Financial Constraints and Firms Dynamics

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- The factors that determine firm dynamics are important for aggregate productivity.

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    - Financial frictions.

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4. Credit cycle models with heterogeneous firms.

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2. I will talk about a work in progress on financial frictions, innovation and firm dynamics.

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- Extensive Margin :
  - Misallocation of Entry/Exit of firms:
  - Misallocation of other types of "long horizon" investment decisions.

Financing frictions and Misallocation (2)

The Extensive margin:

- Misallocation of Entry/Exit of firms:
  - Too few firms enter, and/or of the wrong type (e.g. Buera, Kaboski and Shin, 2011; Caggese and Cunat, 2013).

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  - Distorted entry into foreign markets (e.g. Caggese and Cunat, 2013)
  - Distorted Innovation decision (This paper)

Financing frictions and Misallocation (3)

Quantitative results

- Buera, Kaboski and Shin (2011): financial frictions explain 60% of the cross-country relation between financial development and TFP.
  - Intensive margin explains almost all of the effect for services sector, and roughly 50% of effect for manufacturing sector.
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- Khan and Thomas (2013): Calibrated DSGE model with firm dynamics, financing frictions and partial irreversibility.
    - Misallocation resulting from a credit shock generates dynamics consistent with the recent Great Recession.

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  - Interaction with adjustment costs along the intensive margin important for cyclical fluctuations.

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- Within-firm accumulation of intangible capital: Hsieh and Klenow (2012) compare US, India and Mexico:

Figure 4: Employment Growth over the Life-Cycle

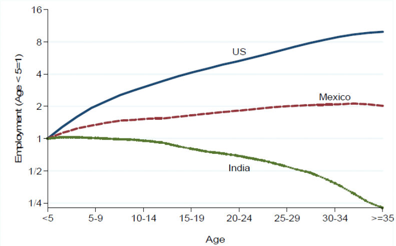
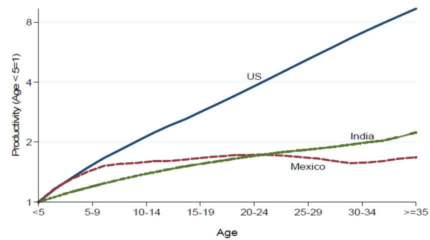


Figure 6: Productivity Over the Life-Cycle



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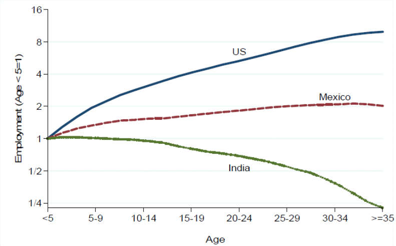

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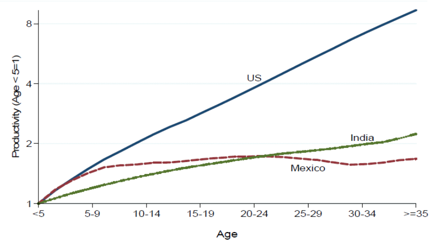

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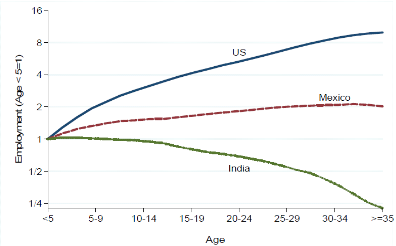

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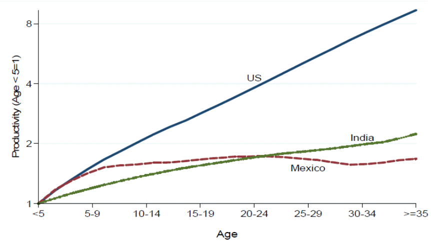

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- Financing factors matter? Complementary or alternative to technology based explanations?

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- Industry model with heterogenous firms, entry and exit, costly bankruptcy and risky innovation.

