Exporting and Plant-Level Efficiency Gains: It’s in the Measure

Alvaro Garcia Marin
UCLA

Nico Voigtländer
UCLA and NBER

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Motivation

Export-related efficiency gains – 2 dimensions:

1. Trade liberalization allows productive firms to grow, while unproductive firms shrink/go bankrupt ⇒ economy-wide efficiency rises due to reallocation across firms/plants
   ▶ Strong empirical support

2. Efficiency gains within firms/plants after export entry
   ▶ Much weaker evidence, vast majority of studies finds no within-plant efficiency gains
   ▶ If there are indeed no (sizeable) within-plant efficiency gains then:
     ▶ Trade liberalization would be bad news for relatively unproductive plants
     ▶ But...
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   - Trade liberalization would be bad news for relatively unproductive plants
   - But...
We should expect export-related within-plant efficiency gains:

- Exporters face tougher competition and larger markets $\Rightarrow$ higher returns to innovate and invest in productive technologies (Bustos, 2011)
- Management case studies report strong micro-level evidence for efficiency improvements within plants
- Access to expertise from international buyers
Key to resolve the puzzling contrast: Efficiency measures

How economists think about efficiency:

- Physical output $Y = A \cdot f(\text{capital, labor, materials...})$
  - $A$: "true" efficiency
  - Typically: do not observe $Y$ but $p \cdot Y = \text{product revenue}$
  - The revenue production function is then $p \cdot Y = p \cdot A \cdot f(\text{capital, labor, materials...})$

Most papers have analyzed revenue productivity $p \cdot A$
The Problem with Revenue Productivity Measures

- Revenue productivity is affected by output prices
  - If more efficient firms charge lower prices, then revenue productivity will be downward biased (Foster et al, 2008):
    \[
    \text{revenue productivity} = \underbrace{p \downarrow} \cdot \underbrace{A \uparrow} \\
    \text{price} \quad \text{efficiency}
    \]
  - Downward bias well-documented for domestic market entrants (Foster et al., 2013)

Could the same bias explain the missing evidence for export entrants? Challenge: find efficiency measure that is (i) not affected by price bias and (ii) applicable to broad set of plants and products.
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  - Challenge: find efficiency measure that is (i) not affected by price bias and (ii) applicable to broad set of plants and products
This Paper

Use marginal production cost as an alternative efficiency measure

- Not affected by price-bias
- Focus on *within-plant-product* trends
  - Allows for comparison of diverse set of products
- Use detailed Chilean plant panel, 1996-2005
- Previous studies have found no effects of export entry on firm efficiency for Chile, using revenue productivity
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Examine effects of

1. Export entry
2. Export expansions of established exporters
Main Results (Preview)

- Strong evidence for within-plant efficiency gains
  - Falling export tariffs in Chile over the period 1996-2005 induced 13% higher efficiency among export entrants, and 10% among established exporters
  - Initially least productive plants see highest efficiency increases
  - When looking at revenue productivity, these gains are reduced to 1% and 4%

Most likely driver of efficiency gains:
- Export entry/expansion provides incentives for technology investment

Main policy implication:
- Initially relatively unproductive plants can also gain from trade
- Combine trade liberalization with incentives to invest in modern technology
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- Main policy implication:
  - Initially relatively unproductive plants can also gain from trade.
  - Combine trade liberalization with incentives to invest in modern technology.
How we compute marginal costs ($MC$)

- Estimate production function at the product level
- Calculate markups $\mu$ at the plant-product level (De Loecker and Warzynski, 2012)
- Since we observe prices ($p$), marginal costs are computed as

$$MC = \frac{p}{\mu}$$

- Methodology allows to recover $MC$ per product
- $MC$ closely matches reported average costs
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- Methodology allows to recover $MC$ per product
- $MC$ closely matches reported average costs
- Compute also revenue productivity following standard methodology
Data
The ENIA

- Panel of Chilean manufacturing plants, period 1996-2005
- Covers universe of manufacturing plants with \(\geq 10\) workers
  - 4,800 plants p/year, 20% exporters, 2/3 of all plants are small (\(\leq 50\) employees)
- Standard plant-level information (size, revenues, sector...). Plus:
  - Plant-level investment by category
  - Value and quantity of all inputs
- Product information
  - Total value and quantity for each product
  - Variable cost for each product
  - About 11,000 plant-product obs./year, 12% are exported
We confirm the standard results in the cross-section: Exporters are larger, more productive, pay higher wages, and charge higher markups.

