14.461: Technological Change, Lecture 10
Misallocation and Productivity

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October 14, 2011.

Introduction

- Could large differences across countries (or sectors) be due to the fact that there is "misallocation" across plants, firms are sectors?
- McKinsey Global Institute country and sector studies found large differences across firms within the same sector in many developing countries (South Korea, Brazil, Turkey, India). In fact, in many of these cases, the most productive firms within most sectors have productivity levels comparable to those in Western Europe or the United States, but there is a long tail of very low productivity firms.
  - Could this be important?
  - Why are these firms not upgrading their productivity?
  - More importantly, why aren't you more productive firms expanding to replace them?

Empirical Framework

- One possible empirical framework to investigate how important this is has been proposed by Hsieh and Klenow (2009) based on (highly parametric) assumptions on preferences and production technology.
- Though these assumptions are problematic, the issue is important and the patterns are very interesting.
- These assumptions also enable a clean representation of the potential impact of "misallocation" on sectoral or aggregate productivity.

Preferences and Technology

- Consider an economy consisting of S sectors, and aggregate output defined as

$$Y = \prod_{s=1}^{S} Y_s^{\theta_s} \text{ with } \sum_{s=1}^{S} \theta_s = 1.$$

- Each sector is a CES aggregate of differentiated products:

$$Y_s = \left(\sum_{j=1}^{M_s} Y_{sj}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}},$$

and each firm in sector s has production function

$$Y_{sj} = A_{sj} K_{sj}^{\alpha_s} L_{sj}^{1-\alpha_s}.$$

Preferences and Technology (continued)

- Hsieh and Klenow (2009) assume (following a practice that has become popular) that there are firm-specific "wedges" affecting total production and capital, essentially modeled as "taxes".
  - What are these? Certainly not taxes.
- As a result of these wedges, firms produce different amounts than what would be dictated by their productivity and also may have different capital-labor ratios.

How to Measure TFP?

- One measure of TFP is given by

$$TFPQ_{sj} = A_{sj},$$

as this is the difference in "physical productivity" across firms (or plants).

- But as Foster, Haltiwanger and Syverson (2008) point out, this is not what we obtained when we use industry price deflator (rather than plant or firm specific price deflators), revenue includes firm or plant specific prices, so what we would estimate is not TFPQ, but "revenue productivity," measured as

$$TFPR_{sj} = P_{sj}A_{sj},$$

where P_{sj} is the price of the product of firm/plant j.

The Different Behavior of TFP Measures

- If there are no firm/plant specific distortions and all firms and plants within a sector have the same markup (assumed by this framework but obviously not true in general), TFPR will be equalized across firms/plants within a sector. (This simply follows from the cost minimization problem of consumers).
- In general, variation of TFPR within a sector will be a measure of misallocation.

Sectoral TFPs

- To see this, let us write

$$Y = \prod_{s=1}^{S} \left(TFP_s \cdot K_s^{\alpha_s} \cdot L_s^{1-\alpha_s} \right)^{\theta_s},$$

  where K_s and L_s are total stock of capital and amount of labor used in sector s.

- Then, this relevant measure of sectoral TFP can be written asEach sector is a CES aggregate of differentiated products:

$$TFP_s = \left(\sum_{j=1}^{M_s} \left(TFPQ_{sj} \cdot \frac{\overline{TFPR}_s}{TFPR_{sj}} \right)^{\sigma-1} \right)^{\frac{1}{\sigma-1}},$$

  where $\overline{TFPR}_s$ is the geometric average of the average marginal revenue product of capital and labor in sector s.

Sectoral TFPs (continued)

- This expression shows the role of misallocation: if plants with lower physical productivity, TFPQ, have also lower TFPR, meaning that their prices are high so that they are producing more than they should, then aggregate TFP will be lower.

- To see this more clearly, considered a special case where $TFPQ_{sj}$ and $TFPR_{sj}$ are jointly log normally distributed, then the previous expression implies:

$$\ln TFP_s = \frac{1}{\sigma - 1} \ln \left(\sum_{j=1}^{M_s} TFPQ_{sj}^{\sigma - 1} \right) - \frac{\sigma}{2} var \left(\ln TFPR_{sj} \right),$$

so that this allocation shows up only in the variance of "revenue productivity" across firms slash fans (recall that the first term is fixed by technology).

