A Literature Review on Finance and Development:

A Tale of Two Sector

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Outline

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- Income per capita differences across countries are primarily accounted for by low total factor productivity (TFP) in poor countries (Klenow and Rodríguez-Clare, 1997; Hall and Jones, 1999).
- These productivity gaps are sector-specific—manufacturing sectors are particularly unproductive in poor countries (Hsieh and Klenow, 2007).
- Buera et al. (2011) discovers that financial frictions explain a substantial part of the development regularities above.

Research Objective

- Buera et al. (2011) presents a rich quantitative framework and analyze the role of financial frictions in explaining a set of empirical regularities in economic development:

  > Poor countries' low per capita income, low aggregate TFP, and large differences across industrial sectors in relative prices and implied sector-level productivity

- i.e., To quantitatively assess how financial frictions contribute to:
  - Cross-country income differences
  - Aggregate and sector-level TFP gaps
  - Sectoral differences in capital-output ratios and relative prices
- To understand the differential effects of financial frictions across sectors, particularly manufacturing and services.

What Previous Literature Has Done

Finance and Development (Macro-level empirical and theoretical work)

- Papers by King and Levine (1993) and Beck et al. (2000) show strong correlations between financial development and GDP per capita.
- La Porta et al. (2002) link financial development with institutional quality.
- Banerjee and Duflo (2005) and Townsend (2011) provide micro-evidence of credit constraints and misallocation in poor countries.

Quantitative Macro Models

- Giné and Townsend (2004) and Jeong and Townsend (2007) study the link between finance and growth using Thai data.
- Amaral and Quintin (2010), Greenwood et al. (2013) use tractable models to quantify long-run effects of financial frictions, often ignoring dynamic self-financing.

Sectoral Heterogeneity & Finance

- Rajan and Zingales (1996) highlight how industries that depend more on external finance grow faster in financially developed countries.
- Erosa and Hidalgo Cabrillana (2008) explore sector-specific financial effects due to fixed costs.
- Castro et al. (2009) study sectoral productivity under volatility and limited risk-sharing.

Misallocation and Aggregate TFP

- Hsieh and Klenow (2009) emphasize the aggregate TFP loss due to misallocation in manufacturing.
- Restuccia and Rogerson (2008) and others model micro-distortions' macro effects

Gaps in the existing literature

1. Most prior work focused on aggregate effects of financial frictions or on one-sector models, focusing on emphasizing micro-level calibration to a single country or rely on tractable models that abstract from rich heterogeneity and sectoral structure.
2. There was little empirical work linking sector-level scale (e.g., average establishment size) to financing needs and financial dependence.
3. Prior quantitative studies often **assumed static financing constraints** or ignored the dynamic self-financing behavior of entrepreneurs.
4. Previous work typically targeted one dimension of development (e.g., output per worker, capital misallocation, or TFP) in isolation.

Contribution to existing literature

1. Develop a multi-sector quantitative model with sector-specific fixed costs and scale differences, endogenous financial frictions via collateral constraints, and self-financing through forward-looking savings
2. Show that financial frictions cause significant misallocation of capital and talent and explain a large share of income and TFP differences across countries. Also, it disproportionately harm large-scale sectors like manufacturing
3. Match empirical patterns across countries and sectors, including: (1) Size distributions of establishments, (2) Sectoral TFP gaps, (3) Capital-output ratios and investment patterns
4. Provide novel empirical evidence on the link between sectoral scale, external finance dependence, and productivity using data from OECD countries and a case study of Mexico vs. the US.

Outline

- In poor countries, **the relative price of manufactured goods** (to services) **is higher**.
- **Left panel of Figure 1**:
  - A **strong negative relationship** between output per worker and the relative price of manufactured goods.
  - **Regression coefficient**: -0.45, significant with $R^2 = 0.40$.

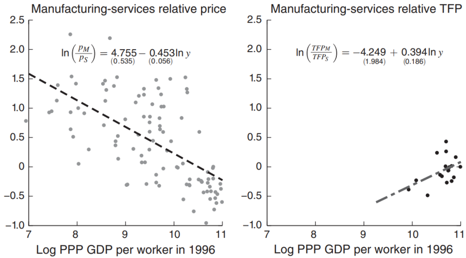
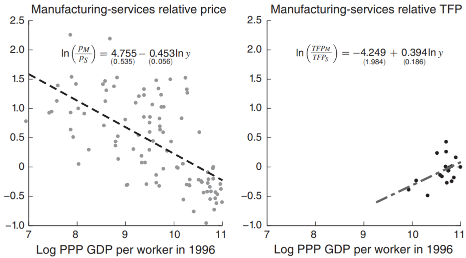


Figure: Relative Prices and Relative Productivity against Output per Worker. *Left panel*: relative price of manufactured goods to services against purchasing power parity (PPP) output per worker; *Right panel*: log relative sector-level TFP of manufacturing to services against log GDP per worker

- According to standard models with constant returns and equal factor shares, **relative prices reflect inverse relative TFP**. That is, **higher prices for manufacturing** in poor countries imply **lower manufacturing TFP** relative to services.
- **Right panel of Figure 1** - construct sector-level TFP measures for 18 OECD countries:
  - **The relative TFP of manufacturing to services** is **positively correlated** with GDP per worker.
  - **Regression coefficient**: 0.39, significant at 5% level with $R^2 = 0.22$.
- These two findings are mutually consistent: Poor countries $\rightarrow$ **high relative price of manufactured goods** $\rightarrow$ **low relative manufacturing TFP**.



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Scale Differences across Sectors (1)

- **Key empirical fact**: Manufacturing requires larger scale/ finance compared to the service sector
- Interpretation:
  - Differences in scale reflect **sector-specific micro-level production technologies**.
  - These technological differences **interact with financial development**, leading to **differential effects** on large-scale sectors (e.g., manufacturing) vs. small-scale sectors (e.g., services).

Scale Differences across Sectors (2)

- **Two scale measures**: (1) Workers per establishment (business location), (2) Workers per enterprise (entire firm, may own multiple establishments)
- **Findings on scale**: From Table 1
  - **US data** (*first column*): **Manufacturing**: 47 workers/establishment, **Services**: 14 workers/establishment → **Scale ratio**: 3.4:1
  - **OECD data** (*second column*): **Manufacturing**: 28 workers/enterprise, **Services**: 8 workers/enterprise → **Scale ratio**: 3.5:1

	Workers per establishment	Workers per enterprise	External dependence	Capital share
	US	OECD	US	US
Manufacturing	47	28	0.21	0.31
Services	14	8	0.09	0.27

Table: Sectoral differences in scale, external finance dependence, and capital share

Scale Differences across Sectors (3)

- **Financing Needs and Scale**: Financial frictions **disproportionately affect larger-scale sectors** (e.g., manufacturing), due to higher **financing needs**.
  - From *third column* Table 1, Median external dependence: **Manufacturing**: 0.21; **Services**: 0.09

    *Since external dependence is limited to publicly traded firms, Buera et al. (2011) focuses on **scale (employment)** instead, as it's available economy-wide.*
- **Capital Intensity Differences**: Capital share in gross output (Ákos Valentinyi and Herrendorf, 2008):
  - From *fourth column* Table 1, Median external dependence: **Manufacturing**: 0.31; **Services**: 0.27 $\rightarrow$ **Difference is small** compared to scale or external dependence.

