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

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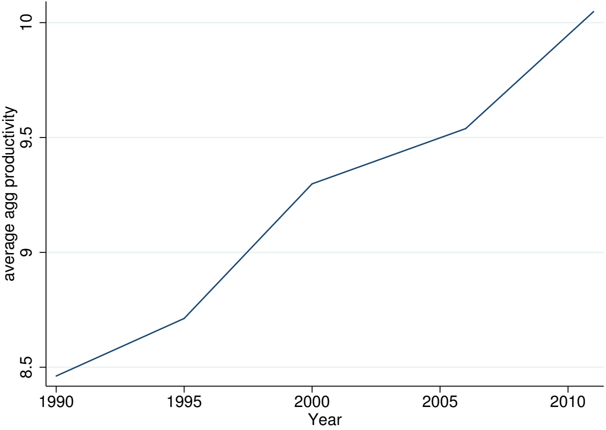
# Motivation

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




Indian financial reforms

# 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.

mechanism

# 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. details
- 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.

model detail

# Log Aggregate Productivity Decomposition

$$Y_i \equiv \text{value added}_i = e^{z_i} L_i \qquad L_i \equiv \text{employment}_i \qquad w_i \equiv \frac{L_i}{\sum_j L_j}$$

$$\text{Log Agg Prod} \equiv \log \frac{\sum_i Y_i}{\sum_i L_i}$$

$$\approx \sum_i w_i z_i = \underbrace{\frac{1}{N}\sum_{i=1}^{N} z_i}_{\text{average productivity: } \mathcal{Z}} + \underbrace{\sum_{i=1}^{N} (z_i - \mathcal{Z})\left(w_i - \frac{1}{N}\right)}_{\text{OP covariance: } \mathcal{C}}$$

details across countries

# Identification

- Increases in collateral rate:
  - Lower cost of capital $\Rightarrow$ highly-productive firms lever up and grow faster on average $\Rightarrow \mathcal{C}$ 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 $\Rightarrow \mathcal{C}$ increases.
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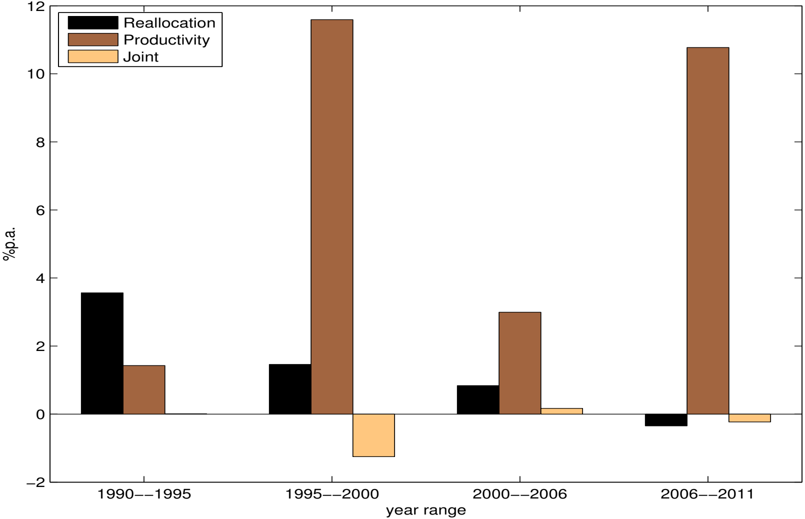
$$\underbrace{(Z, \theta)}_{\text{interpretable}} \underset{\text{model}}{\rightarrow} \underbrace{(\mathcal{Z}, \mathcal{C})}_{\text{observable}}$$

