Misallocation and Manufacturing TFP in China and India

By Chang-Tai Hsieh and Peter J. Klenow

Yewande Olapade

University of Houston

November 6, 2016

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Introduction and Motivation

- Resource misallocation can lower aggregate total factor productivity.
  - Reallocating capital from low MPK firms to high MPK firms can increase TFP and aggregate output.
  - If Capital were allocated efficiently, the capital market adjusts and $MPK_i = r$ (the market interest rate) regardless of firm's productivity.
  - MPK is not the same across firms if there is distortion in the allocation of capital.
- This results into misallocation of resources and aggregate TFP may be lower for the affected country.

Introduction and Motivation

- Imagine an economy with two firms with identical technology.
- One firm benefits from subsidized credit and the other does not.
- The MPK of the subsidized firm is lower than the MPK of the firm that has access to the formal market.
- This is a clear case of misallocation.

Introduction and Motivation.

- Using the revenue productivity (product of physical productivity (MPK) and a firm's output price(p)) they calculated TFP for each sector.
- Their result shows a sizable gaps in MPK across firms for China and India compared with the united States.

Introduction and Motivation.

GRAPH OF TFPR IN INDIA, CHINA, AND US

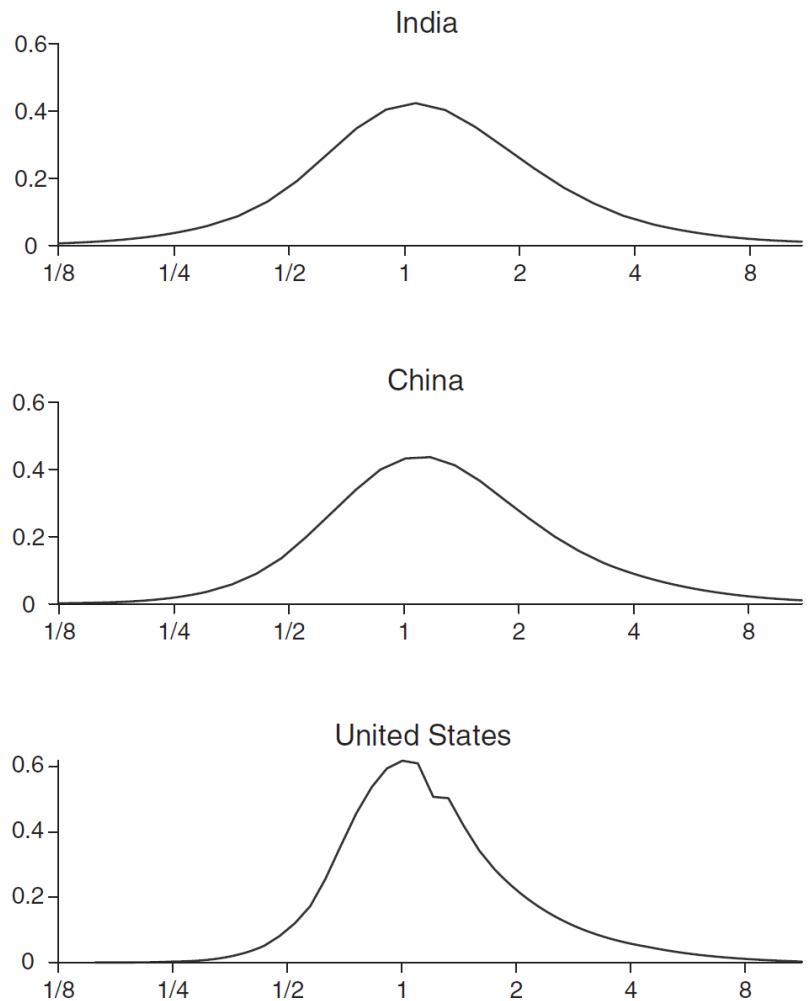

FIGURE II

Introduction and Motivation.

