Born in Hard Times:
Startups and Intangible Capital during the Financial Crisis

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The opinions expressed do not necessarily represent those of the BoI or the IMF.
Motivation

Falling entry rates and rising exit rates during the financial crisis:

- In Southern European countries: drop prolonged for 6 years.

What are the implications for growth?

- “missing generation”: Siemer (2014) Clementi and Palazzo (2016);
- being born in recession may be a permanent “scar” on growth (Moreira 2016);
- but positive selection of new cohorts may mitigate these effects (Lee and Toshihiko 2006, Ates and Saffie 2016).
What are the effects of the financial crisis on startups?

1. We combine detailed firm balance-sheets with matched firm-bank data for the census of Italian corporations over the period 1999-2016;

2. While initially hit by the financial crisis, revenues and employment of cohorts born during the crisis quickly catch-up during the recovery; yet, they remain persistently under-capitalized;

3. They have higher share of intangibles-to-total capital and higher productivity;

4. Intangible-intensity is a persistent feature of firms, associated with higher productivity, lower K/L ratio, lower leverage at entry.

5. Selection on intangible-intensity during the crisis is causally linked to tightening credit supply;
Our paper

How can we interpret these results in a comprehensive framework?

- We develop a firm dynamics model featuring:
  - Two types of capital (material & intangibles)
  - Two technologies (high- & low-intensity of intangibles)
  - External financing costs (fixed & variable + pledgeability of material K)

- Intangible-intensive firms are more profitable and less capital intensive $\implies$ less leveraged at entry

- Smaller leverage makes them less vulnerable to credit tightening

- Startups born during the crisis display higher productivity on average because of:
  - higher share of intangible-intensive firms (between-technologies effect)
  - stronger selection among material-intensive firms (within-technology effect)
The Financial Crisis—Intangibles Micro/Macro Puzzle

- **Micro-Studies**: the financial shock affected intangibility of investments among incumbents (Duval et al. 2017; Manaressi and Pierri 2018);
- **Macro Data**: during the financial crisis, aggregate accumulation of intangibles was more resilient than those of material capital.

A possible solution to this puzzle:

- **Young firms** represent 1/4 of total intangible capital, but **contribute for 64% to intangible capital formation**
Roadmap

- Data
- Stylized Facts on Intangibility and Selection
- Identifying the Financing Channel: Evidence from a Natural Experiment
- The Model
- Conclusions
Data

- Census of Italian incorporated firms
- Sample selection
  - Manufacturing, Construction, Private Services
  - From 1999 to 2016
- Variables
  - Revenues \(\rightarrow\) balance-sheet
  - Capital \(\rightarrow\) perpetual inventory method
  - Employment \(\rightarrow\) wagebill OR employees
  - TFPR \(\rightarrow\) translog, DL-W

### Definition of a Firm
- Fiscal Code
- Controls for M&A

### Variable Mean Median St.Dev.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Median</th>
<th>St.Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rev.</td>
<td>955.7</td>
<td>135.7</td>
<td>2286.2</td>
</tr>
<tr>
<td>VA</td>
<td>232.0</td>
<td>25.3</td>
<td>658.8</td>
</tr>
<tr>
<td>L</td>
<td>136.6</td>
<td>10.4</td>
<td>319.2</td>
</tr>
<tr>
<td>K</td>
<td>204.5</td>
<td>13.3</td>
<td>680.4</td>
</tr>
<tr>
<td>Intang. K (%)</td>
<td>25</td>
<td>7</td>
<td>33</td>
</tr>
</tbody>
</table>
Firm Lifecycle Before and During the Crisis

Log-Revenues - residuals

Log-Employment - residuals

Log-Capital - residuals

Share of Intangible Capital - residuals

Born in Hard Times: Startups and Intangible Capital during the Financial Crisis
Firms born during the crisis have higher share of intangibles to total capital

\[
\frac{K^I}{(K^I + K^M)}_{i\text{pst}} = \sum_{a=1}^{A} \beta_{a} \times A_{it} + \sum_{a=1}^{A} \gamma_{a} \times A_{it} \times CrisisCohort_{i} + \lambda_{t} + \theta_{p} + \pi_{s} + \varepsilon_{ipst}
\]
Firms born during the crisis are more productive

\[
\log \text{Prod}_{ipst} = \sum_{a=1}^{A} \beta_a \times A_{it} + \sum_{a=1}^{A} \gamma_a \times A_{it} \times \text{CrisisCohort}_i + \lambda_t + \theta_p + \pi_s + \varepsilon_{ipst}
\]
What is Intangible Capital?

According to the Italian law:

1. R&D expenditures
2. Softwares
3. Value of patent rights, trademarks, designs (either owned or granted)
4. Goodwill (intangibles of a purchased company) and setting-up costs
5. Amortization of past intangible investments (net of goodwill and setting-up costs)

In our data:
### Persistency of intangibility

Cohorts born **before** the crisis

<table>
<thead>
<tr>
<th>Age 1</th>
<th>Age 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>70</td>
</tr>
<tr>
<td>High</td>
<td>21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age 1</th>
<th>Age 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>30</td>
</tr>
<tr>
<td>High</td>
<td>79</td>
</tr>
</tbody>
</table>

