Skill Supply, Firm Size, and Economic Development

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Motivation

Cross-country differences in income per capita are large.

- Few high-productivity wage jobs in poor countries – LIC: 20% vs. HIC : 80%.
- Firms are smaller in poor countries - Poschke, 2018; Bento and Restuccia 2017, 2021

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Explanations

- Financial, labor market, and entry frictions
- Delegation frictions - Grobovsek, 2020; Akcigit and Peters, 2021
- Size/productivity-dependent distortions - Restuccia and Rogerson, 2008; Guner et al, 2018

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This paper

Skill supply $\Rightarrow$ **Technology choice** $\Rightarrow$ **Firm size distribution**

How does skill scarcity affect the structure of employment?

New facts

1. Large firms account for much smaller share of employment in poor countries.
2. Large firms are more skill intensive ← NEW
3. Skill gap between large and small firms is much greater in poor countries ← NEW
4. Skilled workers are scarce and costly to hire in poor countries ← NEW

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Theory: Heterogeneous firm model à la Hopenhayn (1992) with technology choice

- *Assumption 1:* Large firms have greater returns to scale.
- *Assumption 2:* Large firms use skills more intensively
- *Implication:* When skills are more costly → less employment in large firms.

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Quantitative Exercise

– Differences in skill endowment between the US and an average LIC explain 88% of the difference in the share of employment in large firms.

Data: Harmonized World Labour Force Survey (HWLFS)

We use the HWLFS, a large-scale micro dataset on labor supply we assembled.

NEW: Observe both education and firm size

Sources

- Nests traditional data sources – IPUMS and Eurostat
- Household and labour force surveys sourced from national statistics offices.

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Coverage

- 449 surveys from 54 countries.
- \$871 (Rwanda 2000) - \$62,313 (Norway 2012)

Individual information

- **Education:** low-skill $= <$ 10 yrs high-skill $= \geq$ 10 yrs
- **Firm size:** small $= <$ 10 employees large $= \geq$ 10 employees

"How many employees work in your place of work (establishment/work site)?"

Data: Comparison to other data sources

HWLFS:

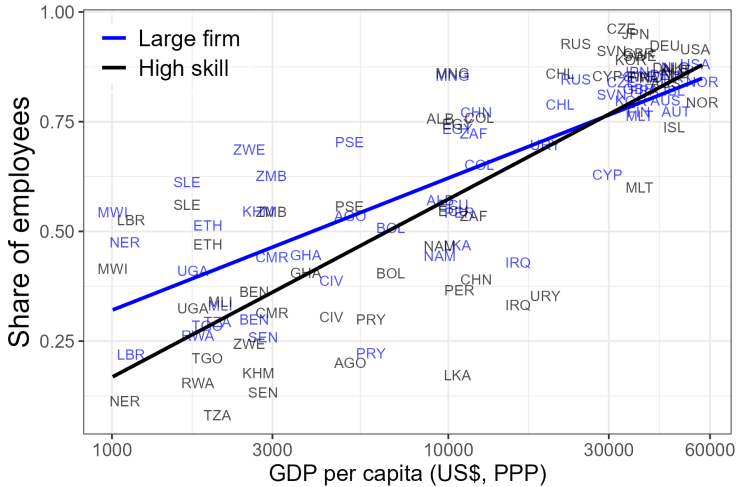
1. Nationally representative
2. Employment composition by firm size
3. Many countries at all income levels.

