Aggregate Effects of Firing Costs with Endogenous Firm Productivity Growth

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July 2019

Introduction

- Firing cost may generate important TFP losses. Two channels:

  1. Static effects: worse allocation of labor given a firm-productivity distribution.
     Distoting hiring and firing choices
  2. Dynamic effects: shift in the firm-productivity distribution.
     Higher cost of failure reduce incentives to grow

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- Second channel largely absent in the literature.
  - Productivity distribution is typically exogenous
  - Exception: Da-Rocha, Tavares and Restuccia (2019)
    - Much lager TFP losses when the distribution of productivities is affected by firing taxes.
    - Size-dependent (but exogenous) law of motion of productivity

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    - Much lager TFP losses when the distribution of productivities is affected by firing taxes.
    - Size-dependent (but exogenous) law of motion of productivity
- I quantify the aggregate effects of firing costs accounting for the two channels.

This paper

- **What I do:** Quantify the aggregate implications of firing costs accounting for the two channels

- **How I do it:** Extend the framework in Hopenhayn and Rogerson (1993).

  - Endogenous firm-productivity dynamics

    - Firms can invest recourses in affecting tomorrow's productivity ("innovation")

    - "Control-cost" approach: innovation modeled as prob.

  - Calibrate the model with Spanish firm-level data (Central de Balances).

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  - **NEW**: How much to the higher/lower average productivity?

Preview of results

- Firing costs equivalent to 2.5 monthly wages generates a **3% loss in TFP**
  - Losses raise to 11% if firing costs of 1 year wages
  - Hopenhayn and Rogerson (1993) find 2.1% loss from the same level of firing costs

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  - Losses raise to 11% if firing costs of 1 year wages
  - Hopenhayn and Rogerson (1993) find 2.1% loss from the same level of firing costs
- **Decomposition** of TFP losses:
  - 55% due to distortion in hiring/firing choices (standard misallocation channel)
  - 22% due to a lower average firm productivity
  - 23% due to the changing shape productivity distribution
- **Take-away**: models with exogenous productivity dynamics underestimate the aggregate implications of firing costs

Related literature

- **Misallocation**

  Hopenhayn and Rogerson (1993), Guner et al. (2008), Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Bartelsman et al. (2013), Hsieh and Klenow (2014), García-Santana et al. (2016)

  - Contribution: implications of firing costs with endogenous firm productivity growth

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- **Frictions with endogenous productivity distribution**

  Bhattacharya et al. (2013), Gabler and Poschke (2013), Da-Rocha et al. (2019), López-Martín (2013), Mukoyama and Osotimehin (2019)

  Grossman & Helpman (1991), Aghion & Howitt (1992), Atkenson & Burstein (2010)

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  - Contribution: extensive and intensive margin of innovation

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- **"Control-cost" in macroeconomics**

  Costain (2017), Turen (2018), Costain et al. (2019)

  - Contribution: use the "control-cost" approach to model firm innovation

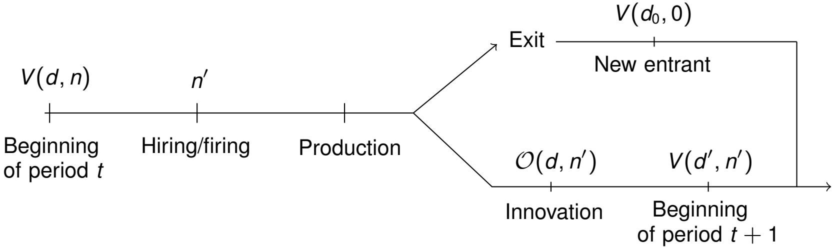
Model

Model setup

- I take Hopenhayn and Rogerson (1993) as the **building block**:
  - Representative household: consumption & labor supply
  - Continuum of heterogeneous firms: productivity (d) and labor (n).
  - Decreasing returns to scale technology with labor as only input
  - Firing is costly: $\kappa_F w$ per worker fired
  - Exogenous exit: replaced by entrant, with $E(d_0) = 1$ and $\mathrm{V}(d_0) = \sigma_0^2$.

