# 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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  - Misallocation of other types of "long horizon" investment decisions.

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  - 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 Innovation decision (This paper)

# Financing frictions and Misallocation (3)

Quantitative results

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  - Decline in capacity utilization accounts for around 1/2 drop in TFP.
- 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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Figure 4: Employment Growth over the Life-Cycle

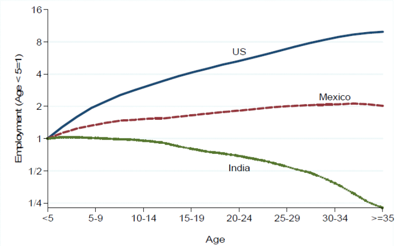
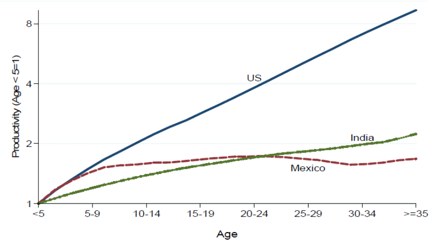



Figure 6: Productivity Over the Life-Cycle



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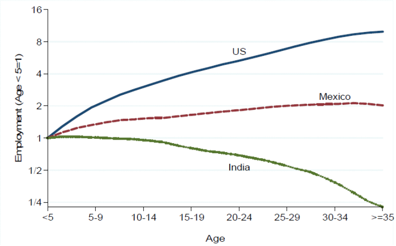


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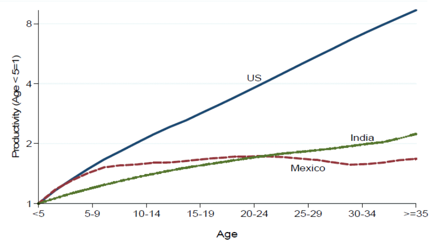


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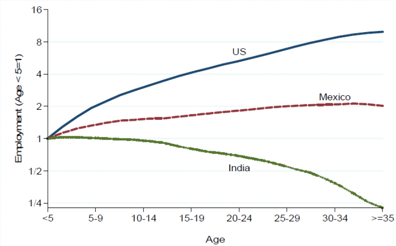


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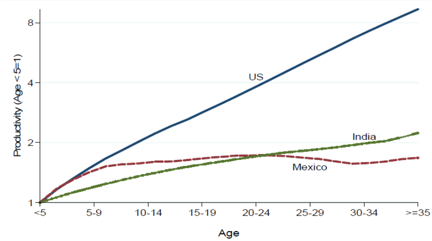


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- Financing factors matter? Complementary or alternative to technology based explanations?

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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.

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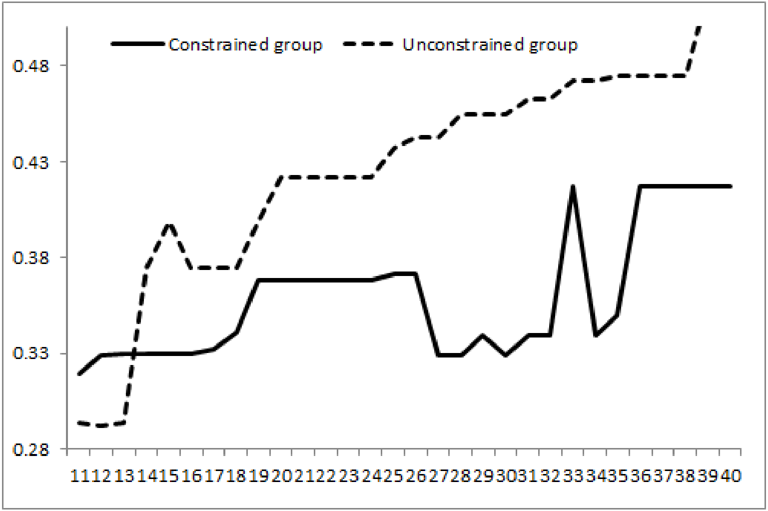
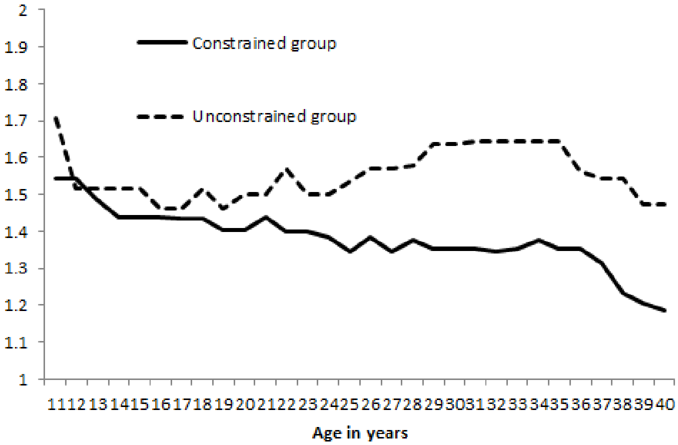
- For incremental innovation, the indirect effect is positive, and much larger than the negative direct effect. This type of innovation generates counterfactual dynamics.
- However, the indirect competition effect reduces radical innovation (because of downside risk).
- Once also this type of innovation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

