Recent Changes in Firm Dynamics and the Nature of Macroeconomic Trends

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Motivation

- Many advanced economies have experienced similar macroeconomic trends
    - A fall in the firm entry rate
    - A rise in the average firm size
    - A fall in the aggregate labor income share
    - An increase in industry concentration
- What causes these trends?

Motivation

- One view in the literature: falling population growth

  Hopenhayn, Neira, Singhania (*Ecma*, 2022); Karahan, Pugsley, Sahin (*AER*, 2024); Peters, Walsh (2024)

  - Falling population growth absorbed by falling firm entry
  - Falling firm entry shifts the firm-age distribution toward older firms
  - Older firms are larger, less likely to exit, feature lower labor shares
  - Rising share of old firms: avg. firm size $\uparrow$, indus. concentration $\uparrow$, agg. labor share $\downarrow$

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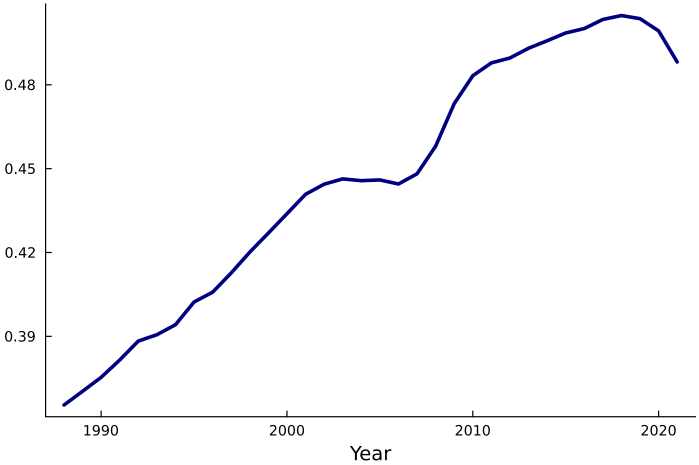
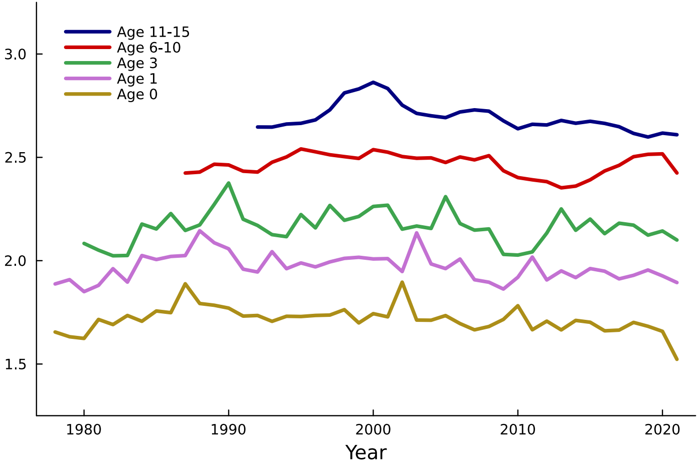
  - Rising share of old firms: avg. firm size $\uparrow$, indus. concentration $\uparrow$, agg. labor share $\downarrow$
- Literature provides suggestive evidence from U.S. Census data in support of this view
  - Shift in the firm-age distribution toward older firms...
  - ...While firm characteristics *conditional on firm age* have remained stable

Fraction of firms aged 11+



Notes: U.S. Census data. Business Dynamics Statistics (2021).

Log employment per firm by firm age



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- The stability of firm characteristics (e.g., size) conditional on firm age suggests that
  - Agg. trends (e.g., rise in avg. firm size) are driven by shift in firm-age distribution
  - . . . And not by changes within firm-age groups
- Attributes incumbent firms a somewhat passive role in agg. trends
  - Firm-age distribution shifts naturally in response to falling entry (pop. growth)

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- Attributes incumbent firms a somewhat passive role in agg. trends
    - Firm-age distribution shifts naturally in response to falling entry (pop. growth)
- Stability of firm-size patterns surprising given alternative explanations behind agg. trends
    - Most efficient incumbents **expand** into new product markets
      Aghion, Bergeaud, Boppart, Klenow, Li (*REStud*, 2023); De Ridder (*AER*, 2024); Hsieh, Rossi-Hansberg (*JPE Macro*, 2023) . . .
    - Incumbent firms **expand** relative to laggard firms within product markets
      Liu, Mian, Sufi (*Ecma*, 2022); Olmstead-Rumsey (*R&R REStud*, 2022); Akcigit, Ates (*JPE*, 2023) . . .

This paper

- Revisit the stability of firm size conditional on age
  - Almost all sectors experienced an increase in firm size conditional on age
  - Stability is due to declining firm size conditional on age in manufacturing sector

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- Revisit the stability of firm size conditional on age
  - Almost all sectors experienced an increase in firm size conditional on age
  - Stability is due to declining firm size conditional on age in manufacturing sector
- Build a structural model
  - Which forces drive the changes in firm size conditional on age and the agg. economy?

Related literature

- Trends in firm size (growth)
  Sterk, Sedlácek and Pugsley (2021), Karahan, Pugsley and Sahin (2022), Hopenhayn, Neira and Singhania (2022)
- Explaining recent macroeconomic trends
  Davis (2017), Gutiérrez and Philippon (2018), Bloom, Jones, Van Reenen and Webb (2020), Liu, Mian and Sufi (2022), Olmstead-Rumsey (2022), Peters and Walsh (2022), Akcigit and Ates (2023), Aghion, Bergeaud, Boppart, Klenow and Li (2023), De Ridder (2024), ...
- Quantifying the sources of economic growth
  Akcigit and Kerr (2018), Garcia-Macia, Hsieh and Klenow (2019), Peters (2020)
- Macroeconomic implications of reallocation
  Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Song, Storesletten and Zilibotti (2011), Acemoglu, Akcigit, Alp, Bloom and Kerr (2018)

Outline

Outline

Revisiting firm-size dynamics

Model

- Explaining the changes in firm-size dynamics across BGPs
- Implications for the macroeconomy (long run)
- Transition dynamics