Preview of empirical results

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  - On average product innovation is related to increases in productivity in both constrained and unconstrained sectors.
- Product innovation is risky:
  - Doraszelski and Jaumandreu (2013): innovative activity increases volatility of productivity;
  - Caggese (2012): innovation to introduce new products increases volatility of profits more than other types of innovation.

This paper - Theory

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  - They start with low wealth and cannot borrow. Some young firms may go bankrupt. If they survive, they gradually overcome financing frictions.
  - New firms enter with a better technology. Existing firms need to innovate, otherwise their profits drop and they eventually exit because of obsolescence.

This paper - Theory (2)

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  - Type-two, "radical": If it fails, profits drop relative to pre-innovation level, but if it succeeds, the firm reaches the frontier.
  - In equilibrium, the most productive firms engage in type one innovation. Laggard firms either do not innovate or try type two innovation.

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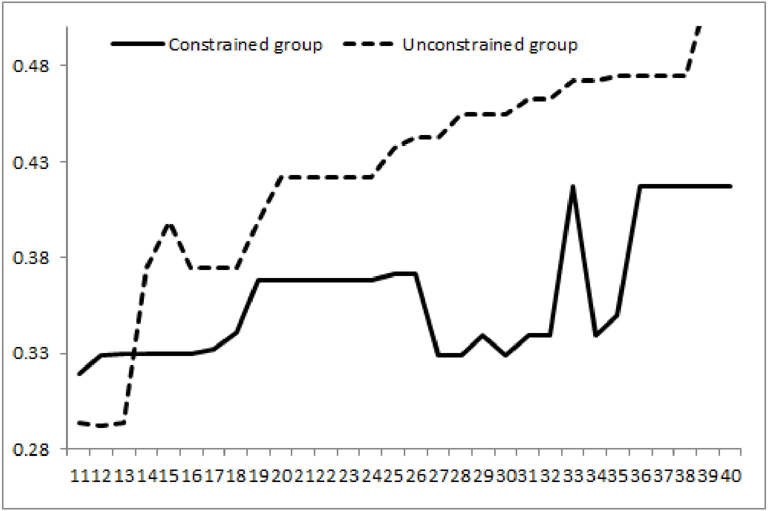
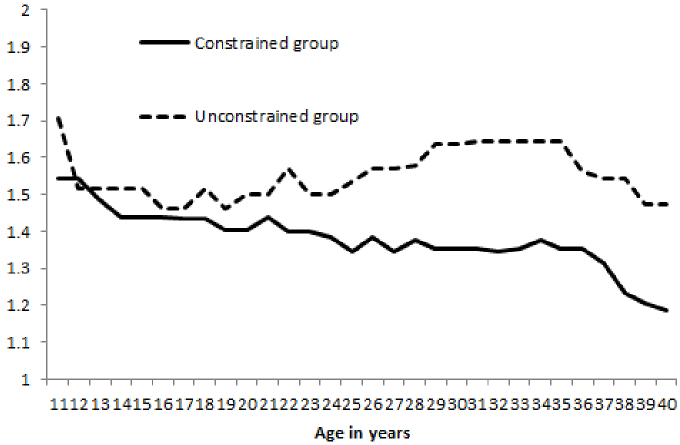
- For incremental innovation, the indirect effect is positive, and much larger than the negative direct effect. This type of innovation generates counterfactual dynamics.
- However, the indirect competition effect reduces radical innovation (because of downside risk).
- Once also this type of innovation is possible, innovation dynamics in the model are consistent with the empirical evidence.

