Do Financial Factors Drive Aggregate Productivity? Evidence from Indian Manufacturing Establishments

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Motivation

- Does financial development increase economic growth?
- Log aggregate labor productivity in India:

![Graph showing the increase in average aggregate productivity from 1990 to 2010.](graph.png)
What I Do

- Derive a model in which financial development can increase aggregate productivity, by reallocating resources to more productive uses.
- Derive implications for cross-sectional distribution of size and productivity.
- Identify financial shocks that re-allocate resources vs. common shocks to productivity using establishment-level microdata from India.
What I Find

- Common shocks to productivity, not financial development, explain the time-series evolution of the cross-sectional distribution of size and productivity from 1995–2011.

- If finance is to explain aggregate productivity growth, it must affect productivity within firms, not allocation of resources across them.
Single Agent’s Problem

Assumptions:
- Productivity shocks are exogenous, idiosyncratic, and persistent.
- Firm owner-operators have finite intertemporal elasticity of substitution.
- Firms can borrow but default occurs in equilibrium and is priced.

Results:
- Un-productive firms do not borrow.
- Among productive firms, more-productive firms choose higher leverage ratios and grow faster on average.
- In equilibrium, positive (endogenous) correlation between size and productivity.
- Correlation depends on level of financial development.
Log Aggregate Productivity Decomposition

\[ Y_i \equiv \text{value added}_i = e^{z_i} L_i \quad L_i \equiv \text{employment}_i \quad w_i \equiv \frac{L_i}{\sum_j L_j} \]

Log Agg Prod \( \equiv \log \frac{\sum_i Y_i}{\sum_i L_i} \)

\[ \approx \sum_i w_i z_i = \frac{1}{N} \sum_{i=1}^N z_i + \sum_{i=1}^N (z_i - \bar{Z}) \left( w_i - \frac{1}{N} \right) \]

average productivity: \( \bar{Z} \)

OP covariance: \( C \)
Identification

- Increases in collateral rate:
  - Lower cost of capital $\Rightarrow$ highly-productive firms lever up and grow faster on average $\Rightarrow C$ increases.
  - Idiosyncratic productivity unaffected $\Rightarrow \mathcal{Z}$ constant.
- Increases in productivity:
  - All firms more productive $\Rightarrow \mathcal{Z}$ increases.
  - Lower cost of capital $\Rightarrow$ highly-productive firms lever up and grow faster on average $\Rightarrow C$ increases.

$$(Z, \theta) \xrightarrow{\text{interpretable}} \text{model} \xrightarrow{\text{observable}} (Z, C)$$
Aggregate Productivity Decomposition

- Reallocation
- Productivity
- Joint

<table>
<thead>
<tr>
<th>Year Range</th>
<th>%p.a.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990−−1995</td>
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</tr>
<tr>
<td>1995−−2000</td>
<td>0</td>
</tr>
<tr>
<td>2000−−2006</td>
<td>2</td>
</tr>
<tr>
<td>2006−−2011</td>
<td>4</td>
</tr>
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</table>
Conclusion

- Derived a model in which financial development affects aggregate productivity through the allocation of resources across firms.
- Calibrated model to Indian microdata: financial development may have increased aggregate productivity only in 1990–1995.
- Other factors that affect within-firm productivity may be more important than re-allocative financial frictions.
  - Informational barriers (Bloom et al 2013).
  - Entry and financial constraints (Buera Kaboski & Shin 2011).
Time Series for \( Z \)

![Graph showing the time series for \( Z \) from 1989 to 2014.](image)

- **y-axis:** Avg productivity

The graph illustrates the increase in average productivity over the specified years.
Plugging in the guess for the value function yields

\[ a + b \log x = \text{const} + \log x + \beta [(1 - \pi) b + \pi] \]

so that \( b \) satisfies

\[ b = \frac{1 + \beta \pi}{1 - \beta (1 - \pi)} \]

Define

\[ \tilde{\beta} \equiv \beta [(1 - \pi) b + \pi] \]

Then

\[ \beta^* = \frac{\tilde{\beta}}{1 + \tilde{\beta}} \]
Why Is This Hard?

▶ Macro evidence: causality
  ▶ Previous financial development predicts future growth. But markets are forward-looking.
  ▶ Instruments (country of legal origin): static, don’t satisfy exclusion restriction.

▶ Micro evidence: impact
  ▶ Suggests mechanism.
  ▶ But is mechanism important for aggregate productivity?

