

Firms I

Stefano Caria

Michaelmas Term 2025

Acknowledgement

For the material taught in weeks 5-7, I relied extensively on materials developed by Muhammad Meki, Doug Gollin and Simon Quinn.

What is a firm?

- What is a firm?
 - Usually defined as a production technology.
 - Production technologies are typically given as constant returns to scale.
 - But if CRS holds, then firm size is indeterminate
 - It is unclear whether we will have one large firm or many small ones; they are equivalent.
 - Demand determines the total size of the market. . . but does not tell us much about the firm.
- To get useful predictions about firm size and choices, we typically need to add in some assumptions about cost structures (e.g., short-run fixed costs) that are inconsistent with CRS

Firms in contemporary development economics

- Growing interest in firms at both the micro and macro level. For example, we discussed microenterprises in the context of much of the recent literature on microfinance (which we will briefly touch upon).
- Productivity differences at the country level must, in some sense, be reducible to productivity differences at the firm level.
- An intersection between micro development, macro, trade, industrial organization, and labour economics.
- Increasingly, there are data available at the firm level.

What are firms? Coasian approaches

Theory of the firm goes back quite far:

- Coase (1937) argued that transaction costs are the key to firms.
 - If transactions were costless, there would be no reason to have firms.
 - All transactions would simply take place in the market.
 - A firm would not only hire its workers, but it would hire in all kinds of services.
 - Many firms already outsource a range of activities: cleaning, legal services, cafeteria operation, etc.
 - Why not more?
- A trade-off between transaction costs and efficiency

Other early theories of the firm

Alchian and Demsetz (1972) modified the Coase view to some extent, arguing that firms provide a kind of team-based monitoring.

- Emphasized moral hazard issues and monitoring of effort, rather than market-linked transaction costs.

Williamson (2002) theorized firms in several ways but was extremely interested in the ways that hierarchical structures of management create challenges for aligning incentives properly

- Self-employed people presumably face the right incentives
- As firms grow, management structures become more complex and require complex contracts to align incentives.

These theories take on particularly interesting angles in developing countries.

Roadmap

Key stylized facts

Firm size

Returns to labor

Selection

References

A firm as a technology

$$Y = AK^{\beta}L^{1-\beta} \quad (1)$$

Do firms in LMICs differ in their L , K , β , and A ?

Four key facts about firms in LIMCs

1. Firms are small (L)
2. They use less capital (K)
3. Have lower labor shares ($1 - \beta$)
4. Productivity is low and dispersed (A)

Four key facts about firms in LIMCs

1. Firms are small (L)
2. They use less capital (K)
3. Have lower labor shares ($1 - \beta$)
4. Productivity is low and dispersed (A)

The average firm in LMICs is small

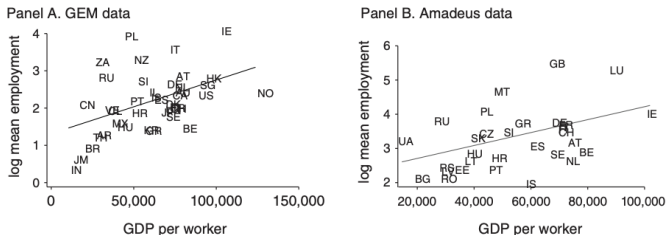


FIGURE 3. AVERAGE EMPLOYMENT AND INCOME PER WORKER

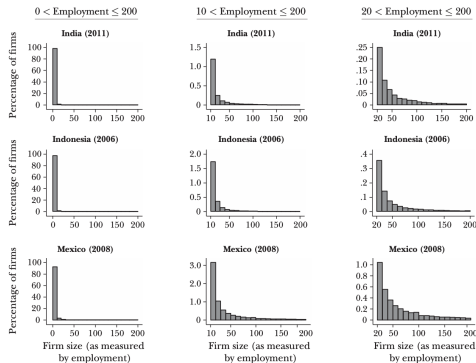
Notes: GDP per worker outside agriculture is computed as real GDP for 2005 at purchasing power parity from the Penn World Tables 8 (Summers and Heston 1991; Heston, Summers, and Aten 2009) minus value added in agriculture, forestry, and fishing (from FAO macro indicators), divided by total persons engaged minus persons engaged in agriculture, also from the FAO. Firm employment data from the GEM for panel A and from Amadeus for panel B. The vertical axis shows log average employment. The lines represent the best linear fits. Regression results are reported in Table 2.