    *Since external dependence is limited to publicly traded firms, Buera et al. (2011) **abstracts from capital intensity** in their model and focus on the **larger cross-sector differences in scale and financing needs**.*

	Workers per establishment	Workers per enterprise	External dependence	Capital share
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Manufacturing	47	28	0.21	0.31
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Relative Prices, Productivity, & Scale (1)

- The study investigates whether **relative prices, productivity, and scale** are systematically related at a **disaggregated industry level**, beyond broad sectoral trends.
- **Data & Methodology**:
  - Constructs industry scale from the average number of workers per enterprise across 9 OECD countries using SSIS data.
  - Regresses log relative prices on log output per worker, log industry scale, and their interaction.
- **Main price regression result**:

$$\ln\left(\frac{p_{i,j}}{PPP_i}\right) = \underset{(0.56)}{-7.48} + \underset{(0.05)}{0.29 \ln y_i} + \underset{(0.15)}{1.01} \ln \bar{l}_j - \underset{(0.02)}{0.10 \ln y_i \ln \bar{l}_j}, \quad R^2 = 0.22, \tag{1}$$

  - Relative prices of large-scale industries are **higher in low-income countries**.
  - **The interaction term is negative**, indicating that **scale amplifies the price divergence** across countries.

Relative Prices, Productivity, & Scale (2)

- **TFP regression using GGDC data (29 industries in 18 countries)**:

$$\ln\left(\frac{TFP_{i,j}}{TFP_i}\right) = \underset{(0.28)}{12.18} - \underset{(0.32)}{1.10} \ln y_i - \underset{(1.00)}{3.52} \ln \bar{l}_j + \underset{(0.09)}{0.32 \ln y_i \ln \bar{l}_j}, \quad R^2 = 0.08, \tag{2}$$

  - Shows **relative TFP is lower in large-scale industries** in low-income countries.
  - The interaction term is **positive**, implying **scale effects are more productivity-depressing** in poorer economies.
- **Conclusion**: Even at a more disaggregate level, less developed countries have relatively **high prices** and **low productivity** in **industries with larger scales**.

Summary of Key empirical facts

1. The **price of manufactured goods is high relative to services in less developed countries**. Such relative prices are closely linked to sector-level relative productivity.
2. There are large differences in scale (establishment size) across sectors, with the **manufacturing sector having much larger establishments** on average than the service sector.
3. This sectoral pattern in relative scale and relative productivity also holds at a more **disaggregate level**:

    Goods and services that are produced with large-scale technologies tend to be relatively more expensive in less developed economies, implying their low relative productivity in these industries.

Proof that financial markets could substantially boost productivity and development, especially in capital-intensive sectors like manufacturing and for underdeveloped to developing countries

Outline

Model Setup

- Consider an economy with 2 sectors: services **(S)**, and manufacturing **(M)**.
  - **Services:** This represents a small-scale sector, where output is only used for consumption.
  - **Manufacturing:** This represents a large-scale sector, where output is only used for both consumption and investment.
- **Population and Heterogeneity**: There are N infinitely-lived individuals in our economy
  - These individuals are heterogeneous in wealth **(a)**, which is determined endogenously by savings behaviors.
  - These individuals are also heterogeneous in their entrepreneurial talents $z = (z_S, z_M)$, which represents productivity in either sector.
- In each period, an individual can choose their occupation: work for a wage or be an entrepreneur in sectors **(S)** or **(M)**. Occupational choice depends on:
  - Individuals' comparative advantage as an entrepreneur **(z)**.
  - Their access to capital, which is limited by their wealth through an endogenous collateral constraint, because capital rental contracts may not be perfectly enforceable in our model.

Entrepreneurial Talents

- Each individual's entrepreneurial talent is represented by $z = (z_S, z_M)$.
- The vector **(z)** is drawn from a distribution $\mu(z)$.
- Entrepreneurial ideas die with a constant hazard rate of $1 - \gamma$:
  - In this case, a new vector **(z)** is independently drawn from $\mu(z)$.
  - γ controls the persistence of the entrepreneurial talents process.
  - γ can also be interpreted as the change in market conditions that affect the profitability of individual skills.
- One entrepreneur can only operate one establishment in one period.
- Entrepreneurial ideas are inalienable, meaning that there is no market for them, and entrepreneurs must operate their own firms.

Preferences

- To analyze how individuals allocate consumption over time and across different goods, Buera et al. (2011) defines their preferences using an **expected lifetime utility function**:

$$U(c) = \mathbb{E}\left[\sum_{t=0}^{\infty} \beta^t u(c_t)\right] \tag{3}$$

- c_t represents the sequences of consumption: $c_t = (c_{S,t}, c_{M,t})$
- The per-period utility function is given by:

$$u(c_t) = \frac{1}{1-\sigma}\left(\psi c_{S,t}^{1-1/\varepsilon} + (1-\psi) c_{M,t}^{1-1/\varepsilon}\right)^{(1-\sigma)/(1-1/\varepsilon)} \tag{4}$$

  - σ is the coefficient of relative risk aversion (CRRA).
  - ϵ is the elasticity of substitution between two goods.
  - ψ controls the share of services in overall consumption expenditure.

Technology

- **Scale Difference**: Fixed cost in **(M)** is higher than that in **(S)** ($\kappa_M > \kappa_S$).
- Production function of an entrepreneur with talent z_j:

$$z_j f(k, l) = z_j k^{\alpha} l^{\theta} \tag{5}$$

- The general entrepreneur's profit function:

$$\pi_j(k, l; R, w, \mathbf{p}) = p_j z_j k^{\alpha} l^{\theta} - Rk - wl - (1 + r)p_j \kappa_j \tag{6}$$

- The optimal level of capital and labor inputs when production is not subject to financial constraints:

$$\left(k_j^* \left(z_j\right), l_j^* \left(z_j\right)\right) = \arg\max_{k,l} \left\{p_j z_j k^{\alpha_j} l^{\theta_j} - Rk - wl\right\} \tag{7}$$

- Non-convexity: firms must operate at a minimum scale to cover their fixed costs:

$$z_j k_j^{\alpha_j} l_j^{\theta_j} \geq (1 + r)\kappa_j \tag{8}$$

Credits and Rental Markets

- Individuals have access to financial intermediaries. These intermediaries accept deposits, rent capital k to entrepreneurs at a rental rate R, and provide loans to cover the fixed costs $p_j\kappa_j$ required for business operations.
- **Restrictions:** Both borrowing and capital rental are within a period. That is, individuals' financial wealth remains nonnegative at all times ($a \geq 0$).
- **The zero-profit condition:** The rental rate of capital must be equal to the sum of the interest rate on deposits (r) and the depreciation rate (δ): $R = r + \delta$.
- **Imperfect enforceability of contract:** If entrepreneurs choose to renege, they can keep a fraction $1 - \phi$ of the undepreciated capital and the revenue net of labor payments:
$$(1-\phi)\left[p_j z_j f(k,l) - wl + (1-\delta)k\right] \tag{9}$$
  - ϕ measures the strength of legal enforcement in financial markets ($\phi \in [0, 1]$).
- The only punishment is the garnishment of their financial assets deposited with the financial intermediary, a.

