Market Power and Innovation in the Intangible Economy

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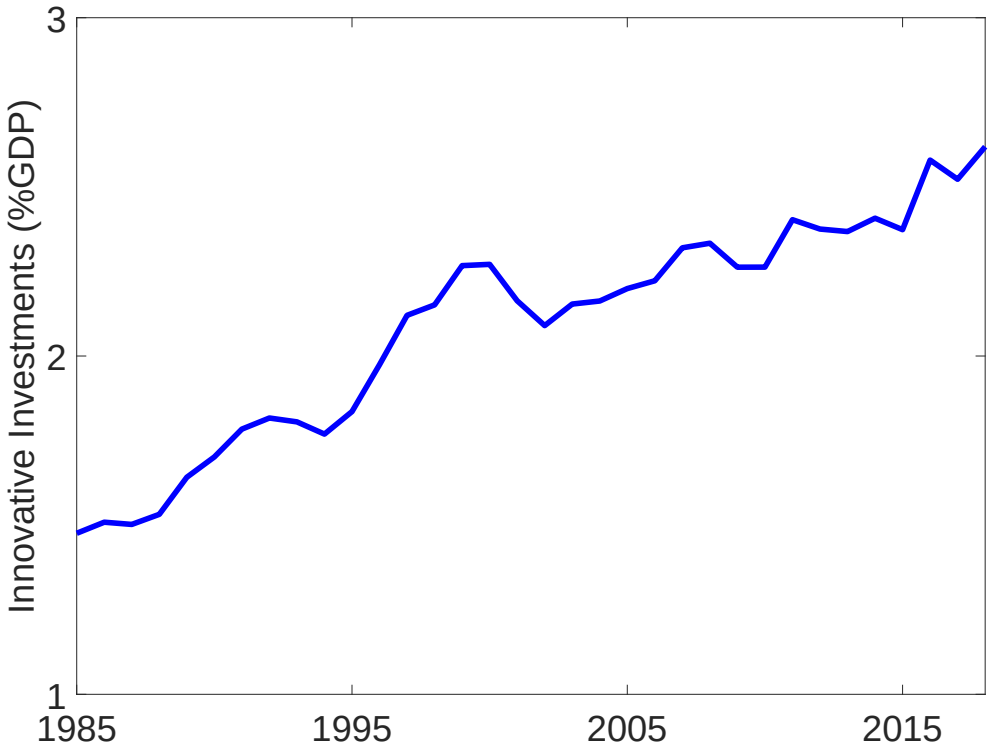
London School of Economics

Global Forum on Productivity
2021 Annual Conference

Productivity growth

- Ideas are getting harder to find (Bloom et al. 2017)



U.S. Investments in Intellectual Property excluding Software

Source: BEA, Fernald (FRBSF) ▸ France

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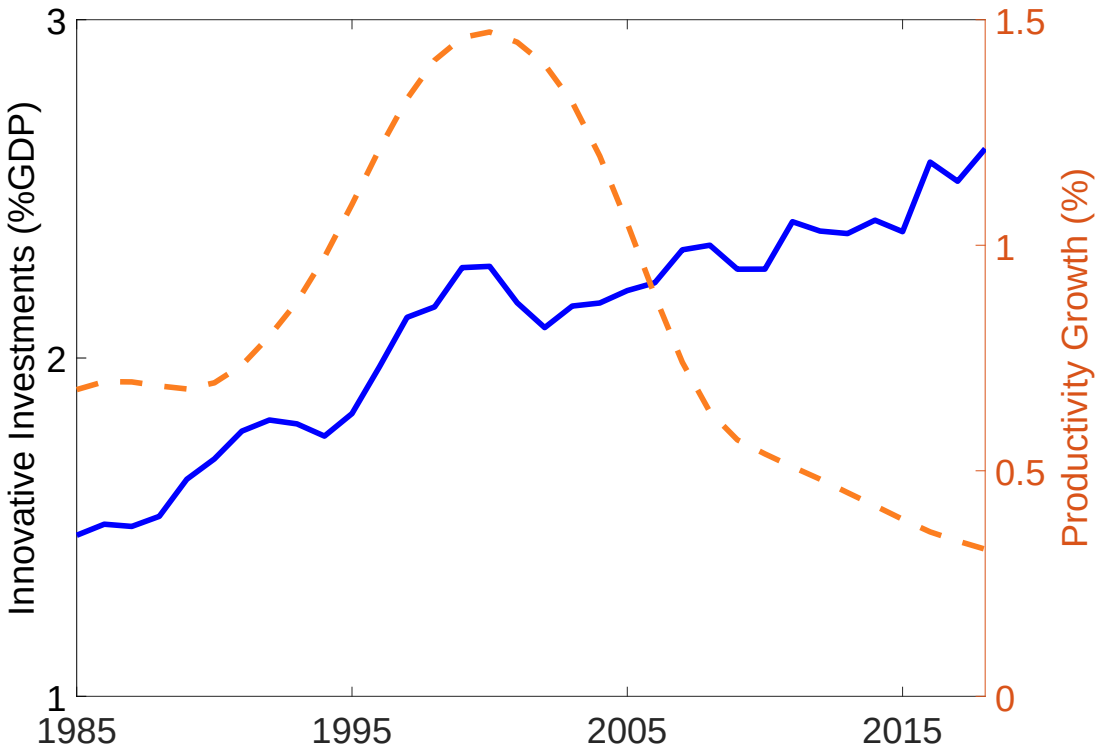

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Medium-term macroeconomic trends

- Productivity growth has been sluggish
  - High growth in the 1990s, low growth since 2005
  - Research and development expenditures increased: ideas harder to find?

  ▸ United States ▸ France

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  - Entry rate from 14% to 8%
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- Market power is increasing
  - Markups are increasing
  - Product market concentration is rising

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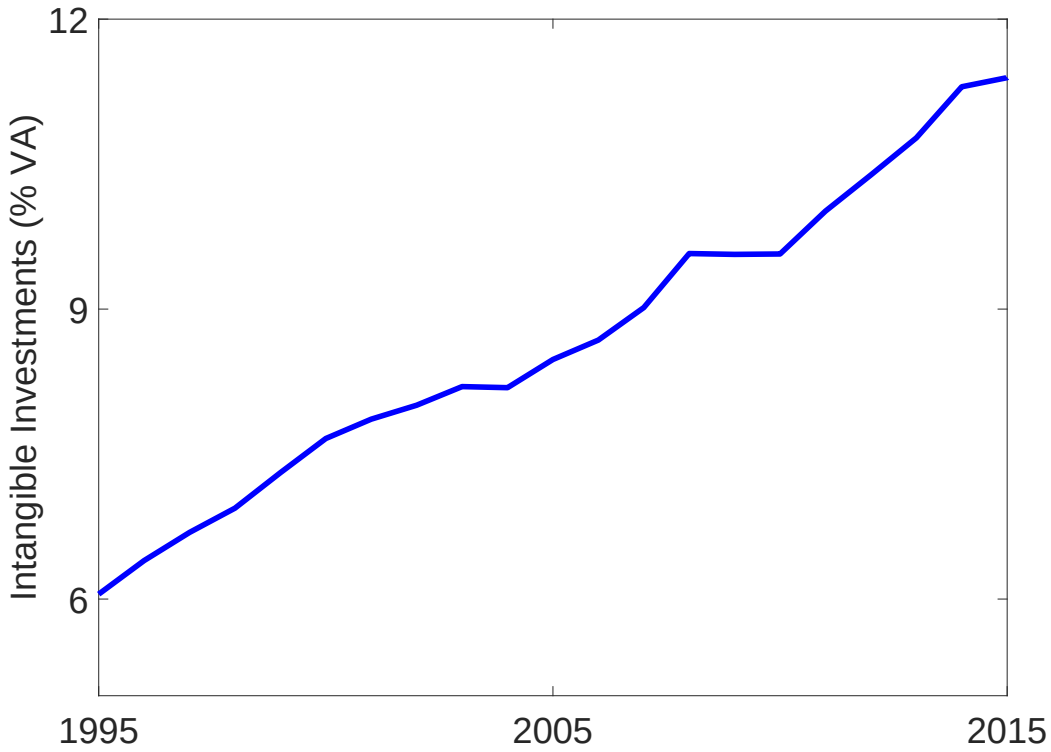
▸ Literature Review

My explanation: intangible inputs



U.S. Investments in Software and Economic Competencies

Source: Intan-Invest, Corrado et al. (2016)

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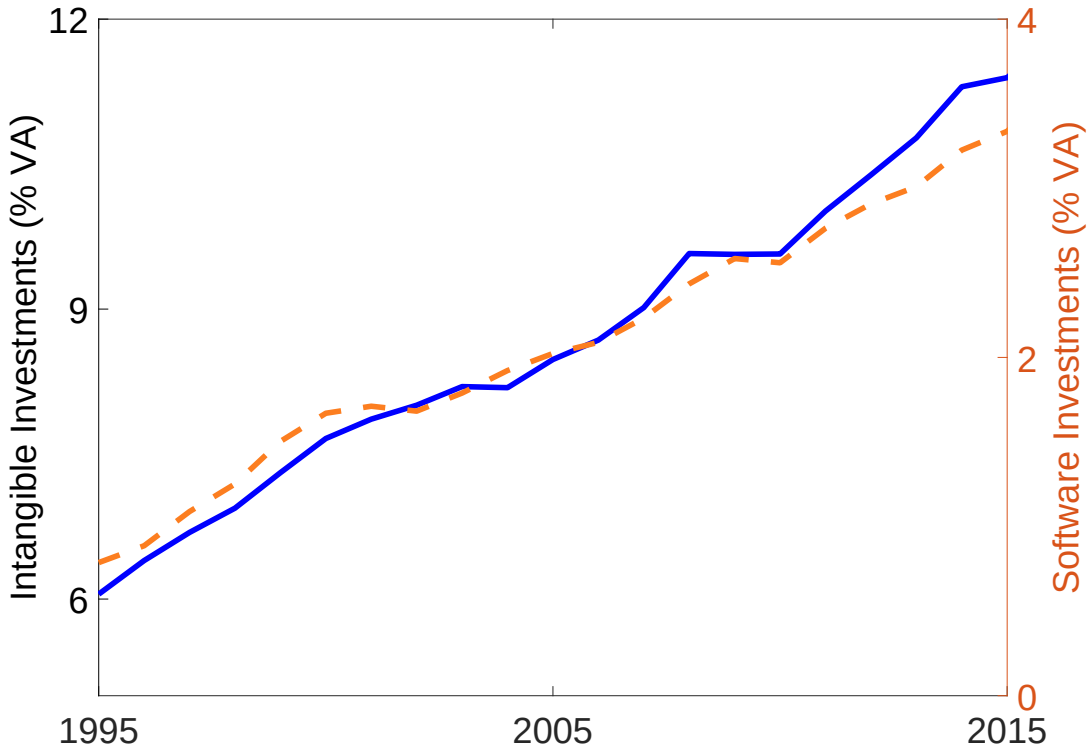

