Misallocation

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Introduction

TFP seems to account for about half of cross-country income gaps.
What determines TFP is not well understood.
The leading candidate for "deep" causes is "institutions"

- but nobody knows how to quantify those

One (quantifiable) candidate for "proximate" causes is **misallocation**

- too much agriculture in low income countries
- poor allocation of resources to highly productive firms

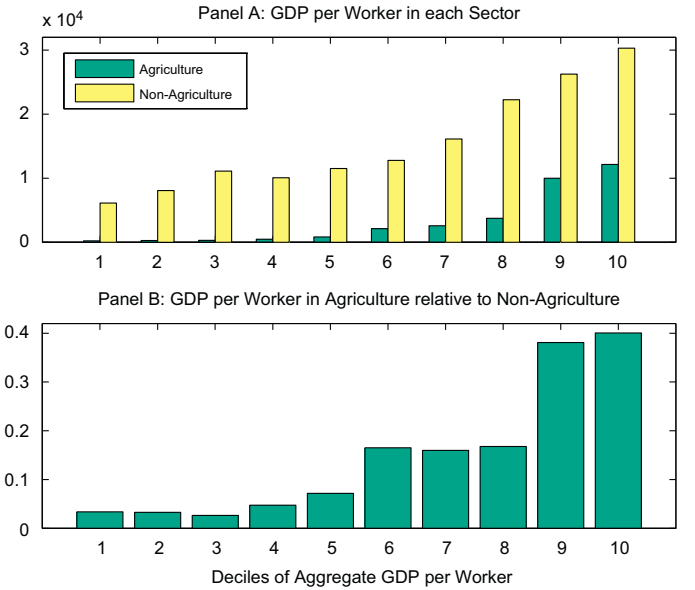
Surveys on misallocation: Restuccia and Rogerson (2013), Hopenhayn (2014).

Agriculture

Facts:

1. Low income countries employ most of their labor in ag.
2. Most food needs are met from domestic production.
3. TFP in agriculture varies much more than TFP in "industry"

Facts



Source: Restuccia et al. (2008)

Questions

1. Why is ag TFP so low in poor countries?
2. Why do poor countries employ so much labor in ag?

Why Do Low Income Countries Employ So Much Labor in Ag?

Gollin et al. (2007): subsistence food consumption

- when poor, all resources are devoted to food production
- ag tfp grows exogenously
- at some point, resources are freed up to move into industry

Restuccia et al. (2008):

- some "barrier" prevents labor from moving out of ag

Lagakos and Waugh (2013):

- there is no misallocation
- the wage gap is selection

Why Is Ag Productivity So Low?

Possible answers:

1. Labor market restrictions push too much labor into ag
   (a) Restuccia et al. (2008)
2. Lack of intermediate inputs
   (a) Restuccia et al. (2008)
   (b) Gollin et al. (2007): lack of capital forces use of an inefficient technology

Restuccia et al. (2008)

A "representative" paper from this literature: Restuccia et al. (2008)

Points of note:

1. a very simple model
2. some really strong assumptions permit calibration
3. not much data used in calibration

Why did the paper make the JME?

it has a hook: new data

Model

Static

Demographics:

- a representative household with mass $N = 1$

Preferences:

- $U = a \ln (c_a - \bar{a}) + (1 - a) \ln (c_n)$

Endowments:

- Z units of land

Technologies:

- ag: $Y_a = X^{\alpha} \left[Z^{1-\sigma} (\kappa A L_a)^{\sigma} \right]^{1-\alpha} = c_a$
- non-ag: $Y_n = A L_n = \pi X + c_m$
- $L_a + L_m = 1$

Markets:

- non-ag goods (numeraire), ag goods (p_a)
- labor: $w_a = (1 - \theta) w_n$
- θ: tax on labor in non-ag
- land rental

Calibration

US data in 1985

Table 1
Calibration of parameter values to U.S. data

Parameter	Value	Target
Z/N	1.6	Land-to-employment ratio
A	34,206	Labor productivity in non-agriculture
κ	34.1	Labor productivity in agriculture
σ	0.7	Hayami and Ruttan (1985)
α	0.4	Intermediate input share
$(1-\theta)$	0.385	Value of relative marginal labor products
a	0.0046	Long-run share of employment in agriculture
$\overline{a}$	752.6	Share of employment in agriculture

No validation (the model is, so to speak, exactly identified).

Experiment

Vary across countries:

1. labor market distortion θ
2. price of ag inputs π
3. tfp A (to match Y/N)
4. land per worker Z/N (data)

Key: the distortions are observable.