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>(1) Plant Size</th>
<th>(2) Productivity</th>
<th>(3) Wages</th>
<th>(4) Markup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export Dummy</td>
<td>ln(Workers)</td>
<td>ln(Sales)</td>
<td>ln(TFPR)</td>
<td>ln(Wage)</td>
</tr>
<tr>
<td></td>
<td>1.403*** (.0844)</td>
<td>2.227*** (.179)</td>
<td>.122*** (.0307)</td>
<td>.907*** (.148)</td>
</tr>
<tr>
<td>Sector-Year FE</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.26</td>
<td>.30</td>
<td>.99</td>
<td>.18</td>
</tr>
<tr>
<td>Observations</td>
<td>42,264</td>
<td>42,070</td>
<td>42,228</td>
<td>42,264</td>
</tr>
</tbody>
</table>

*Notes:* The table reports the percentage-point difference of the dependent variable between exporting plants and non-exporters in a panel of 8,500 (4,900 average per year) Chilean plants over the period 1996-2005. All regressions control for sector-year effects at the 2-digit level. Markups in column 6 are computed at the plant-product level; correspondingly, the coefficients reflect the difference in markups between exported products and those that are only sold domestically. Clustered standard errors (at the sector level) in parentheses. Key: *** significant at 1%; ** 5%; * 10%.
Roadmap

1. **Export entry**

2. Export expansions of established exporters
Efficiency trajectories for export entrants
Within-plants; Period $t = 0$ corresponds to the export entry year.

Notes: The left panel shows the estimated within plant trajectory for revenue productivity, and the right panel, for price, marginal cost and markup before and after export entry. Period $t = 0$ corresponds to the export entry year. For each plant-product, export entry occurs at period $t = 0$. A product is defined as an entrant if it is the first product exported by a plant and is sold domestically for at least one period before entry into the export market.
Investment in new technology and export entry go hand-in-hand

- Prospect of larger market $\Rightarrow$ incentives to invest
- Data on investment support this channel

Additional check: Plants with lower initial productivity experience larger efficiency gains (Lileeva and Trefler, 2010)
- Require larger efficiency gains to ‘break even’
Further results

1. Use **tariff changes** to predict export entry: 13% decline in MC induced by avg. tariff drop of 5.5 percentage points 1996-2005

[Table]
Further results

1. Use tariff changes to predict export entry: 13% decline in MC induced by avg. tariff drop of 5.5 percentage points 1996-2005

2. Reported Average Costs: Results not driven by estimation of markups

3. Balanced Panel: Larger effects already in the first periods

4. Single-Product Producers: Results unchanged, but noisier

5. Matching Estimation: Varying number of neighbors or size of caliper do not affect our results

6. Estimation of Prd Function: Robust to variety of specifications
Roadmap

1. Export entry

2. Export expansions of established exporters
Export expansions that are driven by declining tariffs

Exploit tariff declines (5.5% on avg. 1996-2005)

- Increasing export sales driven by *permanent* declines in export tariffs
- We find strong evidence for efficiency gains: About 10% over sample period
- Channel: Investment in capital stock
Export expansions that are driven by declining tariffs

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Role of efficiency measures

- Again, efficiency gains stronger when using marginal costs
- Revenue productivity now captures about 1/2 of actual efficiency gains (4%)
In the absence of falling tariffs, export expansions and efficiency are not associated

- Increasing export sales within plants mostly due to temporary demand shocks
- Temporarily higher demand for exporting may not be sufficient to trigger technology upgrading
Concluding Remarks

- Within-plant efficiency gains after export entry
  - Previously weak evidence
- We find substantial within-plant efficiency gains based on marginal costs
  - Resolves puzzle (invest and expand w/o efficiency increases?)
  - Substantial part of efficiency gains passed on to customers
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Policy implications

- Unproductive firms don’t necessarily lose – they may even gain the most
- Since within-plant gains can be substantial, and are driven by technology investment: Combine trade liberalization with incentives to invest in technology
- Certainty about trade policy (*permanent* tariff declines) crucial for firms to undertake investment
Export entry driven by tariff declines