Credits and Rental Markets (cont.)

- We study equilibria where the rental of capital is quantity-restricted by an upper bound: $\bar{k}^j(a, z_j; \phi)$. This constraint ensures that entrepreneurs do not have an incentive to default on their obligations. Without loss of generality, we assume:

$$\bar{k}^j(a, z_j; \phi) \leq k_u^j(z_j) \tag{10}$$

  - k_u^j is the profit-maximizing capital inputs in the unconstrained static problem.
- This guarantees that borrowing constraints are always binding for some entrepreneurs, thereby influencing sectoral investment dynamics.

Credits and Rental Markets (cont.)

- Enforceability conditions:

Proposition 1

Capital rental k in sector j by an entrepreneur with wealth a and talent z_j is enforceable if and only if

$$\begin{aligned} &\max_{l} \{p_j z_j f(k,l) - wl\} - Rk - (1+r)p_j \kappa_j + (1+r)a \\ &\geq (1-\phi)\left[\max_{l} \{p_j z_j f(k,l) - wl\} + (1-\delta)k\right]. \end{aligned} \tag{11}$$

The upper bound on capital rental that is consistent with entrepreneurs choosing to abide by their contracts can be represented by a function $\bar{k}^j(a, z_j; \phi)$, which is increasing in a, z_j, ϕ.

- An entrepreneur must end up with (weakly) more economic resources when he fulfills his credit and rental obligations (left-hand side) than when he defaults (right-hand side).

Recursive Representation of Individuals' Problem

- At the beginning of a period, an individual's state is summarized by his wealth **a** and vector of talent **z**.
- The value for him at this stage, $v(a, \mathbf{z})$, is:

$$v(a, \mathbf{z}) = \max \left\{ v^W(a, \mathbf{z}), v^S(a, \mathbf{z}), v^M(a, \mathbf{z}) \right\} \tag{12}$$

  - We denote the optimal occupational choice by $o(a, \mathbf{z}) \in \{W, S, M\}$.

Employee's Problem

- An individual chooses a consumption bundle $\mathbf{c} = (c_S, c_M)$ and next period's assets a' to maximize his continuation value s.t. budget constraints.

$$
\begin{aligned}
v^W(a, \mathbf{z}) = \max_{\mathbf{c}, a' \geq 0} u(\mathbf{c}) + \beta \left\{ \gamma v\left(a', \mathbf{z}\right) + (1-\gamma)\mathbb{E}_{\mathbf{z}'}\left[v\left(a', \mathbf{z}'\right)\right]\right\} \\
\text{s.t. } \mathbf{p} \cdot \mathbf{c} + a' \leq w + (1+r)a,
\end{aligned}
\tag{13}
$$

- $(1+r)a$ is the return on assets, $\mathbf{p}$ is vector of goods prices.
- γ is the probability that talent remains unchanged; $1-\gamma$ follows a stochastic process $\mathbf{z}' \sim \mu\left(\mathbf{z}'\right)$.

Enterpreneur's Problem

- Entrpreneurs choose between the two sectors j (where $j = S, M$) by comparing expected profits and financial constraints.

$$
\begin{aligned}
v^j(a, \mathbf{z}) = & \max_{\mathbf{c}, a', k, l \geq 0} u(\mathbf{c}) + \beta \left\{ \gamma v\left(a', \mathbf{z}\right) + (1-\gamma) \mathbb{E}_{\mathbf{z}'}\left[v\left(a', \mathbf{z}'\right)\right] \right\} \\
& \text{s.t. } \mathbf{p} \cdot \mathbf{c} + a' \leq p_j z_j f(k, l) - Rk - wl - (1+r) p_j \kappa_j + (1+r) a \\
& k \leq \bar{k}^j\left(a, z_j; \phi\right)
\end{aligned} \tag{14}
$$

- $p_j z_j f(k, l)$ is the revenue from production.
- Rk is the capital rental costs.
- $(1+r) p_j \kappa_j$ is fixed entry cost for entrepreneurship.
- $(1+r) a$ is return on financial wealth.
- His choices of capital inputs are constrained by the rental limit $\bar{k}^j(a, z_j; \phi)$

Stationary Competitive Equilibrium

- A **stationary competitive equilibrium** is a state where the economy reaches a **steady-state** (*i.e., invariant*) distribution of wealth and entrepreneurial abilities $G(a, \mathbf{z})$, such that all markets clear, financial contracts hold, and the decision-making behavior of individuals remains consistent over time.
- Each individual in the economy makes decisions about consumption in each sector $c_S(a, \mathbf{z})$, $c_M(a, \mathbf{z})$, next period asset accumulation $a\prime(a, \mathbf{z})$, occupational choice $o(a, \mathbf{z})$ (whether to be a worker or entrepreneur), labor and capital input choices $l(a, \mathbf{z})$, $k(a, \mathbf{z})$ (if they are enterpreneurs in either sector).
- These decisions depend on prices $(w, R, r, \mathbf{p})$ and the borrowing limit $\bar{k}_j(a, z_j; \phi)$.

Conditions for the Stationary Competitive Equilibrium

Financial Markets and Capital Rental

- **Zero-profit condition:** Financial intermediaries provide capital rental but must break even, leading to the condition $R = r + \delta$ so that financial institutions cover depreciation costs while still earning a return equal to the risk-free rate.
- **Borrowing limits:** The borrowing limits $\bar{k}^j(a, z_j; \theta)$ reflect financial frictions and credit constraints. However, these limits cannot exceed the capital demand of the most productive firms, given by $k_u^j(z_j)$, ensuring that resources are allocated efficiently among businesses: $\bar{k}^j(a, z_j; \theta) \leq k_u^j(z_j)$.

Conditions for the Stationary Competitive Equilibrium

Market-clearing conditions - supply equals demand in all factor and goods markets.

- **Capital Rental Market:**

$$K_N \equiv \int k(a, \mathbf{z}) G(da, dz) = \int a G(da, dz). \tag{15}$$

  - *Left side*: entrepreneurs's total ***capital demand***. *Right*: agents' **total wealth**.
  - **The available capital supply must be fully allocated to entrepreneurs who rent it for production**. If not, entrepreneurs may not be able to rent the capital they need $\rightarrow$ misallocation

- **Labor Market:**

$$\int l(a, \mathbf{z}) G(da, dz) = \int_{\{o(a,\mathbf{z})=W\}} G(da, dz). \tag{16}$$

  - *Left side*: firms' total labor hired. *Right*: total no. workers choosing to remain in wage employment rather than becoming entrepreneurs.
  - Wages are too high $\rightarrow$ fewer entrepreneurs will demand labor $\rightarrow$ excess labor supply, vice versa.