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From the literature:

- Strong relationship between firm-level **intangibles** and **markups**
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- Intangibles cause **increasing returns to scale**, differ **persistently** across firms
  - Bessen (2017), Lashkari et al. (2020)
- Positive corr. intangibles and market power/concentration across **industries**
  - Bajgar et al. (2019), Bijnens and Konings (2018), Calligaris et al. (2018), Criscuolo et al. (2018)

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New analysis:

- **Micro data** analysis on France and the United States
  - France: micro data on universe of firms from 1994-2016 from tax records
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  - Assumes constant marginal costs within firm-year

$$\pi_{it} = (p_{it} - mc_{it}) \cdot y_{it} - F_{it} \Rightarrow \frac{F_{it}}{p_{it} \cdot y_{it}} = \left(1 - \frac{1}{\mu_{it}}\right) - \frac{\pi_{it}}{p_{it} y_{it}}$$

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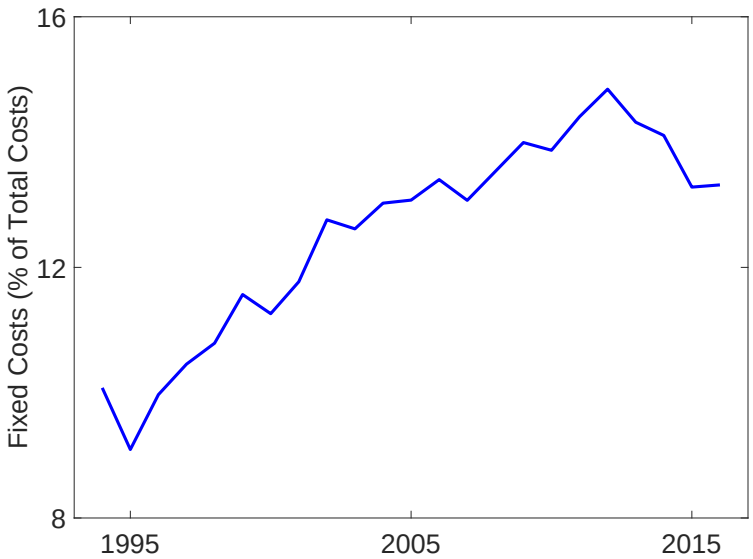
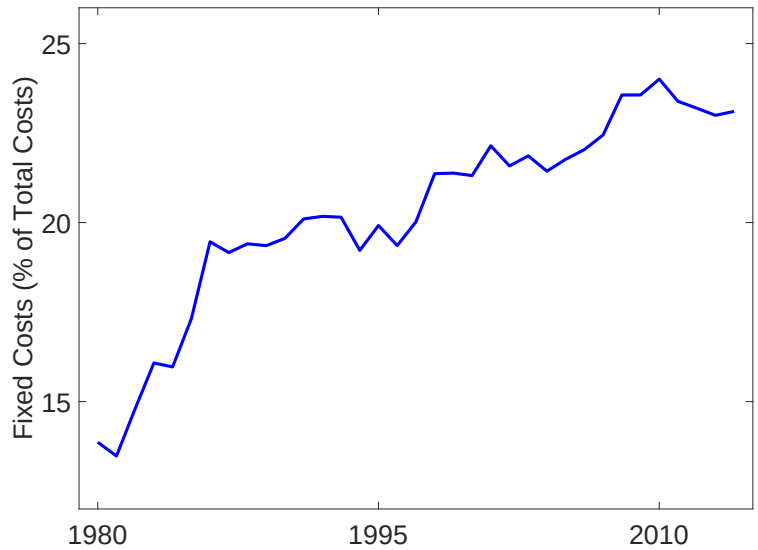
- Conditional **correlations** on fixed costs, intangibles, market power, innovation

Evidence: fixed costs over time



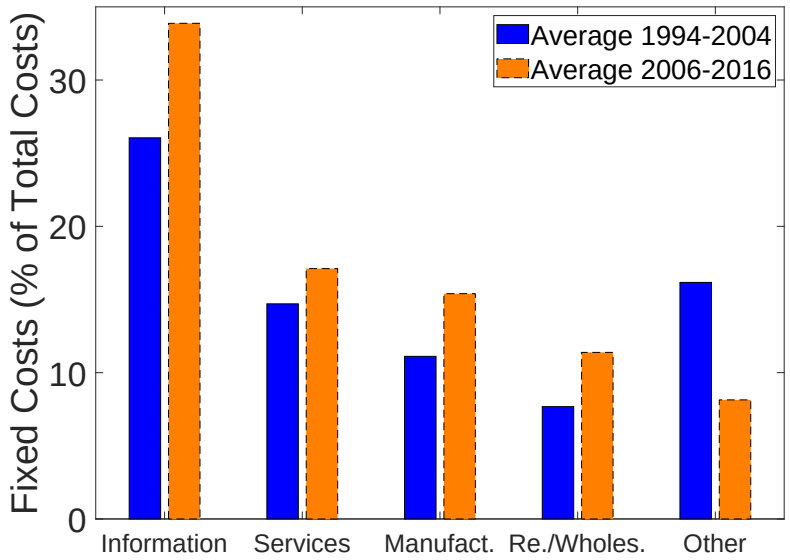
(a) France



(b) United States

Sales-weighted average of fixed costs as a percentage of total costs

Evidence: fixed costs across sectors



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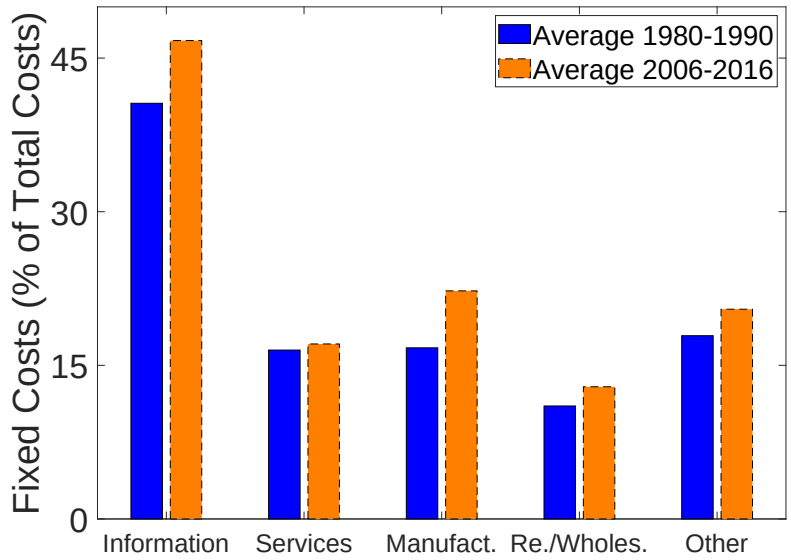

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Sales-weighted average of fixed costs as a percentage of total costs

- The level of fixed costs is particularly high in IT sectors
- But the upward trend happens within sectors

Evidence: fixed costs and intangibles

$$\frac{f_{ijt}}{tc_{ijt}} = \alpha_j^h + \psi_t^h + \beta^h \cdot \textit{Technology}_{ijt}^h + \beta^{h\prime} g(p_{ijt} \cdot y_{ijt}) + \varepsilon_{ijt}^h$$

	TIC (2006-2016)			EAE (1994-2007)
Fixed Cost Share	ERP	CAD	RFID	Software
Technology Adopted	0.015***	0.020***	0.023***	
	(0.002)	(0.006)	(0.006)	
Software Investment				0.550***
				(0.127)
N	63,928	30,415	16,847	136,208
R^2	0.32	0.32	0.39	0.20
Year fixed effects	✓	✓	✓	✓
Industry fixed effects	✓	✓	✓	
Firm fixed effects				✓
Size polynomial	✓	✓	✓	✓

Firm-clustered standard errors in brackets.

▸ Other information technologies ▸ All software regressions
▸ Communication Technologies ▸ Marketing and social media

Additional correlations

Firms with higher fixed costs invest more in innovation

- Control for size, firm and time fixed effects
- U.S. coefficient 0.034***, French coefficient 0.019**

▸ Full regression table

Firms with higher fixed costs grow faster

- Control for size, firm and time fixed effects
- U.S. coefficient 0.13***, French coefficient 0.51***

▸ Full regression table

Firms with higher fixed costs charge higher markups

- Control for size, firm and time fixed effects (2SLS)
- U.S. coefficient 1.66***, French coefficient 0.67***

▸ Full regression table

Innovation in the macroeconomic model

Modern Schumpeterian models of economic growth:

- Firms expand the range of products they can produce through R&D
- If a firm innovates it becomes the market leader
- Incumbent firm loses market leadership: creative destruction

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This model: high-IT firms have lower marginal production costs

- Trade-off consumers: high-cost innovative good vs low cost incumbent
- Greater chance that innovator does not become market leader
- Discourages entry and innovative investments by low-IT firms

Theoretical mechanism

Trade-off: **high-intangible** firms invest **relatively much in innovation**

- Higher profits, lower discount rate, more success: greater innovation
- All firms better at intangibles? Aggregate growth will increase

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- Explains increase in aggregate R&D and initial boom in productivity growth
- But there's a negative **externality** on other firms' innovation
- Rise of intangibles only beneficial if it is sufficiently **inclusive**

Main exercise

Initially:

- Assume an equal (low) level of intangible efficiency across firms
- Structurally estimate model to match 1980 moments for U.S.
- ▸ Structural estimation ▸ Targeted moments ▸ Untargeted moments

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Exercise: assign higher efficiency to a fraction of entrants

- Need to calibrate level of high efficiency and fraction of entrants with the high efficiency
- Two targets: increase in non-R&D intangible investments, decline entry rate
  - United States: 10% of all entrants are born with 7.8% higher efficiency

Balanced Growth Path

	Δ Model	Δ Data
Growth and Innovation		
Productivity growth rate	↓	↓
Aggregate R&D over value added	↑	↑
Dynamism		
Entry rate (target)	↓	↓
Reallocation rate	↓	↓
Market Power		
Average Markup	↑	↑
Cost Structure		
Intangibles over value added (target)	↑	↑
Average fixed-cost Share	↑	↑

↑ denotes increase, ↓ denotes decrease

Δ data: change in U.S. data for 2016 vs 1980.