+ **Endogenous productivity dynamics**: "innovation"
  - Intensive and extensive margin
  - Firm choices affect the whole distribution of d': growth vs. risk
  - Model firm choices as probability distributions: "control-cost"

Timeline



$V(d_0, 0)$
Exit
New entrant
$V(d, n)$
n'
Beginning of period t
Hiring/firing
Production
$\mathcal{O}(d, n')$
$V(d', n')$
Innovation
Beginning of period $t + 1$

Firms

$$V(d,n) \;=\; \max_{n'} \; \underbrace{\Pi(d,n',n)}_{\text{Profits}} + \underbrace{\beta\delta V_E(n')}_{\text{Exit}} + \underbrace{\beta(1-\delta)\mathcal{O}(d,n')}_{\text{Innovation stage}}$$

- Profits given by:

$$\Pi(d,n',n) \;=\; Ae^{d}(n')^{\gamma} - wn' - \underbrace{w\kappa_F \max\{0, n-n'\}}_{\text{Firing costs}}$$

- Exogenous exit, prob $\delta \in (0,1) \;\rightarrow\;$ value of exit: $V_E(n') = -\kappa_F w n'$.
- $\mathcal{O}(d,n)$ is the value at the innovation stage.

Innovation

- Most models assume $d \sim f(d)$, but in reality:

$$d' \sim f(\underbrace{d, n}_{\text{State}}, \underbrace{x_1, x_2, ..., x_N}_{\text{Firms actions}}) \equiv \mathcal{F}(d, n, X)$$

where X are total investments.

Innovation

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  where X are total investments.

- "Control-cost": choices $\equiv$ distribution over feasible alternatives.
  - I model $\mathcal{F}$ indirectly: choose $\mathcal{F}$ and define cost function for X

$$X = \mathcal{D}(d, n, \mathcal{F})$$

- I divide innovation in two stages:
  - Extensive: Should we innovate?
  - Intensive: Which innovation should we implement?

Innovation

- **Extensive margin**: Firms choose the probability of innovation λ
  - Cost given by $\kappa_I \mathcal{D}(\lambda|\bar{\lambda})$.
  - $\bar{\lambda} \in (0, 1)$ is a default probability of innovation.
- **Intensive margin**: Firms choose the distribution of productivity $\pi(d'|d, n)$
  - Cost given by $\kappa_I \mathcal{D}(\pi|\eta)$.
  - η is a default distribution of next period's productivity, with

$$\sum_{i=1}^{D} \eta(d_i|d) d_i = d(1-\mu) < d,$$

    $\mu > 0$: non-innovators expect their productivity to decrease
- **Non-innnovators**: Productivity distributed according to η.

Extensive margin

$$\mathcal{O}(d,n) \;=\; \max_{\lambda} \quad \underbrace{\lambda\, \mathcal{O}^I(d,n)}_{\text{Innovate}} \;+\; \underbrace{(1-\lambda)\left(\sum_{i=1}^{D} \eta(d_i|d)\, V(d_i,n)\right)}_{\text{Not innovate}} \;-\; \kappa_I\, \mathcal{D}(\lambda|\bar{\lambda})$$

- Cost function given by the Kullback-Leibler divergence between λ and $\bar{\lambda}$:

$$\mathcal{D}(\lambda|\bar{\lambda}) \;=\; \lambda \log\left(\frac{\lambda}{\bar{\lambda}}\right) + (1-\lambda)\log\left(\frac{1-\lambda}{1-\bar{\lambda}}\right)$$

Closed-form solution:

$$\lambda(d,n) \;=\; \frac{\bar{\lambda}\exp\left(\kappa_I^{-1}\; \mathcal{O}^I(d,n)\right)}{\bar{\lambda}\exp\left(\kappa_I^{-1}\; \mathcal{O}^I(d,n)\right) + (1-\bar{\lambda})\exp\left(\kappa_I^{-1}\; \mathcal{O}^N(d,n)\right)}$$