Conditions for the Stationary Competitive Equilibrium

Market-clearing conditions - supply equals demand in all factor and goods markets.

- **Services Market:**

$$\int c_S(a,\mathbf{z})G(da,dz) = \int_{\{o(a,\mathbf{z})=S\}} \left[z_S k(a,\mathbf{z})^{\alpha} l(a,\mathbf{z})^{\theta} - \kappa_S\right] G(da,dz). \tag{17}$$

- **Manufacturing Market:**

$$\int c_M(a,\mathbf{z})G(da,dz) + \delta K_N = \int_{\{o(a,\mathbf{z})=M\}} \left[z_M k(a,z)^{\alpha} l(a,\mathbf{z})^{\theta} - \kappa_M\right] G(da,dz). \tag{18}$$

  - *Left side*: total demand for services (for mfg, this includes capital depreciation δK_N). *Right*: total output produced net of fixed costs

- All goods produced are either consumed (or used for capital replacement in the case of manufactured goods).

Stationary Condition of the Wealth Distribution

- The economy reaches a stationary equilibrium when the joint distribution of wealth and entrepreneurial talent remains constant over time:

$$G(a, \mathbf{z}) = \gamma \int_{\{(a', \mathbf{z}') | \mathbf{z}' \leq \mathbf{z}, a'(a', \mathbf{z}') \leq a\}} G(da', dz') + (1 - \gamma)\mu(\mathbf{z}) \int_{\{(a', \mathbf{z}') | a'(a', \mathbf{z}') \leq a\}} G(da', dz'). \tag{19}$$

  - *First term*: entrepreneurs who continue operating. *Second term*: new entrants replacing existing entrepreneurs.

Perfect Credit Benchmark

- Perfect credit benchmark: $\phi = 1$.

Key Assumptions

1. Entrepreneurs have **unrestricted access to capital** within a period:

$$\bar{k}^j (a, z_j, \phi) = k_j^u (z_j), \quad \forall a \tag{20}$$

   - There is no between-period borrowing or consumption insurance so that entrepreneurs cannot transfer wealth across time or insure against shocks.

2. **Entrepreneurial Talent Follows a Pareto Distribution:** Entrepreneurial ability z_j (where $j = S, M$ for service and manufacturing sectors) follows a mutually independent Pareto distribution:

$$\eta, (z_S, z_M) \sim \eta^2 (z_S z_M)^{-(\eta+1)} \quad \text{for} \quad z_j \geq 1$$

   - η: degree of inequality in entrepreneurial talent. A lower $\eta \rightarrow$ larger firms.

- Closed-form expressions of the net sectoral output function, factor shares, and endogenous productivity:

Proposition 2

Assume that entrepreneurial talents for the two sectors follow mutually independent Pareto distributions with the same tail parameter η, $(z_s, z_M) \sim \eta^2 (z_S z_M)^{-(\eta+1)}$ for $z_j \geq 1, j = S, M$, and that active entrepreneurs are a small fraction of the population. Then the output of a sector, net of fixed costs, equals

$$Y_j\left(K_j, L_j; N\right) = A_j N^{\frac{(1/\eta)}{(\alpha+\theta+1/\eta)}} K_j^{\frac{\alpha}{(\alpha+\theta+1/\eta)}} L_j^{\frac{\theta}{(\alpha+\theta+1/\eta)}} \tag{21a}$$

$$A_j = \frac{w + p_j\kappa_j\left(\alpha+\theta+\eta^{-1}\right)}{w + p_j\kappa_j}\left[\frac{\eta(1-\alpha-\theta)}{\eta(1-\alpha-\theta)-1}\right]^{\frac{1}{(1+\eta(\alpha+\theta))}}\left[\frac{w + p_j\kappa_j}{p_j(1-\alpha-\theta)}\right]^{\frac{(1-\eta(1-\alpha-\theta))}{(1+\eta(\alpha+\theta))}} \tag{21b}$$

- where sector-specific productivity A_j is **endogenously** determined by wages w, fixed costs $p_j\kappa_j$, and the distribution of entrepreneurial talent.

Perfect Credit Benchmark - Production output

- Entrepreneurs earn **rents** from their abilities, factor payments (to labor and capital) *do not exhaust* total output.

  $\rightarrow$ The sum of factor income shares is strictly less than one $\rightarrow$ the actual payments to capital are lower than the capital elasticity in the production function.

- The **payments to capital**: determined by the share of income allocated to capital in each sector j

$$s_{K,j} = \frac{RK_j}{Y_j(K_j, L_j; N)} = \frac{\alpha(w + p_j\kappa_j)}{w + p_j\kappa_j(\alpha + \theta + \eta^{-1})} \tag{22}$$

Establishment Size Distribution in Each Sector

Proposition 3a

Assume that entrepreneurial talents for the two sectors follow mutually independent Pareto distributions with the same tail parameter η, $(z_s, z_M) \sim \eta^2 (z_S z_M)^{-(\eta+1)}$ for $z_j \geq 1, j = S, M$, and that active entrepreneurs are a small fraction of the population. Then the establishment size distribution in each sector follows the power law

$$\Pr\left[\tilde{l}_j > l\right] = \left(\frac{l(\hat{z}_j)}{l}\right)^{\eta\cdot(1-\alpha-\theta)}, \quad l \geq l(\hat{z}_j) \tag{23}$$

where $l(\hat{z}_j)$ is the employment in the marginal establishment of sector j.

- The upper tail of firm sizes becomes heavy and follows a Pareto law, with the **exponent** determined by both the talent distribution (η) and the returns to scale $(1 - \alpha - \theta)$.
- Larger firms are less frequent, thick right tail characterized by $\eta \cdot (1 - \alpha - \theta)$.

  $\rightarrow$ A **small number of large firms coexist with many small firms.**

Perfect Credit Benchmark - Establishment distribution

Aggregate Establishment Size Distribution

Proposition 3b

Furthermore, the establishment size distribution in the aggregate economy is given by a mixture of Pareto distributions:

$$\Pr[\tilde{l} > l] = n_S \left(\frac{l(\hat{z}_S)}{l} \right)^{\eta(1-\alpha-\theta)} + n_M \left(\frac{l(\hat{z}_M)}{\max\{l, l(\hat{z}_M)\}} \right)^{\eta(1-\alpha-\theta)}, l \geq l(\hat{z}_M) \tag{24}$$

where n_S and n_M are, respectively, the fraction of service and manufacturing establishments in the economy, with $n_S + n_M = 1$.

- At the economy-wide level, while both sectors follow a Pareto distribution, their composition in the aggregate economy matters. The dominance of one sector can affect the overall establishment size distribution.