Balanced Growth Path

	Δ Model	Δ Data
Growth and Innovation		
Productivity growth rate	-0.4 pp	-0.9 pp
Aggregate R&D over value added	41.9%	64.5%
Dynamism		
Entry rate (target)	-5.8 pp	-5.8 pp
Reallocation rate	-42.0%	-23%
Market Power		
Average Markup	21.8 pt	30 pt
Cost Structure		
Intangibles over value added (target)	1.5 pp	2.1 pp
Average fixed-cost Share	3.8 pp	10.6 pp

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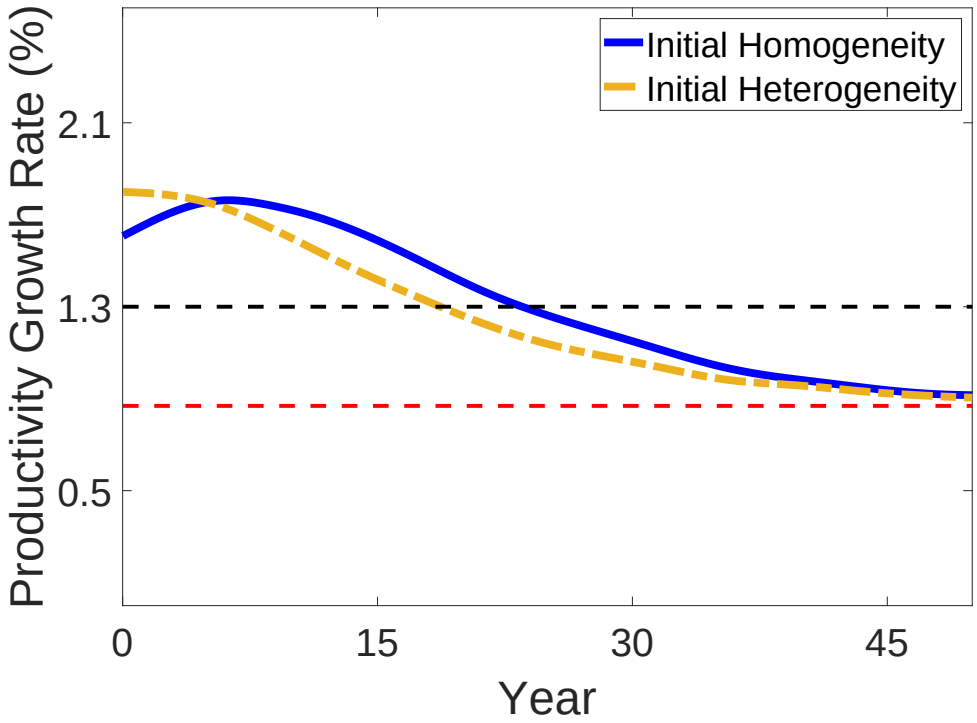
Transition: productivity growth

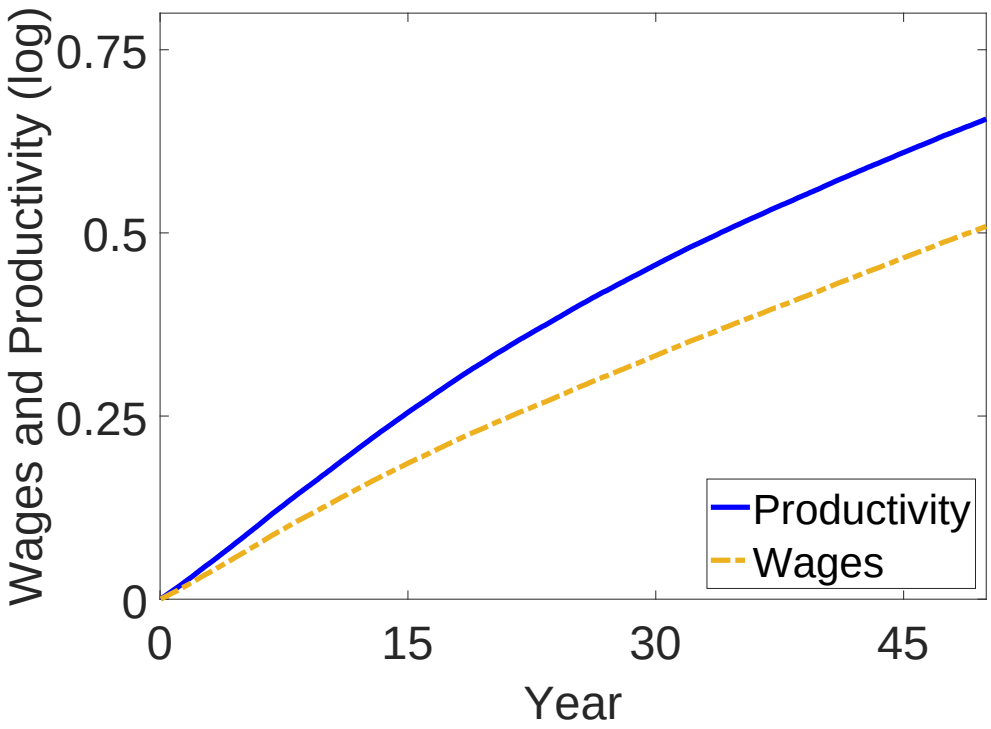
- Transitory boom due to intangibles
- Long-Term decline due to concentration and entry



Black-dashed: original steady state. Red-dashed: new steady state.

Transition: wages

- Markups up: growing productivity without growing wages



(a) Wage and Productivity become Decoupled

Black-dashed: original steady state. Red-dashed: new steady state.

Conclusion

Three macroeconomic trends:

- Low productivity growth despite high R&D, fall in business dynamism, rise of market power/concentration

Explanation:

- Intangible inputs reduce marginal costs, raise fixed costs
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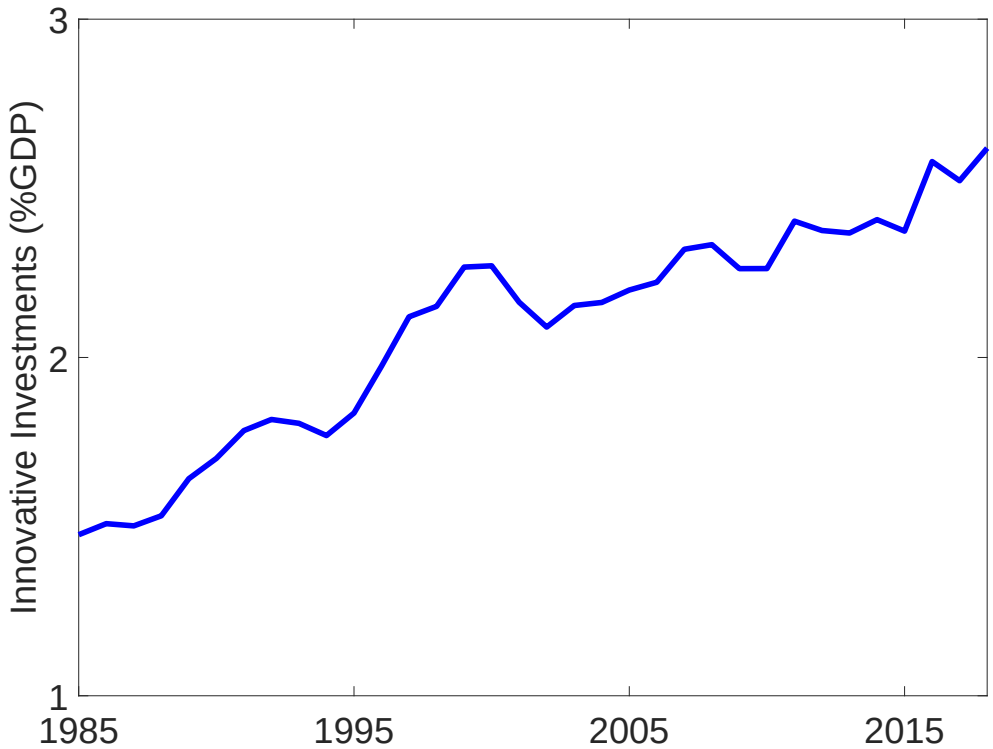
What do we learn from this?

- Important to make rise of intangibles **inclusive**
- Technology *diffusion* vital for welfare and growth

Appendix

Research and Development

- R&D intensity increased 62%.
- Ideas are getting harder to find (Bloom et al. 2017) Back Back - Lit rev



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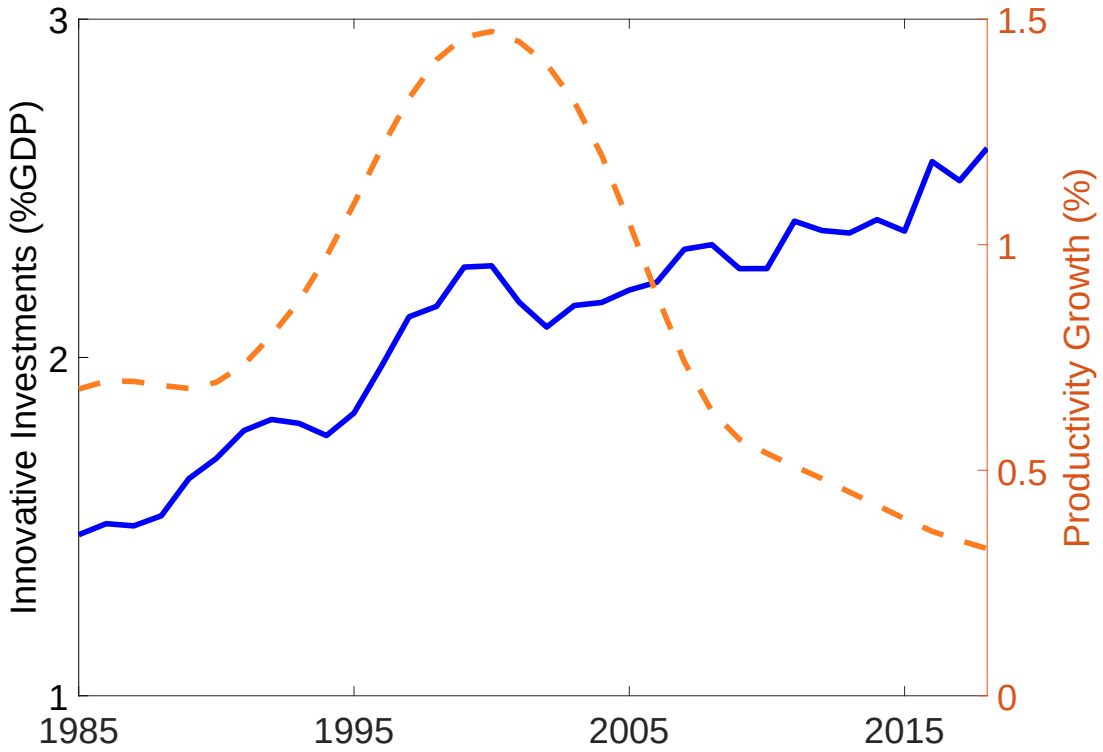