From **Poschke 2018**

The firm size distribution is highly skewed. The modal firm has no employees.

Figure 1

Distribution of Firm Size as Measured by Number of Workers



Source: We use microdata from the manufacturing sector in the Mexican Economic Census, the Indonesian Econ Sample Survey (Schedule 2). See footnote 1.

Notes: The figure shows distribution of firm size measured by the number of workers. The bin size is 10 workers, z . For all graphs, the y-axis indicates the share of all firms in the specified size. The different columns truncate the :

Rich countries are dominated by large firms

US firm size distribution is very stable and heavily skewed **Luttmer (2010)**.

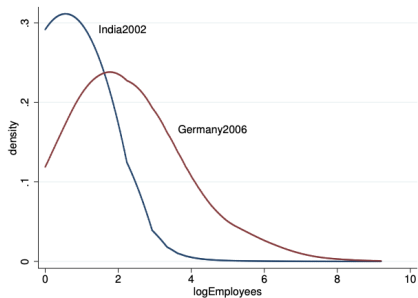
- About 6 million firms.
- Half of employment is in 18,000 very large firms with more than 500 employees each.
- One-quarter of employment is accounted for by the 1,000 largest firms, with more than 10,000 employees each.
- Most firms are very small; 80 percent have fewer than 10 employees.
- It is likely that in low income economies most workers are employed in small firms, but this is harder to show systematically.
- Most datasets do not include small production units in their sample frames, which is translated into an overestimation of the importance of middle firms.

Germany vs India: Garcia-Santana et al. (2012)

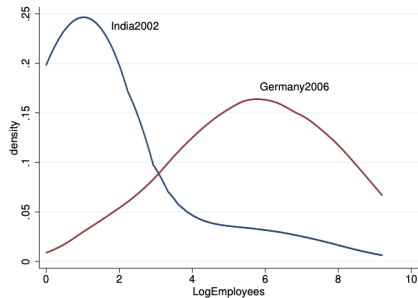
- Garcia-Santana et al. (2012) use a dataset of the Indian manufacturing sector that allows them to measure small production units: the National Sample Survey (NSS). Also use the popular Annual Survey of Industries (ASI) for the same year, which covers larger plants.
- Together, have representative sample of the whole distribution of plants in the Indian manufacturing sector
- Take Germany as an “undistorted” benchmark economy and compare its manufacturing size distribution

Germany vs India: Garcia-Santana et al. (2012)

FIGURE IV
GERMANY VS INDIA



(a) Distribution of production units



(b) Distribution of employment

Germany vs India

The distribution of production units in India is heavily concentrated among smaller firms compared to Germany.

This pattern becomes even more pronounced in the distribution of employment: in Germany, employment is more evenly distributed across firms of different sizes, while in India, it is highly concentrated in smaller firms.

As a result, the share of employment accounted for by small plants is much higher in India than in Germany (see the paper for a plot of the ratio of employment shares between the two countries).

Four key facts about firms in LIMCs

1. Firms are small (L)
2. They use less capital (K)
3. Have lower labor shares ($1 - \beta$)
4. Productivity is low and dispersed (A)