Perfect Credit Benchmark

Ratio of Average Establishment Sizes Across Sectors

Proposition 3c

Also, the ratio of the average establishment sizes of the two sectors is

$$\frac{\bar{l}_j}{\bar{l}_{j'}} = \frac{p_j \kappa_j + w}{p_{j'} \kappa_{j'} + w} \tag{25}$$

- Proposition 3 compare sectoral firm sizes by relating them to sector-specific fixed costs and wages.
- **High fixed costs** ($\kappa_j \uparrow$) act as a barrier to entry, restricting operation to only the most talented entrepreneurs with sufficiently high productivity levels. $\rightarrow$ **fewer but larger firms**.
- **Lower fixed costs** ($\kappa_j \downarrow$) allow a broader range of entrepreneurs to operate $\rightarrow$ more **numerous but smaller firms**.

Outline

Quantitative Analysis: An overview

1. **Calibrate the benchmark model to the U.S. economy** under **perfect credit conditions** (no financial frictions).
2. **Assess the effect of financial frictions by varying** ϕ - the degree of financial constraints, to generate variations in the external finance to GDP ratio, matching the cross-country range observed in real data.
3. Evaluate the model's predictions for: (1) Aggregate and sector-level Total Factor Productivity (TFP), (2) Output per worker, (3) Capital-to-output ratios
4. **Assumptions**: Hold fixed all technological parameters across countries, and vary only the parameter ϕ (i.e., *assume a common entrepreneurial talent distribution across countries*)

Calibration I

- Preference and technology parameters are calibrated to match key features of the U.S. economy.
- Target moments correlate with standard macroeconomic aggregates, the establishment size distribution within and across sectors, and establishment dynamics.
- Need to specify values for **11 parameters**:
    1. Four technological parameters α, θ, κ_S, κ_M, depreciation δ
    2. Two parameters describing the process for entrepreneurial talent γ, η
    3. Preference parameters: discount factor β, risk aversion σ, elasticity of substitution ε
    4. Consumption preference: manufacturing share ψ

Standard values from literature are used for:

- $\sigma = 1.5$ (risk aversion), $\varepsilon = 1.0$ (elasticity of substitution)
- $\delta = 0.06$ (annual depreciation)
- $\alpha/(1/\eta + \alpha + \theta)$ is chosen to yield a capital income share of 0.30

Seven parameters are calibrated to match U.S. data moments:

Target Moment	U.S. Data	Model	Calibrated Parameter
Top 10-percentile employment share	0.69	0.69	$\eta = 4.84$
Top 5-percentile earnings share	0.30	0.30	$\alpha + \theta = 0.79$
Average scale in services	14	14	$\kappa_S = 0.00$
Average scale in manufacturing	47	47	$\kappa_M = 4.68$
Establishment exit rate	0.10	0.10	$\gamma = 0.89$
Manufacturing share of GDP	0.25	0.25	$\psi = 0.91$
Interest rate	0.04	0.04	$\beta = 0.92$

Table: Calibration of Model Parameters to U.S. Data

Outline

Result I (Left Panel): Financial frictions lower output per worker

Positive relationship between Output per Worker vs. External Finance/GDP

- From Figure 3, the variation in financial frictions can bring down output per worker to ***less than half of the perfect-credit benchmark level***.
- The regression coefficient of output per worker on external finance-to-GDP ratios is 0.22 for model simulations (*solid line, left panel*) and 0.34 for the data (*dashed line*).

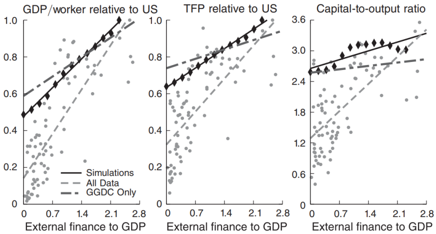

Figure: Aggregate Impact of Financial Frictions on output per worker at PPP, aggregate TFP, and capital-to-output ratios at PPP. *Solid lines*: simulations, *dashed lines*: country data

→ The model explains **two-thirds** of the cross-country relationship between output per worker and financial development.

TFP differences (not just capital) are a key transmission mechanism of financial frictions

- From Figure 3, the per capita income differences in our model are primarily accounted for by differences in TFP.
- Financial frictions can reduce aggregate TFP by 36% in our model. The regression coefficient of aggregate TFP on external finance-to-GDP ratios is 0.15 for model simulations (*solid line, center panel*), and 0.26 for the data (*dashed line*).

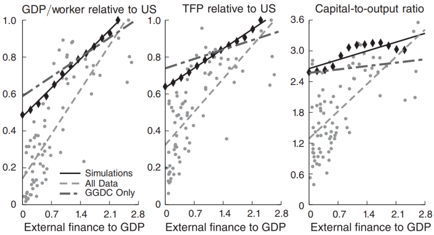

Figure: Aggregate Impact of Financial Frictions on output per worker at PPP, aggregate TFP, and capital-to-output ratios at PPP. *Solid lines*: simulations, *dashed lines*: country data

- The model explains about 60% of the cross-country relationship between aggregate TFP and financial development

Result I (Right Panel): Financial frictions lower output per worker

Capital accumulation is constrained in economies with weak financial markets

- Capital-to-output ratios fall by 15% as we move from the perfect-credit benchmark to financial autarky, when measured at common fixed prices across economies.
- The regression coefficient of capital-to-output ratios on external finance to GDP is 0.25 for model simulations (*solid line*) and 0.76 for the data measured at international prices (*dashed line*).

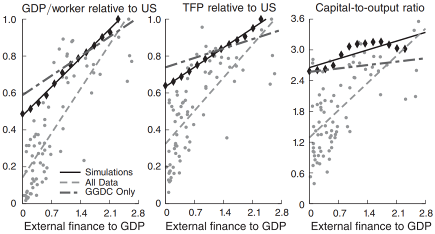

Figure: Aggregate Impact of Financial Frictions on output per worker at PPP, aggregate TFP, and capital-to-output ratios at PPP. *Solid lines*: simulations, *dashed lines*: country data

- Higher relative price of investment goods (due to financial frictions) explains most of the decline in capital-to-output ratios.

Financial frictions hit manufacturing harder than services: TFP declines by 26% (*left*) in services and 55% in manufacturing (*right*) (Figure 6).

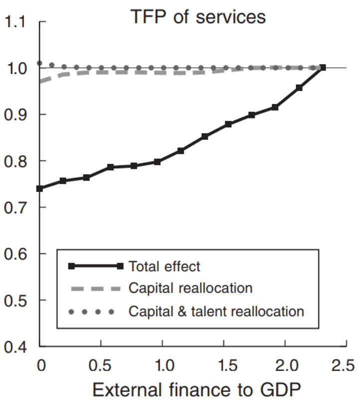

Figure: Effect of financial frictions on the measured TFP of the service sector (*left panel*) and the manufacturing sector (*right panel*). *Note: Sector-level TFPs are normalized by their respective levels in the perfect-credit benchmark.*

Result II: Mechanisms Behind the Effects on Sector-level Productivity

We decompose the effects of financial frictions on sector-level TFP into

1. **Financial frictions distort the allocation of productive capital** among entrepreneurs in operation. $\rightarrow$ **Intensive margin**

   E.g., in the financial autarky ($\phi = 0$) Std. dev. of log MPK: 1.07 (services), 1.23 (manufacturing)

2. **Financial frictions also distort the entry and exit decisions of entrepreneurs** $\rightarrow$ **Extensive margin**, in which is further decomposed into

   - the number of active entrepreneurs in each sector
   - the distribution of talent among active entrepreneurs (*misallocation of talent*)

   E.g., Productive but poor entrepreneurs delay entry until they can overcome financing constraints, and incompetent but wealthy ones remain in business.