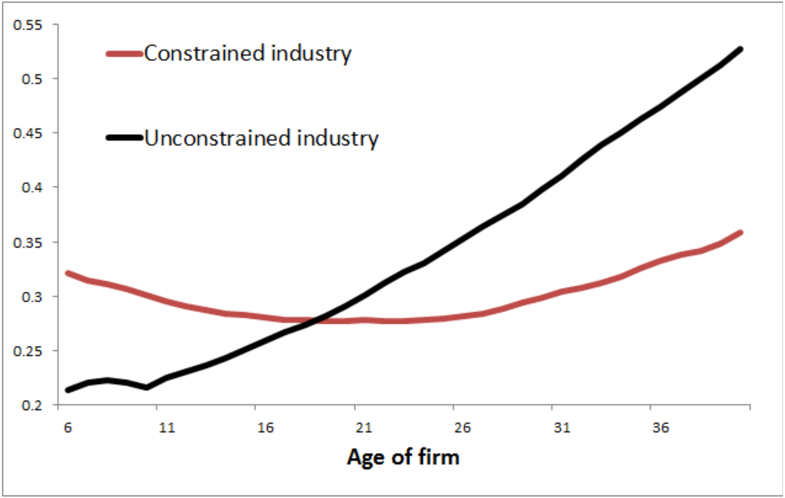
Innovation over the life cycle (empirical data)



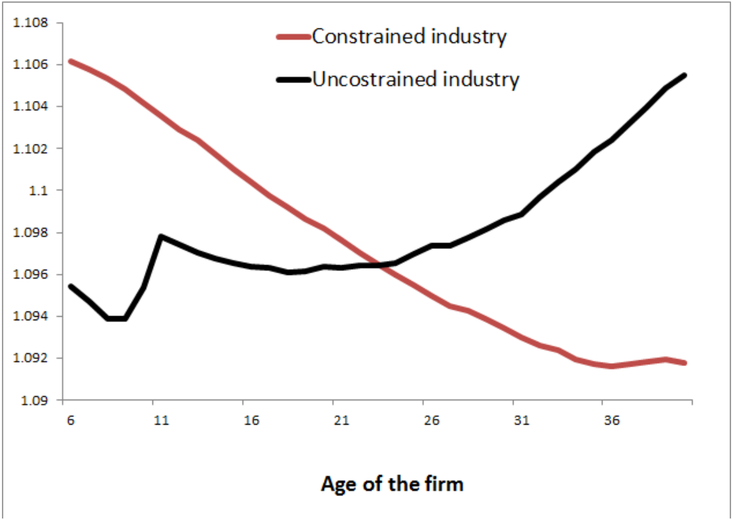
Total factor productivity over the life cycle (data)



Innovation over the life cycle (model simulations)



Productivity over the life cycle (model simulations)



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- A calibrated model with heterogenous firms can replicate these dynamics if we introduce the possibility of "radical" innovation.
- The most important effect of financing frictions on innovation and aggregate productivity is the indirect competition effect.

Empirical data

- I construct a survey based measure of financing constraints.
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  - Firms answer questions on difficulty in obtaining loans, or high cost of loans.
- Calculate the percentage of financially constrained firms in each 4 digit manufacturing industry
- Create two groups:
  - The 50% four digit sectors with higher frequency of constrained firms, called the "Constrained" group,
  - The 50% four digit sectors with lower frequency of constrained firms, called the "Unconstrained" group.

Productivity over the life cycle

Fixed effects regression. Dependent variable: revenue based TFP				
	Most constrained sectors		Least constrained sectors.	
AGE_{it}	-0.115 (0.048**)		0.048 (0.059)	
$AGE_{it} = 3$		-0.074(0.089)		0.474(0.217**)
$AGE_{it} = 4$		-0.259(0.132**)		0.337(0.319)
$AGE_{it} = 5$		-0.298(0.182)		0.302(0.344)
$AGE_{it} = 6$		-0.374(0.220*)		0.502(0.384)
$AGE_{it} = 7$		-0.472(0.280*)		0.444(0.405)
$AGE_{it} = 8$		-0.480(0.320)		0.497(0.450)
$AGE_{it} = 9$		-0.662(0.361*)		0.693(0.495)
$AGE_{it} = 10$		-0.854(0.407**)		0.607(0.538)
$AGE_{it} = 11$		-0.915(0.449**)		0.682(0.572)
$AGE_{it} = 12$		-1.064(0.456***)		0.888(0.629)
n. obs.	2958	2958	2055	2055
R^2	0.020	0.020	0.002	0.002