Intensive margin

$$\mathcal{O}^I(d,n) \;=\; \max_{\pi} \sum_{i=1}^{D} \pi(d_i|d,n)V(d_i,n) \;-\; \kappa_I\,\mathcal{D}(\pi|\eta)$$

- Cost function given by Kullback-Leibler divergence btw π and η

$$\mathcal{D}(\pi|\eta) \;=\; \sum_{i=1}^{D} \pi(d_i)\log\left(\frac{\pi(d_i)}{\eta(d_i)}\right)$$

Closed-form solution:

$$\pi(z|d,n) = \frac{\eta(z|d)\exp\left(\kappa_I^{-1}V(z,n)\right)}{\sum_{i=1}^{D}\eta(d_i|d)\exp\left(\kappa_I^{-1}V(d_i,n)\right)}$$

Households

- Simplest household problem as in Hopenhayn and Rogerson (1993)

$$U = \max_{C,L} \ln C - \theta L, \quad \text{s.t. } C = wL + F + \Pi$$

$F \equiv$ aggregate firing costs, $\Pi \equiv$ aggregate profits.

- First-order condition:

$$\frac{1}{wL + F + \Pi} = \theta \quad \rightarrow \quad w = \frac{\theta^{-1} - F - \Pi}{L}$$

- In the baseline equilibrium I set θ such that $w^* = 1$.

Calibration

Calibration

- Exogenous parameters:

$\beta = 1.05^{-1}$	$\rightarrow$	Interest rate of 5%
$\delta = 7.56\%$	$\rightarrow$	Average firm age of 9.7
$\gamma = 0.60$	$\rightarrow$	Standard value
$\psi = 0.50$	$\rightarrow$	Frisch elasticity of 2

- Data from Central de Balances from 2005 to 2007.
  - Unbalanced panel of non-financial Spanish firms.
  - Rich information from balance sheet and income statement

Calibration

- Calibration of innovation $(\mu, \sigma^2, \bar{\lambda}, \kappa_I)$:
  - I lack data on innovation (what's innovation in this model?)
  - I follow Garcia-Macia, Hsieh and Klenow (2019) $\rightarrow$ use employment data.
  - Targets:
    - Firm size distribution
    - Volatility of employment
    - Share of hiring firms
    - Firing and hiring rate (firings/employment and hiring/employment)
- Other parameters: $(A, \sigma_0^2, \kappa_F)$. Targets:
  - Relative size entrants
  - Volatility of employment among entrants
  - Share of firing firms

Calibration. Parameters

Parameter			Description
A	$=$	2.95	Aggregate productivity term
σ_0	$=$	1.10	Standard deviation of initial productivity draw
μ	$=$	0.07	Depreciation of productivity (default distribution)
σ	$=$	0.30	Standard deviation of shocks (default distribution)
κ_0	$=$	0.14	Cost of innovation, level parameter
κ_1	$=$	1.25	Cost of innovation, shape parameter
$\bar{\lambda}$	$=$	0.47	Default probability of innovation
κ_F	$=$	0.20	Firing cost

- Default law of motion of d: $\log(d') = \log(d) - \hat{\mu} + \sigma\epsilon$ with $\mu = \exp(\hat{\mu}) - 1$
- Cost of innovation: $\kappa_I = \kappa_0 \exp(-\kappa_1 d)$

Calibration. Model fit

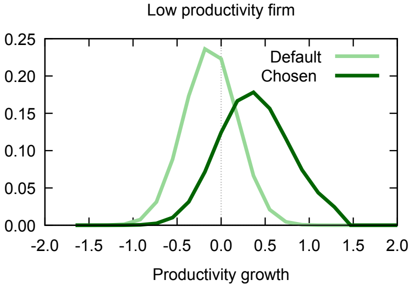
Moment	Model	Data
Average size of entrants	3.53	3.40
Coefficient of variation of firm size	1.21	1.19
Coefficient of variation of firm size among entrants	1.39	1.36
Share of firing firms	0.26	0.27
Share of hiring firms	0.35	0.34
Firing rate among firing firms	0.19	0.20
Hiring rate among hiring firms	0.44	0.44
Share of firms with 0-5 workers	0.63	0.60
Share of firms with 6-10 workers	0.21	0.20
Share of firms with 11-15 workers	0.07	0.08
Share of firms with 16-20 workers	0.04	0.04
Share of firms with 21-25 workers	0.02	0.02
Share of firms with 25+ workers	0.04	0.05

