Griliches Lecture 1: Firm Heterogeneity

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The Helpman-Krugman model features “universal” exporting by firms in a differentiated product industry:

- Only a small fraction of firms export.
- Exporters sell most of their output domestically.
- Exporters are bigger than non-exporters.
- Exporters are more productive than non-exporters.
Motivation

- The Helpman-Krugman model features “universal” exporting by firms in a differentiated product industry:
  - every brand is produced by a single firm in just one country, which exports its output everywhere else in the world;
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### Table 2
Exporting By U.S. Manufacturing Firms, 2002

<table>
<thead>
<tr>
<th>NAICS industry</th>
<th>Percent of firms</th>
<th>Percent of firms that export</th>
<th>Mean exports as a percent of total shipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>311 Food Manufacturing</td>
<td>6.8</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>312 Beverage and Tobacco Product</td>
<td>0.7</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>313 Textile Mills</td>
<td>1.0</td>
<td>25</td>
<td>13</td>
</tr>
<tr>
<td>314 Textile Product Mills</td>
<td>1.9</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>315 Apparel Manufacturing</td>
<td>3.2</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>316 Leather and Allied Product</td>
<td>0.4</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>321 Wood Product Manufacturing</td>
<td>5.5</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>322 Paper Manufacturing</td>
<td>1.4</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>323 Printing and Related Support</td>
<td>11.9</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>324 Petroleum and Coal Products</td>
<td>0.4</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>325 Chemical Manufacturing</td>
<td>3.1</td>
<td>36</td>
<td>14</td>
</tr>
<tr>
<td>326 Plastics and Rubber Products</td>
<td>4.4</td>
<td>28</td>
<td>10</td>
</tr>
<tr>
<td>327 Nonmetallic Mineral Product</td>
<td>4.0</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>331 Primary Metal Manufacturing</td>
<td>1.5</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>332 Fabricated Metal Product</td>
<td>19.9</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>333 Machinery Manufacturing</td>
<td>9.0</td>
<td>38</td>
<td>16</td>
</tr>
<tr>
<td>334 Computer and Electronic Product</td>
<td>4.5</td>
<td>38</td>
<td>21</td>
</tr>
<tr>
<td>335 Electrical Equipment, Appliance</td>
<td>1.7</td>
<td>38</td>
<td>13</td>
</tr>
<tr>
<td>336 Transportation Equipment</td>
<td>8.4</td>
<td>28</td>
<td>13</td>
</tr>
<tr>
<td>337 Furniture and Related Product</td>
<td>6.4</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>339 Miscellaneous Manufacturing</td>
<td>9.1</td>
<td>2</td>
<td>15</td>
</tr>
</tbody>
</table>

Aggregate manufacturing | 100 | 18 | 14

Source: Data are from the 2002 U.S. Census of Manufactures.

Notes: The first column of numbers summarizes the distribution of manufacturing firms across three-digit NAICS manufacturing industries. The second reports the share of firms in each industry that export. The final column reports mean exports as a percent of total shipments across all firms that export in the noted industry.
Table 3
Exporter Premia in U.S. Manufacturing, 2002

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log employment</td>
<td>1.19</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td>Log shipments</td>
<td>1.48</td>
<td>1.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Log value-added per worker</td>
<td>0.26</td>
<td>0.11</td>
<td>0.10</td>
</tr>
<tr>
<td>Log TFP</td>
<td>0.02</td>
<td>0.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Log wage</td>
<td>0.17</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Log capital per worker</td>
<td>0.32</td>
<td>0.12</td>
<td>0.04</td>
</tr>
<tr>
<td>Log skill per worker</td>
<td>0.19</td>
<td>0.11</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Additional covariates