- Measure π using FAO data on the **relative price of intermediate inputs** in agriculture (relative to non-ag output; the numeraire).
- Measure θ using data on **relative wages** (ag / non-ag).

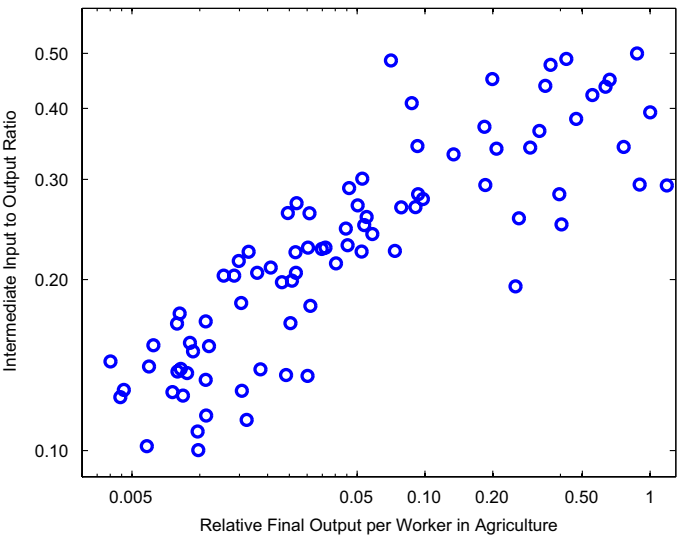
Question:

- to what extent can the model account for variation in $L_a, X/Y_a, Y_a/L_a$?

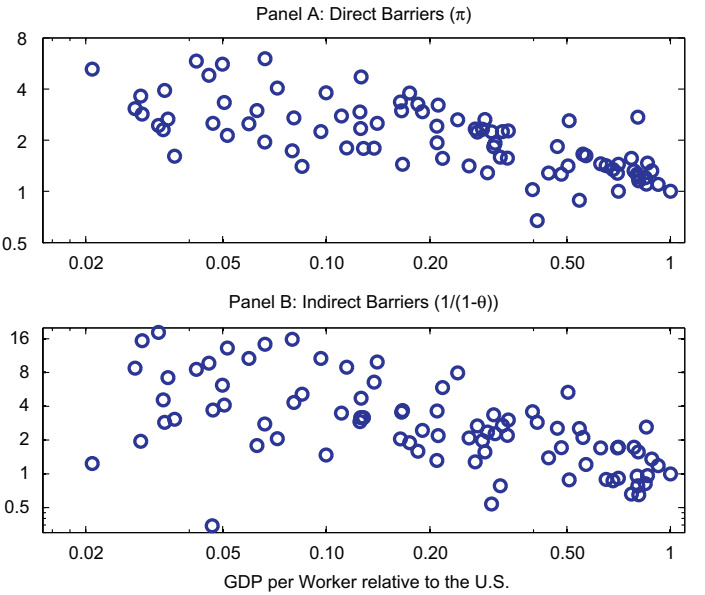
The Hook

This is the paper's hook:

- the data on π are new
- it shows that X/Y_a is rising with GDP (not surprising but new)



Measures of the distortions π and θ



π: price of ag intermediate inputs / price of ag output

θ: mean wage non-ag / mean wage in ag

- this gap is huge in poor countries (factor 30!)

Results

Table 2
Effects of barriers and economy-wide productivity on equilibrium outcome variables

	L_a/N Rich/poor	X/Y_a Ratio of rich to poor countries	Y_a/L_a Ratio of rich to poor countries	Y/N Ratio of rich to poor countries
Data	0.04/0.86	3.1	109.1	34.3
(7) Baseline model	0.04/0.68	2.7	23.4	10.8
Decomposing the contribution of individual factors				
(6) Add direct barriers π only	0.04/0.39	1.5	10.2	6.2
(5) Add indirect barriers θ only	0.03/0.38	1.5	13.8	7.0
(4) Two-sector with $\{L_a, Z, X\}$	0.04/0.20	0.9	6.3	5.5
(3) Two-sector with $\{L_a, Z\}$	0.04/0.24	–	8.2	5.4
(2) Linear two-sector with $\{L_a\}$	0.04/0.17	–	5.0	5.0
(1) One-sector	–	–	–	5.0
Unexplained % or factor	0.00/0.18	1.1	4.7	3.2

Message: TFP gaps needed to account for 20-fold output gaps are smaller than in standard growth model.