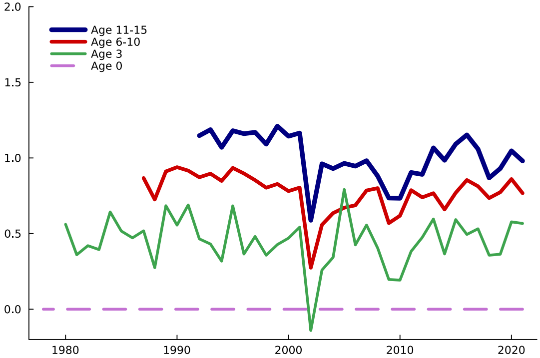
Discussion

Revisiting firm-size dynamics

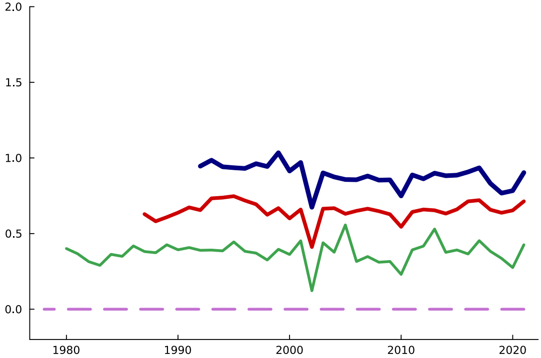
- As the previous literature
  - Study trends in firm size conditional on firm age
  - Use U.S. Census Data (publicly available Business Dynamism Statistics)
- In contrast to the previous literature
  - Study trends by sector

Log employment per firm by firm age (normalized)

(a) Manufacturing



(b) Retail Trade



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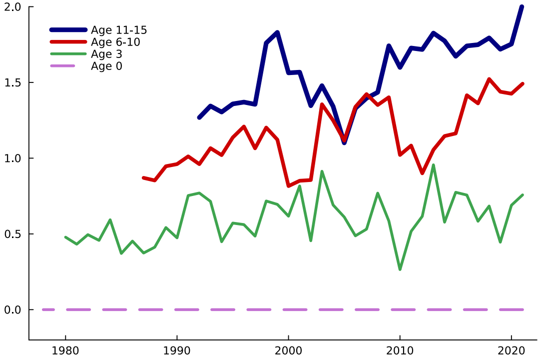
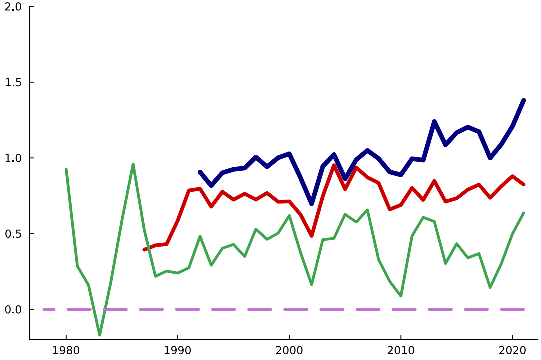
(a) Information

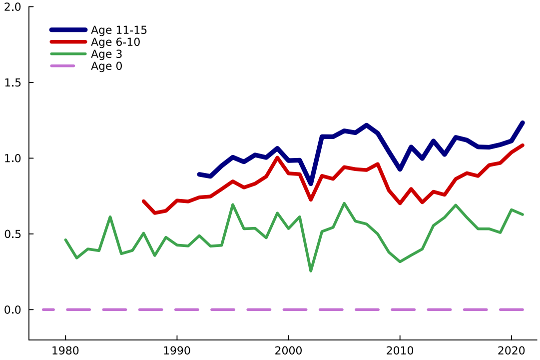


(b) Finance and Insurance

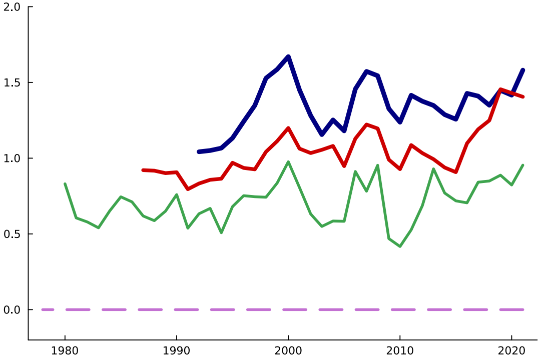


Log employment per firm by firm age (normalized)

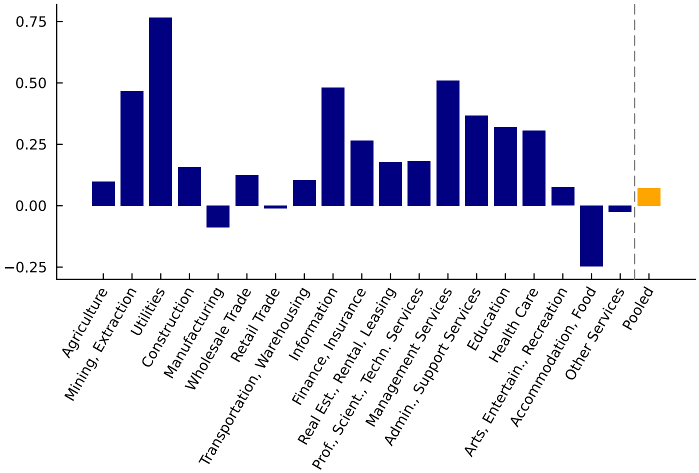
(a) Profess., Scient., and Techn. Services



(b) Administrative and Support Services



Δ Log employment per firm (1992–2017), ages 11-15 relative to entrants



Accommodation and Food sector accounts for 9% of firms (but only 3% of GDP) in U.S.

Evidence from Swedish adminstrative data

- The rise in firm size conditional on firm age is not just a U.S. phenomenon
- Using high-quality Swedish administrative data at the firm level, I document that
  - Firm size **increased** relative to the size of entrants for firms of *any* age
  - Relative size increased by more when measured by employment rather than sales
    - Firms aged eight are 0.29 (0.47) log points larger than entrants in 1990s (2010s)
    - Firms aged eight are 0.56 (0.67) log points larger than entrants in 1990s (2010s)
  - Patterns hold for different entrant classifications and are not due to Great Recession

▸ Analysis

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Model overview

Build a structural model that includes key ingredients, prominently featured in the literature

- Firms constantly expand into new product markets
- Firms face the threat of replacement by entrants
- Firms grow their markups over time
- Systematic heterogeneity in the efficiency of firms

Which forces explain the increase in firm size cond. on age and are consistent with agg. trends?

