Misallocation and Financial Market Distortions: Some Direct Evidence from the Dispersion of Borrowing Costs

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presentation by Ashique Habib

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**Economic Question:** What portion of TFP loss is due to misallocation caused by financial frictions? They address the problem by:

- Developing an accounting framework for TFP loss.
- Estimating the loss using data on a subset of US manufacturing firms.
- They find that losses are very small (1% to 4%).

**Main Implication:** In order to generate large TFP losses, the dispersion in borrowing costs across firms must be implausibly high.
Some recent papers:

- **Evidence of large losses:** Amaral and Quintin (2010) and Greenwood et al (2010) suggest a large portion of TFP differences across countries can be attributed to imperfect financial markets (50% to 80%).

- **Evidence of small losses:** Other papers, such as Midrigan and Xu (2010) suggest that firms can overcome borrowing constraints by self-financing (5%).
This paper’s main contribution is methodological:

- The above papers generally use in some way the distribution of firm sizes (sales) to identify TFP loss.
- This paper develops an identification framework that uses the dispersion of borrowing costs.
Outline of this Presentation:

I will discuss the following:

- The derivation of their TFP loss accounting framework
- The dataset
- The main results
- Summary and contributions.
Goal: Express TFP loss from financial market frictions in terms of the dispersion of borrowing costs.

We achieve this through the following steps:

- Set up and solve the individual firm’s problem.
- Aggregate factor demands and output.
- Express $\log(TFP)$ in terms of parameters and ”wedges”.
- Characterize the joint distributions of the wedges and productivity.
- Take a second-order approximation of $\log(TFP)$, and get $\log(TFP_E)$
- Under this framework, get $\log(TFP/TFP_E)$ and express it in terms of $\sigma_{\log(r)}$
• Diminishing returns to scale production technology.
• Firms borrow at *idiosyncratic rates*. Possibly both factor markets can be distorted.
  • Firms may have to also borrow to pay their wage bill.
• The firm’s problem (FP) is:

\[
\max_{K_i, L_i} \Pi_i = A_i^{1-\eta} (K_i^{1-\alpha} L_i^\alpha)^\eta - L_i (1 + r_i) w - K_i (r_i + \delta)
\]

FOCs are:

\[
\eta (1 - \alpha) \frac{Y_i}{K_i} = r_i + \delta
\]

\[
\eta \alpha \frac{Y_i}{L_i} = w (1 + r_i)
\]
From the FOCs, we can get factor demands ($c_1$ and $c_2$ are functions of parameters, used for notational simplicity).

$$L_i = c_1A_i \left[(1 + r_i)^{-\frac{1-(1-\alpha)\eta}{1-\eta}} (r_i + \delta)^{-\frac{(1-\alpha)\eta}{1-\eta}}\right]$$

$$K_i = c_2A_i \left[(1 + r_i)^{-\frac{1-\alpha\eta}{1-\eta}} (r_i + \delta)^{-\frac{1-\alpha\eta}{1-\eta}}\right]$$

The right-most terms in the above expressions are the "wedges". If firms face different borrowing costs, then they face different wedges.
Define labour and capital wedges $w^l_i$ and $w^k_i$ as follows:

\[
\begin{align*}
    w^l_i &\equiv [(1 + r_i)^{-\frac{1-(1-\alpha)\eta}{1-\eta}} (r_i + \delta)^{-\frac{(1-\alpha)\eta}{1-\eta}} ] \\
    w^k_i &\equiv [(1 + r_i)^{-\frac{1-\alpha\eta}{1-\eta}} (r_i + \delta)^{-\frac{1-\alpha\eta}{1-\eta}} ]
\end{align*}
\]

The efficient allocation of capital and labour is determined by setting $w^l_i = w^l$ and $w^k_i = w^k$. 
Next, we aggregate the factor demands and outputs of each firm:

- Aggregate capital and labour are:
  \[ L = c_1 \int A_i w_i^l d_i \quad \text{and} \quad K = c_2 \int A_i w_i^k d_i \]

- For notational simplicity, define:
  \[ w_i = (w_i^l)^\alpha (w_i^k)^{1-\alpha} \]

- The aggregate output is:
  \[ Y = \int Y_i d_i = Y = c_1^{\alpha \eta} c_2^{(1-\alpha)\eta} \int A_i w_i^\eta d_i \]
Now we can solve for TFP:

- **TFP** is:

  $$TFP = \frac{Y}{L^{\alpha \eta} K^{(1-\alpha)\eta}} = \frac{\int A_i w_i^\eta di}{(\int A_i w_i^l di)^{\alpha \eta} (\int A_i w_i^k di)^{(1-\alpha)\eta}}$$