Results

Results

1. Model evaluation: firm growth
2. Effects of firing costs.
3. Decomposing TFP losses from firing costs

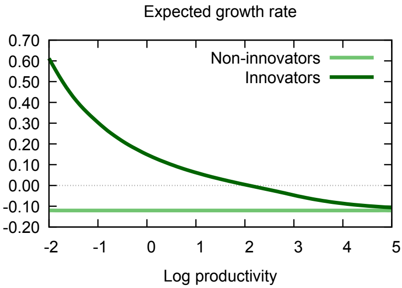
Model evaluation. Firm growth

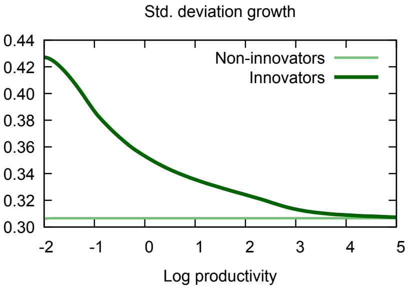


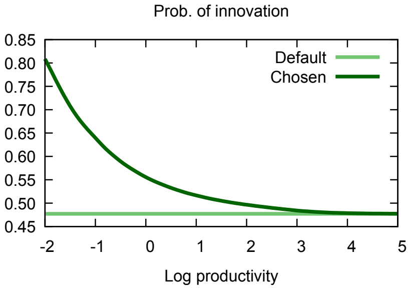
- Growth vs. risk trade-off
  - Low productivity firms expect to grow faster but take more risk
  - High productivity firms decrease their risk at the expense of productivity growth

▷ growth-risk ▷ growth-risk size

Model evaluation. Innovation choices







Aggregate effects of firing costs

- Firing costs (may) lower aggregate productivity by distorting hiring/firing choices
  - Growing firms not hiring due to future potential adjustment costs
  - Shrinking firms not firing due to direct adjustment costs
- Firing costs increase the cost of failure:
  - Innovation is risky (and more so the more you want to grow)
  - Firing costs disincentives growth versus risk

Aggregate effects of firing costs

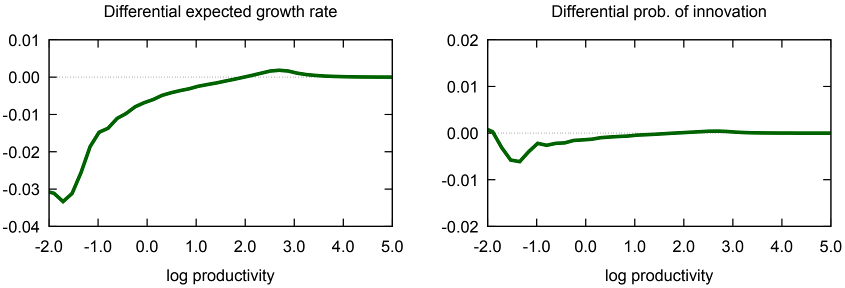
Table: Aggregate effects of firing cost (% fall relative to frictionless economy)

	$\kappa_l = 0.20$ (2.5 month)	$\kappa_l = 0.40$ (5 months)	$\kappa_l = 1.00$ (1 year)
TFP	3.01	5.08	10.6
Average productivity	1.82	3.10	6.54
Average productivity growth	2.22	3.76	7.19
Innovation expenses	3.47	5.86	11.8
Output	2.50	4.54	9.46
Employment	2.55	4.67	9.67
Job destruction rate	52.5	68.6	85.7
Job creation rate	30.8	40.3	50.3

