0057)	(0.0054)
Small	-0.0152***	-0.0242***	-0.0096***	-0.0235***	-0.0152***	-0.0309***
	(0.0035)	(0.0038)	(0.0036)	(0.0036)	(0.0038)	(0.0033)
Small × Industry Intensity	-0.0075	-0.0205***	-0.0216***	-0.0376***	-0.0017	-0.0053
	(0.0051)	(0.0054)	(0.0076)	(0.0078)	(0.0051)	(0.0045)
Medium	-0.0092***	-0.0082***	-0.0067	-0.0065**	-0.0093**	-0.0098***
	(0.0030)	(0.0025)	(0.0043)	(0.0029)	(0.0036)	(0.0027)
Medium × Industry Intensity	-0.0070	-0.0118***	-0.0154*	-0.0276***	-0.0028	-0.0077**
	(0.0048)	(0.0038)	(0.0080)	(0.0062)	(0.0049)	(0.0037)
Observations	377,924	377,924	217,986	217,986	290,405	290,405
R^2	0.05	0.60	0.05	0.59	0.05	0.61
Lag TFP control	No	Yes	No	Yes	No	Yes
Balance sheet controls	No	Yes	No	Yes	No	Yes
Industry × Country FEs	Yes	Yes	Yes	Yes	Yes	Yes

TFP level path by Micro/Small/Medium/Large

Return



Notes: Figure plots the average firm-level TFP for SMEs and large firms. TFP in 2005 is normalized to 100. Firm-level TFP estimated using the Wooldridge 2009 method.

TFP Measure: Wooldridge 2009

Return

Application to Orbis: Andrews, Criscuolo, and Gal 2016, Duval, Hong, and Timmer 2020

- Assume a value-added (y_{it}) Cobb-Douglas production function
- Estimate at the (two-digit) industry level with country (δ_c^j) and year (η_t^j) fixed effects

$$y_{it} = \beta_k^j k_{it} + \beta_l^j l_{it} + \delta_c^j + \eta_t^j + \varepsilon_{it}$$

Challenge: Endogeneity problem of input choices, i.e. violating $E[\varepsilon_{it} \mid l_{it}] = 0$

Wooldridge 2009 method:

- Use material inputs (m_{it}) as proxy variables for productivity
- Use lagged values of labor (l_{it-1}) as instruments
- One-step GMM (approximate $g(\cdot)$ using 3rd degree polynomial):

$$y_{it} = \beta_k^j k_{it} + \beta_l^j l_{it} + g(k_{it-1}, m_{it-1}) + \delta_c^j + \eta_t^j + u_{it}$$

- Calculate Firm-level TFP (a_{it}) as $a_{it} = y_{it} - \hat{\beta}_k^j k_{it} - \hat{\beta}_l^j l_{it-1}$

Estimating TFP growth

Return

Gap between large and SME firms: $\Delta x_L - \Delta x_{SME}$

- where $\Delta x = \frac{1}{4}\sum_{i=0}^{3} x_{T+i} - \frac{1}{4}\sum_{i=1}^{4} x_{T-4+i}$ for variable x

Decompose the SME output gap:

$$\begin{aligned}\Delta y_L - \Delta y_{SME} = &\underbrace{\left(\Delta TFP_L^{gr\prime} - \Delta TFP_{SME}^{gr\prime}\right)}_{\text{Productivity gap}} + \underbrace{\beta_j^{ik\prime}\left(\Delta ik_L - \Delta ik_{SME}\right)}_{ik\prime \text{ gap}} \\ &+ \underbrace{\beta_j^{k}\left(\Delta k_L - \Delta k_{SME}\right)}_{k \text{ gap}} + \underbrace{\beta_j^{l}\left(\Delta l_L - \Delta l_{SME}\right)}_{l \text{ gap}} \\ &- \underbrace{\left(\beta_j^{k} - \beta_j^{k\prime}\right)\left(\Delta k_L - \Delta k_{t-1}\right)}_{\text{Adjustment in } k} - \underbrace{\left(\beta_j^{l} - \beta_j^{l\prime}\right)\left(\Delta l_L - \Delta l_{SME}\right)}_{\text{Adjustment in } l}\end{aligned}$$

Markup Measure: De Loecker and Warzynski 2012

Return

Markup (μ_{it}): Price (P_{it}) to marginal cost (MC_{it}) ratio

Challenge: Firm-level prices and marginal costs not observable

De Loecker and Warzynski 2012

- Use the output elasticity (β_{it}^{v}) to expenditure share (α_{it}^{v}) ratio of a flexible input (V_{it})
- For some production function $F_{it}(\cdot)$, firm's cost-minimization problem gives

$$\mu_{it} = \frac{P_{it}}{MC_{it}} = \frac{\frac{\partial F_{it}(\cdot)}{\partial V_{it}} \frac{V_{it}}{F_{it}(\cdot)}}{\frac{P_{it}^{v} V_{it}}{P_{it} Q_{it}}} = \frac{\beta_{it}^{v}}{\alpha_{it}^{v}}$$

Applied to Orbis data: Diez, Fan, and Villegas-Sánchez 2019

- Compute expenditure share from firm level data
- Estimate output elasticity using a (two-digit) industry-specific production function
  - Ackerberg, Caves, and Frazer 2015 method using Cobb-Douglas or translog

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