Capital per worker is highly correlated with GDP per worker

APPENDIX 2: Additional Figures and Tables

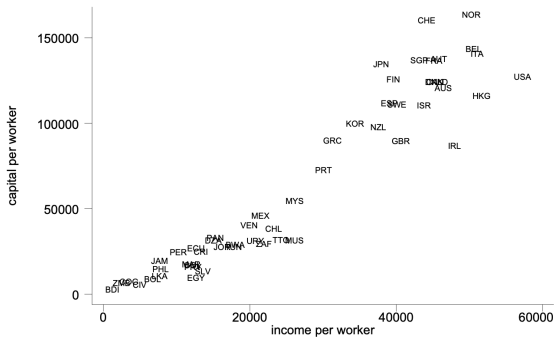


Figure 8: Capital Stocks

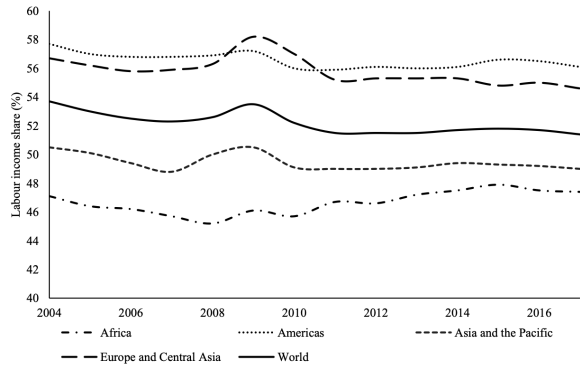
Source: **Caselli Feyer 2005.**

Four key facts about firms in LIMCs

1. Firms are small (L)
2. They use less capital (K)
3. Have lower labor shares ($1 - \beta$)
4. Productivity is low and dispersed (A)

Labour shares are lower in LMICs

Figure 5. Global and regional adjusted labour income shares, 2004-2017



Source: ILO 2019.

Four key facts about firms in LIMCs

1. Firms are small (L)
2. They use less capital (K)
3. Have lower labor shares ($1 - \beta$)
4. Productivity is low and dispersed (A)

Across firms, there is wide dispersion in productivity

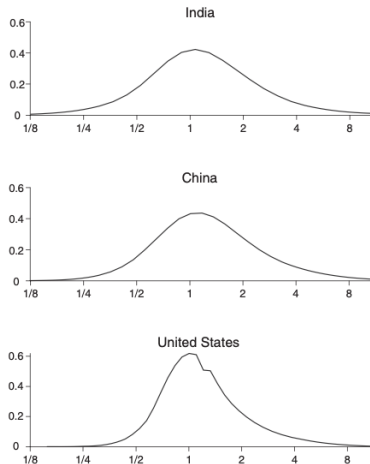


FIGURE II
Distribution of TFPR

Distribution of $\ln(TFPR_s / \overline{TFPR_s})$ from Hsieh and Klenow 2008

Key datasets

- World Bank Enterprise Survey
- Global entrepreneurship monitor
- World Management Survey
- Jobs of the World

Roadmap

Key stylized facts

Firm size

Returns to labor

Selection

References

Modelling firm size

To think about the differences between firms in rich and poor countries, and to understand why there might be systematic differences, it helps to have some understanding of what might account for these differences.

Alternatively, we might want to take the differences in firm size as given and ask how the firm size distribution might change under different circumstances. For instance, all else equal, how might we expect firm size to change when average productivity rises?

Modelling firm size

To model firm size, we may need to look beyond CRS. (Why?)

- But equally, increasing and decreasing returns will be problematic. (Why?)
- Some kind of theoretical structure in which there are trade-offs to expanding the firm.
 - A fixed cost will require a minimum size.
 - A fixed cost with decreasing returns will give a determinate firm size.
 - A fixed cost with decreasing and heterogeneous returns will give a firm size distribution!

This is the basis for a model introduced by Lucas, Jr. (1978).

Lucas model: generically

Lucas (1978): introduced a model that is sometimes referred to as a “span of control” model of firm size.

- The term originates from engineering and reflects the idea that a manager can only exercise control over a limited range of supervisory activities.
- Beyond that, the manager loses effectiveness (Embodies ideas from Alchian and Demsetz, Williamson, as noted above)
- Lucas treats managerial ability as a skill – separable from raw labour ability – that differs across individuals and that determines the extent of an individual's span of control.
- A similar model structure can work with other fixed factors that are inelastically supplied and vary across individuals.

Lucas span-of-control model

A firm consists of two technologies: a production technology and a managerial technology.