1unit=3 years. Firm fixed effects included. Survey dummies included

Innovation over the life cycle (2)

Fixed effects regression. Dependent variable: innovation decision					
	R&D section of the survey			Fixed investment section	
	(1) R&D	(2) R&D for new products	Other R&D	(3) Fixed I. for new prod.	Other F.I.
			Only constrained sectors		
AGE_{it}	0.55 (.46)	0.47 (.51)	-0.34 (.64)	-0.03 (.37)	0.11 (.37)
n.obs.	329	219	81	407	383
Pseudo R^2	0.126	0.144	0.091	0.100	0.102
% of firms inn.	31.4%	15.2%	17.2%	27.0%	62.8%
			Only unconstrained sectors		
AGE_{it}	0.70 (1.0)	2.36 (.9)***	-1.99 (.93)**	1.39 (.58)**	-1.66 (.66)**
n.obs.	122	135	74	242	221
Pseudo R^2	0.141	0.100	0.084	0.071	0.070
% of firms inn.	36.6%	20.3%	17.2%	30.9%	55.5%
Survey dummies included					

Innovation and productivity

Fixed effects regression. Dependent variable: revenue based TFP			
	All firms	Constr. sectors	Unconst. sectors
$R\&D$	0.015 (0.029)	0.007 (0.043)	-0.031 (0.066)
$R\&D$ for new products	0.070 (0.027)***	0.114 (0.046)**	0.051 (0.045)
Other $R\&D$ activity	-0.039 (0.026)	-0.082 (0.039)**	-0.058 (0.048)
Fixed inv. for new products	0.058 (0.022)***	0.072 (0.034) **	0.075 (0.041)**
Fixed inv. for current prod.	-0.046 (0.021)**	-0.037 (0.033)	-0.092 (0.048)**
survey dummies included			

The model

Firm Dynamics monopolistic competition Model a la Hopenhayn (1992) (and Melitz, 2003)

- Each firm in an industry uses labour to produce a variety $w \in \Omega$ of a consumption good.
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- For a firm, profits are increasing in productivity v, and decreasing in competition.$1/v$ =marginal production cost.
- One-off fixed cost to enter S^C;Per-period fixed costs of production F;Fixed innovation cost K_i, i =innovation type.
- Innovation raises v if successful. v stochastically depreciates if no innovation (obsolescence).

Innovation - 1

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  - Innovation cost: $K_2 > K_1 > K_0 = 0$.

Timing and Financing frictions

- Budget constraint:

$$a_t = R\left(a_{t-1} - K\left(l_{t-1}\right) - d_{t-1}\right) + \pi_t\left(v_t, \varepsilon_t\right) \qquad (1)$$

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- Firms need to pay in advance the fixed costs of production F and of innovation K :
- Continuation is feasible only if:

$$a_t \geq F \tag{2}$$

- Innovation is feasible only if:

$$a_t \geq F + K \tag{3}$$

Value functions

we define $V_t^1(a_t, \varepsilon_t, v_t)$ as the value function today conditional on doing incremental innovation:

$$V_t^1(a_t, \varepsilon_t, v_t) = -K(1) + \frac{1-\delta}{R}$$

$$\left\{ \begin{array}{c} \xi^{INC} E_t \left[V_{t+1}(a_{t+1}, \varepsilon_{t+1}, v_t) + \pi_{t+1}(\varepsilon_{t+1}, v_t) \right] \\ + \left(1 - \xi^{INC}\right) E_t \left[V_{t+1}\left(a_{t+1}, \varepsilon_{t+1}, \frac{v_t}{g}\right) + \pi_{t+1}\left(\varepsilon_{t+1}, \frac{v_t}{g}\right) \right] \end{array} \right\}$$

