The Dynamics of Firm-Level Adjustment to Trade Liberalization

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Firms and Trade – Empirical Literature

• Very strong correlation between export status and firm performance (productivity)

• Direction of causation?
  – Most often inferred based on timing of export market entry relative to productivity changes

• Large literature has overwhelmingly confirmed strong self-selection effect:
  – Relatively more productive non-exporters become exporters

• However, there is also some evidence (much more limited, though strong in particular cases), of firm-level productivity increases subsequent to export market entry
  – → so called “Learning-by-Exporting”
  – Significant effect limited to a couple years following export market entry

• The causation inferences must be interpreted with care given the recent evidence that firms make joint decisions on current and anticipated technology use and export status:
  – Bustos (2006): Adoption of new technology & spending on new technology (Argentina)
  – Trefler (2007): One time productivity improvement (Canada)
  – → All linked to firm entry into export markets following trade “liberalization”
This Paper

- Analyze the dynamics of firm-level adjustment to trade liberalization when firms make joint forward looking decisions concerning both innovation (future productivity) and export status

- Our model captures both:
  - Self-selection of more productive firms into export markets
    - Including the potential for innovation ahead of anticipated export market entry
  - Potential for innovation following export market entry
Main Results

- Non-technological factors – such as the pace and anticipation of upcoming trade liberalization – affect the relative timing of the innovation and export market entry decisions
  - Thus, can not infer direction of causation between export participation and productivity based on relative timing
  - Note: our model does not feature any “real” learning-by-exporting
    - There is very little direct evidence on such a channel
    - Virtually all inferences are made based on timing of productivity growth following export market entry

- Anticipation of trade liberalization tends to bring forward innovation relative to export market participation

- In general, our results highlight potential empirical pitfalls for empirical analysis of trade liberalization responses:
  - Current period industrial performance (aggregate outcomes for innovation and export participation) strongly responds to anticipated changes in trade policy – and is not just shaped by concurrent level of trade costs.
Model Overview

- Heterogeneous firms with idiosyncratic firm uncertainty and forward looking entry, exit, export and innovation decisions subject to sunk costs

- Focus on interaction between forward looking decisions to export and undertake a large, one-off innovation (e.g. the adoption of a ‘new’ technology)

- Heterogeneous firms can potentially sort into 4 different states based on innovation and export market status
  - As empirically confirmed, most productive firms choose to undertake both activities
  - and least productive firms undertake none

- Investigate the transition dynamics across these states
  - In particular, the relative timing of firm export and innovation decisions

- We focus on these transition dynamics along different trade liberalization paths between the same two steady states:
  - An initial steady state with high trade costs
  - A final steady state with low trade costs
Model Set-Up: Demand

- Model an industry with a continuum of C.E.S. differentiated varieties. Industry aggregate good

\[ Q_t \equiv \left[ \int_{\omega \in \Omega} q_t(\omega)^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}, \quad \sigma > 1 \]

and C.E.S. price index

\[ P_t = \left[ \int_{\omega \in \Omega} p_t(\omega)^{1-\sigma} \right]^{1/(1-\sigma)}. \]

- We model this industry in partial equilibrium, specifying an industry demand function:

\[ Q_t = A P_t^{1-\eta}, \quad \eta < \sigma \]

- Yielding demand for each variety \( \omega \):

\[ q_t(\omega) = Q_t P_t^\sigma p_t(\omega)^{-\sigma} = A P_t^{\sigma-\eta} p_t(\omega)^{-\sigma} \]
Model Set-Up: Production

- Labor is the only factor of production, with wage level normalized to unity
- Perfectly elastic labor supply to the industry at this wage
- All firms face the same per-period overhead cost $F$, but have heterogeneous productivity levels $v \in \gamma$
  - $\longrightarrow$ Constant marginal cost $1/v$
  - Given product differentiation, can also think of $v$ as product quality
Model Set-Up: Export