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: First Stage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dependent Variable:</td>
<td>log Exports</td>
<td>Export status</td>
</tr>
<tr>
<td>Industry Tariffs</td>
<td>-66.98***</td>
<td>-8.084***</td>
</tr>
<tr>
<td></td>
<td>(6.934)</td>
<td>(1.024)</td>
</tr>
<tr>
<td>Predicted Expansion</td>
<td>[3.081]</td>
<td>[.3719]</td>
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<tr>
<td>First Stage F-Statistic</td>
<td>93.31</td>
<td>62.38</td>
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<tr>
<td><strong>Panel B: Second Stage, log Marginal Cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exports (predicted)</td>
<td>-.0408*</td>
<td>-.338*</td>
</tr>
<tr>
<td></td>
<td>[.0938]</td>
<td>[.0938]</td>
</tr>
<tr>
<td>Predicted effect</td>
<td>-.126</td>
<td>-.126</td>
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<tr>
<td><strong>Panel C: Second Stage, log Markup</strong></td>
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<td></td>
</tr>
<tr>
<td>Exports (predicted)</td>
<td>-.00820</td>
<td>-.0679</td>
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<tr>
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<td>[.294]</td>
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<tr>
<td>Predicted effect</td>
<td>-.0253</td>
<td>-.0253</td>
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<tr>
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</tr>
<tr>
<td><strong>Panel D: Second Stage, log Revenue TFP</strong></td>
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<td></td>
</tr>
<tr>
<td>Exports (predicted)</td>
<td>-.00264</td>
<td>-.0219</td>
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<tr>
<td></td>
<td>[.627]</td>
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<td>Predicted effect</td>
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<td></td>
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<tr>
<td>For all regressions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant FE</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>log Sales</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Observations</td>
<td>1,333</td>
<td>1,333</td>
</tr>
</tbody>
</table>
### Export expansions driven by tariff declines

#### Panel A: First Stage: Tariffs and within-plant exports

<table>
<thead>
<tr>
<th>Export Share</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt;0%</td>
<td>&gt;10%</td>
<td>&gt;20%</td>
<td>&gt;30%</td>
<td>&gt;40%</td>
<td>&gt;50%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tariffs</th>
<th>-.735</th>
<th>-1.521**</th>
<th>-2.087***</th>
<th>-1.771***</th>
<th>-1.345***</th>
<th>-.917***</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(.915)</td>
<td>(.627)</td>
<td>(.436)</td>
<td>(.273)</td>
<td>(.347)</td>
<td>(.289)</td>
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<table>
<thead>
<tr>
<th>Predicted Expansion</th>
<th>.0338</th>
<th>.0700</th>
<th>.0960</th>
<th>.0815</th>
<th>.0619</th>
<th>.0422</th>
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</table>

<table>
<thead>
<tr>
<th>First Stage F-Statistic</th>
<th>.645</th>
<th>5.876</th>
<th>22.87</th>
<th>42.20</th>
<th>14.99</th>
<th>1.07</th>
</tr>
</thead>
</table>

#### Panel B: Second Stage, log Marginal Cost Index

<table>
<thead>
<tr>
<th>log Exports (predicted)</th>
<th>-2.153*</th>
<th>-1.297***</th>
<th>-1.113***</th>
<th>-1.170***</th>
<th>-1.141**</th>
<th>-.564</th>
</tr>
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<table>
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<tr>
<th>Predicted Effect</th>
<th>-.0728</th>
<th>-.0907</th>
<th>-.1068</th>
<th>-.0953</th>
<th>-.0706</th>
<th>-.0238</th>
</tr>
</thead>
</table>

#### Panel C: Second Stage, log Average Markup

<table>
<thead>
<tr>
<th>log Exports (predicted)</th>
<th>.237</th>
<th>.568**</th>
<th>.478**</th>
<th>.576***</th>
<th>.477</th>
<th>-.364</th>
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<table>
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<tr>
<th>Predicted Effect</th>
<th>.0080</th>
<th>.0398</th>
<th>.0459</th>
<th>.0469</th>
<th>.0295</th>
<th>-.0153</th>
</tr>
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#### Panel D: Second Stage, log Revenue TFP

<table>
<thead>
<tr>
<th>log Exports (predicted)</th>
<th>.678</th>
<th>.613**</th>
<th>.456**</th>
<th>.590***</th>
<th>.571*</th>
<th>.126</th>
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<table>
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<tr>
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<th>.0229</th>
<th>.0429</th>
<th>.0438</th>
<th>.0481</th>
<th>.0353</th>
<th>.0053</th>
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For all regressions:
- Plant FE ✓ ✓ ✓ ✓ ✓ ✓
- log Sales ✓ ✓ ✓ ✓ ✓ ✓
- Observations 4,026 2,372 1,901 1,666 1,456 1,267