▶ Measurement error?
Log Aggregate Productivity Approximation

\[
\log \frac{\sum_i Y_i}{\sum_i L_i} = \log \sum_i \frac{L_i Y_i}{\sum_j L_j L_i} = \log \sum_i w_i e^{z_i}
\]

\[
f (\vec{z}) = \log \sum_i w_i e^{z_i} \approx f (\vec{1} z) + f' (\vec{1} z) \cdot (\vec{z} - \vec{1} z)
\]

\[
\frac{\partial f}{\partial z_j} (\vec{z}) \bigg|_{\vec{1} z} = \frac{1}{\sum_i w_i e^{z_i}} w_j e^{z_j} \bigg|_{\vec{1} z} = \frac{w_j e^{z}}{e^{z} \sum_i w_i} \bigg|_{\vec{1} z} = w_j
\]

\[
f' (\vec{1} z) = \frac{\vec{w}}{\vec{w} \cdot \vec{1}} = \vec{w}
\]

\[
f (\vec{z}) \approx z + \vec{w} \cdot (\vec{z} - \vec{1} z) = z + \vec{w} \cdot \vec{z} - (\vec{w} \cdot \vec{1}) z
\]

\[
= \sum_i w_i z_i
\]
Time Series for World Bank Doing Business Recovery Rate
More Motivation

- Rajan & Zingales (1998): “One way to make progress on causality is to focus on the details of theoretical mechanisms through which financial development affects economic growth, and document their working.”

- Levine (2005): “If finance is to explain economic growth, we need theories that describe how financial development influences resource allocation decisions in ways that foster productivity growth.”
### Robustness to $\eta$

<table>
<thead>
<tr>
<th>$\eta$</th>
<th>Terminal $\theta$</th>
<th>Percent of Growth from 1990–1995</th>
<th>Growth from 1995–2011</th>
<th>$\Delta$% NSS Share Model</th>
<th>$\Delta$% NSS Share Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>0.29</td>
<td>70%</td>
<td>-8.4–10.0%</td>
<td>-14.0%</td>
<td>-11.2%</td>
</tr>
<tr>
<td>0.4</td>
<td>0.33</td>
<td>71%</td>
<td>-3.5–8.6%</td>
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<tr>
<td>0.5</td>
<td>0.38</td>
<td>71%</td>
<td>2.4–7.5%</td>
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<tr>
<td>0.6</td>
<td>0.45</td>
<td>71%</td>
<td>6.6–9.9%</td>
<td>-10.0%</td>
<td>-11.2%</td>
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</table>
 Aggregate Productivity Decomposition, $\eta = 0.3$
Aggregate Productivity Decomposition, $\eta = 0.4$
Aggregate Productivity Decomposition, $\eta = 0.5$

![Chart showing productivity decomposition over different year ranges](chart.png)
Aggregate Productivity Decomposition, $\eta = 0.6$
At the beginning of the period, after idiosyncratic shocks are realized, agent has total resources $\tilde{k}$.

Working capital constraint: labor must be paid before production occurs.

Agent’s problem at start of period:

$$\max_{k,L} \quad Ae^z k^{\alpha} L^{1-\alpha} - wL + k$$

subject to:

$$k + wL \leq \tilde{k}$$
Labor Productivity

Solution: \( m(z) \equiv \frac{L}{K} \) solves

\[
Ae^z \left[ \frac{1 - \alpha}{w} - \alpha m \right] = 2m^\alpha
\]

and

\[
k(z) = \frac{\bar{k}}{1 + wm(z)}.
\]

Labor productivity is

\[
\frac{Y}{L} = \frac{Ae^z m^{1-\alpha} k}{mk} = 2 \left[ \frac{1 - \alpha}{w} - \alpha m \right]^{-1}
\]
Mechanism

- Growth & productivity correlated with financial intermediation.
- Growth of externally-dependent industries, constrained firms more correlated with financial intermediation.
- Suggests the following mechanism:

  financial development
  \[\rightarrow\] lower cost of capital
  \[\rightarrow\] improved resource allocation
  \[\rightarrow\] higher aggregate productivity

more motivation  back
## Across Countries: OP Covariance Growth

<table>
<thead>
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<tbody>
<tr>
<td>United States</td>
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</tr>
<tr>
<td>United Kingdom</td>
<td>0.06</td>
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<tr>
<td>Germany</td>
<td>0.14</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.11</td>
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<tr>
<td>Hungary</td>
<td>0.18</td>
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<tr>
<td>Romania</td>
<td>0.25</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.16</td>
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</table>

source: Bartelsman Haltiwanger & Scarpetta (2013)