Experiment 1 - Capital Reallocation

Reallocate capital among active entrepreneurs within each sector to equalize the marginal product of capital across them (*dashed lines*), *fixing talent distribution of existing active entrepreneurs, and number of entrepreneurs in each sector*.

- **Services**: Misallocation of capital explains nearly all TFP loss.
- **Manufacturing**: Capital misallocation explains less than half of TFP loss.

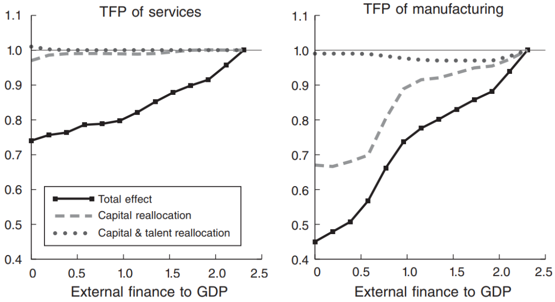

Figure: Effect of financial frictions on the measured TFP of the service sector (*left panel*) and the manufacturing sector (*right panel*).

Experiment 2 - Talent Reallocation

Select most talented entrepreneurs and reallocate capital efficiently, *holding fixed the number of active entrepreneurs, total capital and labor employed in each sector* - (*dotted lines*).

- **Services**: Explains less than 10% of TFP loss.
- **Manufacturing**: Talent misallocation explains *more than half* of TFP loss.

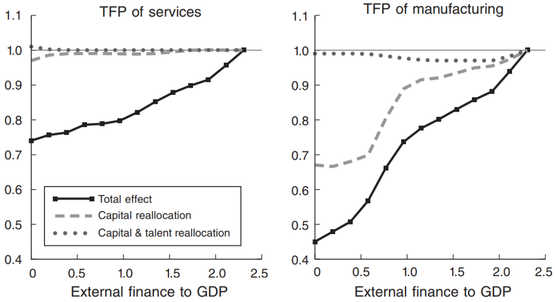

Figure: Effect of financial frictions on the measured TFP of the service sector (*left panel*) and the manufacturing sector (*right panel*).

Experiment 3 - Allow Free Entry/Exit of Entrepreneurs

Allow the number of entrepreneurs to adjust in each sector at the perfect-credit equilibrium prices.

- Small additional gains in TFP.
- Suggests entry barriers matter less than who enters (talent composition).

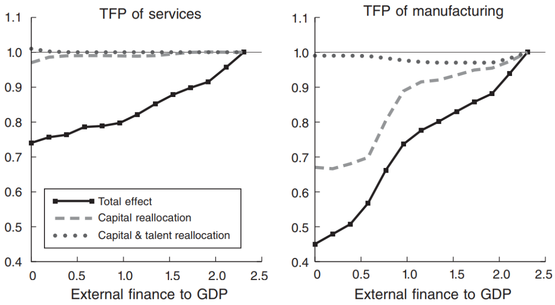

Figure: Effect of financial frictions on the measured TFP of the service sector (*left panel*) and the manufacturing sector (*right panel*).

Result II: Conclusion on The Impact on Sector-Level Productivity

1. Establishments in **manufacturing are more vulnerable** to financial frictions because of (1) *their larger scale and financing needs* and (2) greater misallocation of both capital and talent.
2. Entrepreneurial entry/exit distortions are especially important in manufacturing.

Left panel – Regression of log relative price (manufacturing/services) on external finance-to-GDP

- **Higher relative price** of manufactured goods in countries with weaker financial systems is driven by **lower relative productivity** in manufacturing, caused by financial frictions.
- The regression coefficients are −0.67 for the data (*gray dots, dashed line*) and −0.16 for model simulations (*diamonds, solid line*).
- The model explains about 25% of the observed cross-country variation, leaving room for other explanations of relative prices that are correlated with financial frictions.

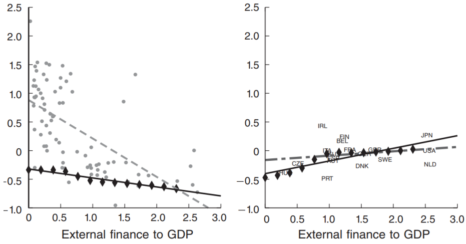

Figure: Relative Prices and Relative Productivity against External Finance. *Left panel*: relative price of manufactured goods to services in log from the 1996 ICP against external finance-to-GDP ratios; *Right panel*: relative productivity of manufacturing to services in log against external finance-to-GDP ratios

Result III: Relative Productivity and Relative Prices

Right panel – Regression of log relative productivity (manufacturing/services) on external finance-to-GDP

- **Model simulation** (*solid line, diamond*): slope = 0.22
- **Empirical data** (GGDC, 18 OECD countries) - *dash-dot line*: slope = 0.08. → Model predicts a **stronger link** between finance and sector-level productivity differences than observed in data.

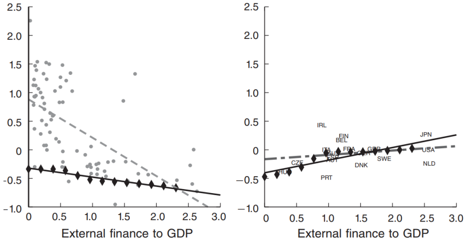

Figure: Relative Prices and Relative Productivity against External Finance

Financial underdevelopment raises relative prices of manufactured goods → Leads to misallocation of resources toward services. → Contributes to lower capital-to-output ratios in less financially developed economies (as also seen in Figure 3).

Result IV: Impact on Establishment-Level Productivity & Size Distribution

Top Left & Top Right panel – Average Entrepreneurial Talent vs. External Finance (1)

- In economies with limited access to external finance, both entrepreneurial talent and wealth determine who becomes an entrepreneur.

  (1) Incompetent but wealthy individuals stay in business, while (2) Talented but poor individuals delay entrepreneurship until they can self-finance.

- As financial frictions worsen, **wealth becomes more important** for business entry/exit decisions. → Individuals with more diverse entrepreneurial talents will be operating business in equilibrium

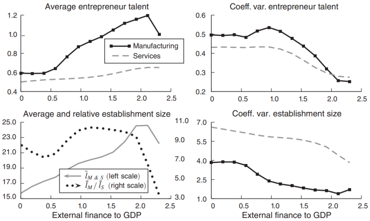

Figure: Establishment-Level Impact of Financial Frictions. *Top left*: against external finance-to-GDP ratios—the average talent or productivity (z_j) of active entrepreneurs in manufacturing (*solid line*) and services (*dashed line*), normalized by the average manufacturing entrepreneurial talent in the perfect-credit benchmark

Result IV: Impact on Establishment-Level Productivity & Size Distribution

Top Left & Top Right panel – Average Entrepreneurial Talent vs. External Finance (2)

Two consequences

1. The average talent of active entrepreneurs falls, especially in manufacturing - Drops by 40% in **manufacturing**, drops by 20% in **services** (*top left*).
2. The within-sector distribution of active entrepreneurs' talent becomes more disperse - Coefficient of variation of entrepreneurial talent increases (*top right*).