Model overview

Build a structural model that includes key ingredients, prominently featured in the literature

- Firms constantly expand into new product markets
  - Changes in the cost of firm expansion
- Firms face the threat of replacement by entrants
  - Changes in the entry costs
- Firms grow their markups over time
  - Changes in firm-markup growth
- Systematic heterogeneity in the efficiency of firms
  - Subset of firms gains productivity advantage

Which forces explain the increase in firm size cond. on age and are consistent with agg. trends?

Aggregate economy

- Household preferences

$$U = \int_0^\infty \exp(-\rho t) \ln C_t dt$$

- Final good production

$$Y_t = \exp\left(\int_0^1 \ln\left(q_{it} y_{it}\right) di\right)$$

  q_{it} denotes the quality of product i.

- Firms increase q_{it} through innovation

Market structure within product markets

- Firm f produces in product market i with

$$y_{ift} = \varphi_f L_{ift}$$

- Innate heterogeneity in firm productivity φ_f

$$\varphi_f \in \{\varphi^h, \varphi^\ell\}$$

- Firms compete in prices (Bertrand competition)

  $\rightarrow$ firm with the highest quality adjusted productivity is producing in market i

Static allocation, product level

- Incumbent f in market i sets price according to

$$p_{ift} = \frac{q_{ift}}{q_{if't}} \frac{w_t}{\varphi_{f'}}$$

- Incumbent f in market i sets markup according to

$$\mu_{ift} \equiv \frac{p_{ift}}{w_t/\varphi_f} = \frac{q_{ift}}{q_{if't}} \frac{\varphi_f}{\varphi_{f'}}$$

$\implies$ Markup is increasing in incumbent quality and productivity

- Labor demand by incumbent f in market i

$$l_{if} = \frac{Y}{w} \mu_{if}^{-1}$$

Static allocation, firm level

- Firm sales

$$\sum_{i \in N_f} p_i y_i \propto |N_f|$$

- Firm employment

$$l_f = \sum_{i \in N_f} l_{if} = \frac{Y}{w} \left(\sum_{i \in N_f} \mu_{if}^{-1} \right)$$

- Firm markup

$$\mu_f = \frac{\sum_{i \in N_f} p_i y_i}{w l_f} = \left(\frac{1}{n} \sum_{k=1}^{n} \mu_{kf}^{-1} \right)^{-1}$$

Dynamic firm problem, high-productivity firm

Firm chooses its internal (vertical) and expansion (horizontal) R&D efforts (I_k,x_k)

$$r_t V_t^h(n, \boldsymbol{\mu}, S_t) - \dot{V}_t^h(n, \boldsymbol{\mu}, S_t) =$$

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$$\sum_{k=1}^{n} \underbrace{\pi(\mu_k)}_{\text{Flow profits}} + \sum_{k=1}^{n} \underbrace{\tau_t \left[V_t^h \left(n-1, \boldsymbol{\mu}_{-k}, S_t \right) - V_t^h(n, \boldsymbol{\mu}, S_t) \right]}_{\text{Agg. creative destruction}}$$

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& \qquad + \max_{[I_k, x_k]} \left\{ \sum_{k=1}^{n} \underbrace{I_k \left[V_t^h\left(n, \left[\boldsymbol{\mu}_{-k}, \mu_k \times \lambda\right], S_t\right) - V_t^h(n, \boldsymbol{\mu}, S_t) \right]}_{\text{Internal R\&D}} \right.
\end{aligned}
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& + \sum_{k=1}^{n} \underbrace{x_k \left[S_t V_t^h \left(n+1, [\boldsymbol{\mu}, \lambda], S_t \right) + (1 - S_t) V_t^h \left(n+1, \left[\boldsymbol{\mu}, \lambda \times \varphi^h / \varphi^\ell \right], S_t \right) - V_t^h(n, \boldsymbol{\mu}, S_t) \right]}_{\text{Expansion R\&D}}
\end{aligned}
$$

S_t is the share of product lines operated by high-productivity firms

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& \qquad \left. - \underbrace{w_t \Gamma \left([I_i, x_i]; n, \boldsymbol{\mu} \right)}_{\text{R\&D costs}} \right\}
\end{aligned}
$$

S_t is the share of product lines operated by high-productivity firms

R&D costs

- R&D costs in labor units

$$\Gamma\left([x_i, I_i]; n, [\mu_i]\right) = \sum_{k=1}^{n} \left[\mu_k^{-1} \frac{1}{\psi_I} (I_k)^{\zeta} + \frac{1}{\psi_x} (x_k)^{\zeta}\right]$$

  ζ innovation cost curvature, ψ_I and ψ_x internal and expansion R&D efficiency

- ψ_I and ψ_x discipline firm markup, sales and employment growth

▸ Analytical characterization

Firm entry and exit

- Entrants improve the quality of a randomly chosen product line
- Flow rate of entry z determined by a linear technology $z = \psi_z \ell_z$
- ψ_z governs the entry efficiency
- Entrants get assigned the high productivity type with probability p^h, revealed after entry
- Free entry condition

$$p^h \times E\left[V^h(1, \mu, S)\right] + (1 - p^h) \times E\left[V^\ell(1, \mu, S)\right] = \frac{w_t}{\psi_z}$$

- Firm becomes inactive when losing its last product to competitors

Value of a product line

Proposition

Along a BGP, the value of a product line of firm productivity type $d \in \{h, \ell\}$ is

$$V_t^d(1, \mu_i, S) = \frac{1}{\rho + \tau}\left[\underbrace{Y_t\left(1 - \frac{1}{\mu_i}\right)}_{\textit{Profits}} + \underbrace{\frac{\zeta - 1}{\psi_x}(x^d)^\zeta w_t}_{\textit{Continuation value expansion R\&D}} + \underbrace{\frac{\zeta - 1}{\psi_I} I^\zeta w_t \mu_i^{-1}}_{\textit{Continuation value internal R\&D}}\right]$$

with $x^h > x^\ell$ and $I \equiv I^h = I^\ell$.