- Production technology is standard concave CRS:

$$y = F(k, n) = nf\left(\frac{k}{n}\right) \quad (2)$$

where k is capital, n is labour. Suppose that individuals differ in entrepreneurial ability, x .

- An individual with ability x who is managing a firm produces: $xg(y)$
- Note that entrepreneurial ability enters in a simple linear fashion. (This is not essential but simplifies analysis.)
- The managerial technology $g(\cdot)$ is strictly increasing and strictly concave.

Lucas on the Description of Management

“This description of management is a shallow one, in at least two respects. First, it does not say anything about the nature of the tasks performed by managers, other than that whatever managers do, some do it better than others. Given this assumption, however, one is led immediately to the question: why does the best manager not run everything? Therefore, I assume concavity of the function g . Second, this technology precludes pyramidal managerial structures: managers managing other managers. One could postulate a technology for such organizations without any difficulty in a mathematical sense, but without a clear idea of where one is going, this is likely to lead to an uninformative taxonomy.”

– Lucas (1978, p. 512)

Lucas span-of-control model

Managerial talent cannot be traded and is a fixed input; you cannot purchase more!

The decreasing returns to scale of $g(\cdot)$ reflects the span of control issue.

- Even the best manager loses effectiveness as the size of the firm increases.

Putting the two technologies together gives:

$$q = x g(f(\kappa) n), \quad \text{where } \kappa \equiv \frac{k}{n} \quad (3)$$

Firm's optimisation

Consider the problem of a firm that faces factor prices w and r .

- The firm is managed by an entrepreneur with ability x .
- The firm's optimization problem is given by:

$$\pi(x \mid w, r) = \max_{\kappa, n} [x g(f(\kappa) n) - r\kappa n - wn] \quad (4)$$

First-order conditions...

Using the notation $y = f(\kappa)n$, we have:

$$xg'(y)f'(\kappa) = r, \quad \text{by the chain rule} \quad (5)$$

$$xg'(y)f(\kappa) = r\kappa + w \quad (6)$$

Towards solving the model...

From (5) and (6), we can derive:

$$\frac{f(\kappa) - f'(\kappa) \kappa}{f'(\kappa)} = \frac{w}{r} \quad (7)$$

Note that this holds for any value of x .

In other words, all firms choose the same ratio of $\kappa \equiv k/n$

But different entrepreneurs will hire different quantities of the two inputs.

The relative scale of the firm can be found from solving for the value of y .

An example

Suppose we take a very simple production function with one input, given by $y = n$.

The managerial technology is xy^α .

Suppose further that the x is drawn from a distribution $\Delta(x)$ that can be characterized as a Pareto distribution.

- In general, the firm size distribution in rich countries is consistent with a Pareto distribution.
- Not quite so clear in poor countries, because of data limitations, but possibly also true.

Pareto distribution

The Pareto distribution is a skewed distribution with that has useful properties for looking at distribution of income, wealth. . . and for our purposes, firm size.

The random variable Z has a Pareto distribution with shape parameter $\gamma \in (0, \infty)$ on the interval $[1, \infty)$ with CDF G given by:

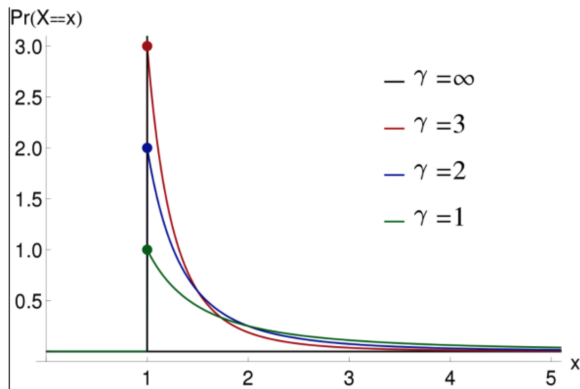
$$G(z) = 1 - \frac{1}{z^\gamma}, \quad z \in [1, \infty) \quad (8)$$

With $\gamma = 1$, this is the standard Pareto distribution.