- **log(TFP)** is:

  $$\log(TFP) = \log(\int A_i w_i^\eta di) - \alpha \eta \log(\int A_i w_i^l di) - (1 - \alpha) \eta \log(\int A_i w_i^k di)$$
At this point, there are two ways we can proceed to estimate the TFP loss:

- **The Standard Approach:**
  - We can calculate $A_{it}$ from the firm’s problem:
    \[ A_{it} = \frac{Y_{it}}{W_{it}} \]
  - Given these $A_{it}'$s, we can calculate the efficient factor demands and output. Then calculate $TFP_{E}$.
    \[ TFP_{E} = \frac{Y_{E}}{L_{E}^{\alpha \eta} K_{E}^{(1-\alpha)\eta}} \]
  - In order to estimate $\log\left(\frac{TFP}{TFP_{E}}\right)$ using this approach, we need firm borrowing costs and sales data.
The authors propose the following approach, which will require only data on borrowing costs.

- Assume that the idiosyncratic productivity and wedges are jointly distributed as follows:

\[
\begin{bmatrix}
\log A_i \\
\log w_i^l \\
\log w_i^k 
\end{bmatrix}
\sim MVN
\begin{pmatrix}
\begin{bmatrix}
a \\
w_l \\
w_k 
\end{bmatrix}
\begin{bmatrix}
\sigma_a^2 & \sigma_{a,w_l} & \sigma_{a,w_k} \\
\sigma_{a,w_l} & \sigma_{w_l}^2 & \sigma_{w_l,w_k} \\
\sigma_{a,w_k} & \sigma_{w_l,w_k} & \sigma_{w_k}^2
\end{bmatrix}
\end{pmatrix}
\]
A second-order approximation of $\log(TFP)$:

$$
\log(TFP) = (1 - \eta) \left[ a + \frac{1}{2} \sigma_a^2 \right] + \frac{\eta \alpha (1 - \alpha \eta)}{2} \sigma_{wl}^2 \\
+ \frac{\eta (1 - \alpha) (1 - \eta (1 - \alpha))}{2} \sigma_{wk}^2 \\
- \eta^2 \alpha (1 - \alpha) \text{Corr}(w_l, w_k) \sigma_{wl} \sigma_{wk}
$$

**Key Point:** Notice that the correlation between productivity and wedges do not appear.

To get the efficient $\log(TFP_E)$, set $\sigma_{wl}^2 = 0, \sigma_{wk}^2 = 0$:

$$
\log(TFP_E) = (1 - \eta) \left[ a + \frac{1}{2} \sigma_a^2 \right]
$$
TFP loss can be measured as follows:

\[
\log \left( \frac{TFP}{TFP_E} \right) = \frac{\eta \alpha (1 - \alpha \eta)}{2} \sigma_{wl}^2 + \frac{\eta (1 - \alpha)(1 - \eta (1 - \alpha))}{2} \sigma_{wk}^2
\]

\[-\eta^2 \alpha (1 - \alpha) Corr(w_l, w_k) \sigma_{wl} \sigma_{wk}\]

Note that the above expression does not require data on productivity or output.
We can continue to simplify the expression for TFP loss:

- Note that the $w_i^k$, $w_i^l$ functions of parameters and $r_i$.
- Take the log of those expressions, and take a first-order approximation around $\log(r)$.
- If we assume both input choices are fully distorted, we get $\text{Corr}(w_k, w_l) = 1$ and the following approximation:

$$\frac{\sigma_{w_l}}{\sigma_{w_k}} \approx \frac{(1 - \alpha) \eta}{1 - \alpha \eta}$$
Measure of TFP Loss, in terms of $\sigma_{\log(r)}$

Accounting Framework

- When both markets are distorted:

$$\log \left( \frac{TFP}{TFP_E} \right) = \frac{\eta(1 - \alpha)(1 - \eta(1 - \alpha))}{2} + \frac{\eta \alpha (1 - \alpha \eta)}{2} \left( \frac{(1 - \alpha)\eta}{1 - \alpha \eta} \right)^2$$

$$- \eta^2 \alpha (1 - \alpha) \frac{(1 - \alpha)\eta}{1 - \alpha \eta} \sigma_{w_k}^2$$

- where $\sigma_{w_k}$ is

$$\sigma_{w_k} = \frac{1}{1 - \eta} \left[ \alpha \eta \frac{r}{1 + r} + (1 - \alpha \eta) \frac{r}{\delta + r} \right] \sigma_{\log(r)}$$
Measure of TFP Loss, in terms of $\sigma \log(r)$

**Accounting Framework**

- When only the capital market is distorted:

\[
\log \left( \frac{TFP}{TFP_E} \right) = \left[ \frac{\eta(1-\alpha)(1-\eta(1-\alpha))}{2} \right] \frac{1-\alpha\eta}{1-\eta} \left[ \frac{r}{\delta + r} \right] \sigma \log(r)
\]

- In general, losses are greater when only one market is distorted than when both markets are distorted.