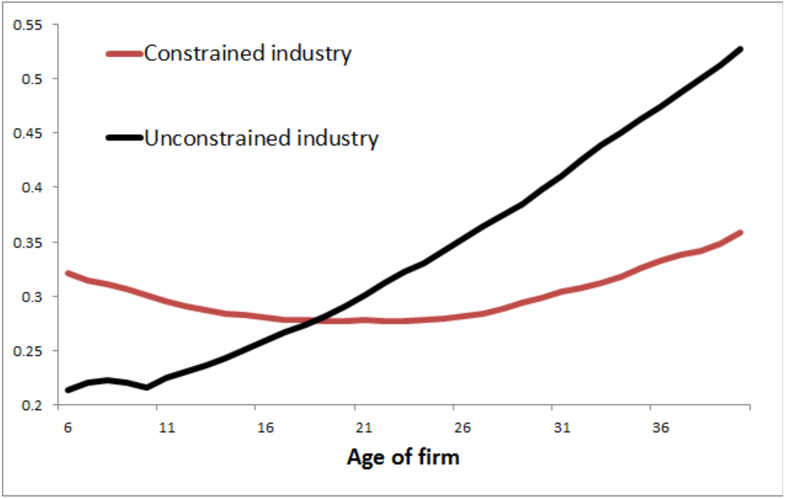
# Innovation over the life cycle (empirical data)



# Total factor productivity over the life cycle (data)



# Innovation over the life cycle (model simulations)



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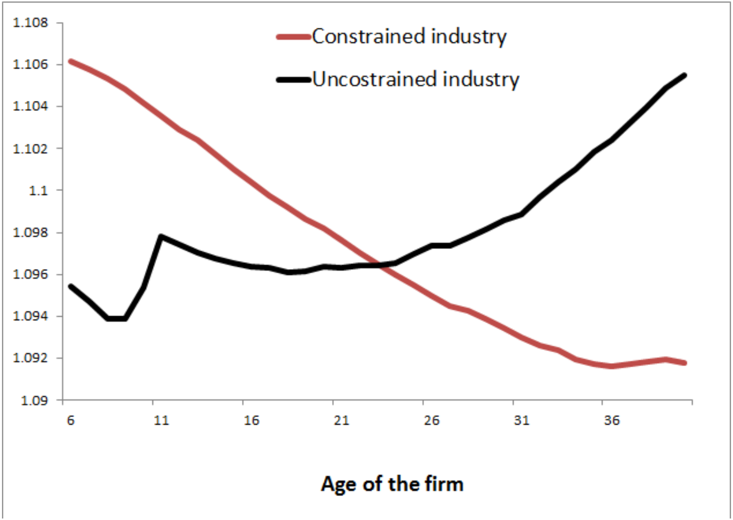

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- A calibrated model with heterogenous firms can replicate these dynamics if we introduce the possibility of "radical" innovation.
- The most important effect of financing frictions on innovation and aggregate productivity is the indirect competition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

# Empirical data

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- 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).

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

# Timing and Financing frictions

- Budget constraint:

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

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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 |
| $\delta$ | 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 |
| $\xi$ | 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% |
| $\alpha^{not}$ | 0.6 | average age of firms | 24 | 21 |
| $\alpha^{keep}$ | 0.8 | % of innovating firms (all innovation together) | 47% | 58% |
| $\alpha^{inn}$ | 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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- Empirical analysis shows that financing frictions are correlated to slower innovation growth and productivity growth along the life cycle of firms.
- 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.