More productive firms

- charge higher markups and enjoy greater profits per product (on average)
- choose higher expansion R&D rates, $x^h > x^\ell$

BGP definition

Stationary distribution of productivity types

Proposition

Along a BGP, the constant share of product lines operated by high-productivity incumbents is

$$S = \frac{zp^h}{(1-S)(x^\ell - x^h) + z}$$

- Given the firm entry rate, z, the difference in expansion R&D rates determines S

Growth rate of the economy

Proposition

Along a BGP, the constant growth rate of the economy is

$$g = \frac{\dot{Y}_t}{Y_t} = \Big(\underbrace{I}_{\text{Incumbent internal R\&D}} + \underbrace{Sx^h + (1-S)x^\ell}_{\text{Incumbent expansion R\&D}} + \underbrace{z}_{\text{Entry}} \Big) \times \ln(\lambda)$$

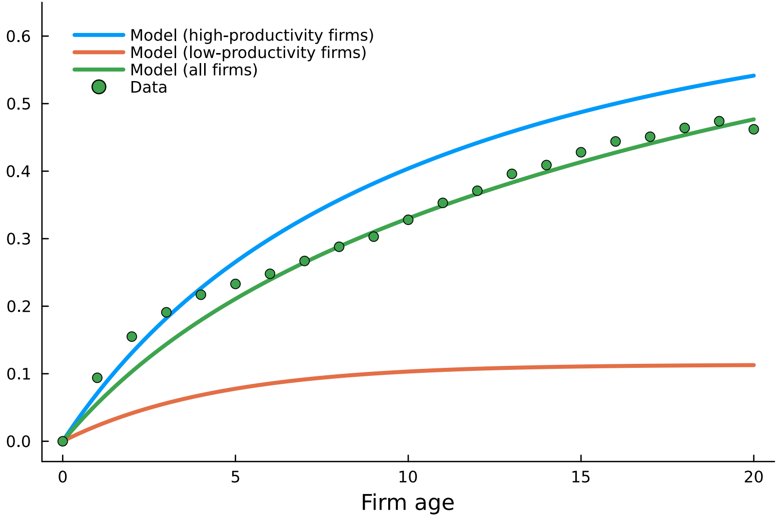
- Share of product lines operated by each productivity type affects aggregate growth rate

Outline

GMM estimation: initial balanced growth path

	Data	Model
Moments (Sweden)		
Avg. sales age 8 relative to entrants in logs (cohorts 1997–2000)	0.559	0.558
Avg. employment age 8 relative to entrants in logs (cohorts 1997–2000)	0.288	0.288
Cross-sectional SD of log labor shares across entrants (1997–2005)	0.053	0.053
TFP growth g in % (1997–2005; FRED)	3.02	3.02
Entry rate in % (1997–2005)	14.3	14.3
Agg. markup μ in % (Sandström, 2020; De Loecker and Eeckhout, 2018)	7.5	7.5
Parameters		
ψ_I *Internal R&D efficiency*		0.144
ψ_x *Expansion R&D efficiency*		0.282
ψ_z *Entry efficiency*		1.483
λ *Step size of innovation*		1.136
φ^h/φ^ℓ *Productivity gap*		1.091
p^h *Share of high type firms among entrants*		0.683
Set exogenously		
ρ *Discount rate*		0.02
ζ *R&D cost curvature*		2

Average log employment relative to entrants (untargeted)



Notes: graph shows the employment dynamics in the model (initial BGP) and data (cohorts 1997–2000).

BGP outcomes in response to a 5% parameter change

	Rel. employment	Rel. sales	Entry rate	S	g
Fall in expansion R&D costs $\psi_x \uparrow$	+0.018	+0.019	-0.19	+0.94	+0.02
Rise in internal R&D costs $\psi_I \downarrow$	+0.002	-0.002	-0.07	+0.10	-0.03
Rise in entry costs $\psi_z \downarrow$	+0.025	+0.020	-1.02	+1.84	-0.06
Rise in productivity gap $\varphi^h/\varphi^\ell \uparrow$	+0.034	+0.028	-1.56	+6.31	-0.09
Rise in share high prod. entrants $p^h \uparrow$	+0.003	+0.002	-0.15	-1.81	-0.01

- Avg. employment age 8 relative to entrants (Δ in logs)
- Avg. sales age 8 relative to entrants (Δ in logs)
- Firm entry rate (Δ in percentage points)
- Share of product lines operated by high-productivity firms (Δ in percentage points)
- Aggregate growth rate (Δ in percentage points)

$\psi_z \downarrow$ and $\varphi^h/\varphi^\ell \uparrow$ lead to size expansion, $\psi_I \downarrow$ to expansion in employment relative to sales

GMM estimation: new balanced growth path

	Data	Model	ΔBGPs
Moments (Sweden)			
Avg. employment age 8 relative to entrants in logs (cohorts 2009–2012)	0.466	0.466	+0.178
Avg. sales age 8 relative to entrants in logs (cohorts 2009–2012)	0.674	0.674	+0.115
Parameters			
ψ_I *Internal R&D efficiency* (Δ in %)			-51.0
ψ_z *Entry efficiency* (Δ in %)			-22.0

- Estimation points to rising costs of firm entry and internal R&D
- Potential drivers (*more later*)
  - Rising sector-level stock of fixed assets (e.g. IPP, structures) increased startup costs
  - Goods-producing firms increasingly offer (less patentable) services

Outline

Implications for the macroeconomy in the long run

	Initial BGP (in %)	ΔBGPs (in pp.)
Share of product lines operated by high-prod. firms, S	80.6	+17.1
Agg. markup, μ	7.5	-1.2
Entry rate	14.3	-8.1
Agg. growth rate, g	3.02	-0.6

- Reallocation of market shares to high-productivity (high-markup) firms

  Baqaee, Farhi (*QJE*, 2020); De Loecker, Eeckhout, Unger (*QJE*, 2020); Kehrig, Vincent (*QJE*, 2021)
- Agg. markup roughly unchanged (reallocation vs. slower within-firm markup growth)
- Agg. growth rate falls (but agg. productivity increases). ΔWelfare ambiguous
- Fall in entry rate (agg. growth rate) accounts for 80% (60%) of that in the data

Decomposing the fall in the aggregate growth rate

- Write the agg. growth rate g as

$$g = Sg^h + (1 - S)g^\ell + g^z,$$

where $g^h \equiv (I + x^h)\ln(\lambda)$, $g^\ell \equiv (I + x^\ell)\ln(\lambda)$ and $g^z \equiv z\ln(\lambda)$.