# Aggregate Productivity Decomposition

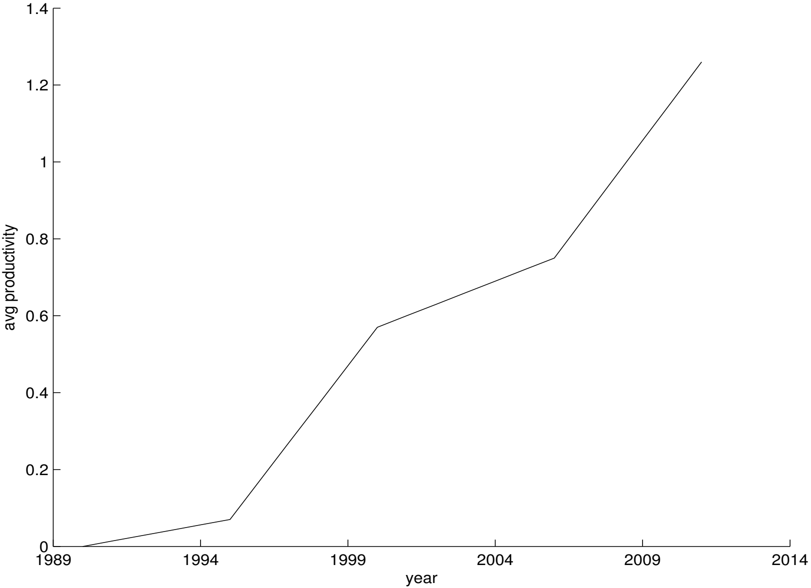



back data

# 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 $\mathcal{Z}$ z



- Plugging in the guess for the value function yields

$$a + b \log x = \text{const} + \log x + \beta \left[ (1-\pi) b + \pi \right] \underbrace{E \log x'}_{= E\{\log x + \text{const}\}}$$

- so that b satisfies

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

- Define

$$\widetilde{\beta} \equiv \beta \left[ (1-\pi) b + \pi \right]$$

- Then

$$\beta^* = \frac{\widetilde{\beta}}{1 + \widetilde{\beta}}$$

back

# 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?

back

# Log Aggregate Productivity Approximation

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

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

$$\frac{\partial f}{\partial z_j}\left(\vec{z}\right)\Big|_{\vec{1} z} = \frac{1}{\sum_i w_i e^{z_i}} w_j e^{z_j}\Big|_{\vec{1} z} = \frac{w_j e^z}{e^z \sum_i w_i}\Big|_{\vec{1} z} = w_j$$

$$f'\left(\vec{1} z\right) = \frac{\vec{w}}{\vec{w} \cdot \vec{1}} = \vec{w}$$

$$f\left(\vec{z}\right) \approx z + \vec{w} \cdot \left(\vec{z} - \vec{1} z\right) = z + \vec{w} \cdot \vec{z} - \left(\vec{w} \cdot \vec{1}\right) z$$

$$= \sum_i w_i z_i$$

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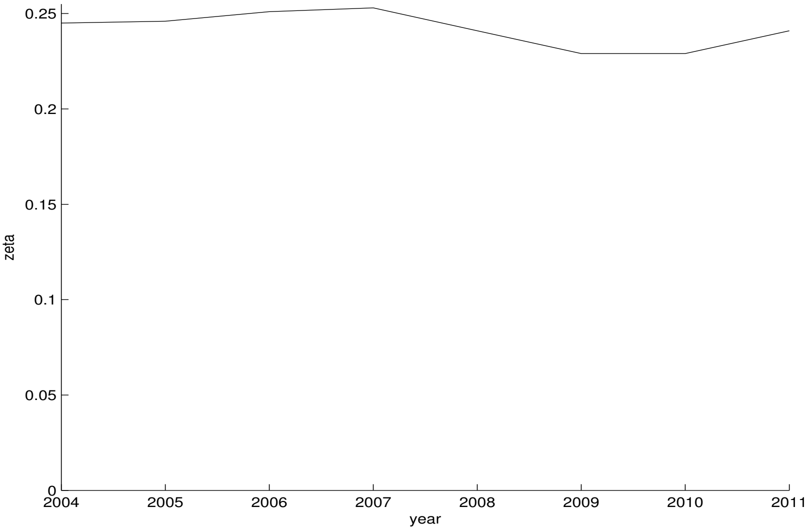
# Time Series for World Bank Doing Business Recovery Rate

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# 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."

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# Robustness to $\eta$

| $\eta$ | Terminal $\theta$ | Percent of Growth from $\theta$ 1990–1995 | 1995–2011 | Δ% NSS Share Model | Data | |
|---|---|---|---|---|---|---|
| 0.3 | 0.29 | 70% | -8.4–10.0% | -14.0% | -11.2% | graph |
| 0.4 | 0.33 | 71% | -3.5–8.6% | -12.3% | -11.2% | graph |
| 0.5 | 0.38 | 71% | 2.4–7.5% | -11.1% | -11.2% | graph |
| 0.6 | 0.45 | 71% | 6.6–9.9% | -10.0% | -11.2% | graph |