Alternative data sources on firm size

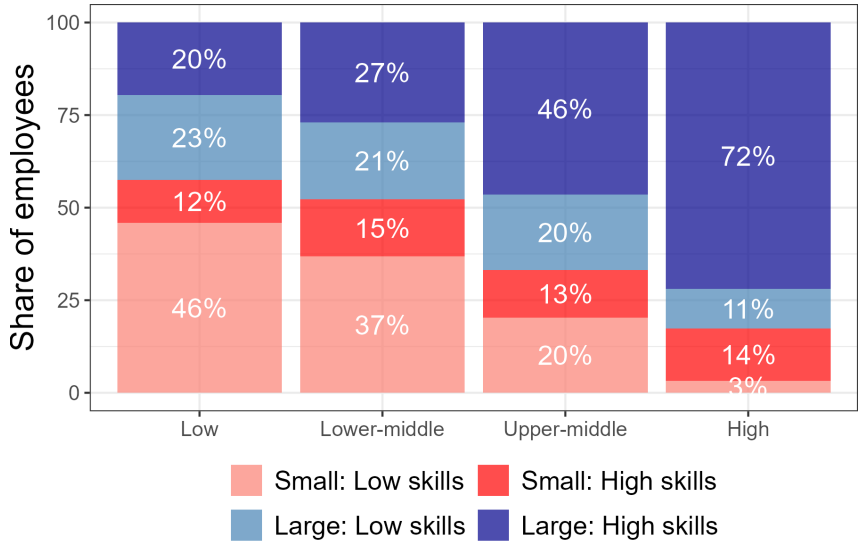
- Firm level data such as WB Enterprise Surveys, Amadeus, Orbis, Register Data - Poschke (2013), Guner et al (2024)
- Little/no information on workers.
- Miss informal/small firms.

$\rightarrow$ We validate our measurement and compare implied firm size with other above mentioned sources.

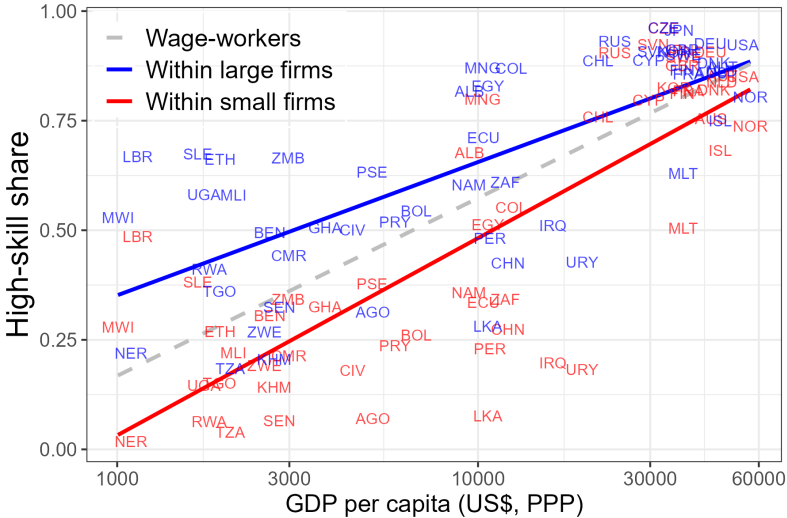
Poor countries: low skills, little employment in large firms



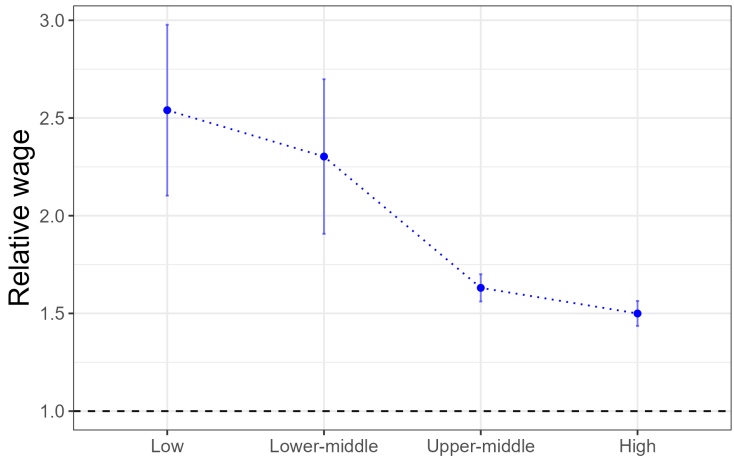
Poor countries: low skills, little employment in large firms – 2