- Shift-share decomposition of $\Delta g \equiv g_{new} - g_{old}$

$$\Delta g = \underbrace{S_{old}\Delta g^h + (1 - S_{old})\Delta g^\ell}_{\Delta\text{Within}} + \underbrace{g^h_{old}\Delta S - g^\ell_{old}\Delta S}_{\Delta\text{Between}} + \underbrace{\Delta g^h \Delta S - \Delta g^\ell \Delta S}_{\Delta\text{Cross}} + \underbrace{\Delta g^z}_{\Delta\text{Entry}}$$

    - ΔWithin: changes in incumbents' innovation rates
    - ΔReallocation $= \Delta$Between $+ \Delta$Cross: reallocation across productivity types
    - ΔEntry: changes in the entry rate

Decomposing the fall in the aggregate growth rate

	Δg (in pp.)
ΔWithin	+0.22
ΔReallocation	+0.27
ΔEntry	-1.10
Total	-0.62

- Incumbents' average innovation rates increase
  - More productive firms expand faster into new product markets, $x^h \uparrow$
- The reallocation of market shares, ΔS, increases long-run growth
  - Sales shares increasingly concentrated among productive firms that innovate faster
  - Positive long-run growth effects due to changes in industry concentration
- Firm entry rate falls by 8pp. across BGPs, lowering g by 1.1pp.

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- Transition dynamics

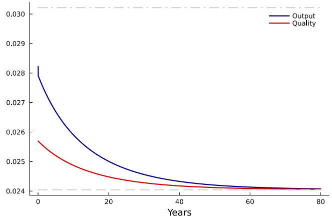
Discussion

Transition dynamics

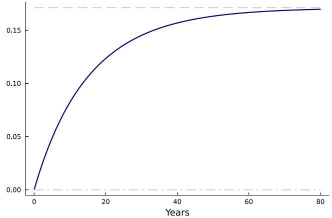
- Economy converges to a new BGP with a lower *growth rate* of aggregate productivity
- Reallocation to more productive incumbents increases the productivity *level*
- Opposing level and growth effects on aggregate productivity
- What are the welfare effects associated with the changes in firm-size dynamics?

Transition dynamics

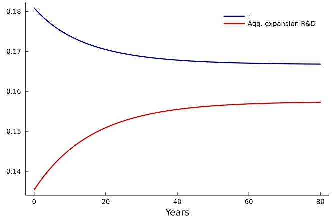
(a) Output and quality growth



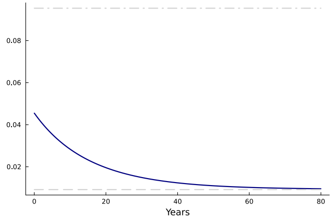
(b) Change in concentration, $S_t - S_{\text{initial}}$



(c) Rate of creative destruction, τ_t



(d) Rate of entry, z_t



Welfare effects

- Perm. consumption change that yields indifference b/w initial and transition to new BGP
- Transition to new BGP equivalent to permanent 23.3% consumption loss in initial BGP
- Welfare loss sizable
  - Caveat: interpreted high-growth period of late 1990s as initial BGP
  - Transition is quick and no further burst in growth (consistent with data)

Outline

Discussion

- Firm-size dynamics in Sweden
- Alternative explanations for the changes in firm-size dynamics
- Changes in firm growth vs. selection conditional on survival
- Evidence for estimated cost changes: sector level
- Evidence for estimated cost changes: firm level

Conclusion

- The avg. size of firms of any age has increased relative to the size of entrants
- Suggests that active firm expansion rather than passive aging explains agg. trends
- Structural model identifies rising entry costs behind incumbent firm expansion
- Firm entry falls, lowering long-run productivity growth and welfare
  - Edmond, Midrigan, Xu (*JPE*, 2023): small effect of entry subsidies on agg. markup
  - Entry subsidies more promising policy tool to increase long-run productivity growth?

– Backup Slides –

Data

- Universe of Swedish firms 1997–2017
- Information from balance sheets and profit and loss statements
- Restrict to firms in the private economy with at least one employee
- Birth year defined as year when firm hires its first employee

Data: summary statistics

	25th Pct.	50th Pct.	75th Pct.	Mean	SD	Obs.
*Sales**	1.2	2.7	7.8	27.8	568.2	4,918,996
*Value added**	0.5	1.1	2.9	7.6	142.3	4,918,996
Employment	1	2	5	9.9	131.1	4,918,996
*Wage bill**	0.2	0.6	1.6	3.7	53.0	4,918,996
*Capital stock**	0.04	0.2	1.1	9.3	277.0	4,918,996
*Intermediate Inputs**	0.4	0.9	2.6	10.8	270.0	4,918,996

Note: variables marked with * are in units of million 2017-SEK (1 SEK $\approx$ 0.1 US dollars). The capital stock is defined as fixed assets minus depreciation.

The dynamics of firm size

- Characterize firm size as a function of firm age in the unbalanced panel of firms

$$\ln \text{Size}_{f,t} = \gamma_0 + \sum_{a_f=1}^{20} \gamma_{a_f} \mathbb{1}_{\text{Age}_{f,t}=a_f} + \theta_c + \theta_k + \epsilon_{f,t} \tag{1}$$

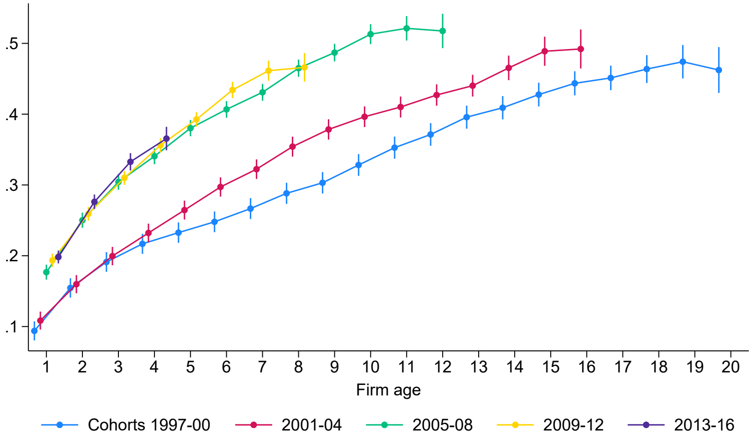
  - $\text{Size}_{f,t} \in \{\text{Employment}_{f,t}, \text{Sales}_{f,t}\}$ for firm f
  - $\mathbb{1}_{\text{Age}_{f,t}=a_f}$ age dummies
  - θ_c cohort c fixed effects
  - θ_k 5-digit industry k fixed effects