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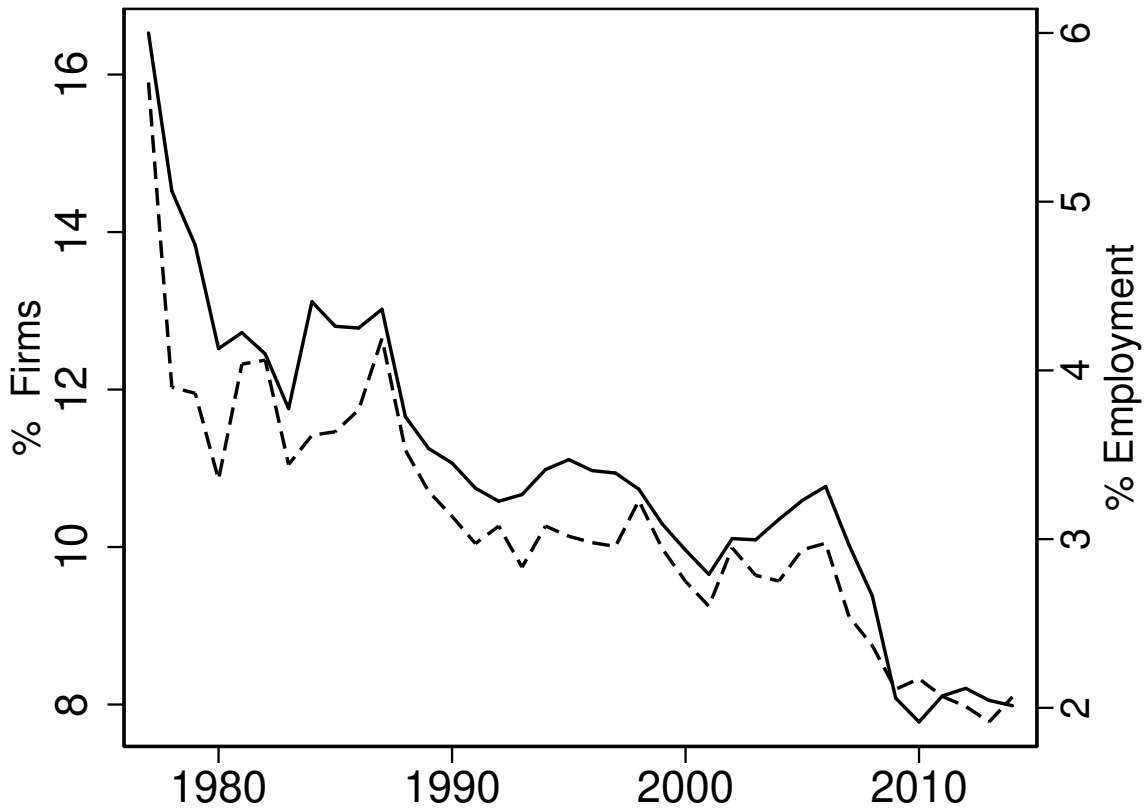
Business dynamism: entry



Start-ups as percentage of firms (solid) and employment (dash)

Data: Business Dynamics Statistics, U.S. Census

▸ Back - Intro ▸ French evidence

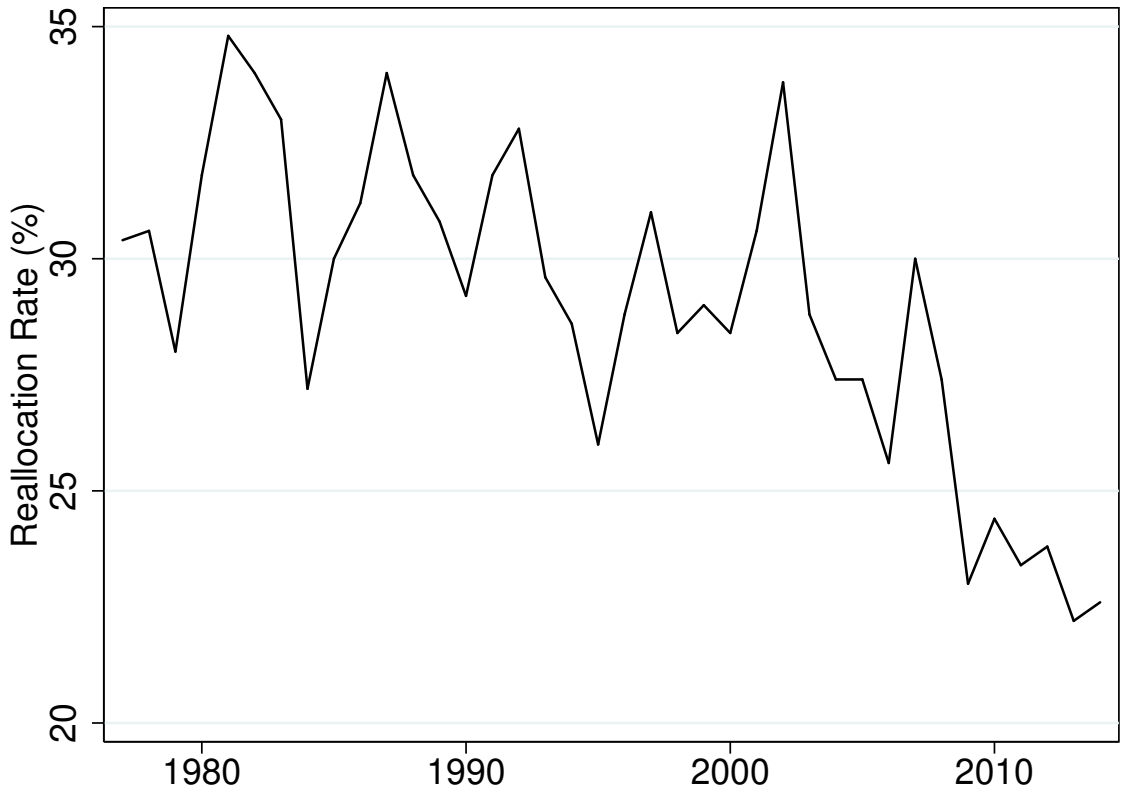
Business dynamism: entry rate (France)

Percentage of employment by new firms ($\leq$ 1yr) in private sector employment (HP).

Source: own calculations based for universe of French firms (FARE-FICUS)

▸ Back - Intro ▸ Back - Data

Business dynamism: reallocation rate

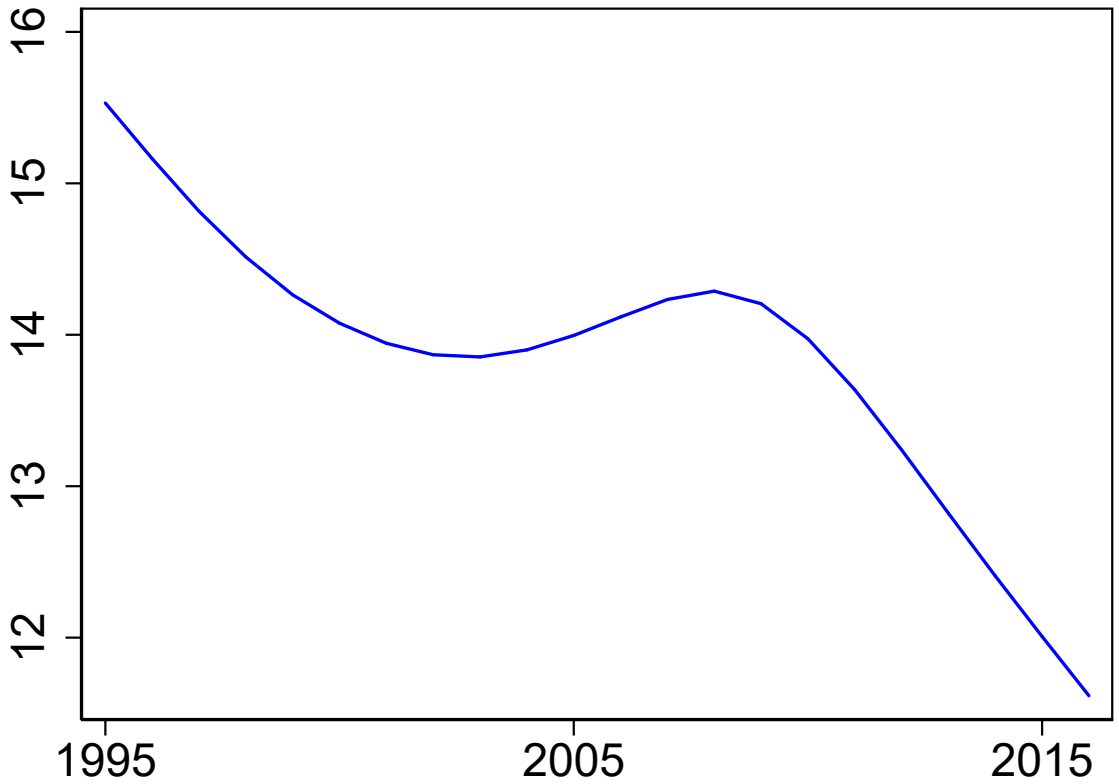


Sum of job destruction and creation rate (%)

Data: Business Dynamics Statistics, U.S. Census

▸ French evidence ▸ Back - Intro

Business dynamism: reallocation rate (France)

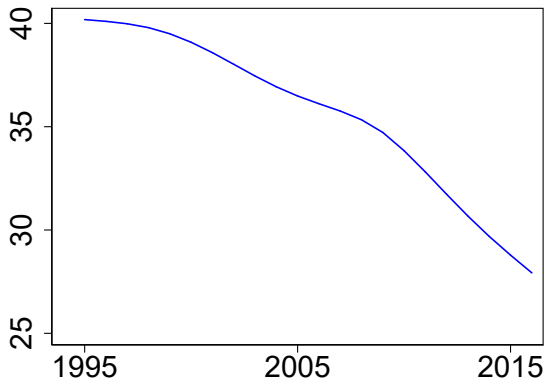


Sum of job creation and job destruction rates across companies (HP).