Ashique Habib  
Misallocation and Financial Market Distortions: Some Direct Evidence
The paper uses a panel data set on 497 U.S. manufacturing firms:
- These firms have access to the corporate bond market.
- Time period is 1985:M1 - 2010:M12
- Half are durable goods manufacturers and half are non-durable goods manufacturers.

Secondary market prices of outstanding securities.
- Source: Lehman/Warga and Merrill Lynch databases.
- For comparability, limit to senior to senior-unsecured issues with a fixed coupon schedule.

Daily data on equity valuations.
- Source: Center for Research into Security Prices (CRSP).

Quarterly income and balance sheet data.
- Source: Compustat
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>P50</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of bonds per firm/month</td>
<td>2.86</td>
<td>3.04</td>
<td>1.00</td>
<td>2.00</td>
<td>52.0</td>
</tr>
<tr>
<td>Mkt. value of issue (§mil.)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>358.9</td>
<td>360.1</td>
<td>1.22</td>
<td>260.4</td>
<td>5,628</td>
</tr>
<tr>
<td>Maturity at issue (yrs.)</td>
<td>12.8</td>
<td>9.2</td>
<td>1.0</td>
<td>10.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Term to maturity (yrs.)</td>
<td>10.8</td>
<td>8.5</td>
<td>1.0</td>
<td>7.7</td>
<td>30.0</td>
</tr>
<tr>
<td>Duration (years)</td>
<td>6.42</td>
<td>3.36</td>
<td>0.92</td>
<td>5.92</td>
<td>15.8</td>
</tr>
<tr>
<td>Credit rating (S&amp;P)</td>
<td>-</td>
<td>-</td>
<td>D</td>
<td>A3</td>
<td>AAA</td>
</tr>
<tr>
<td>Coupon rate (pct.)</td>
<td>7.06</td>
<td>1.97</td>
<td>1.70</td>
<td>6.85</td>
<td>15.25</td>
</tr>
<tr>
<td>Nominal effective yield (pct.)</td>
<td>6.80</td>
<td>2.20</td>
<td>0.46</td>
<td>6.71</td>
<td>19.89</td>
</tr>
<tr>
<td>Credit spread (bps.)</td>
<td>170</td>
<td>157</td>
<td>5</td>
<td>116</td>
<td>1,000</td>
</tr>
</tbody>
</table>

**Note:** Sample period: 1985:M1–2010:M12; Obs. = 141,770; No. of bonds = 2,623; No. of firms = 497. Sample statistics are based on trimmed data (see text for details).

<sup>a</sup> Market value of the outstanding issue deflated by the CPI (2005 = 100).
Figure 1: Distribution of Firm-Level Borrowing Costs

Data

Note: The histogram depicts the distribution of firm-specific average credit spreads for our sample of 497 manufacturing firms.
Why use firms with access to the corporate bond market, from 1985?

- The corporate bond market is relatively frictionless, and efficient at price discovery.
  - Most risks can be hedged using derivatives.
  - "Associated with sound financial reporting, a thriving community of financial analysts, multiple credit rating agencies, wide range of corporate debt instruments, efficient procedures for reorganization/liquidation".

- Therefore, any firm-specific variation reflects dispersion in the "true" borrowing costs.
Furthermore, the 497 firms in the dataset account for about 50% of manufacturing sales in the U.S.

- Their credit rating spans the full range.
- Their sales strongly co-move with the sales of other firms in the economy (see figure 2).
Figure 2: Growth of Real Sales in U.S. Manufacturing Data

Note: Sample period: 1985:Q1–2010:Q4. The solid line depicts the quarterly growth rate of real sales for our sample of 497 manufacturing firms that have access to the corporate bond market; the dotted line depicts the growth rate of real sales for all publicly-traded U.S. manufacturing firms in Compustat. The nominal sales are deflated by the implicit price deflator for the nonfarm business sector output (2005 = 100); all data are seasonally adjusted. The shaded vertical bars represent the NBER-dated recessions.
Default risk is strongly related to degree of leverage. Smaller firms are more leveraged.

To account for default risk, use Merton *Distance-to-Default (DD) framework*

\[
s_{it} = \beta_1 DD_{it} + \beta_2 DD_{it}^2 + \lambda_t + \epsilon_{it}
\]

DD is a market-based measure of distance to default.

Used widely in finance industry.

Schaefer and Strebulaev (2008) show that the Merton-DD approach accounts well for default risk.

Regression explains 55% of the variation in credit spreads.