- $\gamma_{a_1}, \ldots, \gamma_{a_f}, \ldots \gamma_{a_{20}}$ capture the average firm size conditional on age relative to entry

$$\gamma_{a_f} = E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = a_f, c, k\right] - E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = 0, c, k\right]$$

- Divide cohorts 1997–2017 into five groups and estimate (1) by cohort group

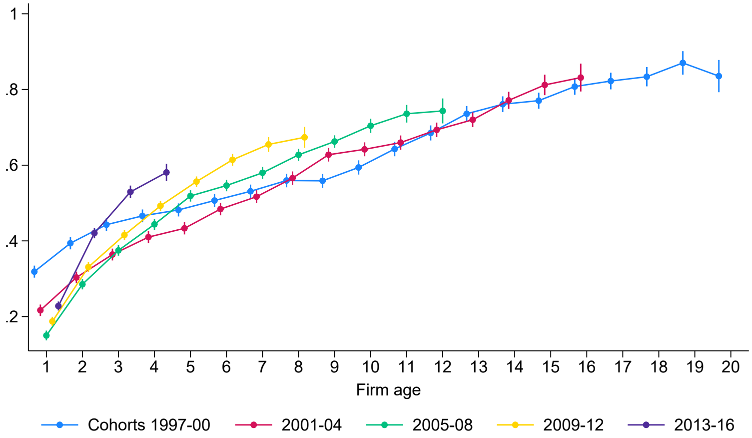
Average firm size relative to entry: log employment



Notes: graph shows γ_{a_f} indicating the difference in average log employment at age a_f and zero. 95% confidence intervals shown.

Intro Discussion

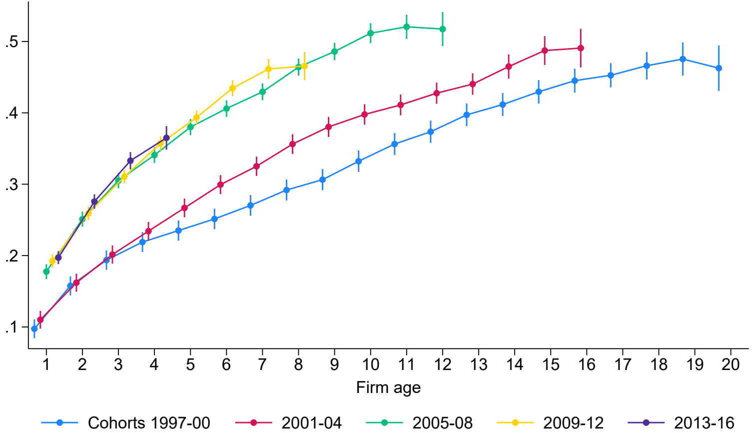
Average firm size relative to entry: log sales



Notes: graph shows γ_{a_f} indicating the difference in average log sales at age a_f and zero. Nominals sales deflated to 2017-SEK. 95% confidence intervals shown.

▸ Intro ▸ Discussion

Firm size regressions, cohort × industry fixed effects



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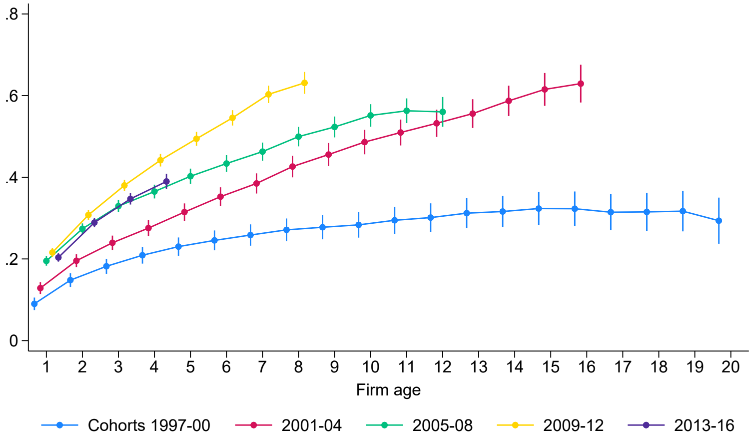
Firm size regressions, year $\times$ industry fixed effects



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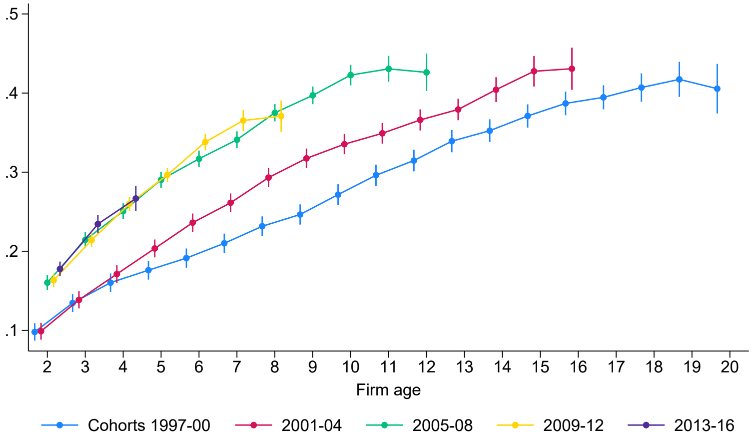
Firm size regressions, log employment relative to age < 2



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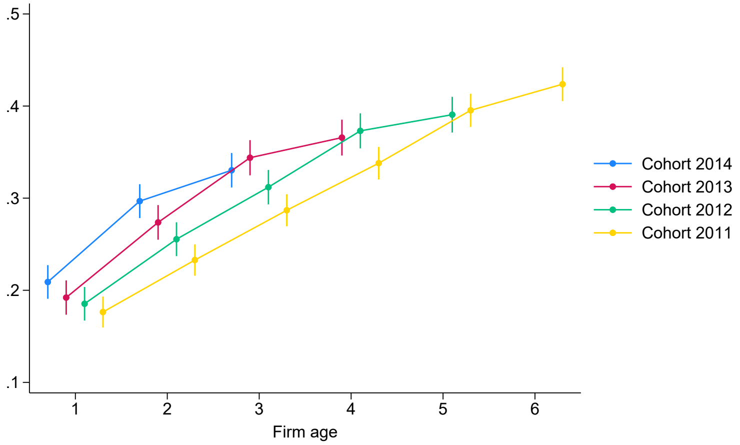
Firm size regressions, post Great Recession



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Balanced growth path definition

Definition

A balanced growth path (BGP) is a set of allocations $[x_{it}, l_{it}, \ell_{it}, z_t, S_t, y_{it}, C_t]_{it}$ and prices $[r_t, w_t, p_{it}]_{it}$ such that firms choose $[x_{it}, l_{it}, p_{it}]$ optimally, the representative household maximizes utility choosing $[C_t, y_{it}]_{it}$, the growth rate of aggregate variables is constant, the free-entry condition holds, all markets clear and the distribution of quality and productivity gaps is stationary.