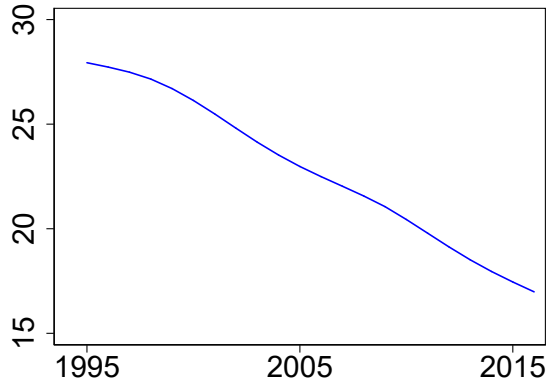
Source: own calculations based for universe of French firms (FARE-FICUS)

▸ Back - Intro ▸ Back - Data

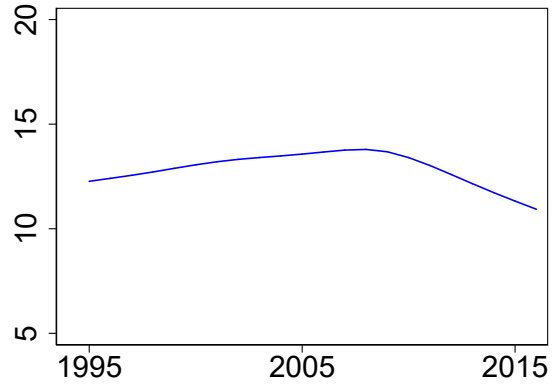
Business dynamism: skewness of growth (France)



(b) 90-10 Difference



(c) 90-50 Difference



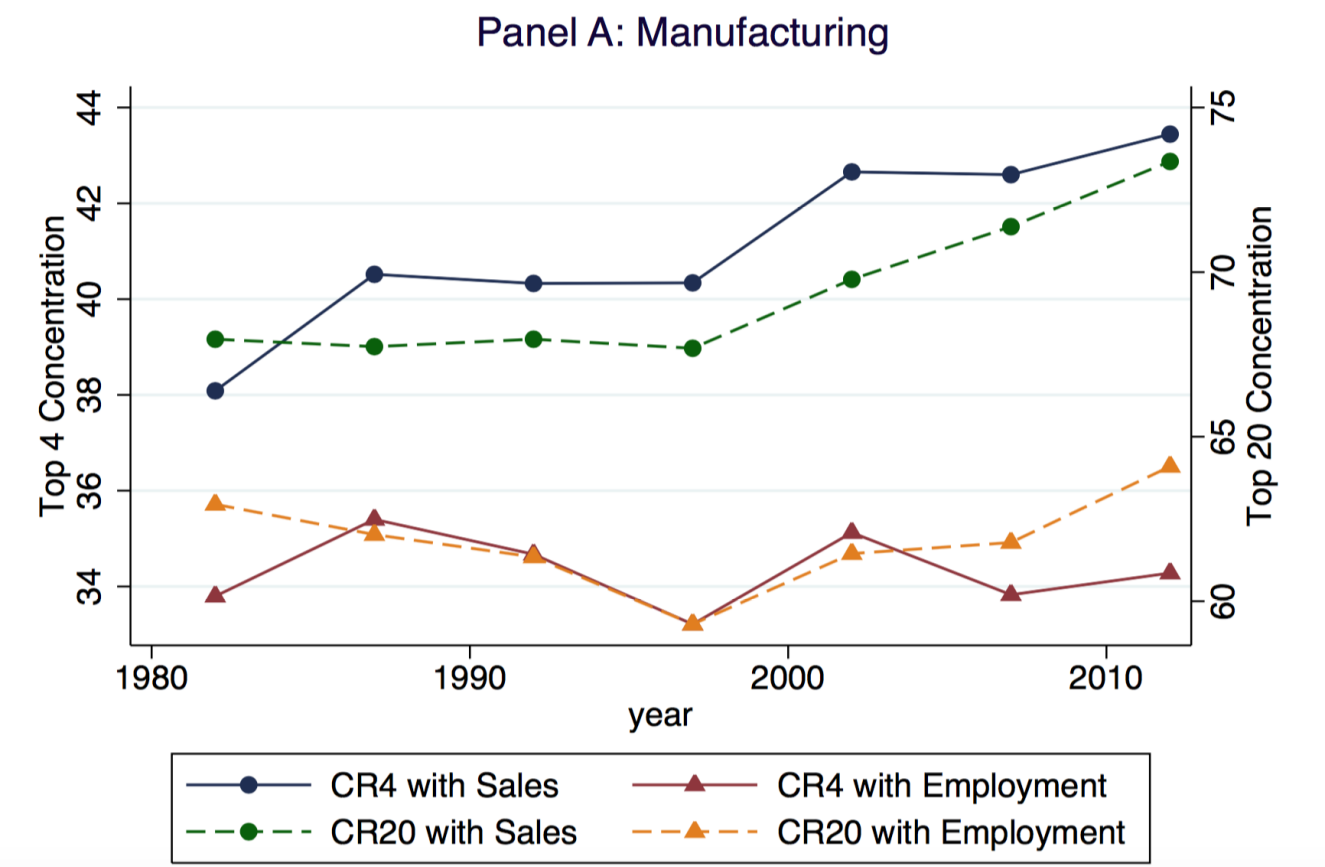
(d) 50-10 Difference

Difference (perc. point) in growth between percentiles of the employment-growth distribution.

Source: own calculations based for universe of French firms (FARE-FICUS)

▸ Back - Intro ▸ Back - Data

Firm concentration



Fraction of sales and employment by top 4 or 20 firms by 4-digit industry.

Source: Autor et al (2017) based on U.S. Census Data

▸ French evidence

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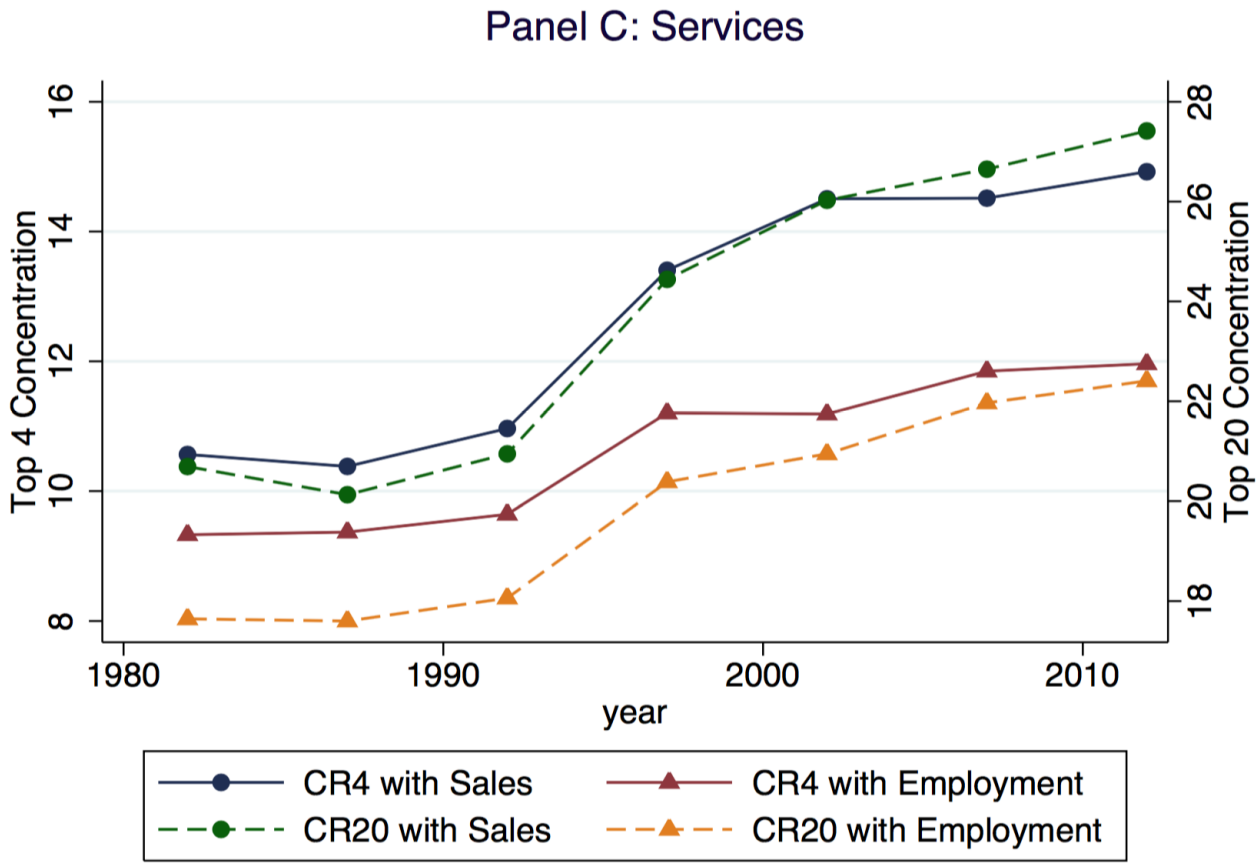

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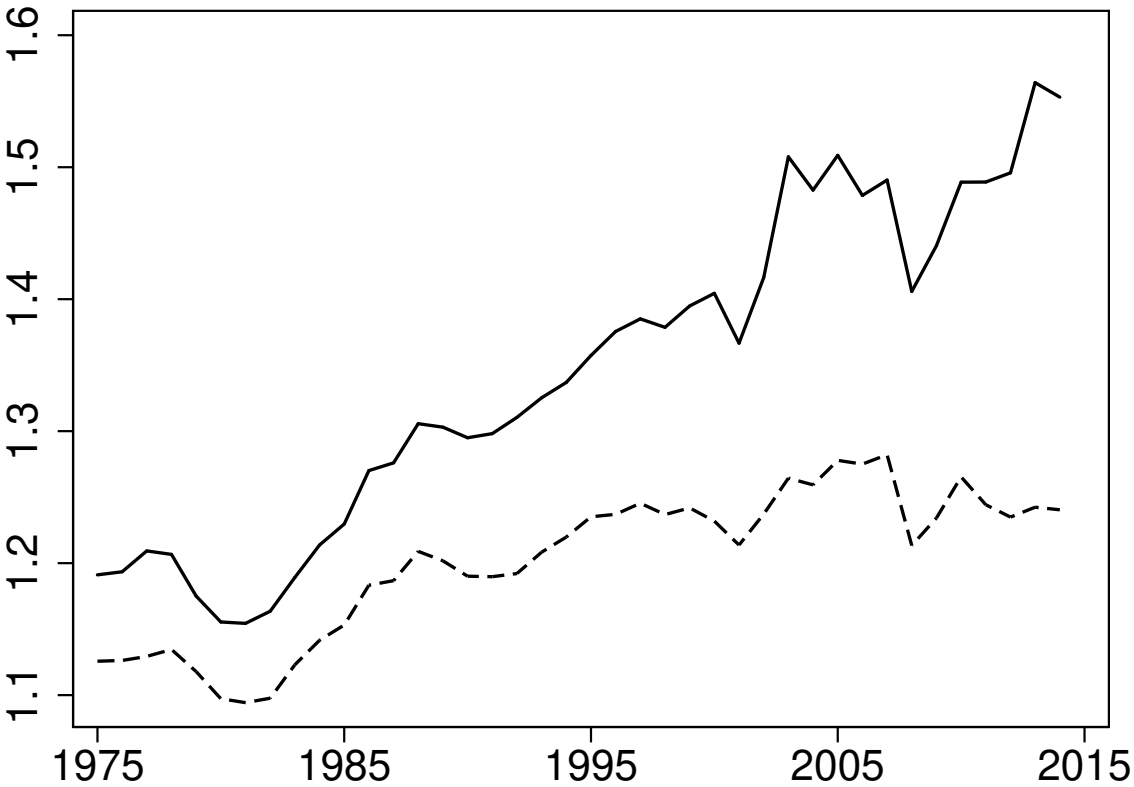
Markups