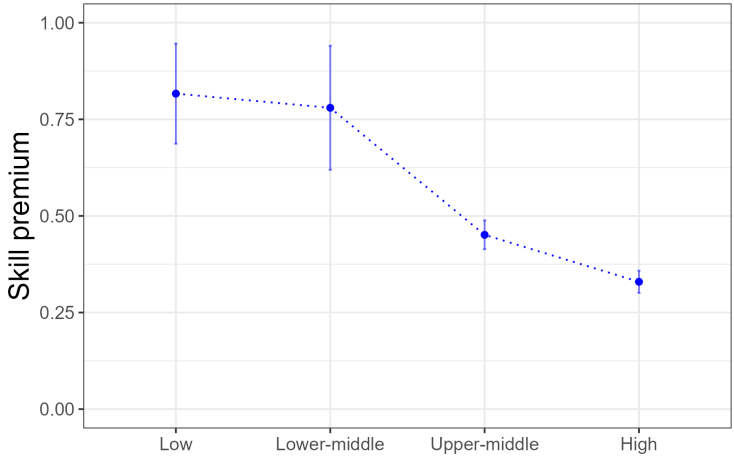
Skill gap between large and small firms is larger in poor countries



Skill premium greater in poor countries



Skill premium greater in poor countries – also with controls



Skill premium: $\log w_{icst} = \beta \mathbb{1}\{\text{HS}\}_i + X_i\gamma_i + \varepsilon_{icst}$
X: sex, age, age^2, marital status.

Empirical findings

1. Large firms account for much smaller share of employment in poor countries.
2. Large firms are more skill intensive ← NEW
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Suggestive mechanism:

- Large firms are skill-intensive
- Skills are scarce and costly in poor countries

$\Rightarrow$ Fewer large firms and smaller average firm size in poor countries

Quantitative question:

How much can differences in skill endowments explain x-country differences in firm size?

Model: Overview

Agents

- Workers j can be low (l) or high (h) skill and earn a wage w_j.
- Firms i can be small (s) or big (b) technology and produce a final good.

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Entry, exit, technology choice

- Entrants pay cost c^e and draw productivity z
- Per period fixed cost c^f to operate
- If they operate, choose *big* or *small* technology

$\Rightarrow$ The share of large (big tech.) firms and the size distribution are endogenous.

Model: Production

Technologies $i = \{\text{s,b}\}$

$$y^i(z) = z\left[(1-\mu^i)L_l^{i\,\frac{\rho^i-1}{\rho^i}} + \mu^i(AL_h^i)^{\frac{\rho^i-1}{\rho^i}}\right]^{\frac{\rho^i}{\rho^i-1}\gamma^i}.$$

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Maximize profits $\rightarrow$ Optimal skill mix:

$$\left(\frac{L_l}{L_h}\right)^i = \left(A^{\frac{\rho^i-1}{\rho^i}}\frac{\mu^i}{1-\mu^i}\frac{w_l}{w_h}\right)^{-\rho^i}$$

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Profits

$$\pi^i(z) = \Pi^i\left(\frac{w_l}{w_h}\right)^{-\frac{\gamma^i}{1-\gamma^i}} z^{\frac{1}{1-\gamma^i}}$$

where Π^i depends on w_l/w_h and parameters.

Model: Technology choice

Firms pay c^e labor units to enter and draw productivity z from a Pareto with shape parameter α.

- Firms choose the *big technology* if $\pi^b(z) > \pi^s(z)$.

$$\pi^s(z^*) = \pi^b(z^*) \qquad \Longrightarrow \qquad z^* = w_h \left(\frac{\Pi^s}{\Pi^b} \right)^{\frac{(1-\gamma^b)(1-\gamma^s)}{\gamma^b - \gamma^s}}$$

$\Rightarrow$ Firms with productivity draw $z > z^*$ choose *big technology*.