▸ Back

Characterization of firm dynamics

- Markups (high and low productivity firms)

$$E\left[\mu_f^h|\text{firm age} = a_f, \varphi^h\right] = \underbrace{\ln\lambda \times \left(1 + I \times E[a_P^h|a_f]\right)}_{\text{Quality improvements}} + \underbrace{(1-S) \times \ln\left(\varphi^h/\varphi^\ell\right)}_{\text{Productivity advantage}}$$

$$E\left[\mu_f^l|\text{firm age} = a_f, \varphi^\ell\right] = \underbrace{\ln\lambda \times \left(1 + I \times E[a_P^\ell|a_f]\right)}_{\text{Quality improvements}} + \underbrace{S \times \ln\left(\varphi^\ell/\varphi^h\right)}_{\text{Productivity disadvantage}}$$

- Sales growth productivity type $f \in \{h, \ell\}$

$$E\left[\ln npy|a_f, \varphi^f\right] - E\left[\ln npy|0, \varphi^f\right] = \underbrace{g \times a_f}_{\text{Aggregate growth}} + \underbrace{\sum_{n=1}^{\infty} \ln n \times p^f\left(n|a_f\right)}_{\text{Firm's product growth}}$$

- Employment growth productivity type $f \in \{h, l\}$

$$E[\ln l_f|a_f, \varphi^f] - E[\ln l_f|0, \varphi^f] = \underbrace{E\left[\ln n|a_f, \varphi^f\right]}_{\text{Firm's product growth}} - \underbrace{\left(E\left[\ln \mu_f|a_f, \varphi^f\right] - E\left[\ln \mu_f|0, \varphi^f\right]\right)}_{\text{Firm's markup growth}}$$

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Rising productivity gaps

- Aghion et al. (2023): $\varphi^h/\varphi^\ell \uparrow$ as a driver behind rising concentration and falling growth
- Estimate alternative new BGP where φ^h/φ^ℓ (instead of ψ_z) and ψ_I are subject to change
- Estimated fall in internal R&D efficiency almost identical to before (-54% vs. -51%)
- Increase in productivity gap *qualitatively* consistent with changes in firm growth

	Data	Model
Moments		
Avg. sales age 8 relative to entry in logs (cohorts 2009–2012)	0.674	0.579
Avg. employment age 8 relative to entry in logs (cohorts 2009–2012)	0.466	0.362
Parameters		
ψ_I *Internal R&D efficiency* (Δ in %)		-54
φ^h/φ^ℓ *Productivity gap* (Δ in %)		$+6$

Rising productivity gaps

- Long-run macroeconomic implications in line with recent trends
  - The aggregate growth rate g falls by 0.49pp (0.42pp in Aghion et al., 2023)
  - The entry rate falls by 3pp
  - Concentration S rises

- Decomposing the fall in the growth rate g as before

	Δg ($\psi_I \downarrow, \varphi^h/\varphi^\ell \uparrow$)	Δg ($\psi_I \downarrow$)	Δg ($\varphi^h/\varphi^\ell \uparrow$)
ΔWithin	-0.13	-0.24	+0.11
ΔReallocation	+0.18	+0.01	+0.13
ΔEntry	-0.53	-0.12	-0.35
Total	-0.49	-0.35	-0.11

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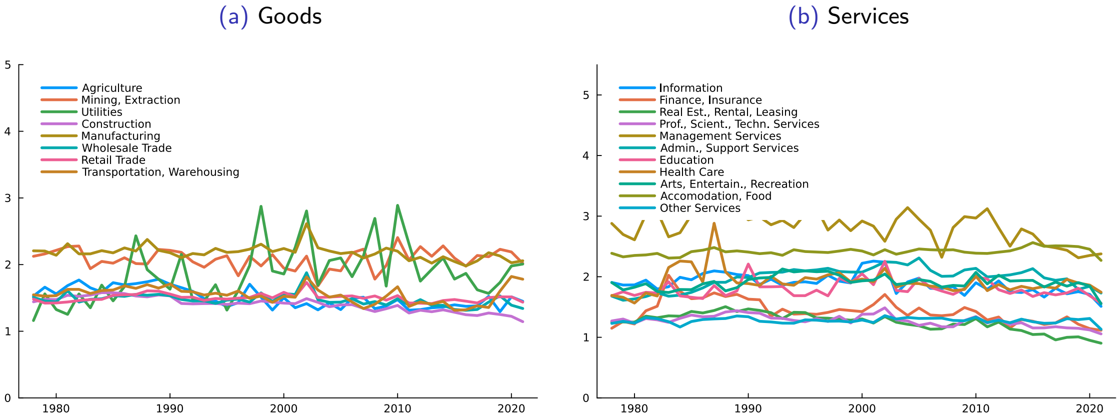
Selection among entrants

- Selection among entrants (instead of selection among incumbents)
- Acceleration of firm size growth could be due to more productive firms entering
- Equivalent to increase in p^h
- Selection of productivity types should be reflected in employment of entrants
- Employment of entrants has been relatively stable in U.S. Census data
- Suggests that there are no systematic changes in the types of entrants

Selection among entrants



Notes: average log employment of entrants in U.S. Census data.