- None
- Industry fixed effects
- Industry fixed effects, log employment

Sources: Data are for 2002 and are from the U.S. Census of Manufactures.
Notes: All results are from bivariate ordinary least squares regressions of the firm characteristic in the first column on a dummy variable indicating firm's export status. Regressions in column 2 include industry fixed effects. Regressions in column 3 include industry fixed effects and log firm employment as controls. Total factor productivity (TFP) is computed as in Caves, Christensen, and Diewert (1982). “Capital per worker” refers to capital stock per worker. “Skill per worker” is nonproduction workers per total employment. All results are significant at the 1 percent level.
This suggests that the most productive firms self-select into export markets, but it could also reflect learning by exporting, except that the evidence supports the former (Clerides et al., 1998).
Motivation (continued)

- This suggests that the most productive firms self-select into export markets, but it could also reflect learning by exporting, except that the evidence supports the former (Clerides et al., 1998).
- Micro-level studies have found evidence of substantial reallocation effects within an industry following trade liberalization.

These studies suggest that a successful theoretical framework should include two features:

1. Within sectoral heterogeneity in size and productivity.
2. A feature that leads only more productive firms to export: This could be fixed or sunk costs of exporting as documented by Roberts and Tybout (1997) and Bernard and Jensen (2004), and formalized by Melitz (2003).
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   - Different market structures (e.g., BEJK 2003).
The demand side is CES:

\[ q(\omega) = R p(\omega) P^\sigma, \]
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- Yields constant elasticity demand functions

\[
q(\omega) = \frac{R}{P} \left[ \frac{p(\omega)}{P} \right]^{-\sigma},
\]

where \( R \) is total spending and \( P \) is the ideal price index.
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Melitz (2003): Closed Economy

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  - Monopolistic competition; every variety is produced by a single firm and there is free entry into the industry.
  - Constant marginal costs and a fixed overhead production cost in terms of the single input (labor), which we take as numeraire.
  - The fixed cost is identical across all firms; denote it by $f$. 
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$$TC(\varphi) = f + \frac{q(\varphi)}{\varphi}. \quad (2)$$
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Firms with higher $\varphi$ are more productive. Higher productivity firms charge lower prices, produce more output, and obtain higher revenues $r(\varphi)$ and higher profits $\pi(\varphi)$:

$$p(\varphi) = \frac{1}{\rho \varphi}; \quad q(\varphi) = R P^{\sigma-1} (\rho \varphi)^{\sigma};$$

$$r(\varphi) = p(\varphi) q(\varphi) = R (P \rho \varphi)^{\sigma-1}; \quad (3)$$

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New Features

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- After observing $\varphi$, a producer decides whether to exit or produce.
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Every firm faces a probability $\delta$ of death per unit time.
Firm Behavior

- Given stationarity, a firm with productivity $\varphi$ earns profits $\pi(\varphi)$ in every period, until it is hit by a shock. The expected value of the firm is:

$$v(\varphi) = \max \left\{ 0, \sum_{t=s}^{\infty} (1 - \delta)^{t-s} \pi(\varphi) \right\} = \max \left\{ 0, \frac{1}{\delta} \pi(\varphi) \right\}. \quad (5)$$

It is clear from (4) and (5) that there is a unique threshold productivity $\varphi^*$ such that $v(\varphi) > 0$ if and only if $\varphi > \varphi^*$. 

$$\pi(\varphi) = \frac{\varphi^{\sigma - 1} - \varphi^{\sigma - 1} f(\varphi^*)^{\sigma - 1}}{\sigma - 1} \pi(\varphi)$$
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\[\text{Diagram:} \quad \pi(\phi) \quad \text{versus} \quad \phi^{\sigma-1} \]
Free entry ensures that, in the industry equilibrium, the *expected* discounted value of profits for a potential entrant equal the fixed cost of entry, or

$$\int_0^\infty v(\varphi)g(\varphi)\,d\varphi = f_e \iff \bar{\pi} = \frac{\delta f_e}{1 - G(\varphi^*)},$$

(6) (FE)

where $\bar{\pi}$ is average industry profits.
Industry Equilibrium

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$$\int_0^\infty v(\phi)g(\phi)\,d\phi = f_e \Leftrightarrow \bar{\pi} = \frac{\delta f_e}{1 - G(\phi^*)},$$  \hspace{1cm} (FE) \hspace{1cm} (6)

where $\bar{\pi}$ is average industry profits.