Empirical Implementation

- Hsieh and Klenow (2009) compute these measures (using essentially these expressions, only with adjustment for labor quality differences by using wage bills) on Chinese, Indian and US manufacturing data.
- They been in for the extent of misallocation and its contribution to aggregate productivity.
- What could go wrong with this empirical approach? What are the challenges?

Summary of Results

- They find that there is greater dispersion of TFPR in India and China than in the United States (this is also true for TFPQ, but less so).
  - For example, for TFPR, the 90-10 ratio is 1.59 in China, 1.60 in India and 1.19 in the United States.
- They estimate that this could account for lower aggregate productivity. In particular, there estimates suggest that this type of misallocation could increase TFP in China by 30%-50% and in India by 40%-60% (which would also imply comparable or twice as large output gains depending on whether capital at the plant/firm level responds).
- They also find evidence for more rapid reallocation towards firms/plants with higher TFPQ in China than even in the United States, possibly reflecting rapid reallocation as less efficient state-owned enterprises are being weeded out there. But reallocation away from less efficient firms seems slower in India.

Summary of Results (continued)

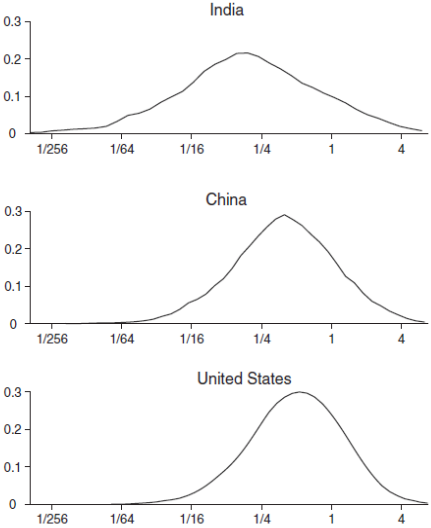


FIGURE I
Distribution of TFPQ

Summary of Results (continued)

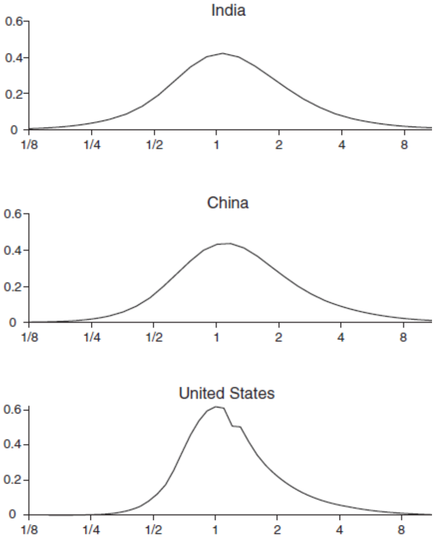


FIGURE II
Distribution of TFPR

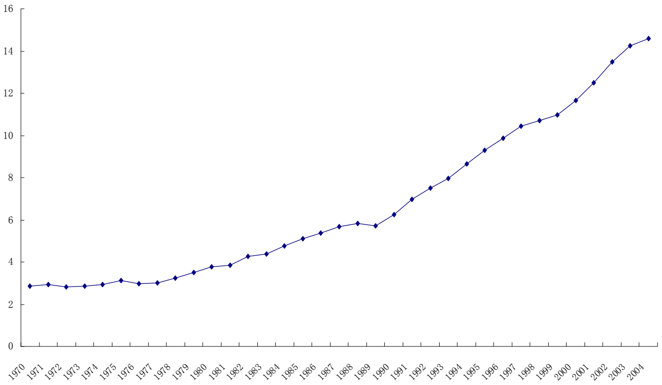
Summary of Results (continued)

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

Reallocation and Chinese Growth

- China: a case of growth due to reallocation?



Reallocation and Chinese Growth (continued)

- Rapid reallocation from rural sector to urban sector and from inefficient state-owned enterprises to other firms (private or state owned).
- No sign of slowing down as would be predicted by the standard neoclassical convergence story.
- Also:
  - Wage growth below productivity growth. Growing inequality
  - High saving rates (total 50%, household 28%)
  - Foreign imbalance ($2.5 trillion foreign reserves built up since 1992).

Reallocation and Chinese Growth: Questions

- How this type of reallocation takes place?
- Why is it slow? Why is it sustained?
- Is it related to high savings rates and foreign imbalances?
- Song, Storeslettten and Zilibotti (2010): a model of sustained, slow reallocation due to credit market constraints.
  - Consistent with certain cross-sectional pattern (rapid growth and labor-intensive sectors)
  - Consistent with high savings rates and foreign imbalances.