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Decomposing the avg. firm size conditional on age relative to entry

$$E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = a_f\right] - E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = 0\right] =$$

$$s^h(a_f) \times \underbrace{\left(E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = a_f, \varphi_f = \varphi^h\right] - E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = 0, \varphi_f = \varphi^h\right]\right)}_{\text{Size growth cond. on survival (high productivity)}}$$

$$+ \left(1 - s^h(a_f)\right) \times \underbrace{\left(E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = a_f, \varphi_f = \varphi^\ell\right] - E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = 0, \varphi_f = \varphi^\ell\right]\right)}_{\text{Size growth cond. on survival (low productivity)}}$$

$$+ \left(s^h(a_f) - s^h(0)\right) \times \underbrace{\left(E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = 0, \varphi_f = \varphi^h\right] - E\left[\ln \text{Size}_{f,t} | \text{Age}_{f,t} = 0, \varphi_f = \varphi^\ell\right]\right)}_{\text{Firm exit correction term}}$$

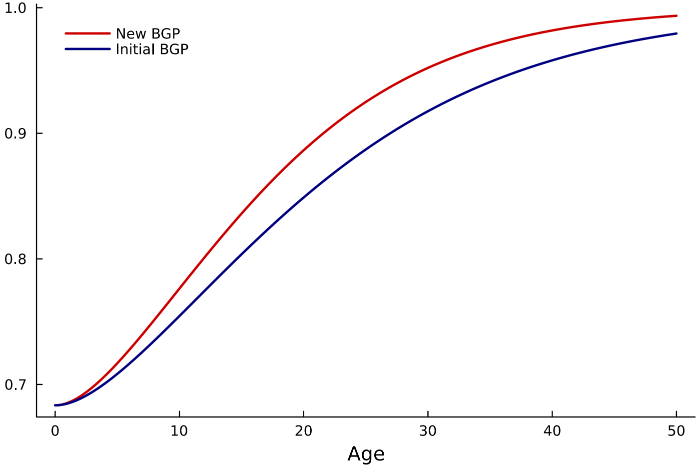
where $s^h(a_f)$ denotes the share of high-productivity firms among firms of age a_f (selection).

Size growth conditional on survival over the first eight years

	Initial BGP (logs)	New BGP (logs)
Sales (high productivity)	0.625	0.792
Sales (low productivity)	0.370	0.317
Employment (high productivity)	0.357	0.585
Employment (low productivity)	0.096	0.106

- Sales of high-productivity firms grow faster, that of low-productivity firms slower
- Employment of high-productivity firms grows faster
- **Size growth conditional on survival of high-productivity firms accelerated**

Share of high-productivity firms among firms of age a_f



- Share of high-productivity firms among surviving firms increases for any age

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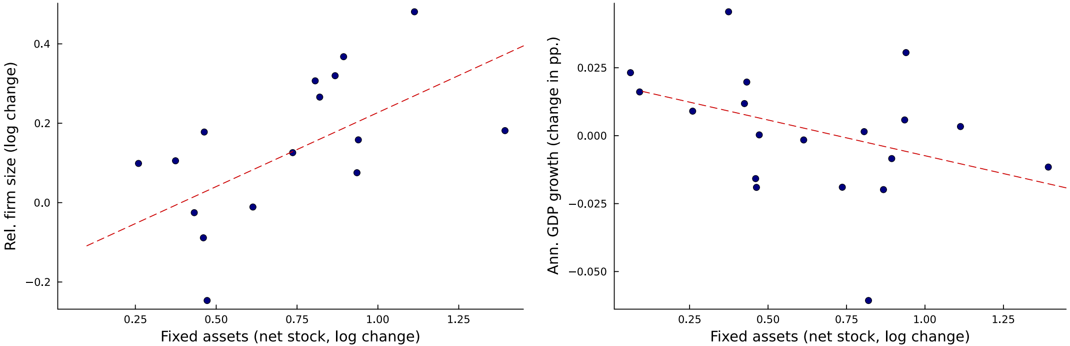
Potential causes behind rising entry costs

- Rising stock of fixed assets (e.g. IPP, structures) increases the cost of firm startups
  - Relative firm size increased the most in U.S. sectors with largest rise in fixed assets
  - Sectors with largest rise in fixed assets experienced greatest decline in GDP growth



- Rising complexity of regulatory requirements and tax systems, lobbying expenditures

Davis (2017), Gutiérrez and Philippon (2018)

Potential causes behind rising internal R&D costs

- Structural transformation to service economy
  - Swedish manufacturing firms increasingly offer services
    - Volvo offering car maintenance, insurance, leasing, car sharing
    - H&M offering clothing repair and recycling, clothing rentals ...
    - Agg. level: workforce employed in services from 72% to 79% (1997–2012)
  - U.S. firms responded to China-Shock by increasing employment in services
  - Harder to distance competitor within product markets in services than manufacturing
- Falling R&D output relative to R&D inputs in the U.S. (Bloom et al., 2020)
  - Model points to rising internal rather than expansion R&D costs
    - $\varphi_I \downarrow$ consistent with trends in firm growth
    - $\varphi_x \downarrow$ would counterfactually slow firm growth and reduce concentration

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Firm productivity and firm growth in the data

- Model suggests that a firm's productivity type is captured by the markup at entry
- Test relation between firm's productivity and firm growth in the data

$$\Delta \ln \text{Size}_{\text{Age}_{f,t}=8} = \beta_0 + \beta_1 \log \left(\frac{py}{wl} \right)_{\text{Age}_{f,t}=0} + \beta_2 \mathbb{1}_{c>2003} \log \left(\frac{py}{wl} \right)_{\text{Age}_{f,t}=0} + \theta_c + \theta_k + \epsilon_{f,t}.$$

- Use employment growth of firms that survive up to age eight
- β_1 captures the effect of firm productivity on firm growth conditional on survival

Firm productivity and firm growth in the data

	Δ ln Size$_{\text{Age}=8}$	Δ ln Size$_{\text{Age}=8}$	Δ ln Size$_{\text{Age}=8}$	Δ ln Size$_{\text{Age}=8}$
$\log\left(\frac{py}{wl}\right)_{\text{Age}=0}$	0.066	0.095	0.104	0.113
	(0.006)	(0.006)	(0.006)	(0.006)
$\mathbb{1}_{c>2003} \log\left(\frac{py}{wl}\right)_{\text{Age}=0}$	0.011	0.015	0.017	0.017
	(0.008)	(0.008)	(0.008)	(0.008)
$\log K_{\text{Age}=0}$			-0.031	-0.009
			(0.002)	(0.003)
$\log M_{\text{Age}=0}$				-0.053
				(0.003)
Cohort fixed effects	✓	✓	✓	✓
Industry fixed effects	✓	✓	✓	✓
$\log\left(\frac{py}{wl}\right)_{\text{Age}=0} > 0$		✓	✓	✓
N	63,521	62,692	58,304	58,192
R^2	0.04	0.05	0.05	0.05

- More productive firms grow faster in size than less productive ones
- Size growth of productive firms has accelerated over time

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