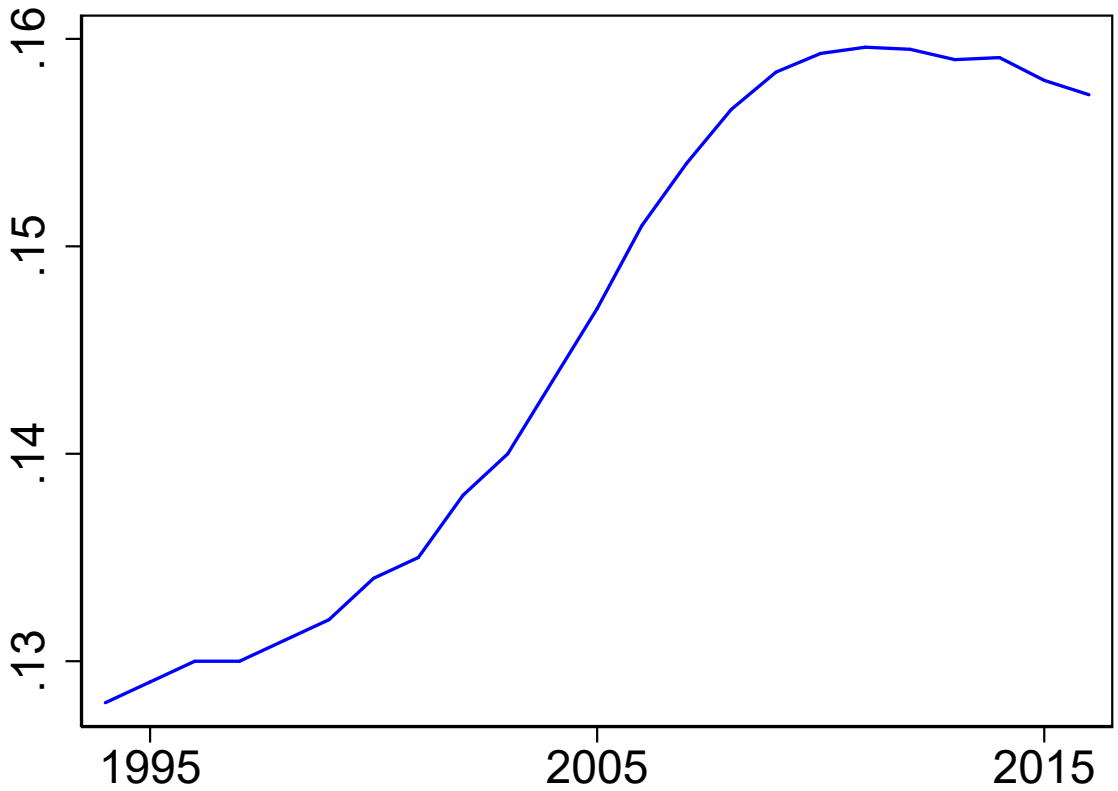


Average markup weighted by sales (solid) and costs (dashed)

Source: Own calculations based on Compustat Data

Back - Into

Firm concentration (France)



Average Herfindahl Index at 4-digit NACE level, weighted by value added (HP).

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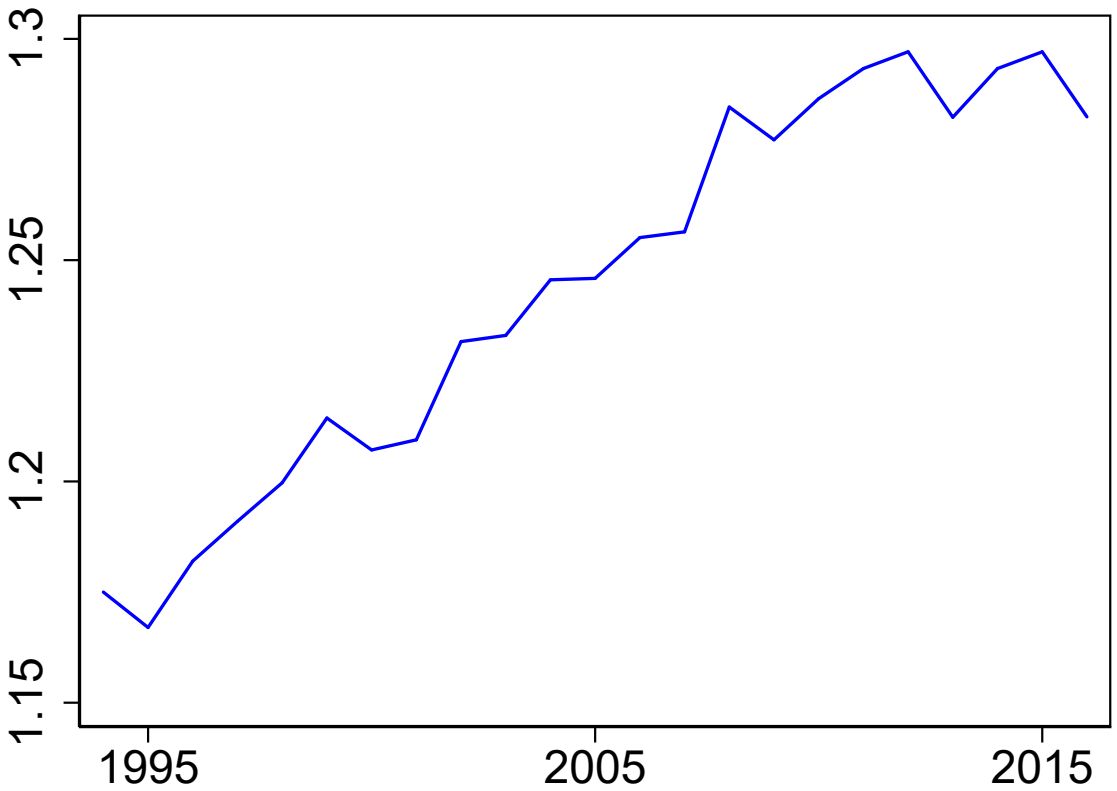
▸ Back - Into ▸ Back - Data

Markups (France)



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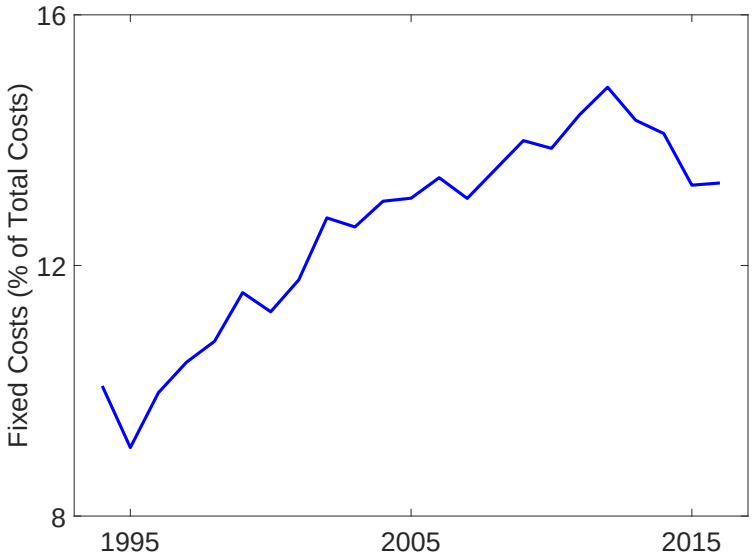
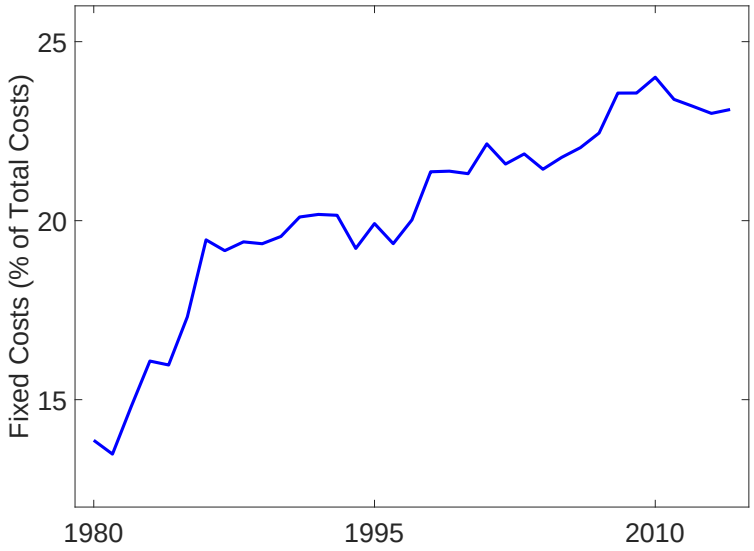
Back - Into

Fixed costs over time



(e) France



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- But the upward trend happens within sectors ▸ Sector evidence

▸ Back

Fixed costs and intangibles

$$\frac{f_{ijt}}{tc_{ijt}} = \alpha_j^h + \psi_t^h + \beta^h \cdot \textit{Technology}_{ijt}^h + \beta^{h\prime} g(p_{ijt} \cdot y_{ijt}) + \varepsilon_{ijt}^h$$

	TIC (2006-2016)			EAE (1994-2007)
Fixed Cost Share	ERP	CAD	RFID	Software
Technology Adopted	0.015***	0.020***	0.023***	
	(0.002)	(0.006)	(0.006)	
Software Investment				0.550***
				(0.127)
N	63,928	30,415	16,847	136,208
R^2	0.32	0.32	0.39	0.20
Year fixed effects	✓	✓	✓	✓
Industry fixed effects	✓	✓	✓	
Firm fixed effects				✓
Size polynomial	✓	✓	✓	✓

Firm-clustered standard errors in brackets.