Intuition:

- labor market distortion pushes labor into ag
  - price of ag falls
- π keeps intermediates out of ag
  - ag productivity falls
- we end up with lots of labor in a sector with low TFP

Open Issues

What barrier sustains a 30 fold wage gap between ag and non-ag?
Properly measured, is that gap really 30 fold?

The Ag Productivity Gap

Herrendorf and Schoellman (2011):

- Question: is the gap in productivity ag / non-ag due to misallocation?
- Fact 1: even in the U.S., there are large gaps in ag / non-ag productivity (median factor 3)
- Fact 2: gaps in wages are smaller than gaps in productivities (U.S., median factor 2)
- Fact 3: measured output fails to count some pieces (land rents, some self-employment income)
- Fact 4: correcting output measures reduces the ag / non-ag gap to factor 2
- Fact 5: similar patterns in other countries
  - especially: wage gaps are smaller than productivity gaps

Gollin et al. (2013):

- adjustments to measured output and inputs (hours, human capital) reduce the productivity gap, but do not eliminate it.
- this sounds pedestrian, but it's a really nice paper with very careful data work

Misallocation Across Plants

The key paper: Hsieh and Klenow (2009)

The idea:

- the most productive plants should be the largest
- if not, moving capital and labor from low to high efficiency plants could increase output

To quantify this:

- write down a model with heterogeneous plants
- each plant is a monopolist
- benchmark: "revenue productivity" should be equated across plants
- obtain data on distribution of revenue productivity for manufacturing plants in US, India, China
- infer distortions
- compute output gain from lowering distortions to U.S. levels (about 50%)

Model

Static

The only agents are plants

Final output

$$Y = \Pi_{s=1}^{S} Y_s^{\theta_s} \tag{1}$$

Sector output:

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{1-\sigma}{\sigma}} \tag{2}$$

Firm output

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s} \tag{3}$$

Market clearing

$$K = \sum_s \sum_i K_{si} \tag{4}$$

$$L = \sum_s \sum_i L_{si} \tag{5}$$

Factor supplies are fixed

Final Goods Producer

Perfect competition

Static cost minimization yields

$$Y_s = \theta_s Y P / P_s \tag{6}$$

with

$$P = \Pi_s \left(P_s/\theta_s\right)^{\theta_s} \equiv 1 \tag{7}$$

Intermediate Goods Producer

Static profit maximization

$$\pi_{si} = (1 - \tau_{Ysi})\, P_{si} Y_{si} - wL_{si} - (1 + \tau_{Ksi})\, RK_{si} \tag{8}$$

The firm takes the demand function (with price elasticity σ) as given.
The τ are distortions that affect

- size of the firm (τ_Y)
- capital-labor allocation (τ_K)

Implications for the Allocation

Without distortions, marginal revenue products of K and L are equated across all firms.

- $MRPL_{si} = w/(1 - \tau_{Ysi})$
- $MRPK_{si} = R\frac{1+\tau_{Ksi}}{1-\tau_{Ysi}}$

Backing Out TFP

The object of interest: TFP_s, defined by

$$Y_s = TFP_s K_s^{\alpha_s} L_s^{1-\alpha_s} \tag{9}$$

This determines aggregate output via

$$Y = \Pi_s \left(TFP_s K_s^{\alpha_s} L_s^{1-\alpha_s} \right)^{\theta_s} \tag{10}$$

TFP_s aggregates the A_{si}

The task: convert TFP_s into something observable.

Backing Out TFPs

Key result (15):

$$TFP_s = \left[\sum_i \left(A_{si} T\bar{F}PR_s / TFPR_{si} \right)^{\sigma - 1} \right]^{1/(\sigma - 1)} \tag{11}$$

where

$$TFPR_{si} \propto \frac{P_{si} Y_{si}}{K_{si}^{\alpha_s} \left(wL_{si} \right)^{1-\alpha_s}} \propto \frac{\left(1 + \tau_{Ksi} \right)^{\alpha_s}}{1 - \tau_{Ysi}} \tag{12}$$

is revenue TFP

and $T\bar{F}PR_s$ is a (geometric) average of $TFPR_{si}$.

Key: $TFPR_{si}$ is observable (up to a scale factor).

A bit of trickery: to account for labor quality, measure labor input by the wage bill.

Some intuition:

- In the undistorted case, $TFPR_{si} / T\bar{F}PR_s = 1$
- Under some assumptions, dispersion in $TFPR_{si}$ reduces TFP_s

Motivating Evidence

Large dispersion of revenue TFP in China and India vs U.S.

