Misallocation or Mismeasurement?

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From Micro to Macro:
Market Power, Firms’ Heterogeneity and Investment

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Motivation

- Sizable dispersion across plants in revenue/inputs (TFPR)
  - Syverson (2011)

- Huge potential gains from reallocating inputs
  - Restuccia & Rogerson (2008)
  - Hsieh & Klenow (2009)
  - Baqae & Farhi (2018)

- But differences in *measured average* products need not reflect differences in *true marginal* products
U.S. manufacturing in recent decades

- Sharply rising TFPR dispersion
  - Suggests falling allocative efficiency

- It would seem to imply:
  - A drag on TFP growth of 1.75 percentage points per year

- Has misallocation really increased dramatically? Or has mismeasurement worsened?
U.S. allocative efficiency

% Allocative Efficiency

What we do

- Propose a way to quantify measurement error
  - in revenue and inputs
  - exploiting panel data

- Adjust for measurement error and revisit allocative efficiency
  - manufacturing plants in the U.S. 1978–2007
  - manufacturing plants in India 1985–2013
Simple model setup

- \( Y = \left( \sum_i Y_i^{1 - \frac{1}{e}} \right)^{\frac{1}{1 - \frac{1}{e}}} \)

- \( Y_i = A_i I_i \)

- \( \max (1 - \tau_i^Y) P_i Y_i - w I_i \)
  - Monopolistic competitor takes \( w \) and \( Y \) as given

- \( \hat{R}_i = \hat{P}_i Y_i = R_i + g_i \)
Simple model TFPR

- $P_i = \text{markup} \times \text{marginal cost}$

- $P_i = \left( \frac{\epsilon}{\epsilon - 1} \right) \times \left( \tau_i \cdot \frac{w}{A_i} \right)$, where $\tau_i \equiv \frac{1}{1 - \tau_i^Y}$

- $\frac{R_i}{I_i} \propto \tau_i$

- TFPR$_i \equiv \frac{\hat{R}_i}{I_i} \propto \tau_i \cdot \frac{\hat{R}_i}{R_i}$
Levels and growth rates of revenue and inputs

If constant $\tau$, constant measurement error in revenue, and no measurement error in inputs (all relaxed in the paper):

$$\hat{R} = R + g = \left( \frac{\tau}{A} \right)^{\epsilon-1} + g$$

$$\text{TFPR} \equiv \frac{\hat{R}}{I} = \tau \cdot (1 + g/R)$$

$$d \ln \left( \hat{R} \right) = d \ln (I) + d \ln (\text{TFPR})$$

$$d \ln \left( \hat{R} \right) = d \ln (I) - \frac{g}{\hat{R}} \cdot d \ln (R)$$
Measurement error and the elasticity of revenue wrt inputs

\[
d \ln \left( \hat{R} \right) = d \ln (I) - \frac{g}{\hat{R}} \cdot (\epsilon - 1) \cdot d \ln A
\]

\[
d \ln \left( \hat{R} \right) = d \ln (I) - \frac{g}{\hat{R}} \cdot d \ln I
\]

\[
d \ln \left( \hat{R} \right) = (1 - g/\hat{R}) \cdot d \ln I
\]

\[
\frac{d \ln \hat{R}}{d \ln I} = \frac{\tau}{\text{TFPR}} \quad \Rightarrow \quad \tau = \frac{d \ln \hat{R}}{d \ln I} \cdot \text{TFPR} = \delta \cdot \text{TFPR}
\]
Adjusting for measurement error in TFPR

For a sample of plants in a given year:

Step 1: Regress $d \ln \hat{R}$ on $d \ln \hat{I}$ to get $\hat{\delta}$ for 10 deciles of plant TFPR

(note: instrument for $d \ln \hat{I}$ with plant employment growth)

Step 2: Add the log $\hat{\delta}$ coefficients from Step 1 to $\ln$ TFPR

Step 3: Add back lognormal noise to arrive at $\hat{\tau}$ such that:

$$\text{var}\, \hat{\tau} = \text{var}\, \text{TFPR} + \text{cov}_{\text{TFPR}, \hat{\delta}}$$

Step 4: Recalculate allocative efficiency with $\hat{\tau}$ instead of TFPR
Survey of Indian manufacturing plants

- Long panel 1985–2013

Sampling frame

- All plants > 100 or 200 workers (45% of plant-years)
- Probabilistic if > 10 or 20 workers (55% of plant-years)
- ~ 43,000 plants per year

Variables used

- Gross output ($R_i$), intermediate inputs ($X_i$), labor ($L_i$), wage bill ($wL_i$), and capital ($K_i$)
U.S. Census Bureau data on manufacturing plants
  ▶ Long panel, 1978–2007

Sampling frame
  ▶ Annual Survey of Manufacturing (ASM) plants
  ▶ \( \sim 50k \) plants per year with at least one employee
  ▶ Probabilistic sampling for \( \sim 34k \) plants, certainty for other \( \sim 16k \)

Variables used
  ▶ Gross output \((R_i)\), intermediate inputs \((X_i)\), labor \((L_i)\), wage bill \((wL_i)\), and capital \((K_i)\)
Corrected average allocative efficiency

<table>
<thead>
<tr>
<th></th>
<th>uncorrected AE</th>
<th>corrected AE</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>49%</td>
<td>53%</td>
</tr>
<tr>
<td>U.S.</td>
<td>50%</td>
<td>62%</td>
</tr>
<tr>
<td>U.S. / India</td>
<td>0%</td>
<td>17%</td>
</tr>
</tbody>
</table>
Corrected *changes* in allocative efficiency

<table>
<thead>
<tr>
<th></th>
<th>uncorrected change per year</th>
<th>corrected change per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>0.0%</td>
<td>0.2%</td>
</tr>
<tr>
<td>U.S.</td>
<td>–1.8%</td>
<td>–1.0%</td>
</tr>
</tbody>
</table>
Relaxing our simplifying assumptions

Allowing changes in $\tau$ and measurement error, and including measurement error in inputs, we get:

$$\frac{d \ln \hat{R}}{d \ln \hat{I}} = \frac{\tau}{\text{TFPR}} \cdot \left[ 1 + \frac{d \ln \tau}{d \ln I} \right] \cdot \left[ \frac{d \ln I}{d \ln I + df/I} \right] + \frac{dg/\hat{R}}{d \ln \hat{I}}$$

We use simulations to see how far this deviates from $\tau$/TFPR.
Simulations to test the validity of our strategy

- $A_{it}$ and $\tau_{it}$ follow
  \[ \ln(x_{it}) = \rho_x \cdot \ln(x_{it-1}) + \eta_{it}^x \text{ where } \eta_{it}^x \sim N(0, \sigma^2_x) \]

- $g_{it}$ follows
  \[ g_{it} = \rho_g \cdot g_{it-1} + \eta_{it}^g \cdot R_{it} \text{ where } \eta_{it}^g \sim N(0, \sigma^2_g) \]

- Use $\epsilon = 4$, $\rho_a = \rho_\tau = \rho_g = 0.9$

- Estimate $\{\sigma_a, \sigma_\tau, \sigma_g\}$ to fit $\{\hat{\delta} \text{ by TFPR}, \sigma_{TFPQ}, \sigma_{TFPR}\}$
Takeaways from simulations

\[ \ln(\delta) \text{ vs. } \ln(\text{TFPR}) \text{ approach:} \]

- does well at correcting for additive measurement error
- does not at all correct for multiplicative measurement error
- does not at all correct for adjustment costs