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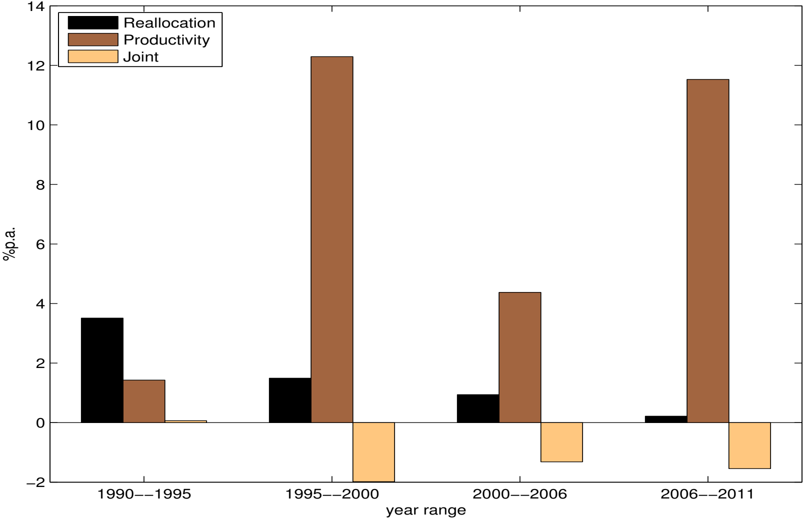
# Aggregate Productivity Decomposition, $\eta = 0.3$

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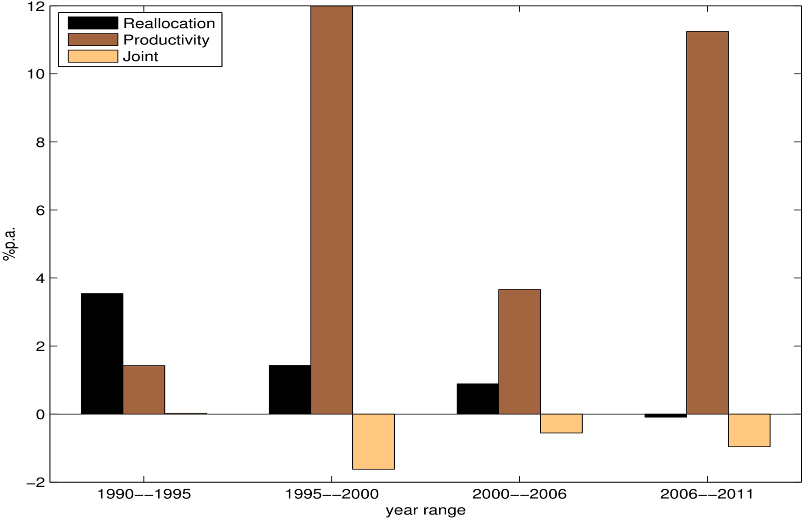
# Aggregate Productivity Decomposition, $\eta = 0.4$

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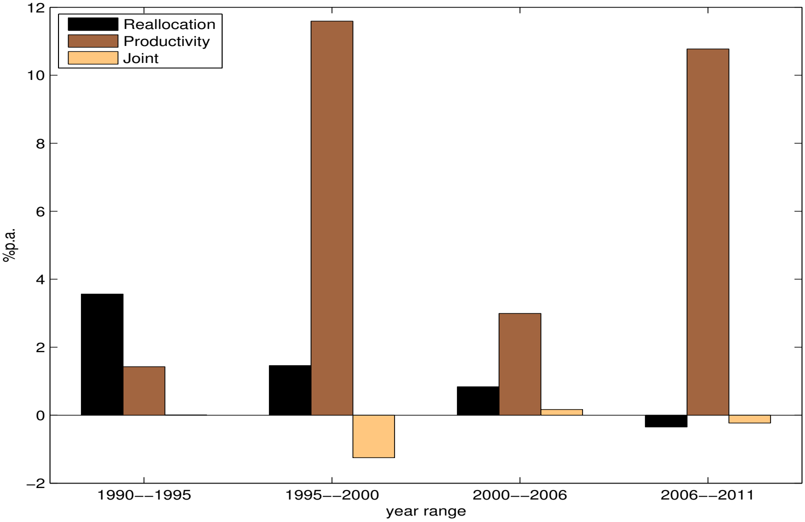
# Aggregate Productivity Decomposition, $\eta = 0.5$