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Quantification

Parameter	Description	Method
ρ	Discount rate	External (.01)
ψ	Intangibles cost elasticity	External (2.0)
ψ^x	Cost elasticity of innovation (incumbents)	External (2.0)
ψ^e	Cost elasticity of innovation (entrants)	External (2.0)
η^x	Cost scalar of innovation (incumbents)	Indirect inference
η^e	Cost scalar of innovation (entrants)	Indirect inference
$\bar{\lambda}$	Average innovation step size	Indirect inference
σ	Relationship firm-size and firm-growth	Indirect inference
ϕ	Intangible efficiency	Indirect inference

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Structural estimation

- Separately for France (1994 moments) and the U.S. (1980 moments)
- Assume all firms have equal intangible productivity ϕ
- Minimize objective function:

$$\min \sum_{k=1}^{5} \frac{\mid \text{model}_k - \text{data}_k \mid}{(\mid \text{model}_k \mid + \mid \text{data}_k \mid) \cdot 0.5} \cdot \Omega_k$$

- Simulated method of moments: 32,000 firms for 50 years

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Structural estimation

Targeted moments:

Parameter	Moment	France		U.S.	
		Data	Model	Data	Model
$\bar{\lambda}$	Productivity growth	1.3%	1.3%	1.3%	1.3%
ϕ	Fixed costs (%)	9.5%	9.5%	12.0%	12.0%
σ	Gibrat's Law (OLS β)	-.035	-.035	-.035	-.035
η^e	Entry rate	10.0%	9.9%	13.8%	12.2%
η^x	R&D intensity	3.1%	2.6%	2.5%	2.5%

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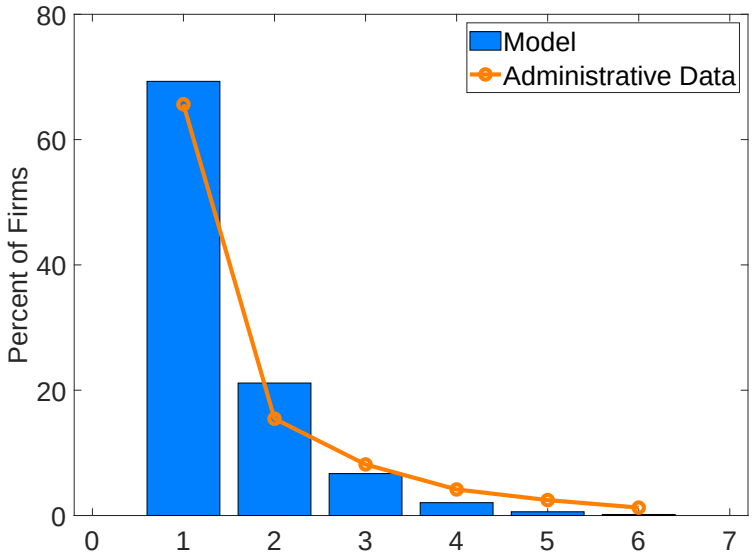
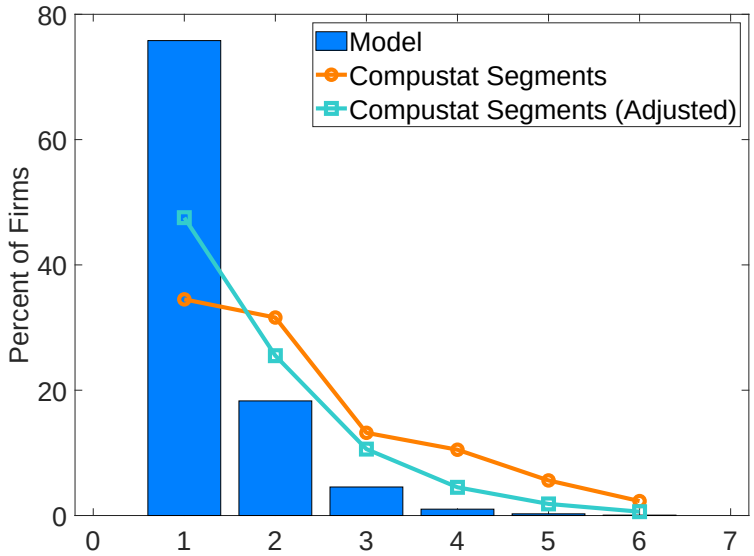
Products by firm



(a) France



(b) United States

Notes: French data is taken from the EAP (manufacturing only, 2009). U.S. data is taken from the Compustat Segments (count of primary 6-digit NAICS codes) in 1990.

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Untargeted: firm size, age, exit, product loss

		France			United States		
	Quartile	Model	Data	St. Dev.	Model	Data	St. Dev.
Size and Age	1st (Age)	1.21	1.98	(1.01)	1.23	2.17	(1.04)
	2nd (Age)	1.61	2.39	(1.06)	1.62	2.28	(1.05)
	3rd (Age)	1.92	2.69	(1.07)	1.93	2.47	(1.09)
	4th (Age)	2.11	3.04	(1.03)	2.14	3.05	(1.08)
Exit Rate and Age	1st (Age)	.145	.060	(.238)	.149	.114	(.318)
	2nd (Age)	.121	.055	(.229)	.132	.122	(.317)
	3rd (Age)	.105	.038	(.190)	.118	.110	(.306)
	4th (Age)	.094	.036	(.189)	.106	.075	(.265)
Exit Rate and Size	1st (Size)	.159	.114	(.318)	.156	.127	(.333)
	2nd (Size)	.159	.040	(.196)	.156	.109	(.312)
	3rd (Size)	.029	.028	(.165)	.156	.091	(.287)
	4th (Size)	.004	.024	(.153)	.023	.067	(.251)
Product Loss Prob. and Age	1st (Age)	.175	.105	(.306)	0.172	.045	(.208)
	2nd (Age)	.205	.127	(.333)	0.195	.048	(.213)
	3rd (Age)	.234	.152	(.359)	0.218	.055	(.228)
	4th (Age)	.252	.164	(.370)	0.233	.068	(.252)

Notes: French data from FICUS-FARE dataset (1994-2016). U.S. data is from Compustat (1980-2016). Size is sector-deflated sales, age is the number of years since creation or Compustat entry. Items under 'model' and 'data' are the mean of the variable within the quartile considered.

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Fixed costs and communication technology

$$Communication_{it}^{x} = \beta^{x} \cdot \frac{F_{it}}{TC_{it}} + \gamma^{x\prime} X_{it} + \varepsilon_{it}^{x}$$

Technology:	Videoconferencing	Internal soc. med.	Remote access
Fixed Cost Share	0.144***	0.118***	0.020
	(0.012)	(0.016)	(0.040)
Year F.E.	✓	✓	✓
Industry F.E.	✓	✓	✓
Size Poly.	✓	✓	✓
N	45,572	8,990	60,327
R^2	0.243	0.056	0.262

Data: FARE-FICUS merged with TIC 2006-2016, observations weighted with TIC sample weights. Firm-clustered standard errors in brackets. All dep. variables are binary.

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Fixed costs and online sales and marketing

$$Adoption_{it}^{x} = \beta^{x} \cdot \frac{F_{it}}{TC_{it}} + \gamma^{x\prime} X_{it} + \varepsilon_{it}^{x}$$

	Social Media (binary)				
Technology:	Image	Reviews	Client contact	Website	Websales (%)
Fixed Cost Share	0.014	-0.018	-0.026	0.020	-0.002
	(0.033)	(0.042)	(0.041)	(0.016)	(0.005)
Year F.E.	✓	✓	✓	✓	✓
Industry F.E.	✓	✓	✓	✓	✓
Size Poly.	✓	✓	✓	✓	✓
N	8,990	8,990	8,990	76,377	76,377
R^2	0.040	0.138	0.059	0.136	0.138

Data: FARE-FICUS merged with TIC 2006-2016, observations weighted with TIC sample weights.
Firm-clustered standard errors in brackets.

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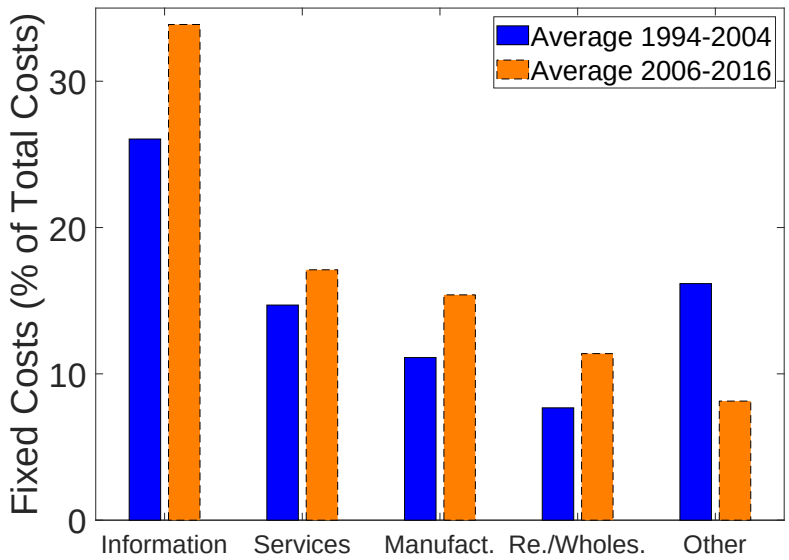
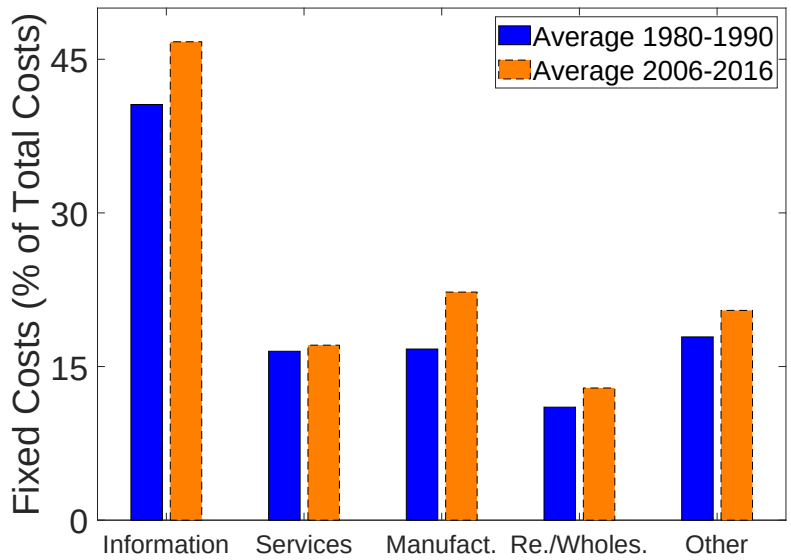
Fixed costs across sectors



(a) France



(b) United States

Sales-weighted average of fixed costs as a percentage of total costs

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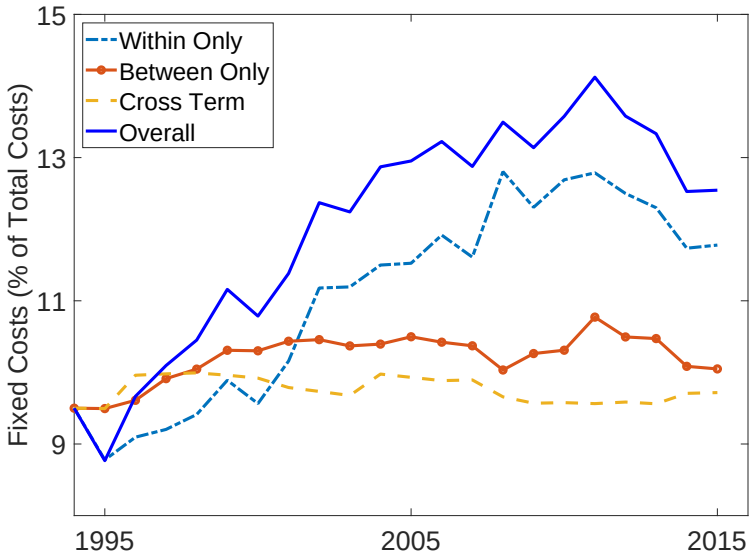
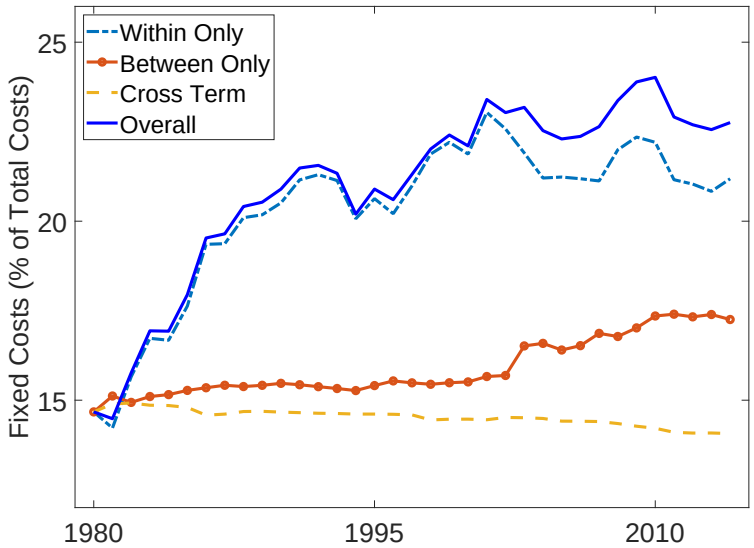
Fixed costs across sectors