Then we define $V_t^2(a_t, \varepsilon_t, v_t)$ as the value function today conditional on doing radical innovation:

$$V_t^2(a_t, \varepsilon_t, v_t) = -K(2) + \frac{1-\delta}{R}$$

$$\left\{ \begin{array}{c} \xi^{I} E_t \left[V_{t+1}(a_{t+1}, \varepsilon_{t+1}, 1) + \pi_{t+1}(\varepsilon_{t+1}, 1) \right] \\ + \left(1 - \xi^{I}\right) E_t \left[V_{t+1}\left(a_{t+1}, \varepsilon_{t+1}, \frac{v_t}{g^{fail}}\right) + \pi_{t+1}\left(\varepsilon_{t+1}, \frac{v_t}{g^{fail}}\right) \right] \end{array} \right\}$$

Value functions

And finally, the value function conditional on not innovating is:

$$V_t^0\left(a_t, \varepsilon_t, v_t\right) = \frac{1-\delta}{R}$$

$$\left\{ \begin{array}{c} \xi^{NI} E_t\left[V_{t+1}\left(a_{t+1}, \varepsilon_{t+1}, v_t\right) + \pi_{t+1}\left(\varepsilon_{t+1}, v_t\right)\right] \\ + \left(1-\xi^{NI}\right) E_t\left[V_{t+1}\left(a_{t+1}, \varepsilon_{t+1}, \frac{v_t}{g}\right) + \pi_{t+1}\left(\varepsilon_{t+1}, \frac{v_t}{g}\right)\right] \end{array} \right\}$$

The firm then makes the innovation decision I_t which maximizes the firms' value:

$$V_t^*\left(a_t, \varepsilon_t, v_t\right) = \underset{I_t \in \{0,1,2\}}{\arg\max} \left\{ V_t^0\left(a_t, \varepsilon_t, v_t\right), V_t^1\left(a_t, \varepsilon_t, v_t\right), V_t^2\left(a_t, \varepsilon_t, v_t\right) \right\}$$

Such that: $a_t \geq F + K_i$

Given the innovation decision, the value of the firm at time t is:

$$V_t\left(a_t, \varepsilon_t, v_t\right) = 1\left(a_t \geq F\right)\left\{\max\left[V_t^*\left(a_t, \varepsilon_t, v_t\right), 0\right]\right\} \quad (4)$$

Entry decision

- Every period there is free entry. New potential entrants, with endowment a_0, can learn their type v_0 after having paid an initial cost S^C.
- Once they learn their type v_0, they decided whether or not to start activity.
- The free entry condition:

$$\int_{\underline{v}}^{\overline{v}} \max\left\{E^{\varepsilon_0}\left[V_0\left(a_0, v_0, \varepsilon_0\right)\right], 0\right\} f\left(v_0\right) dv_0 - S^C = 0 \qquad (5)$$

Calibration with risky innovation

Matched parameters				
	Value	Moment to match	Data	Baseline sir
δ	0.03	employment share of exiting firms	8.2%	8%
r	1.02	average real interest rate	2%	2
F	0.2	average ratio fixed costs/labour costs	0.3	0.23
$\overline{v}$	1	normalized to 1.	n.a.	n.a.
$\underline{v}$	0.969	Cross sectional dispersion of firm average profits/added v.	0.044-0.064*	0.020
S^C	0.6	mean profits/added value	0.019-0.030*	0.023
ξ	0.15	average of time series vol of profits/ad.v. at the firm level	0.060-0.084*	0.052
g	1.0035	average yearly decline in profits/sales. for a non inn. firm	3%	3%
K^{inn}	0.05	average r&d/added value	3%	4%
α^{not}	0.6	average age of firms	24	21
α^{keep}	0.8	% of innovating firms (all innovation together)	47%	58%
α^{inn}	0.1	% of firms making losses	0.46%	25%
a_0	0.4	% of firms going bankrupt every period	0.5%	0.5%

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- Effects 1 to 3 reduce innovation of young firms.
- Effect 4 encourages incremental innovation and penalizes risky innovation: essential to match life cycle dynamics.

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- A calibrated model with heterogenous firms can replicate these dynamics if we introduce the possibility of "radical" innovation.
- The most important effect of financing frictions on innovation and aggregate productivity is the indirect competition effect.