TABLE II
DISPERSION OF TFPR

China	1998	2001	2005
S.D.	0.74	0.68	0.63
75 – 25	0.97	0.88	0.82
90 – 10	1.87	1.71	1.59
India	1987	1991	1994
S.D.	0.69	0.67	0.67
75 – 25	0.79	0.81	0.81
90 – 10	1.73	1.64	1.60
United States	1977	1987	1997
S.D.	0.45	0.41	0.49
75 – 25	0.46	0.41	0.53
90 – 10	1.04	1.01	1.19

Empirical Strategy

Start with a dataset of plants for a given country.

Data on Y_{si}, K_{si}, wL_{si}.

Use equations for marginal revenue products to back out distortions.

- $MRPL_{si} = w/(1 - \tau_{Ysi})$
- $MRPK_{si} = R\frac{1+\tau_{Ksi}}{1-\tau_{Ysi}}$

Since marginal products are not observed, use the ones implied by the model:

- $\frac{\sigma}{\sigma-1}\frac{wL_{si}}{(1-\alpha_s)P_{si}Y_{si}} = 1 - \tau_{Ysi}$
- $\frac{\alpha_s}{1-\alpha_s}\frac{wL_{si}}{RK_{si}} = 1 + \tau_{Ksi}$

In words:

- τ_K distorts the capital / labor allocation (measured by factor shares)
- τ_Y really distorts the scale of the plant; it moves along the demand curve

Also compute A_{si} to match $TFPR_{si}$.

Gains From Removing Distortions

Compute the efficient allocation (setting all $\tau = 0$).

Holding capital and labor supplies fixed.

This simply amounts to setting all $TFPR_{si}$ equal, so that

$$TFP_s = \left[\sum_i (A_{si})^{\sigma-1} \right]^{1/(\sigma-1)} \tag{13}$$

Many caveats:

- dispersion in U.S. $TFPR$ could represent something other than distortions (model misspecification)
- measurement error could be larger in low income countries
- etc

Main Result

TABLE IV
TFP GAINS FROM EQUALIZING TFPR WITHIN INDUSTRIES

China	1998	2001	2005
%	115.1	95.8	86.6
India	1987	1991	1994
%	100.4	102.1	127.5
United States	1977	1987	1997
%	36.1	30.7	42.9

Gains from removing distortions are much larger in China / India than in U.S.

Moving to "U.S. Efficiency"

A bit of a strange calculation:

How much larger are welfare gains from moving to the efficient allocation for China vs. U.S.?

Call that the gains from moving to U.S. efficiency (which it is not)

TABLE VI

TFP GAINS FROM EQUALIZING TFPR RELATIVE TO 1997 U.S. GAINS

China	1998	2001	2005
%	50.5	37.0	30.5
India	1987	1991	1994
%	40.2	41.4	59.2

Notes. For each country-year, we calculated $Y_{\text{efficient}}/Y$ using $Y/Y_{\text{efficient}} = \prod_{s=1}^{S} \left[\sum_{i=1}^{M_s} \left(\frac{A_{si}}{A_s} \right. \right.$ $\left. \left. \frac{\overline{\text{TFPR}}_s}{\text{TFPR}_{si}} \right)^{\sigma-1} \right]^{\theta_s/(\sigma-1)}$ and $\text{TFPR}_{si} \equiv \frac{P_{si} Y_{si}}{K_{si}^{\alpha_s} (w_{si} L_{si})^{1-\alpha_s}}$.

We then took the ratio of $Y_{\text{efficient}}/Y$ to the U.S. ratio in 1997, subtracted 1, and multiplied by 100 to yield the entries above.

Result: Moving to "US efficiency" increases TFP by roughly 50%

For comparison: TFP gap is about 150%

Comments

A really nice idea.

Difficult to implement quantitatively.

The answer depends on functional forms (elasticity of demand, nature of distortions, ...).

There is also a serious concern that more dispersion in TFPR in low income countries could be

- efficient or
- measurement error.

Other Sources of Misallocation

1. Credit frictions
2. Regulations that restrict the size of establishments or that lead to informality
3. Regulations that limit competition

Unexplored (as far as I know):

Do the "right" people get allocated to the "right" jobs / education levels?

Papers for student presentations

Misallocation across occupations:

- Hsieh et al. (2013), Guner et al. (2015)

Agriculture:

- Lagakos and Waugh (2013), Adamopoulos and Restuccia (2014), Restuccia and Santaeulalia-Llopis (2015)

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