▷ PE results

Aggregate effects of firing costs

Figure: Innovation choices. Experiment, $\kappa_F = 0.2$ *vs.* $\kappa_F = 0$



▷ $\kappa_F = 1$

Aggregate effects of firing costs. Decomposition I

- Olley and Pakes (1996) decomposition:

$$\text{TFP} \;=\; \bar{d} \;+ \int_{x\in\mathcal{X}} \tilde{d}(x)\tilde{s}(x)d\mu(x) \;=\; \bar{d} \;+\; C(d,n)$$

- We can decompose TFP gains as:

$$\frac{\Delta \text{TFP}}{\text{TFP}} \quad = \quad \frac{\Delta \bar{d}}{\text{TFP}} \quad + \quad \frac{\Delta C(d,n)}{\text{TFP}}$$

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- We can decompose TFP gains as:

$$\begin{array}{ccccc} \dfrac{\Delta \text{TFP}}{\text{TFP}} & = & \dfrac{\Delta \bar{d}}{\text{TFP}} & + & \dfrac{\Delta C(d,n)}{\text{TFP}} \\ 3\% & = & 0.7\% & + & 2.3\% \\ & & (22\%) & & (78\%) \end{array}$$

- Changes in average firm productivity explain 22% of the fall in aggregate TFP.

Aggregate effects of firing costs. Decomposition II

- Olley and Pakes (1996) allows us to disentangle the role of average productivity.
- However, innovation in the model drives the whole distribution of productivity.
- Simulate an economy with no innovation ($\kappa_I \to 0$) and:

$$d' \sim \begin{cases} \pi(d, n|\kappa_F = 0) & \text{w.p. } \lambda(d, n|\kappa_F = 0) \\ \eta(d) & \text{w.p. } 1 - \lambda(d, n|\kappa_F = 0) \end{cases}$$

where $\pi(d, n|\kappa_F = 0)$ and $\lambda(d, n|\kappa_F = 0)$ are innovation choices in the frictionless economy.

$\Rightarrow$ innovation cannot respond to changes in firing costs

Aggregate effects of firing costs. Decomposition II

Table: Aggregate effects of firing cost (% fall relative to frictionless economy)

	Endogenous Inn.			Exogenous Inn.		
Firing cost, κ_F	0.20	0.40	1.00	0.20	0.40	1.00
TFP	3.01	5.08	10.6	1.68	2.73	5.52
Average productivity	1.82	3.10	6.45	0.00	0.00	0.00
Output	2.50	4.54	9.46	1.74	3.38	7.05
Employment	2.55	4.67	9.67	2.52	4.75	9.72
Innovation expenses	3.47	5.86	11.8	0.00	0.00	0.00

- Endogenous innovation explain 45% of the overall fall in aggregate TFP.
  - 22% due to a decrease in average firm productivity
  - 23% due to changes in the shape of the productivity distribution