- When resources are hypothetically allocated optimally across firms there is an average 30% to 60% gains in aggregate TFP for China and India.
- Deteriorating allocative efficiency may have shaved 2% off Indian manufacturing TFP from 1987 to 1994 while China may have boosted its TFP 2% over 1998-2005.

Model and Methodology

- The paper is based on Monopolistic competition model with heterogeneous firms .
- Firms differ in efficiency (Melitz model) and face different output and capital distortion.
- Final good Y combines the output Y_s of S manufacturing industries in a C-D production function technology.

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

Model and Methodology

Cost minimization Implies: FOC:

$$P_s Y_s = \theta_s PY \tag{2}$$

P_s is the price of industry output Y_S and aggregate price index is CES.

$$P \equiv \Pi_{s=1}^{S} (P_s/\theta_s)^{\theta_s} \tag{3}$$

Model and Methodology

Industry output Y_s is itself a CES aggregate of M_s differentiated products:

$$Y_s = \left(\sum_{i=1}^{M} Y_{si}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \tag{4}$$

A representative firm production function:

$$Y_{si} = A_{si} L_{si}^{\alpha_s} K_{si}^{1-\alpha_s} \tag{5}$$

where A_{si} is the firm level TFP.

Model and Methodology

Under monopolistic competitive markets, firm output price is a fixed markup over its MC:

$$P_{si} = \frac{\sigma}{\sigma - 1}\left(\frac{R}{\alpha_s}\right)^{\alpha_s}\left(\frac{w}{1-\alpha}\right)^{1-\alpha} \tag{6}$$

And the capital labor ratio from a C-D production function is:

$$\frac{K_i}{L_i} = \frac{\alpha}{1-\alpha}\frac{w}{R} \tag{7}$$

Model and Methodology

- HK introduce distortion. This is usually called a wedge
  - Distortion to both MPK and MPL is represented by τ_Y.
  - Distortion to capital relative to labor si τ_k .

Under monopolistic competitive markets characterised by misallocation, firm output price is a fixed markup over its MC and the distortions:

$$P_{si} = \frac{\sigma}{\sigma - 1}\left(\frac{R}{\alpha_s}\right)^{\alpha_s}\left(\frac{w}{1-\alpha}\right)^{1-\alpha}\frac{(1+\tau_{Ksi})}{A_{si}(1-\tau_{Ysi})} \tag{8}$$

And the capital labor ratio:

$$\frac{K_i}{L_i} = \frac{\alpha}{1-\alpha}\frac{w}{R}\frac{1}{1+\tau_{Ki}} \tag{9}$$

Equation 9 can be inverted to calculate $1 + \tau_{ki}$.

Framework for Measurement of Misallocation

$MRPL_{si}$ and $MRPK_{si}$

$$MRPL_{si} = (1 - \alpha_s)\frac{\sigma - 1}{\sigma}\frac{P_{si}Y_{si}}{L_{si}} = w\frac{1}{1 - \tau_{Ysi}} \tag{10}$$

$$MRPK_{si} = (\alpha_s)\frac{\sigma - 1}{\sigma}\frac{P_{si}Y_{si}}{K_{si}} = R\frac{1 + \tau_{Ksi}}{1 - \tau_{Ysi}} \tag{11}$$

Framework for Measurement of Misallocation

Real TFP:

$$TFPQ_{si} = A_{si} = \frac{Y_{si}}{K_{si}^{\alpha s}(wL_{si})^{1-\alpha s}} \tag{12}$$

Quantified TFP:

$$TFPR_{si} = P_{si}A_{si} = \frac{P_{si}Y_{si}}{K_{si}^{\alpha s}(wL_{si})^{1-\alpha s}} \tag{13}$$

High plant TFPR is a sign that the plants confronts barriers that raise the plants MPK and MPL rendering the plant smaller than optimal.

Framework for Measurement of Misallocation

- If prices don't vary across firms within a particular sector then TFPR is as good as TFPQ.