- Melitz shows that the equilibrium is unique.
Open Economy

There are two types of trade frictions:

- A standard iceberg cost $\tau$. 
- An initial fixed cost of $f$ units of labor to start exporting, which is incurred once the firm has learned $\phi$ (alternatively, the cost $f$ could be fixed rather than sunk).

It is also assumed that the domestic economy can trade with $n$ other countries and that all countries are of equal size, which implies that factor price equalization will hold and the wage will equal 1 everywhere (this can be relaxed).
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It is also assumed that the domestic economy can trade with $n \geq 1$ other countries and that all countries are of equal size, which implies that factor price equalization will hold and the wage will equal 1 everywhere (this can be relaxed).
Firm Behavior Revisited

- Firms charge constant markups in both domestic and foreign markets. Domestic and foreign revenues are:
  
  \[ r_d(\phi) = R (P \rho \varphi)^{\sigma-1}, \]
  
  \[ r_x(\phi) = \tau^{1-\sigma} R_k (P_k \rho \varphi)^{\sigma-1}. \]
Firm Behavior Revisited

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- Factor price equalization implies the same \( RP^{\sigma - 1} \) in all countries, therefore:
  \[
  r(\varphi) = \begin{cases} 
  r_d(\varphi) & \text{if the firm does not export} \\
  (1 + n \tau^{1-\sigma}) r_d(\varphi) & \text{if the firm exports to all countries.}
  \end{cases}
  \]
Firm Behavior Revisited

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- Factor price equalization implies the same \( RP^{\sigma-1} \) in all countries, therefore:

\[ r (\varphi) = \begin{cases} r_d (\varphi) & \text{if the firm does not export} \\ \frac{r_d (\varphi)}{1 + n\tau^{1-\sigma}} r_d (\varphi) & \text{if the firm exports to all countries.} \end{cases} \]

- The corresponding profit levels are

\[ \pi_d (\varphi) = \frac{r_d (\varphi)}{\sigma} - f, \quad (7) \]
\[ \pi_x (\varphi) = \frac{r_x (\varphi)}{\sigma} - f_x = \frac{\tau^{1-\sigma} r_d (\varphi)}{\sigma} - f_x, \quad (8) \]

where \( f_x \) is amortized per-period portion of the initial fixed cost (i.e., \( \delta f_{ex} \)).
Defining per period profits as $\pi(\varphi) = \pi_d(\varphi) + \max\{0, n\pi_x(\varphi)\}$, the value of the firm is again

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But we now have two relevant thresholds:

$$\varphi_d^* = \inf\{\varphi : v(\varphi) > 0\}$$

and

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Firm Behavior Revisited (continued)

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The free entry condition is as before; expected discounted profits equal entry costs.
Comparing the closed-economy and open-economy equilibria implies $\phi^* < \phi^*_d$. Productivity is higher in the open economy: firms with productivity between $\phi^*$ and $\phi^*_d$ exit. Market shares are reallocated to exporters. Intuition: the fall in profits of nonexporters is not explained by a fall in mark-ups driven by increased foreign competition (see, however, Melitz and Ottaviano, 2007). The main channel operates through the domestic factor market. Trade raises profitability of the more productive firms! more entry! increased labor demand! higher real wages ($w/P$)! least productive firms can no longer afford to produce. Welfare: new source of gains from trade; increased average productivity. Similar conclusions for trade liberalization: $\tau$ falls.
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The Impact of Trade

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Helpman, Melitz and Rubinstein (2008) have extended it to a setting with asymmetric countries and they have used it to develop an econometric approach for estimating trade flows. This methodology:

- Provides a generalization of the gravity equation;
- Accounts for zero trade flows across some country pairs;
- Separates the intensive from the extensive margin of trade;
- Allows asymmetric responses to trade resistance measures.

Manova (2007) applies this methodology to sectoral trade flows, focusing on the impact of financial development on comparative advantage.

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