The PDF is:

$$g(z) = \frac{\gamma}{z^{\gamma+1}}, \quad z \in [1, \infty) \quad (9)$$

PDF of Pareto distribution



Example, continued

- The first-order condition from the firm's problem gives:

$$x^\alpha y^{\alpha-1} = w \quad (10)$$

- Because in this case $y(x) = n(x)$ for all x , we then have:

$$n(x) = \left(\frac{\alpha X}{w} \right)^{\frac{1}{1-\alpha}} \quad (11)$$

- If x has a Pareto distribution with shape parameter γ , then firm size will also be distributed as Pareto with exponent $\gamma(1 - \alpha)$.

Extensions of the Model

Consider a few extensions of this simple framework:

- An occupational choice model
- The occupational choice model in general equilibrium
- An occupational choice model with wealth instead of managerial ability
- A simple Roy model of selection

Occupational choice model, partial equilibrium

Suppose that an individual with entrepreneurial ability x can either manage a firm or work for a wage w , where all individuals are assumed to be the same as workers.

Managing a firm is a full-time job; i.e., it takes a full unit of time, so that the entrepreneur forgoes the wage w .

Because profits are monotonic in x , there will be a threshold value of x such that workers above the threshold will choose to manage and individuals below the threshold will choose to be workers.

Occupational choice model, partial equilibrium

Occupational choice consists of individuals choosing between managing a firm and working for a wage.

Our goal is to solve for this threshold value (call it z) such that people are indifferent between being workers and managers.

That threshold will be characterized by the condition that an individual with managerial ability z will earn profits that are identical to the wage rate.

Anyone with a higher level of managerial ability will surely earn more profits and will manage a firm. Anyone with lower managerial ability will surely prefer to work for a wage.

Occupational choice model, partial equilibrium

Solve for this threshold value (call it z) such that people are indifferent between being workers and managers:

$$\pi(z) = xg(f(\kappa)n(x)) - r\kappa n(x) - wn(x) = w \quad (12)$$

This is easy to write down, but analytic solutions are not always possible. This is particularly true if we switch from partial equilibrium to general equilibrium, where the wage rate itself becomes endogenous. In that case, we typically need to solve this problem computationally.

Occupational choice model, general equilibrium (1)

Now allow for w and r to be endogenous, with given economy-wide stocks of labour and capital.

- For instance, suppose that the aggregate capital stock is fixed at K . Suppose further that the labour force is fixed at one unit.
- We need to solve for wages and the rental rate such that the market clears for labour and for capital.
- For heuristic convenience, forget the Pareto distribution, and think of the people in the labour force having a uniform distribution of entrepreneurial ability indexed on $[0, 1]$.

Occupational choice model, general equilibrium (1)

Our strategy for solving the model – finding an equilibrium wage rate and rental rate – is as follows:

1. First, take a particular value of the wage rate. For that wage rate, we can solve the partial equilibrium problem above; i.e., we can again find a threshold value of $z \in [0, 1]$ such that everyone above z will be an entrepreneur and everyone below z will be a worker.
2. From this, we can derive the total labour demand in the economy and we can compare it to the total labour supply (which will in fact be given by z)
3. If there is excess demand in the market, the wage needs to rise to reach equilibrium. If there is excess supply, the wage needs to fall.

We can formalize this. . .

Occupational choice model, general equilibrium (2)

- Total labour supply in this economy is given by z .
- Labour demand is given by $\left[\int_z^1 n(x) dx \right]$.
- In equilibrium, labour supply must equal labour demand.
- That means that wage will adjust to w^* such that $\left[\int_{z^*}^1 n(x) dx \right] = z^*$.
- The rental rate will also adjust. In equilibrium, the rental rate r^* will equate capital demand with the aggregate capital stock.
- All firms will have the same capital-labour ratio, which will be $\kappa = K/z^*$.
- Although we have not specified preferences, it should also hold in equilibrium that the price will adjust so that the supply of goods will be equated with the demand...

Occupational choice model with similar frameworks for firm size distributions

A similar mechanism can be used in a model where occupational choice is related to (say) inherited wealth or borrowing constraints, instead of managerial ability.