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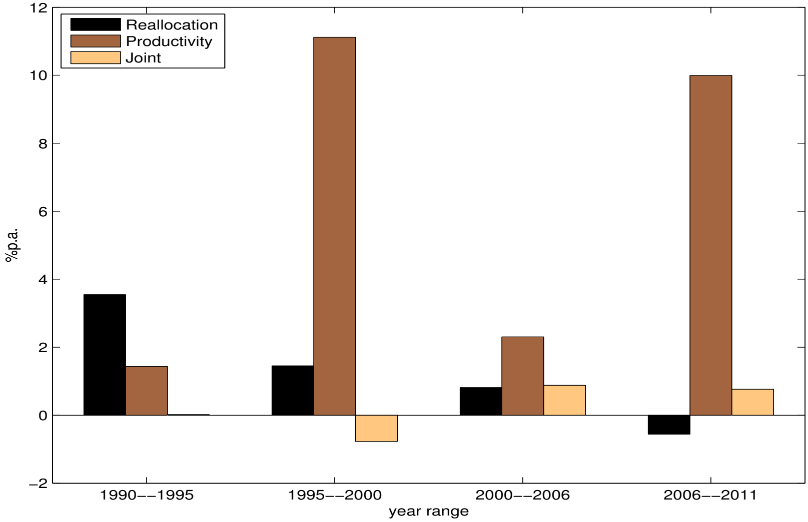
# Aggregate Productivity Decomposition, $\eta = 0.6$

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# Labor Productivity

- At the beginning of the period, after idiosyncratic shocks are realized, agent has total resources $\widetilde{k}$.
- Working capital constraint: labor must be paid before production occurs.
- Agent's problem at start of period:

$$\max_{k,L} \; Ae^z k^\alpha L^{1-\alpha} - wL + k$$
$$\text{s.t.} \;\; k + wL \leq \widetilde{k}$$

back (model setup) back (model OP) timing

# Labor Productivity

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

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

and

$$k(z)=\widetilde{k}/\left[1+wm(z)\right].$$

- Labor productivity is

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

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# 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

| Country | change (1993–1996 → 1997–2001) |
|---|---|
| United States | 0.09 |
| United Kingdom | 0.06 |
| Germany | 0.14 |
| Netherlands | 0.11 |
| Hungary | 0.18 |
| Romania | 0.25 |
| Slovenia | 0.16 |
| source: Bartelsman Haltiwanger & Scarpetta (2013) | |
| India 1990 → 1995 | 0.18 |
| India 1995 → 2000 | 0.09 |
| India 2000 → 2006 | 0.06 |
| India 2006 → 2011 | 0 |

back

# 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

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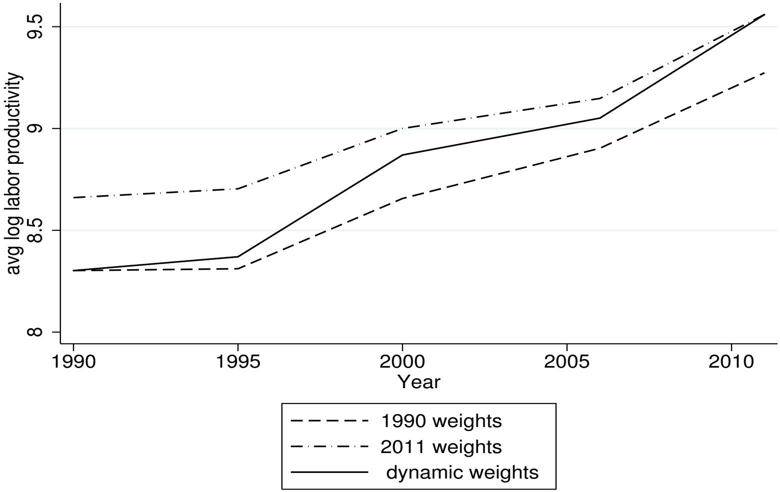
# Average Productivity $\mathcal{Z}$