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Comparative statics

Higher skill premium $(w_h/w_l \uparrow)$

$\Downarrow$

Lower relative profitability of big technology $(\Pi^b/\Pi^s \downarrow)$

$\Downarrow$

Higher cutoff $(z^* \uparrow)$

Model: Free Entry condition

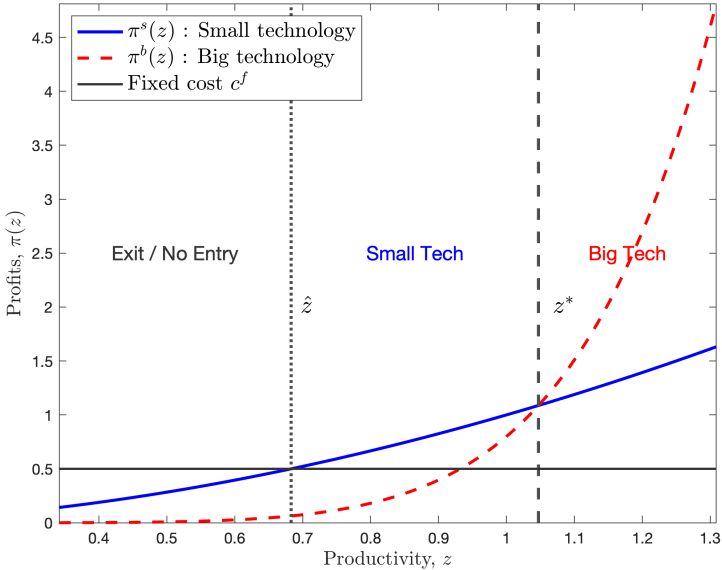
Entrants pay $c^e \Lambda w_h$ and draw productivity z from a Pareto $G(z)$ with shape α and scale z_m parameters.

Firms enter until the expected value of entry, net of operating cost, is zero.

$$c^e \Lambda w_h = \int_{\hat{z}}^{z^*} \pi^s(z) \mathrm{d}G(z) + \int_{z^*}^{\infty} \pi^b(z) \mathrm{d}G(z)$$

$$\text{where} \quad \bar{z}^b \equiv \alpha z_m^{\alpha} \frac{{z^*}^{\frac{1}{1-\gamma^b}-\alpha}}{\alpha - \frac{1}{1-\gamma^s}}, \qquad \bar{z}^s \equiv \alpha z_m^{\alpha} \frac{\hat{z}^{\frac{1}{1-\gamma^s}-\alpha} - {z^*}^{\frac{1}{1-\gamma^s}-\alpha}}{\alpha - \frac{1}{1-\gamma^s}}.$$

The free entry condition pins down w_h.


$\pi^s(z)$: Small technology
$\pi^b(z)$: Big technology
Fixed cost c^f
Exit / No Entry
Small Tech
Big Tech
$\hat{z}$
z^*
Profits, $\pi(z)$
Productivity, z
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3

Model: Equilibrium

An equilibrium consists of $\{w_h, w_l, L_h, L_l, M, \hat{z}, z^*, m^b\}$ such that:

1. **Skill-Mix Ratios** for each $i \in \{s, b\}$
2. **Labor Demand** for each i, $L_h^i(z)$
3. **Cutoff Conditions** for technology choice (z^*) and operating cutoff ($\hat{z}$)
4. **Free Entry condition**
5. **Labor-Market clearing** for low and high skilled workers. where m_b is the share of operating firms that use the big technology, and M is the mass of operating firms.

Calibration: Parameters

We calibrate the model to data from the US.

Parameter	Value	Target/Source
Pre-set:		
ρ_b	4	Bils, Kaymak and Wu (2024)
ρ_s	4	$= \rho_b$
γ_b	0.85	Atkeson and Kehoe (1995)
Calibrated internally:		
μ_b	0.771	Skill intensity large firms, US
μ_s	0.610	Share of employment in large firms, US
γ_s	0.356	Skill premium, US
α	7.57	tail index of employment of 1.13, US (BDS)
c^f	0.729	Share large firms, US