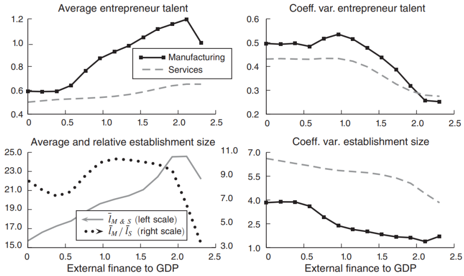

Figure: Establishment-Level Impact of Financial Frictions. *Top left*: against external finance-to-GDP ratios—the average talent or productivity (z_j) of active entrepreneurs in manufacturing (*solid line*) and services (*dashed line*), normalized by the average manufacturing entrepreneurial talent in the perfect-credit benchmark

Bottom Left panel – Financial frictions affect the establishment size distribution (1)

- Financial frictions reduce the average establishment size by up to 30%
- Lower equilibrium wages caused by financial frictions reduce the opportunity cost of entrepreneurship, encouraging more individuals (including less talented ones) to start businesses. $\rightarrow$ **Too many small establishments**, particularly in the service sector.

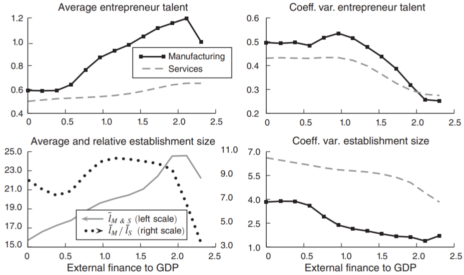

Figure: Establishment-Level Impact of Financial Frictions. Bottom left: *solid line*: traces the average establishment size (i.e., number of workers), inclusive of both sectors (left-hand-side vertical axis). *dotted line*: the ratio of the average establishment size in manufacturing to that in services ($\bar{l}_M / \bar{l}_S$, right-hand side vertical axis)

Bottom Left panel – Financial frictions affect the establishment size distribution (2)

- **Financial frictions widen the size gap between manufacturing and service firms**:
  - **Service-sector establishments increase in number**, but are smaller in scale.
  - **Manufacturing establishments become larger** on average relative to service establishments, as shown by the rising manufacturing-to-service size ratio (*dotted line*).

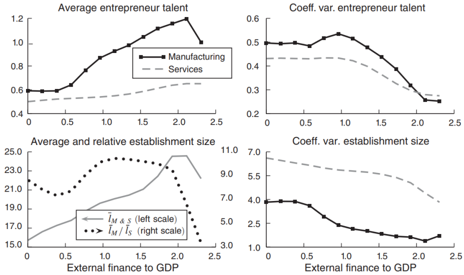

Figure: Establishment-Level Impact of Financial Frictions. Bottom left: *solid line*: traces the average establishment size (i.e., number of workers), inclusive of both sectors (left-hand-side vertical axis). *dotted line*: the ratio of the average establishment size in manufacturing to that in services ($\bar{l}_M / \bar{l}_S$, right-hand side vertical axis)

Top Right & Bottom Right panels – Conclusion on the mechanism

- **Establishment size depends on both entrepreneurial talent and collateral**
- **Financial frictions increase dispersion in talent distribution** among active entrepreneurs (*top-right*), combining with **variation in wealth/collateral**, leads to greater dispersion in establishment size, even for entrepreneurs with similar talent.
- **Result**: Both **within-sector** (*bottom-right*) and **overall establishment size distributions** become more spread out under financial frictions.

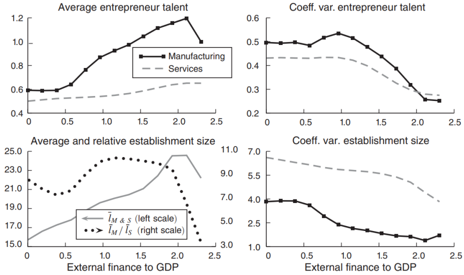

Figure: Establishment-Level Impact of Financial Frictions. *Top right*: Coefficient of variation of entrepreneur talent distribution. *Bottom right*: Coefficient of variation of establishment size distribution.

Result V: Relative Scale of Sectors: A Case Study

- **Model prediction**: Financial frictions lead to a greater disparity in average establishment size between manufacturing and services due to both entry/exit decisions and general equilibrium price effects.
- **Empirical test**: Uses establishment size data from the 2002 US Economic Census and 2004 Mexican Economic Census, adjusted for comparability using Mexico's 1998 ENAMIN survey.
- **Main Result**: Average establishment size in Mexico is about one-third that of the US.

Result V: Relative Scale of Sectors: A Case Study

- But for many industries (especially manufacturing), **Mexico's establishments are larger** than in the US (*those lie above the 45-degree line in Figure 17*).
- The regression slope = 1.22 (> 1), implying **greater variation**: industries large in the US are even larger in Mexico; small ones are even smaller.
- Manufacturing industries dominate above the 45-degree line (*dashed & solid lines*), **consistent with the model's prediction** that manufacturing has larger relative scale in financially constrained economies.

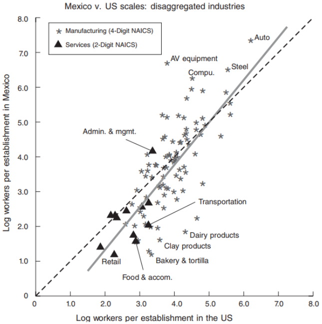

Figure: Average establishment size in Mexico (*in log, vertical axis*) against the average establishment size in the US (*in log, horizontal axis*) for 86 four digit manufacturing industries and 12 two-digit service industries.

Quantitative Analysis: Main Conclusions

1. **Financial frictions distort selection into entrepreneurship**, even when countries *start with the same pool of potential entrepreneurs*.
2. Thus, the productivity distribution of operating entrepreneurs differs across countries, explaining **cross-country differences in aggregate Total Factor Productivity** (TFP):
   - Lower mean productivity in countries with higher financial frictions.
   - Higher dispersion in productivity, i.e., more inequality in establishment-level productivity.

$\Rightarrow$ Aligns with empirical findings by Hsieh and Klenow (2007), particularly for less developed countries.