- Banerjee and Newman (1993): collateral constraints limit capital investment.
- Lloyd-Ellis and Bernhardt (2000): inherited wealth is needed to start a firm.
- Buera et al. (2015): borrowing constraints limit the amount of capital that entrepreneurs can rent.

Roadmap

Key stylized facts

Firm size

Returns to labor

Selection

References

De Mel, McKenzie, Woodruff (2019)

An RCT to measure marginal returns to labor among small firms

- 1533 firms in urban Sri Lanka.
 - 81 percent do not have paid or unpaid workers at baseline.
- Offered a monthly wage subsidy, for 8 months, if firm hired an additional employee.
 - Subsidy is about 1/2 average unskilled worker earnings.
 - 21 check-up visits per firm
- Wage subsidy cross-randomized with:
 - matched savings account
 - training.

What would you expect will happen to employment after the end of the subsidy period?

Appendix Table 3.3: Treatment Effects on Having any Paid Worker by Treatment Arm

	(1a) Wage Subsidy Only Treatment Effect	(1b) Wage Subsidy + Savings Treatment Effect	(1c) Wage Subsidy + Training Treatment Effect	(1d) Savings Only Treatment Effect	(1e) Training Only Treatment Effect	(1f) Savings + Training Treatment Effect	(2) Any Wage Subsidy Effect
Before Subsidy	-0.020 (0.036)	0.027 (0.036)	0.035 (0.037)	0.025 (0.048)	0.023 (0.045)	-0.007 (0.044)	0.015 (0.030)
During Subsidy	0.129*** (0.035)	0.184*** (0.033)	0.156*** (0.034)	0.018 (0.044)	0.039 (0.039)	0.040 (0.040)	0.158*** (0.027)
Year 1 After	0.102*** (0.034)	0.152*** (0.034)	0.113*** (0.033)	0.070 (0.044)	0.073* (0.040)	0.099** (0.041)	0.124*** (0.026)
Year 2 After	0.018 (0.035)	0.056 (0.035)	0.089*** (0.034)	0.015 (0.045)	-0.026 (0.038)	0.026 (0.040)	0.057** (0.028)
Year 3-4 After	-0.012 (0.032)	0.055* (0.033)	0.050 (0.032)	-0.016 (0.043)	-0.003 (0.037)	0.003 (0.039)	0.034 (0.026)
Pooled Impact After	0.029 (0.029)	0.083*** (0.030)	0.079*** (0.029)	0.017 (0.038)	0.012 (0.034)	0.037 (0.035)	0.066*** (0.024)
Sample Size						13887	10,259
P-value: all three wage treatments equal during subsidy period						0.334	
P-value: wage only treatment = savings only treatment during subsidy period						0.018	
P-value: wage+savings=wage only + savings only, wage+training = wage only + training only, during subsidy						0.714	
P-value: all three wage treatments equal one another by round after intervention						0.050	
P-value: wage only treatment = savings only treatment by round after intervention						0.871	
P-value: wage+savings=wage only + savings only, wage+training = wage only + training only, by round after						0.003	
P-value: pooled impact after equal for all three wage treatments						0.152	

Take-aways

- Return to labor in the absence of complementary capital and training seems to be limited
- Results are more nuanced after boosting capital and training.
- Are these results consistent with the span of control model?

Roadmap

Key stylized facts

Firm size

Returns to labor

Selection

References

Occupational choice with heterogeneity in more than one dimension

What if people differ not only in entrepreneurial ability but also in skill as workers?

Two-dimensional heterogeneity raises issues of comparative advantage.

Sorting into workers and entrepreneurs is now more complicated.

Fortunately, a useful framework comes from a model of selection that can be traced to Roy (1951).

A model of selection based on Roy (1951)

Focuses on sorting and self-selection into occupational categories. However, the same model structure is used in many contexts and in many fields of economics.

- Main idea is that people sort on the basis of comparative advantage.
- Gaps in outcomes between individuals in different occupations/sectors reflect not only causal impacts (e.g., the same individual would earn more in sector X compared to sector Y), but also sorting of different types.
- Let's look at an application.