Framework for Measurement of Misallocation

From equation 4 and 5, industry's TFPs is given as:

$$TFPs = \left[\sum_{i=1}^{M} s(A_{si} \frac{\overline{TFPR_s}}{TFPR_{si}})^{\sigma-1} \right]^{\frac{1}{\sigma-1}} \tag{14}$$

$$\overline{TFPR_s} = \overline{(MRPK_s)}^{\alpha s} \overline{(MRPLS_s)}^{1-\alpha s} \tag{15}$$

Where $\overline{TFPR_s}$ is a geometric average of MRPK and MRPL.

Also $TFPR_{si}$:

$$\text{TFPR}_{si} = \frac{\sigma}{\sigma-1}\left(\frac{MRPK_{si}}{\alpha_s}\right)^{\alpha_s}\left(\frac{MRPL_{si}}{w(1-\alpha_s)}\right)^{1-\alpha_s} = \left(\frac{R}{\alpha_s}\right)^{\alpha_s}\left(\frac{1}{1-_s}\right)^{1-\alpha_s}\frac{1+\tau_{ksi}}{1-\tau_{Y_s i}} \quad (16)$$

Framework for Measurement of Misallocation

- When TFPQ and TFPR are jointly log normally distributed

$$logTFP_s = \frac{1}{\sigma - 1} log \left(\sum_{(i=1)}^{M_s} A_{si}^{\sigma - 1} \right) - \frac{\sigma}{2} var(logTFPR_{si}) \qquad (17)$$

Framework for Measurement of Misallocation

- HK assumed that TFPR does not vary within an industry except the firm faces distortion.
- They assumed a fixed aggregate stock of capital.
- Based on these considerations, the variance of log (TFPR) picks up the distortion across firms

Data

- India data is the ASI data : census of registered manufacturing plants from 1987-1988 and 1994-1995.
- Chinese firms (not plant) data are from annual survey of industrial production from 1998 to 2005
- US data is the census of manufactures (CM) from 1977, 1982, 1987 , 1992 and 1997.
- They set Industrial Capital share to those in the corresponding US industry.

Data Analysis

- Rental price R = 0.10 with 5% interest and 5% depreciation
- $\sigma = 3$ misallocation increases with elasticity of substitution

$$1 + \tau_{K_{si}} = \frac{\alpha_s}{1 - \alpha_s} \frac{wL_{si}}{RK_{si}} \tag{18}$$

We infer the presence of capital distortion when the ratio of labor compensation to the capital stock is high relative to what one would expect from the output elasticities.

Dispersion of TFPQ and TFPR

TABLE I
DISPERSION OF TFPQ

China	1998	2001	2005
S.D.	1.06	0.99	0.95
75 – 25	1.41	1.34	1.28
90 – 10	2.72	2.54	2.44
N	95,980	108,702	211,304
India	1987	1991	1994
S.D.	1.16	1.17	1.23
75 – 25	1.55	1.53	1.60
90 – 10	2.97	3.01	3.11
N	31,602	37,520	41,006
United States	1977	1987	1997
S.D.	0.85	0.79	0.84
75 – 25	1.22	1.09	1.17
90 – 10	2.22	2.05	2.18
N	164,971	173,651	194,669

Notes. For plant i in industry s, $\text{TFPQ}_{si} \equiv \frac{Y_{si}}{K_{si}^{\alpha_s}(w_{si}L_{si})^{1-\alpha_s}}$. Statistics are for deviations of log(TFPQ) from industry means. S.D. = standard deviation, 75 – 25 is the difference between the 75th and 25th percentiles, and 90 – 10 the 90th vs. 10th percentiles. Industries are weighted by their value-added shares. N = the number of plants.