<table>
<thead>
<tr>
<th>Country</th>
<th>change</th>
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</thead>
<tbody>
<tr>
<td>India 1990 → 1995</td>
<td>0.18</td>
</tr>
<tr>
<td>India 1995 → 2000</td>
<td>0.09</td>
</tr>
<tr>
<td>India 2000 → 2006</td>
<td>0.06</td>
</tr>
<tr>
<td>India 2006 → 2011</td>
<td>0</td>
</tr>
</tbody>
</table>
Indian Financial Reforms

1991
- Improved accounting rules, bank transparency
- Recapitalized failing public-sector banks
- Allow public-sector banks to raise equity
- Loosened restrictions on FDI

After 1991
- Debt Recovery Tribunals Act
- Sarfaesi Act
- Continual reduction in government ownership of banking sector
OP Covariance $C$
Default Decision

- Net wealth tomorrow:
  
  pay back $b'$: \[ x' = \left( PAe^{z'} + 1 \right) k' + b' \]
  
  default on $b'$: \[ x' = (1 - \zeta) k' \]

- Value function will be increasing in net wealth, so indifference point is
  \[
  \varepsilon = \begin{cases} 
  \frac{1}{\sigma} \left[ \log (\ell - \zeta) - \log A - \log P - \rho z - Z \right] & \ell > \zeta \\
  -\infty & \text{otherwise}
  \end{cases}
  \]

  \[
  \ell \equiv -\frac{b'}{k'}
  \]

- In default, the lender recovers \( \chi \equiv \min \left\{ 1, \zeta \frac{k'}{-b'} \right\} = \min \left\{ 1, \frac{\zeta}{\ell} \right\} \).

- Default iff \( \varepsilon < \varepsilon \), so bond price is
  \[
  q(k', b', z; Z, \zeta, P) = q(\ell, \rho z + Z + \log P; \zeta)
  \]
  \[
  \quad = \frac{1}{1 + r} \left[ 1 - (1 - \chi) \Phi \{ \varepsilon \} \right]
  \]
Individual Agent’s Problem

- Individual agent’s problem:

\[
V(x, z; Z, \zeta, P, F) = \max_{k' \geq 0, b' \leq 0} u(c) + \beta \pi E \left\{ u(x') \right\} \\
+ \beta (1 - \pi) E \left\{ V(x', z'; Z', \zeta', P', F') \right\}
\]

s.t.
\[
c \equiv x - qb' - k' \\
q \equiv q \left( \frac{-b'}{k'}, \tilde{z}; \zeta \right) \\
\tilde{z} \equiv \rho z + Z + \log P \\
x' = \max \left\{ \left[ PAe^{\rho z + Z + \sigma \varepsilon} + 1 \right] k' + b', (1 - \zeta) k' \right\}
\]

- Exogenous aggregate demand curve \( \log P = -\eta \log Y + D. \)
Special Case: Log Utility

- Implies that the optimal decisions satisfy

\[ k' + q(\ell, \rho z + Z + \log P; \zeta) b' = \beta^* x \]
\[ c = (1 - \beta^*) x \]

for a calculable \( \beta^* < \beta \).

- Optimal \( (k', b') \) as a proportion of \( x \) depend only on current value of \( (\rho z + Z + \log P, \zeta) \).

- Wealth distribution \( F \) only affects equilibrium through current \( P \).
Decision Rules

- Define $\tilde{z} \equiv \rho z + Z + \log P$.
- First-order condition for $\ell$ is
  \[
  q + \frac{\partial q}{\partial \ell} \ell = \int_{\varepsilon(\ell, \tilde{z})}^{\infty} \frac{\phi(\varepsilon) d\varepsilon}{A e^{\tilde{z} + \sigma \varepsilon} + 1 - \ell} 
  \]
  (1)
- Let $\tilde{z}(r)$ solve equation (1) for $\ell = 0$. Then

\[
\begin{align*}
\tilde{z} & \quad b' = 0 \\
\tilde{z} & \quad b' < 0 \\
\tilde{z}(r) & \quad k' = \beta^* x \\
\tilde{z} & \quad k' > \beta^* x \\
\ell & \quad \ell > 0
\end{align*}
\]
Model: Approach

- Two aggregate shocks:
  - Common productivity $Z$
  - Financial friction $\theta$: recovery rate for risky loans / fraction borrowers can "steal."

- $Z$ or $\theta \uparrow \Rightarrow$ more-productive firms grow faster $\Rightarrow$ increase OP covariance.

- Only $Z$ shocks increase unweighted average productivity.

\[(Z, \theta) \xrightarrow{\text{model}} (Z, C)\]

interactable \hspace{1cm} observable