▷ More

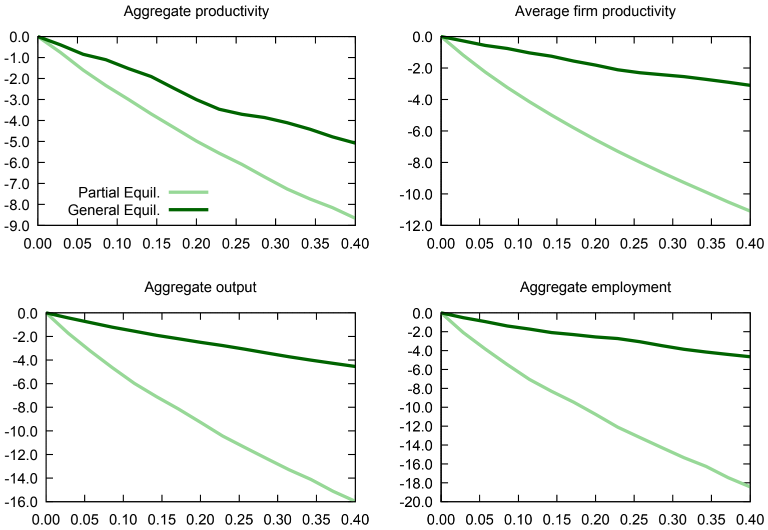
Conclusions

Conclusions

- Build and calibrate a simple extension of Hopenhayn and Rogerson (1993)
  - Posit a flexible innovation technology.
  - Firms have partial control over the whole distribution of next period's distribution
- Firing cost of 2.5 monthly wages generate a 3% fall in aggregate productivity
  - Larger effects than typically found in the literature
  - Distort firing/hiring choices + shaping innovation choices
- Decomposition:
  - 55% due to distortion on hiring/firing choices
  - 22% due to a decrease in average firm productivity
  - 23% due to changes in the shape of the productivity distribution
- **Take-away**: exogenous productivity dynamics largely underestimates the productivity effects of frictions

Thanks for your attention

Effects of firing costs. GE vs. PE



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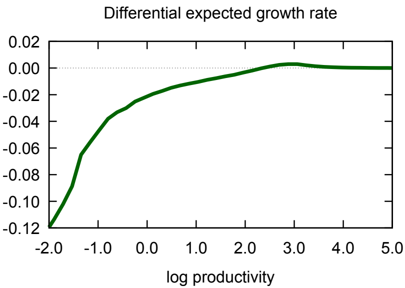
Aggregate effects of firing costs

Figure: Innovation choices. Experiment, $\kappa_F = 1$ *vs.* $\kappa_F = 0$



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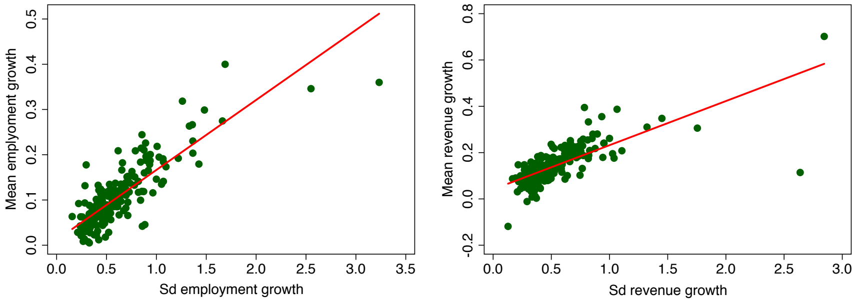
Growth vs. Risk Trade-off

Figure: Sector-year average and standard deviation of employment/revenue growth



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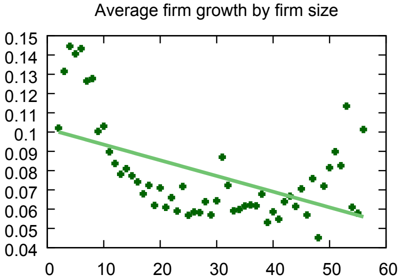
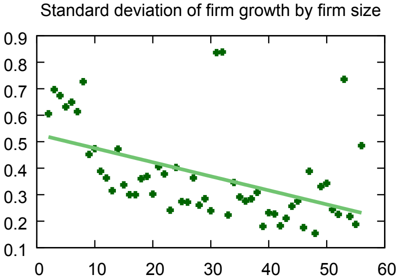
Growth vs. Risk Trade-off. Firm Size

Figure: Sector-year average and standard deviation of employment/revenue growth





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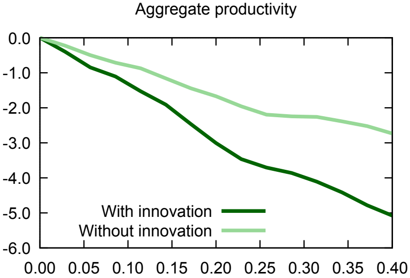
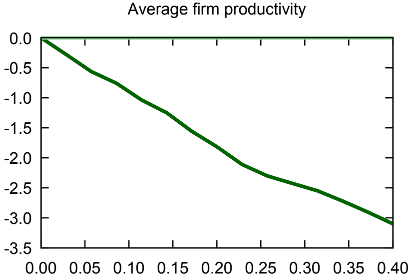
Effects of firing costs. Endogenous vs. Exogenous innovation





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