The unexplained portion reflects some combination of time-varying liquidity premium, tax treatment treatment, and default-risk factor (Duffie et al, 2007).
Figure 3: Firm-Level Borrowing Costs and Firm Size Data

NOTE: The scatter plot depicts the relationship between firm-specific average credit spreads and average firm size, as measured by real sales, for our sample of 497 manufacturing firms. The nominal sales are deflated by the implicit price deflator for the nonfarm business sector output (2005 = 100).
Figure 4: Residual Credit Spreads and Firm Size

Data

Note: The scatter plot depicts the relationship between firm-specific average residual credit spreads and average firm size, as measured by real sales, for our sample of 497 manufacturing firms. The nominal sales are deflated by the implicit price deflator for the nonfarm business sector output (2005 = 100).
Figure 5: Dispersion of Firm-Level Borrowing Costs in U.S. Manufacturing

Results

Note: Sample period: 1985:Q1–2010:Q4. The solid line depicts the median of real interest rates for our sample of 497 manufacturing firms that have access to the corporate bond market; the shaded band depicts the corresponding P90–P10 range. The shaded vertical bars represent the NBER-dated recessions.
The paper measures the borrowing cost as follows:

\[ r_{it} = r_t^* + s_{it} \]

- \( r_t^* \) is the real interest rate, calculated using the 10-year nominal Treasury yield and the expected CPI for the next 10 years (calculated by the Philadelphia Fed).
Assume standard values for parameters:
- $\delta = 0.06$, $\eta = 0.85$, $\alpha = 2/3$

Table 2 summarizes the results of the two exercises.
- Two exercises: (i) Using second-order approximation and (ii) Using sales data
- For (i), consider when both factor markets are fully distorted and when only the capital market is distorted.

In general, the results of the two exercises are similar in magnitude (1% to 4%).
Table 2: TFP Losses Due to Resource Misallocation

Main Results

<table>
<thead>
<tr>
<th>Sector</th>
<th>$\bar{r}$</th>
<th>$\sigma_r$</th>
<th>$[r_{P10}, r_{P90}]$</th>
<th>$\sigma_{w_l}$</th>
<th>$\sigma_{w_k}$</th>
<th>Relative TFP Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Approximate</td>
</tr>
<tr>
<td>All Manufacturing</td>
<td>2.43</td>
<td>1.16</td>
<td>[0.84, 4.71]</td>
<td>0.43</td>
<td>0.59</td>
<td>1.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(3.61)</td>
</tr>
<tr>
<td>Durable Goods Mfg.</td>
<td>2.62</td>
<td>1.69</td>
<td>[0.92, 4.99]</td>
<td>0.43</td>
<td>0.60</td>
<td>1.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(3.65)</td>
</tr>
<tr>
<td>Nondurable Goods Mfg.</td>
<td>2.24</td>
<td>1.61</td>
<td>[0.73, 4.67]</td>
<td>0.42</td>
<td>0.58</td>
<td>1.69</td>
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<tr>
<td></td>
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<td>(3.48)</td>
</tr>
</tbody>
</table>
The paper considers the question: How big does the dispersion in borrowing costs need to be in order to generate large losses?

Consider the two counterfactual cases:

\[
\begin{align*}
    r_{it} &= r_t^* + 2s_{it} \\
    r_{it} &= r_t^* + 10s_{it}
\end{align*}
\]

The second scenario implies that average real interest rates are about 25%, and the P90-P10 range is 8.4% – 46.7%.
Table 3: Counterfactual TFP Losses due to Resource Misallocation

<table>
<thead>
<tr>
<th>Counterfactual Cases</th>
<th>$\bar{r}$</th>
<th>$\sigma_r$</th>
<th>$[r_{p10}, r_{p90}]$</th>
<th>$\sigma_{w_l}$</th>
<th>$\sigma_{w_k}$</th>
<th>Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1: $r_{it} = r^*<em>t + 2s</em>{it}$</td>
<td>4.84</td>
<td>3.30</td>
<td>[1.68, 9.41]</td>
<td>0.68</td>
<td>0.93</td>
<td>4.31</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(8.84)</td>
</tr>
<tr>
<td>S2: $r_{it} = r^*<em>t + 10s</em>{it}$</td>
<td>24.2</td>
<td>16.5</td>
<td>[8.38, 46.7]</td>
<td>1.57</td>
<td>1.95</td>
<td>19.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(39.3)</td>
</tr>
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</table>
This paper tries to estimate the TFP loss due to financial frictions, for a subset of U.S. manufacturing firms.

- It develops an accounting framework that estimates TFP loss using only the dispersion in borrowing costs.
- It estimates using data on manufacturing firms with access to the corporate bond market. It finds the losses are very small.
- Counterfactual exercises suggest that the dispersion in borrowing rates would have to be unreasonably large in order to generate large losses.