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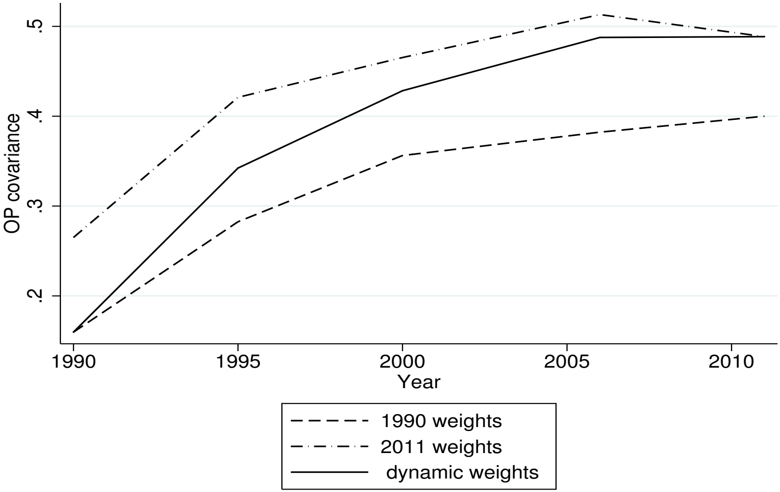
# OP Covariance $\mathcal{C}$

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# Default Decision

- Net wealth tomorrow:

$$\text{pay back } b'\text{:} \quad x' = \left(PAe^{z'} + 1\right) k' + b'$$
$$\text{default on } b'\text{:} \quad x' = (1 - \zeta)\, k'$$

- Value function will be increasing in net wealth, so indifference point is

$$\underline{\varepsilon} = \begin{cases} \frac{1}{\sigma}\left[\log(\ell - \zeta) - \log A - \log P - \rho z - Z\right] & \ell > \zeta \\ -\infty & \text{otherwise} \end{cases}$$
$$\ell \equiv -\frac{b'}{k'}$$

- In default, the lender recovers $\chi \equiv \min\left\{1, \zeta \frac{k'}{-b'}\right\} = \min\left\{1, \frac{\zeta}{\ell}\right\}$.
- Default iff $\varepsilon < \underline{\varepsilon}$, so bond price is

$$q\left(k', b', z; Z, \zeta, P\right) = q\left(\ell, \rho z + Z + \log P; \zeta\right)$$
$$= \frac{1}{1+r}\left[1 - (1 - \chi)\,\Phi\left\{\underline{\varepsilon}\right\}\right]$$

# Individual Agent's Problem

- Individual agent's problem:

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

s.t.

$$c \equiv x - qb' - k'$$

$$q \equiv q\left(\frac{-b'}{k'}, \widetilde{z}; \zeta\right)$$

$$\widetilde{z} \equiv \rho z + Z + \log P$$

$$x' = \max\left\{\left[PAe^{\rho z + Z + \sigma\varepsilon} + 1\right] k' + b', \left(1-\zeta\right) k'\right\}$$

- Exogenous aggregate demand curve $\log P = -\eta \log Y + D$.

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# Special Case: Log Utility

- Implies that the optimal decisions satisfy

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

for a calculable $\beta^* < \beta$. details

- Optimal $\left(k', b'\right)$ 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 $P$.

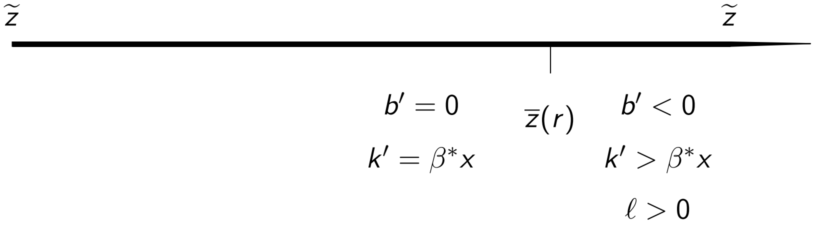
back

# Decision Rules

- Define $\widetilde{z} \equiv \rho z + Z + \log P$.
- First-order condition for $\ell$ is

$$\frac{q + \frac{\partial q}{\partial \ell}\ell}{1 - q\ell} = \int_{\underline{\varepsilon}(\ell,\widetilde{z})}^{\infty} \frac{\phi(\varepsilon)\, d\varepsilon}{Ae^{\widetilde{z}+\sigma\varepsilon} + 1 - \ell} \tag{1}$$

- Let $\overline{z}(r)$ solve equation (1) for $\ell = 0$. Then

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# 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.
-

$$\underbrace{(Z, \theta)}_{\text{interpretable}} \underset{\text{model}}{\rightarrow} \underbrace{(\mathcal{Z}, \mathcal{C})}_{\text{observable}}$$

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