Cross-country labor productivity differences are much larger in agriculture compared to non-agriculture

Labour productivity measured as output per worker

TABLE 1—SECTOR LABOR PRODUCTIVITY DIFFERENCES AND EMPLOYMENT SHARES

	Agriculture	Aggregate	Non-agriculture	Ag/non-agriculture ratio
90–10 labor productivity difference	45	22	4	10.7
Employment shares ninetieth percentile country	3		97	
Employment shares tenth percentile country	78		22	

Notes: The aggregate productivity difference is the ratio of GDP per worker between the ninetieth and tenth percentile countries. Sector productivity differences are the ratio of sector output per worker in the ninetieth and tenth percentile countries. The Ag/Non-agriculture Ratio is the agriculture productivity difference divided by the non-agriculture productivity difference.

Source: Caselli (2005).

Do these difference in output per worker (Y/L) reflect genuine differences in technology (A)? Is LMIC's technology gap in agriculture greater than their technology gap in non-agriculture?

Lagakos and Waugh (2013): Understanding this point is crucial!

Cross-country labor productivity differences are much larger in agriculture than in the non-agricultural sector.

Because developing countries have most of their workers in agriculture, their low productivity in agriculture accounts for nearly all of their low productivity in the aggregate.

This implies that understanding why productivity differences in agriculture are so large compared to those of the non-agricultural sector is at the heart of understanding world income inequality.

Lagakos and Waugh (2013)

Lagakos and Waugh (2013) use a Roy model to think about occupational sorting between sectors – say, agriculture and non-agriculture.

Ingredients:

- Two sectors: agriculture (a) and non-agriculture (n).
- Countries differ in “economy-wide efficiency” A (relative efficiency in agriculture is the same as relative efficiency in non-agriculture)
- Subsistence requirements in preference for ag goods (e.g., Stone-Geary!) that make the demand for agriculture very high when productivity is low.
- Workers heterogeneous in productivity in each sector (Roy, 1951)

Key idea: self-selection of heterogeneous workers determines sector productivity

In poor countries, where economy-wide efficiency is low, most people must work in the agricultural sector in order to satisfy subsistence consumption needs. This is what Schultz (1953) famously called the “food problem.”

Insight: precisely because majority of workers in poor countries employed in agriculture, many must be relatively unproductive at agricultural work.

In rich countries, where A is high, those few workers selecting into agriculture must be those who are relatively most productive at agricultural.

Thus, two countries that differ in economy-wide efficiency will have even larger measured differences in agricultural productivity.

What about productivity in non-agriculture?

Let's now look at the model more formally.

What about productivity in non-agriculture?

Let's now look at the model more formally.

Households

- **Preferences**

$$U^i = \log(c_a^i - \bar{a}) + \nu \log(c_n^i)$$

- **Budget constraint**

$$p_a c_a^i + c_n^i \leq y^i$$

- Each household has an endowment of productivity/effective units of labor:
 $\{z_a^i, z_n^i\}$

- $\{z_a^i, z_n^i\}$ drawn from distribution $G(z_a, z_n)$

Production

- Production in the economy is characterized by an economy-wide level of productivity A .
- Each sector has a simple aggregate production technology:
$$Y_a = AL_a \quad \text{and} \quad Y_n = AL_n$$

Because we are in a constant returns to scale world, we do not need to worry about individual firms, and we can just look at the aggregate production.

Production

- From the perspective of the economy as a whole, each sector uses an effective labor input that is just the aggregation of the effective units supplied by individual workers:

$$L_a \equiv \int_{i \in \Omega_a} z_a^i dG_i \quad \text{and} \quad L_n \equiv \int_{i \in \Omega_n} z_n^i dG_i$$

- Ω_a (Ω_n) is the set of workers that work in ag (non-ag).
- Note that the aggregate labour units will be different from the number of workers. The number of workers in each sector is given by:

$$N_a \equiv \int_{i \in \Omega_a} dG_i \quad \text{and} \quad N_n \equiv \int_{i \in \Omega_n} dG_i$$

Sector Choice and Labor Income

- Due to competition: $w_a = p_a A$ and $w_n = A$ (w is wage per effective unit of labor)
- How do workers sort into sectors? They compare labour earnings in each sector. This is simply:

$$y_i \equiv \max\{p_a A z_a^i, A z_n^i\}$$

- Workers will work in non-agriculture if and only if:

$$\frac{z_i^n}{z_i^a} \geq p_a$$

Equilibrium

An equilibrium is:

- Relative food price p_a
- Wages w_a and w_n
- Allocations to sectors Ω_a and Ω_n

such that (i) workers optimize, and (ii) labor markets and output markets clear.