Dispersion of TFPQ and TFPR

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

Notes. For plant i in industry s, $\text{TFPR}_{si} \equiv \frac{P_{si}Y_{si}}{K_{si}^{\alpha_s}(w_{si}L_{si})^{1-\alpha_s}}$. Statistics are for deviations of log(TFPR) from industry means. S.D. = standard deviation, 75 − 25 is the difference between the 75th and 25th percentiles, and 90 − 10 the 90th vs. 10th percentiles. Industries are weighted by their value-added shares. Number of plants is the same as in Table I.

- From the table above you can see a high TFP dispersion mostly In India and then in China.
- They then calculate efficient output and compare it with actual output to assess the TFP gain from equalization.
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Empirical Results

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

Notes. Entries are $100(Y_{\text{efficient}}/Y - 1)$ where $Y/Y_{\text{efficient}} = \prod_{s=1}^{S}[\sum_{i=1}^{M_s}(\frac{A_{si}}{A_s}\frac{\overline{\text{TFPR}_s}}{\text{TFPR}_{si}})^{\sigma-1}]^{\theta_s/(\sigma-1)}$ and $\text{TFPR}_{si} \equiv \frac{P_{si}Y_{si}}{K_{si}^{\alpha_s}(w_{si}L_{si})^{1-\alpha_s}}$.

- Here, they assumed USA efficiency for these Chinese and Indian firms
- They then calculate efficient output and compare it with actual output .
- Moving to US efficiency might boost TFP by 50% in 1998, 37 % in 2001 and 30% in 2005 begincenter

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 $Y/Y_{\text{efficient}} = \prod_{s=1}^{S} [\sum_{i=1}^{M_s} (\frac{A_{si}}{\overline{A_s}} \frac{\overline{\text{TFPR}_s}}{\text{TFPR}_{si}})^{\sigma-1}]^{\theta_s/(\sigma-1)}$ 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.

Robustness Check

- Given the possible measurement error that could be present in the previous result. They did some robustness check
  - Using the current market value of the capital stock, the result suggests a TFP gain of (29.8% vs 30.5% baseline) in China relative to the US and a TFP gains of (59.9% vs 59.2% baseline)in India relative to the US.
  - Plant labor input was measured by the wage bill, wage could reflect rent sharing between worker and plant.
  - They recalculated the TFP gains by using employment instead. Wage difference appears to amplify TFP differences.
  - They increased elasticity of substitution: $\sigma = 5$ and the TFP gains soar.

Regression Result

- It is possible that differences in TFPs could be due to differences in ownership. The table below presents the result of regressing TFPs on ownership with all the fixed effect.
- The result shows that state and foreign owned firms exhibit lower TFP in China while all type of plants with public involvement exhibit lower TFPR.

TABLE VII
TFP BY OWNERSHIP

	TFPR	TFPQ
China		
State	−0.415	−0.144
	(0.023)	(0.090)
Collective	0.114	0.047
	(0.010)	(0.013)
Foreign	−0.129	0.228
	(0.024)	(0.040)
India		
State (central)	−0.285	0.717
	(0.082)	(0.295)
State (local)	−0.081	0.425
	(0.063)	(0.103)
Joint public/private	−0.162	0.671
	(0.037)	(0.085)

Notes. The dependent variable is the deviation of log TFPR or log TFPQ from the industry mean. The independent variables for China are dummies for state-owned plants, collective-owned plants (plants jointly

Conclusion.

- Misallocation can explain TFP difference across countries.
- Using China and India firm level data, this paper quantify the role of misallocation on TFP.
- Misallocation is measure by the TFPR and TFPS which uses both the MRPL and MRPK.
- The result shows a huge deviation from the mean for Indian and then China relative to the US.
- After imposing the US efficency on these Chinese and Indian firms, the results shows a TFP boost between $30-50\%$ in China and by $40-60\%$ in India.

Future Work and Proposal

- Estimation of misallocation using Africa as my base country with recent data set.
- I hypothesize that the size of misallocation will be larger in comparison to the United States.
- Secondly, I want to evaluate the differences in misallocation of capital in Nigeria resulting from a change in bank's capital base requirements.