Model

- Two type of firms, E-firms (*entrepreneurial*) and F-firms (*financially integrated*)
- E-firms and F-firms produce identical goods, but differ in technology and access to capital markets
- E-firms have higher TFP but are at disadvantage in financial markets:
    - F-firms have a deep pocket (e.g., owned by the state or financial intermediaries)
    - Entrepreneurs' returns are non-verifiable: they *can only* pledge a fraction of their profit cash-flow
- Extreme scenario: entrepreneurs *cannot* borrow at all and must finance investments out of their personal savings

Model (continued)

- E-firms choose the more productive technology

$$y_{Et} = (k_{Et})^{\alpha} (\chi A_t n_{Et})^{1-\alpha}$$

$$y_{Ft} = (k_{Ft})^{\alpha} (A_t n_{Ft})^{1-\alpha}$$

where

$$A_{t+1} = (1+z) A_t$$

(exogenous technical progress)

- Microfoundations in the paper
- (Urban) working population grows at an exogenous rate ν
- Credit constraints keep alive F firms

Model: Households

- OLG of two-period lived agents, who work in the first period and live off savings in the second period
- Preferences

$$U_t = \frac{(c_{1t})^{1-\frac{1}{\theta}} - 1}{1 - \frac{1}{\theta}} + \beta \frac{(c_{2t+1})^{1-\frac{1}{\theta}} - 1}{1 - \frac{1}{\theta}}$$

- Young workers earn a wage (w) and invest their savings in bank deposits paying gross returns R
  - Workers' savings rate is $\zeta^W \equiv \left(1 + \beta^{-\theta} R^{1-\theta}\right)^{-1}$
- Young entrepreneurs earn a managerial compensation (m) and can invest savings in deposits, but also in their *own* business
  - Entrepreneurs' savings rate is $\zeta^W \equiv \left(1 + \beta^{-\theta} \rho_E^{1-\theta}\right)^{-1}$

Model: Banks

- Competitive banks collect deposits and hold portfolios of loans to domestic F-firms (I_t^F) and foreign bonds (B_t)
- Domestic loans yield a gross a return R
- Foreign bonds yield a gross a return R^W
- No-arbitrage: $R^W = R$
- There are intermediation costs for lending to firms
    - For banks to receive R firms must pay a gross return

$$R^l = R/\left(1 - \xi\right),$$

where ξ is an *iceberg* intermediation cost

Analysis: F-Firms

- Investments entirely financed by bank loans:

$$K_{Ft+1} = I_{Ft}$$

- Notation: $\kappa \equiv K / (AN)$
- No-arbitrage implies $R^l = \alpha \kappa_F^{\alpha - 1}$, hence,

$$\kappa_F = \left(\frac{\alpha}{R^l} \right)^{\frac{1}{1-\alpha}}$$

- Wages equal the marginal product of labor:

$$w_t = (1 - \alpha) \kappa_F^{\alpha} A_t .$$

Analysis: E-Firms

- E-firms are owned by old entrepreneurs and run by young *managers*
  - moral hazard problem: managers can steal share ψ of the output without being caught
- Manager's incentive constraint requires $m \geq \psi y_E$
- The optimal contract implies

$$
\begin{aligned}
\Xi_t\left(k_{Et}\right) &= \max_{n_{Et}, m_t} \left\{ \left(k_{Et}\right)^{\alpha} \left(\chi A_t n_{Et}\right)^{1-\alpha} - w_t n_{Et} - m_t \right\} \\
& \text{s.t.} \\
m_t &\geq \psi \left(k_{Et}\right)^{\alpha} \left(\chi A_t n_{Et}\right)^{1-\alpha} \\
m_t &\geq w_t
\end{aligned}
$$

Analysis: E-Firms

- The solution yields

$$\begin{aligned} n_{Et} &= (1-\psi)^{\frac{1}{\alpha}} \chi^{\frac{1-\alpha}{\alpha}} \left(\frac{R^l}{\alpha}\right)^{\frac{1}{1-\alpha}} \times \frac{k_{Et}}{A_t} \\ y_{Et} &= ((1-\psi)\chi)^{\frac{1-\alpha}{\alpha}} \frac{R^l}{\alpha} \times k_{Et} \\ m_t &= \psi \times y_{Et} \end{aligned}$$