Conclusion

1. The paper developed a quantitative framework linking financial development to: (1) Output per worker, (2) Aggregate productivity (TFP), and (3) Sector-level productivity & relative prices
2. Financial frictions distort: (1) Allocation of capital, (2) Selection and scale of entrepreneurs, (3) Overall economic efficiency
3. High fixed-cost sectors, e.g., manufacturing) require more financing and are more adversely affected by poor financial development
4. The model explains cross-country variation in sectoral productivity and differences in average firm size across sectors → Findings hold despite abstracting from within-sector industry heterogeneity

Outline

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Outline

Relative Prices & Financial Development

- **Ratio of external finance to GDP**: A common measure of a country's level of financial development
- This measure is strongly correlated with economic development:
  - **Regression coefficient**: 1.08, significant at 5% level with $R^2 = 0.48$.
- The relationship between log relative prices and external finance-to-GDP ratios is similar to the one between log relative prices and log GDP per worker (*left panel of Figure 1*)
  - **Regression coefficient**: -0.67, significant at 5% level with $R^2 = 0.38$.
- **For the 18 OECD countries with sectoral TFP data**: Relative TFP (manufacturing vs. services) has a **positive but not statistically significant** correlation with external finance-to-GDP.
- The strength of the relationship suggests that **financial development** is potentially closely related to the patterns in relative prices, relative productivity, and output per worker across countries.
- Buera et al. (2011) proposes that **financial development** is a ***causal force*** behind these cross-country differences.

This Appendix explain the choice of the calibrated parameters listed in Table 3.

- $\kappa_S = 0.00$ and $\kappa_M = 4.68$: match average establishment size in services (14) and manufacturing (47)
- $\eta = 4.84$: matches top 10% employment share (0.69)
- $\alpha + \theta = 0.79$: matches top 5% earnings share (0.30)
- $\gamma = 0.89$: matches establishment exit rate (10%)
- $\psi = 0.91$: matches manufacturing share of GDP (0.25)
- $\beta = 0.92$: matches interest rate (4%)
- **External finance-to-GDP ratio** is not a calibration target but is close in the model (2.3 vs. 2.5 in U.S. data).

Appendix I: Model & Data Comparison

- Figure 18 compares the model's establishment size distribution (under perfect credit) with U.S. data from U.S. Census Bureau (2002).

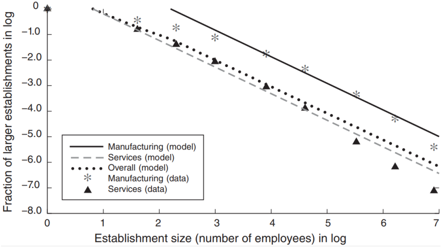

Figure: Establishment Size Distribution in the Model and Data. The horizontal axis shows establishment size (number of employees, l) in log sca
For each l, the vertical axis shows the fraction of establishments with size $\geq l$.

- The model uses **independent Pareto distributions** for entrepreneurial talent in each sector.
- The model captures (1) The tails of the empirical distribution (large establishments); (2) The distance between service and manufacturing distributions; (3) The initial concavity in the combined (**all-sector**) distribution
- However, the model fails to capture initial concavity within **each sector**.

Appendix II: Discussions on Modeling Choices

Setup Costs vs. Fixed Costs

- Using one-time setup costs instead of per-period fixed costs strengthens nonconvexity.
- Financial frictions have larger negative impacts on productivity in this setup.
- Authors choose per-period fixed costs to avoid overstating the impact due to lack of reliable data on setup costs.

Span of Control Differences

- Span of control refers to how effectively a manager can oversee and utilize labor and capital.
- Modeled sectoral scale differences via differences in span of control (α_j (*capital share*) and θ_j (*labor share*) parameters such that $\alpha_S + \theta_S < \alpha_M + \theta_M$ (i.e., manufacturing firms can operate at a larger scale), with $\alpha_S/\theta_S = \alpha_M/\theta_M$).
- Results are qualitatively similar but with smaller magnitude than the main model.
- In this setup, relative scale of manufacturing to services decreases with financial frictions.

Result I: Financial frictions lower output per worker

- The model explains a substantial portion of cross-country differences in nonagricultural productivity without modelling agriculture.
  - *Since it would be unfairly penalizing the model for not explaining differences in agricultural productivity* $\rightarrow$ **Cleaner comparison to sectors** directly influenced by access to finance.
- **Validation**: regress three variables on external finance-to-GDP using GGDC Productivity Level Database for 18 OECD Countries (*dash-dot line*)
  - **Nonagricultural output/worker** - Empirical: 0.15, Model: 0.22
  - **TFP** - Empirical: 0.07, Model: 0.15
  - **Capital-to-output ratio** - Empirical: 0.09, Model: 0.25

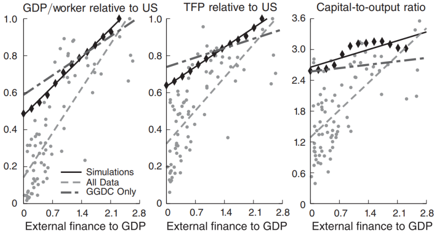

Figure: Aggregate Impact of Financial Frictions on output per worker at PPP, aggregate TFP, and capital-to-output ratios at PPP. *Solid lines*: simulations, *dashed lines*: country data

Comparison with Other Models

Two-Sector vs. One-Sector Model

- Two-sector model yields **richer insights** on relative prices, productivity, and sectoral scale.
- Two-sector model **generates a larger impact of financial frictions** on aggregate output and TFP than does a one-sector model. Financial frictions reduce:
  - Output by 52% (vs. 39% in one-sector),
  - TFP by 36% (vs. 30%),
  - Capital-output ratio by 15% (vs. negligible in one-sector).
- Nonconvexity effects are convex: concentrated fixed costs (manufacturing) have bigger aggregate impact.

Realistic Time Horizon vs. Two-Period Models

- Two-period models **overstate** the effect of financial frictions by limiting self-financing.
- In two-period setups, poor-but-talented entrepreneurs cannot save up, resulting in artificially small establishments.
- Effects of financial frictions are 50% larger in two-period models due to this constraint.

Empirical Context

- Service sector expands as economies develop (Kuznets, 1973).
- Model links development to improved financial access ($\phi \uparrow$), leading to higher output and TFP.

Manufacturing Share of GDP

- Rises with financial frictions because manufacturing produces investment goods.
- Calibrated to match US manufacturing share of 25% under **perfect credit** ($\phi = 1$).
- In **financial autarky** ($\phi = 0$), manufacturing share rises by 2–3 percentage points.

Role of Substitution Elasticity ε

- **Assumption**: that consumers' elasticity of substitution between manufactured goods and services (ε) is one. If ε is less than one, consumers will **not substitute away as much** when the relative price of manufactured goods rises with financial frictions.

  E.g., When $\varepsilon = 0.75$, manufacturing share rises more with financial frictions.

Calibration Conservatism

- Calibration uses **US as benchmark** for perfect credit—conservative choice.
- A higher manufacturing share (e.g., cross-country average) would amplify the measured effects of financial frictions.

Evolving Service Sector

- Growth of **large-scale service industries** (e.g., tech, finance) keeps average establishment size stable.
- Core distinction in the model is scale, not strictly manufacturing vs. services.
- A more granular model could better capture **intra-sector heterogeneity** in structural transformation.