This model generates two key propositions.

(1) Relative Price of Food Higher in Poor Countries

Proposition: Consider two economies, rich and poor, with efficiency terms A^R and A^P such that $A^R > A^P$. In equilibrium, the relative price of agriculture is higher in the poor economy: $p_a^P > p_a^R$.

Intuition:

- Poor country demands relatively more food because of subsistence needs
- To induce workers to enter agriculture, given that they are relatively low-skill at agriculture, the only way to persuade them to join the agricultural workforce is for the price of food to be sufficiently high.
- So this economy will “need” a higher p_a in order to reach equilibrium.

(2) Relative Ag Productivity Lower in Poor Countries

Proposition: Consider two economies such that $A^R > A^P$. Assume $E[z_a|z_a/z_n > x]$ and $E[z_n|z_n/z_a > x]$ increase in x . Then equilibrium labour productivity is such that:

$$\frac{Y_a^R/N_a^R}{Y_a^P/N_a^P} > \frac{A^R}{A^P} \quad (13)$$

$$\frac{Y_n^R/N_n^R}{Y_n^P/N_n^P} < \frac{A^R}{A^P} \quad (14)$$

Intuition

$$\frac{Y_a^R / N_a^R}{Y_a^P / N_a^P} > \frac{A^R}{A^P} \quad (15)$$

- In rich country A is higher, and hence p_a is lower (prop 1).
- Lower returns to ag $\rightarrow$ only workers with high comparative advantage select in agriculture in rich country.
- If workers with greater comparative advantage also have higher absolute advantage, then agricultural productivity in rich country increases.

Simulation with economy-wide efficiency difference: selection alone can account for a large share of the differential productivity of ag

TABLE 2—90–10 PRODUCTIVITY DIFFERENCES, DATA AND BENCHMARK MODEL

	Agriculture	Aggregate	Non-agriculture	Ag/non-agriculture ratio
Data	45	22	4	10.7
Model	29	22	13	2.2
Without selection	19	19	19	1.0

Notes: The aggregate productivity difference is the ratio of GDP per worker between the ninetieth and tenth percentile countries. Sector productivity differences are the ratio of sector output per worker in the ninetieth and tenth percentile countries. The ag/non-agriculture ratios are the agriculture productivity differences divided by the non-agriculture productivity differences.

Source: Authors' calculations and Caselli (2005).

Roadmap

Key stylized facts

Firm size

Returns to labor

Selection

References

Key references

- **Lucas, R. E. (1978)**. On the Size Distribution of Business Firms. *Bell Journal of Economics*, 9(2), 508–523.
Partial equilibrium
- **De Mel, McKenzie, Woodruff (2019)** Labor drops: Experimental evidence on the return to additional labor in microenterprises. *American Economic Journal: Applied Economics* 11, no. 1 (2019): 202-235.
- **Lagakos and Waugh (2013)** Selection, agriculture, and cross-country productivity differences. *American Economic Review* 103, no. 2 (2013): 948-980.
Theory part

Other references

- Alchian, A. & Demsetz, H. (1972). Production, Information Costs, and Economic Organization.
- Banerjee, A. & Newman, A. (1993). Occupational Choice and the Process of Development.
- Buera, F., Kaboski, J., & Shin, Y. (2015). Entrepreneurship and Financial Frictions.
- Coase, R. (1937). The Nature of the Firm.
- Luttmer, E. (2010). Models of Growth and Firm Heterogeneity.
- Williamson, O. (2002). The Theory of the Firm as Governance Structure.