Appendix

GRAPH OF TFPR AND TFPQ IN INDIA, CHINA, AND US

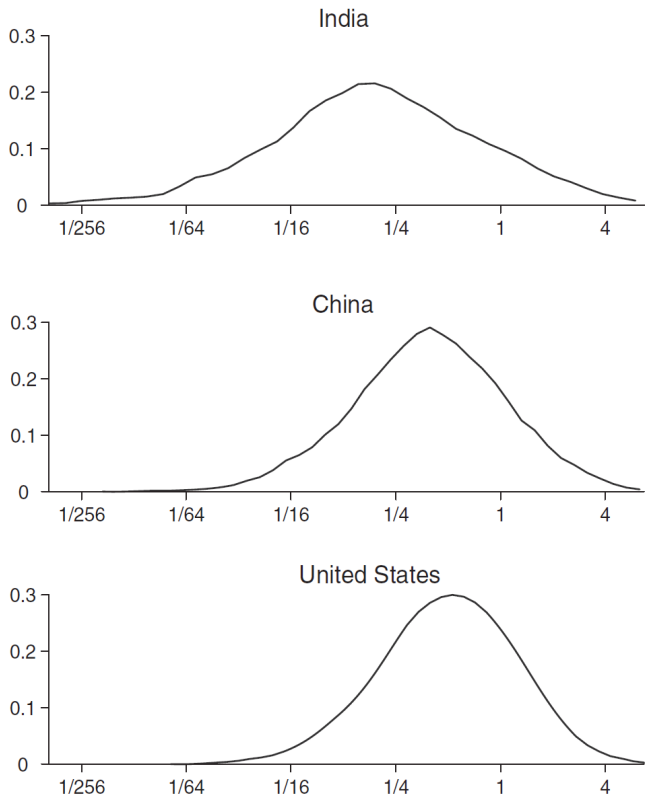

FIGURE I
Distribution of TFPQ

Appendix

GRAPH OF TFPR AND TFPQ IN INDIA, CHINA, AND US

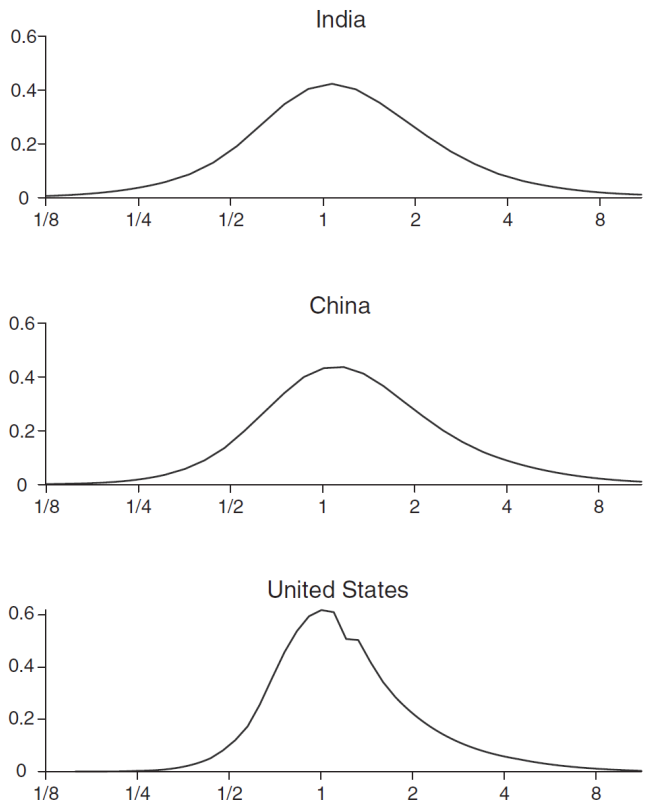

FIGURE II
Distribution of TFPR