- Thus, the value of the firm is

$$\Xi_t(k_{Et}) = \alpha(1-\psi) \times y_{Et} = \underbrace{(1-\psi)^{\frac{1}{\alpha}} (\chi)^{\frac{1-\alpha}{\alpha}} R^l}_{\equiv \rho_E} \times k_{Et}$$

- Note: the entrepreneurial rate of return, ρ_E, is constant

Analysis: Growth

- Entrepreneurial savings are the driving force of the transition

$$\frac{K_{Et+1}}{K_{Et}} = \frac{\zeta^E \times M_t}{K_{Et}} = \zeta^E \psi \left((1-\psi)\chi \right)^{\frac{1-\alpha}{\alpha}} \frac{R^l}{\alpha}$$

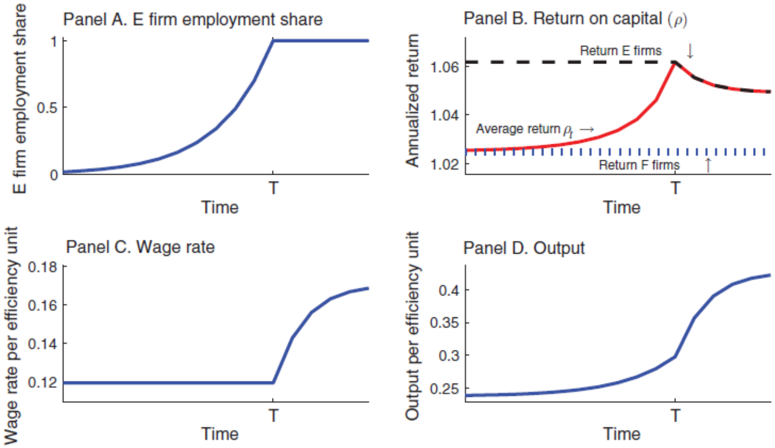
where $M_t = \int_{\Omega_m} m_t = \psi \times Y_{Et}$.

- The E-sector features AK equilibrium dynamics

$$Y_{Et} = \left((1-\psi)\chi \right)^{\frac{1-\alpha}{\alpha}} \frac{R^l}{\alpha} \times K_{Et}$$

because it uses the “labor reserve” of the F sector, which keeps wages per efficiency units constant.

Equilibrium Dynamics



Foreign Imbalance Implications: Extreme Scenario

- No borrowing.
- For entrepreneurs: $S = I$.
- The difference between worker's savings and the investments of F sector determines the foreign balance.
- From the balance sheets of the bank sector,

$$\underbrace{K_{Ft} + B_t}_{\text{ASSETS}} = \underbrace{\zeta \times w_{t-1} N_{t-1}}_{\text{DEPOSITS}}$$

$$\begin{aligned} B_t &= \zeta^W \times (w_{t-1} N_{t-1}) \uparrow - K_{Ft} \downarrow \\ &= \left(\zeta^W \frac{1-\alpha}{(1+z)(1+\nu)} \kappa_F^{\alpha-1} - 1 + \frac{N_{E,t}}{N_t} \right) \times \kappa_F A_t N_t \end{aligned}$$

- As the F sector shrinks, while wage income grows, B increases.
- The economy accumulates a surplus.

Foreign Imbalance Implications: with Borrowing

- The difference between worker's savings and the investments of F + gap of E sector determines the foreign balance.
- From the balance sheets of the bank sector,

$$\underbrace{K_{Ft} + B_t + \frac{\eta \rho_E}{R_l} K_{Et}}_{\text{ASSETS}} = \underbrace{\zeta \times w_{t-1} N_{t-1}}_{\text{DEPOSITS}}$$

$$\begin{aligned} B_t &= \zeta \times \left(w_{t-1} N_{t-1}\right) \uparrow - \left(K_{Ft} \downarrow + \frac{\eta \rho_E}{R_l} K_{Et} \uparrow \right) \\ &= \left(\zeta^W \frac{1-\alpha}{(1+z)(1+\nu)} \kappa_F^{\alpha-1} - 1 + (1-\eta) \frac{N_{E,t}}{N_t} \right) \times \kappa_F A_t N_t \end{aligned}$$

- The economy accumulates a surplus as long as η is not too large

Equilibrium Dynamics of Savings Rate and Foreign Assets