1. Large firms are more skill intensive $\mu^b > \mu^s$
2. Lower returns to scale for small firms $\gamma^s < \gamma^b$

Calibration: Data and model moments

Moment	Data	Model
Skill premium (w_h/w_l)	1.76	1.76
Share workers in large firms with high skills (%)	92	92
Share of employment in large firms (%)	89	89
Share of firms with at least 10 employees (%)	21.4	21.4
Tail index of firm size distribution	1.13	1.136

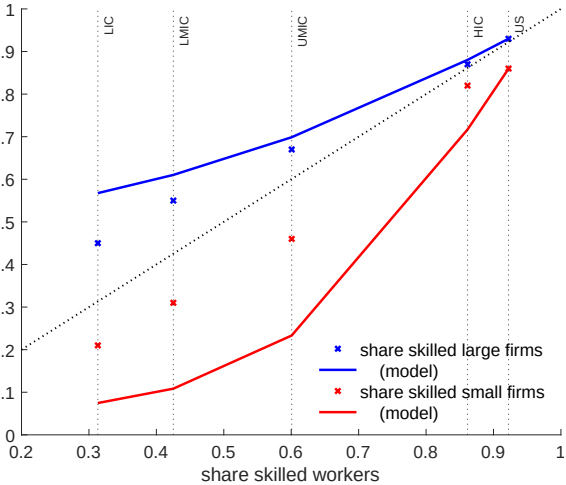
Quantitative Exercise:

How does skill supply shape the firm size distribution and economy activity?

We vary skill supply (L_l, L_h) in line with cross-country data and study effects on

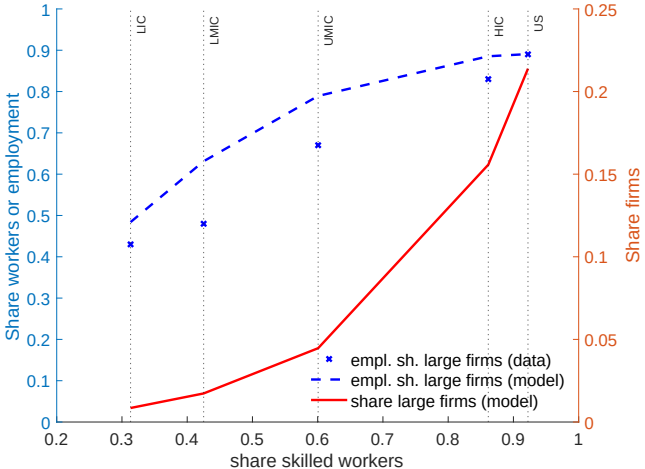
1. Technology choice & Firm size distribution
2. Employment in large firms
3. Skill intensity of large and small firms
4. How do changes in the firm size distribution affect output ?

Aggregate skills and the skill intensity by firm size



- With $\rho_b = \rho_s = 4$, the model reproduces 75% of the US-LIC difference in skill intensity of large firms.
- A closer fit requires larger ρ_b.

Skills and the firm size distribution



The model reproduces

- 88% of the difference in the share of employment in large firms between the US and the mean LIC, and
- 50-60% for MICs.

The elasticity of employment in large firms with respect to the skilled population share is 0.56.

A comparison to productivity-dependent distortions

Consider a productivity-dependent distortion as a tax on revenue, with

$$1 - \tau = z^{-\nu}.$$

Greater ν reduces relative profits of large firms, so $z^*/\hat{z}$ rises.

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Two ways of matching the LIC employment share in large firms L_b (43%):

1. US L_h, calibrate ν
2. Actual L_h, calibrate ν

Approach	L_h	ν
1	0.92 (HIC data)	0.425
2	0.31 (LIC data)	0.03

Conclusion

Empirical findings

1. Large firms are more skill intensive
2. Skill gap between large and small firms is much greater in poor countries
3. Skilled workers are scarce and costly to hire in poor countries

$\rightarrow$ Lack of skills affects **large firms** more.

Model of firm size with technology choice

- **Skill differences** are a major determinant of **firm size differences** and low employment in large firms in LICs.
- Technology choice channel amplifies effect of skills on **output**.