(a) France



(b) United States

Within-between decomposition of sales-weighted average in fixed costs

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Fixed costs and markups

$$\mu_{it} = \alpha_i + \psi_t + \gamma \cdot \frac{f_{it}}{tc_{it}} + \beta' g(p_{it} \cdot y_{it}) + \varepsilon_{ijt},$$

Markups	United States (1980-2016) OLS	France (1994-2016) OLS	France (1994-2007) 2SLS
Fixed-Cost Share	1.66***	1.28***	0.67***
	(0.031)	(0.002)	(0.224)
R^2	0.62	0.52	
Observations	125,231	9,457,679	140,861
Year fixed effects	✓	✓	✓
Firm fixed effects	✓	✓	✓
Size polynomial	✓	✓	✓

Firm-clustered errors in brackets. Data: Compustat, FARE-FICUS merged with EAE. 2SLS IV: third-degree polynomial in the ratio of software to sales (F-stat 16.6).

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Fixed costs and sales growth

$$\Delta(p_{it} \cdot y_{it}) = \alpha_i + \psi_t + \gamma \cdot \frac{f_{it-1}}{tc_{it-1}} + \beta' g(p_{it-1} \cdot y_{it-1}) + \varepsilon_{ijt},$$

Sales Growth	United States (1980-2016)	France (1994-2016)
Lagged Fixed-Cost Share	.125***	.514***
	(.009)	(.002)
R^2	0.02	0.05
Observations	111,397	8,670,007
Year fixed effects	✓	✓
Firm fixed effects	✓	✓
Size polynomial	✓	✓

Firm-clustered standard errors in brackets. Data: Compustat, FARE-FICUS.

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Fixed costs and innovative investments

$$\frac{\text{research and development}_{it}}{p_{it} \cdot y_{it}} = \alpha_i + \psi_t + \gamma \cdot \frac{f_{it}}{tc_{it}} + \beta' g(p_{it} \cdot y_{it}) + \varepsilon_{ijt},$$

Fixed costs and innovative investments

$$\frac{\text{research and development}_{it}}{p_{it} \cdot y_{it}} = \alpha_i + \psi_t + \gamma \cdot \frac{f_{it}}{tc_{it}} + \beta' g(p_{it} \cdot y_{it}) + \varepsilon_{ijt},$$

R&D	United States (1980-2016)	France (1996-2016)
Fixed-Cost Share	.034***	.019**
	(.003)	(.005)
R^2	0.15	0.02
Observations	125,231	92,536
Year fixed effects	✓	✓
Firm fixed effects	✓	✓
Size polynomial	✓	✓

Firm-clustered standard errors in brackets.
Data: Compustat, FARE-FICUS merged with CIS.

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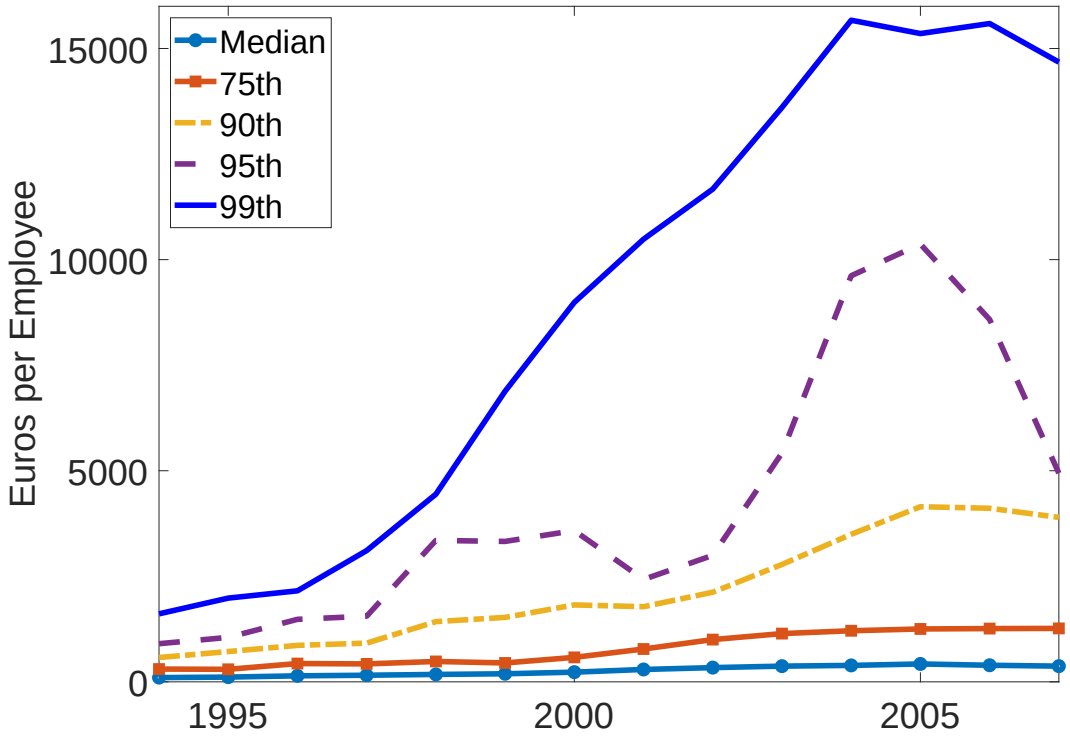
Intangible inequality



Cross-Sectional Percentiles of Software Investments per Employee

Source: EAE (14,000 French firms)

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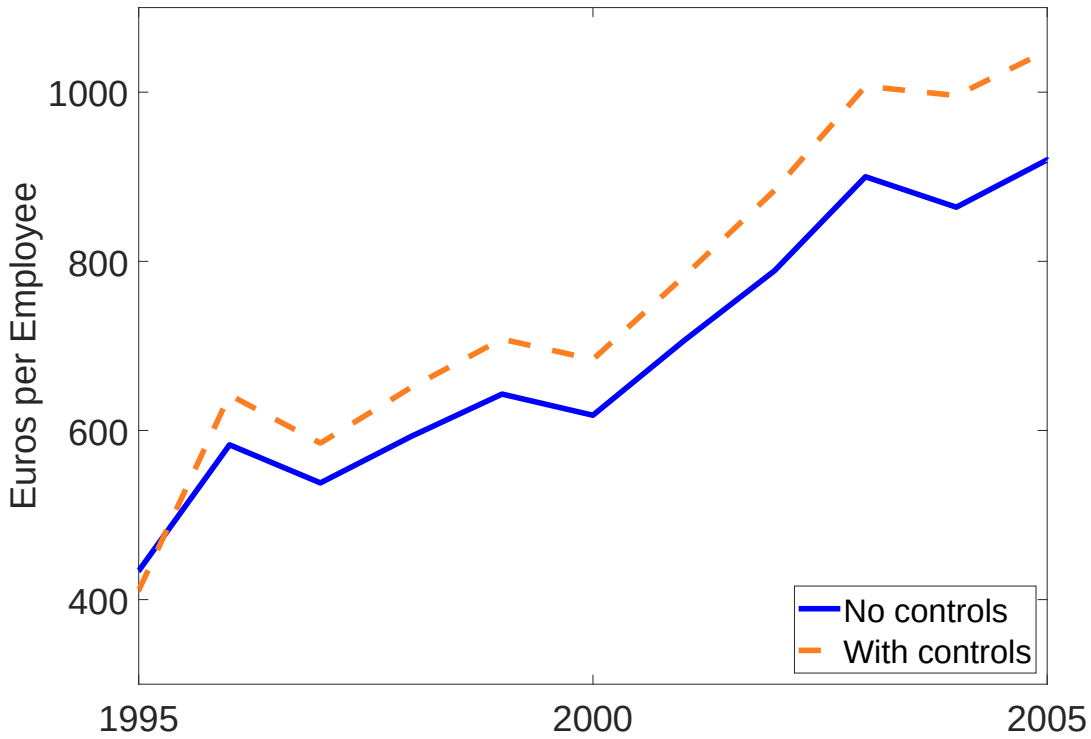
Intangible inequality



Standard Deviation of Software Investments per Employee

Controls: industry-trend, 5-digit f.e., and size. Source: EAE (14.000 French firms)

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Related Literature

- Jointly explaining productivity, dynamism, markups: Aghion et al. (2019), Liu, Mian and Sufi (2019), Akcigit and Ates (2019), Peters and Walsh (2020), Cavenaile et al. (2020), Olmstead-Rumsey (2020)
- Productivity: e.g. Fernald (2015), Adler et al. (2017)
- Business dynamism: e.g. Davis et al. (2006), Decker et al. (2014), Haltiwanger et al. (e.g., 2014), Decker et al. (2016), Pugsley and Sahin (2018), Alon et al. (2018), Borstein (2018), Salgado (2020)
- Markups, labor share, concentration: Karabarbounis and Neiman (2013), Caballero et al. (2017), De Loecker, Eeckhout and Unger (2019), Eggertson et al. (2018), Gutierrez (2017), Kehrig and Vincent (2017), Calvino et al. (2016), Diez et al. (2018), Autor et al. (2017), Gutierrez and Philippon (2017, 2018), IMF (2019).
- Demography: Hopenhayn et al. (2018), Engbom (2020), Karahan, Pugsley, Sahin (2018)
- Misallocation: e.g. Peters (2016), Baqaee and Farhi (2017), Edmond et al. (2018).
- Intangibles: e.g. Bessen (2017), Crouzet and Eberly (2018), Criscuolo et al. (2018), Ayyagari et al. (2018), Callagaris et al. (2018), Brynjolfson et al. (2018), Martinez (2018), Bajgar et al. (2019), Bessen and Righi (2019), Lashkari et al. (2019), Korinek and Ng (2019), Weiss (2020)
- Related growth models: e.g. Grossman and Helpman (1991), Aghion and Howitt (1992), Klette and Kortum (2004), Lenz and Mortensen (2008), Acemoglu et al. (2018), Akcigit and Kerr (2018), Atkinson and Burstein (2018), Garcia-Macia et al. (2016).

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