Cohorts born **during** the crisis

<table>
<thead>
<tr>
<th>Age 1</th>
<th>Age 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>73</td>
</tr>
<tr>
<td>High</td>
<td>21</td>
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<td>Low</td>
<td>27</td>
</tr>
<tr>
<td>High</td>
<td>79</td>
</tr>
</tbody>
</table>

- **High-Intangible firms** $\implies$ Intangibles/Total Capital $= 0.48$
- **Low-Intangible firms** $\implies$ Intangibles/Total Capital $= 0.14$
High-intangibility $\implies \uparrow$ productivity & $\downarrow$ $K/L$ ratio

Log-K Productivity

regression results

$Y_{ipst} = \sum_{a=1}^{A} \beta_a \times A_{it} + \sum_{a=1}^{A} \gamma_a \times A_{it} \times HighIntang_i + \lambda_t + \theta_p + \pi_s + \varepsilon_{ipst}$
High-Intangible Startups Suffered Less at Entry and Through Exit

![Graph showing Entry Rates and Odds-ratios of exit](image)

**Entry Rates**
(over total firms at t-1)

**Odds-ratios of exit**
(exit rates H /exit rates L)
High-intangibility is associated with lower leverage at entry

\[
\frac{\text{Assets}}{\text{NetWorth}}_{ipst} = \sum_{a=1}^{A} \beta_a \times A_{it} + \sum_{a=1}^{A} \gamma_a \times A_{it} \times \text{HighIntang}_{i} + \lambda_t + \theta_p + \pi_s + \varepsilon_{ipst}
\]
Takeaways from Empirical Facts

1. Intangible-intensity is a persistent feature of firms associated with higher revenue productivity...

2. ... and a lower reliance on external finance during early years of life

3. During the crisis, intangible intensity and capital productivity of new cohorts have increased, thanks to selection through entry and exit

4. Has the financial shock (2007-8) being a driver of the selection that we observe?
Credit Tightening Driving Selection? Evidence from a Natural Experiment

- Subprime & Lehman $\implies$ freeze in Interbank market (ITBK) $\implies$ credit reduction
- Local pre-crisis (2006) exposure to ITBK as an exogenous shock to credit supply
- **Credit supply shifter**: weighted average of 2006’s “interbank liabilities-to-assets ratio” of lenders; weights equal to share of credit granted to province $p$ and sector $s$
  
  $ITBK_{p,s,2006} = \sum_b \frac{C_{bps,2006}}{C_{ps,2006}} ITBK_{b,2006}$

- Empirical model (within province-sector)

  $$Y_{p,s,t} = \psi_{ps} + ITBK_{p,s,2006} \times \lambda_t \gamma + [X_{pst}\beta] + \varepsilon_{p,s,t}$$
Interbank Shock and Credit Access of Startups

\[ Y_{p,s,t} = \psi_{ps} + ITBK_{p,s,2006} \times \lambda_t \gamma + [X_{pst}\beta] + \varepsilon_{p,s,t} \]
Interbank Shock and Firm Entry

\[ Y_{p,s,t} = \psi_{ps} + ITBK_{p,s,2006} \times \lambda_t \gamma + [X_{pst}\beta] + \varepsilon_{p,s,t} \]
Main Model’s Ingredients

We build upon Hopenhayn’s (1992) model, augmenting it with

- **Two types of capital**
  \[ \text{⇒ material capital } m \text{ and intangible capital } i \]

- **Two technologies**
  \[ \text{⇒ high- and low-intangible firms, which differ in the share of intangibles in total capital} \]
  \[ \text{⇒ High-intangible firms enjoy higher efficiency units of capital} \]

- **External financing costs** as in Gomes (2001)
  \[ \text{⇒ firms face a cost from investing more than their current profits (fixed & variable + pledgeability premium for material capital)} \]

- **Model calibrated** with micro & macro data to match:
  1. K-prod of intangible-intensive firms
  2. Intangible intensity of the two ‘technologies’
  3. Exit rates by age (pre-crisis)
  4. Debt/assets for start-ups (pre-crisis)

- **Steady-states’ comparison:** low-VS-high financing costs’ economy
Model Replicates the Increase in Share of Intangible-intensive Firms
Increase in the Intangible Share of New Cohorts

Change in Intangible Share after the financial shock

[Graph showing the change in intangible share over age with model average, low intangible, and data lines.

- Model Average
- Low Intangible
- Data]
Low-intangible firms increase their TFP at entry $\implies$ their entry rate declines
Selection of more productive low-intangible firms $\implies$ lower leverage

**No Financial Shock**

**Financial Shock**
Why High-Intangible Firms are Less Selected by the Crisis?

- High-intangible firms have higher efficiency units of capital \( \Rightarrow \) lower capital intensity and lower leverage!

- Increase in financing costs \( \Rightarrow \) ↓ firm’s profitability and the value of starting a business

- Entry value falls more for ventures that are more leveraged at entry: material-intensive firms
Conclusion

We find:

- Intangible-intensity is a persistent feature, correlated with higher productivity;
- Intangible-intensive startups suffered less during the crisis; while material-intensive startups were more fiercely selected;
- Intangible-intensive firms are more resilient to a financial shock thanks to the higher efficiency of their capital which implies a lower leverage at entry.

Implications:

- Startups and young firms are key for capital accumulation, also intangible ones;
- Selection of new firms during financial recessions may spur technological change (Necessity Mother of Inventions);
- Policies aimed at fostering R&D and intangible accumulation may target young firms, rather than being size-dependent.
Thank you!
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