- Two country symmetric world
- Firms decide whether to only serve their domestic market ($D$ firm) or export ($X$ firm)
- Exporting is costly:
  - Per-unit iceberg trade cost $\tau_t$
  - Per-period fixed cost $F_X$
  - Sunk export market entry cost $S_X$
- Trade liberalization entails decreases in $\tau_t$ over time
Model Set-Up: Productivity Evolution and Innovation

- Firm productivity $v$ evolves following a martingale process
- Firms have a one-time opportunity to innovate:
  - $A$ firms have not yet innovated
  - $B$ firms have innovated
- Innovation leads to a one-time better productivity draw
  - Given martingale evolution process, productivity effects of innovation are long-lasting
Firm States, Entry, and Profits

- A firm is characterized by a pair \((v, z)\), with state \(z \in \{AD, BD, AX, BX\}\).

- Entry is unrestricted but involves a sunk cost \(S\).
  - Initial state is set to \(z = AD\), and initial productivity \(v\) is drawn from known distribution \(G_E(z)\).

- Per-period firm profit is given by:
  \[
  \pi_t(v, z') = \begin{cases} 
  \pi_t^D(v) & \text{if } z' \in \{AD, BD\} \\
  \pi_t^D(v) + \pi_t^X(v) & \text{if } z' \in \{AX, BX\} 
  \end{cases}
  \]
  where \(\pi_t^D(v)\) represents profits from sales on the domestic market:
  \[
  \pi_t^D(v) = \frac{(\sigma - 1)^{\sigma-1}}{\sigma} AP_t^{\sigma-\eta} v^{\sigma-1} - F
  \]
  and \(\pi_t^X(v)\) represents profits from export sales:
  \[
  \pi_t^X(v) = \frac{(\sigma - 1)^{\sigma-1}}{\sigma} AP_t^{\sigma-\eta} \left( \frac{v}{\tau_t} \right)^{\sigma-1} - F_t^X
  \]
Value Functions and Exit

• Every firm faces a constant probability \( \delta \) of a death shock (independent of productivity and state)

• A firm may also endogenously decide to exit in any period
  – It’s value \( V_t(v, z) \) is thus bounded below at zero

• Prospective entrants face the following net value of entry:

\[
V_t^E = \int_{v \in \mathcal{V}} V_t(v, AD) dG_E(v) - S
\]
Equilibrium Conditions

- A sequence of price indices \( \{P_t\} \) is an equilibrium price path if:
  - Optimal firm policies based on path of price index
    - Note that given sequence \( \{P_t\} \), \( V_t(v, z) \) is determined in every period
  - Distribution of firms over time and across states reflects firm policies
  - \( V_t^E = 0 \) or \( V_t^E < 0 \) and no entry
  - Distribution of firms/states and entry determines distribution of prices and available product variety in every period
  - ... which in turns leads to a sequence of price indices \( \{P_t\} \) – which must match initial price sequence
Trade Liberalization Scenarios

**Unanticipated, Abrupt**

- **Anticipated, Abrupt**

- **Anticipated, Gradual**
Model Calibration

- **Demand:** $\sigma = 4, \eta = 1.5$

- **Production:** fixed costs around 20% of average firm labor

- **Trade Liberalization:** $\tau_{pre} = 1.35, \tau_{post} = 1.05$
  - set $F_X^X$ and $S_X^X$ so that proportion of exporters rises from ~15% with high $\tau$ to ~45% with low $\tau$

- **Productivity transition:**
  - Firms that do not innovate: lognormal shock with mean at current productivity
  - Firms that do innovate: lognormal shock with mean 10% above current productivity

- **Death shock at 15% per year**

- **Entrants with lognormal distribution:** (20% below mean productivity level for continuing firms)
Steady States

<table>
<thead>
<tr>
<th>Steady State</th>
<th>Firm Distribution</th>
<th>Transitions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># firms</td>
<td>AD</td>
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<tr>
<td>Pre</td>
<td>203</td>
<td>77%</td>
</tr>
<tr>
<td>Post</td>
<td>154</td>
<td>51%</td>
</tr>
</tbody>
</table>

- Pre-liberalization: $\tau = 1.35$
  - Typical transition for growing firm: $AD \rightarrow BD \rightarrow BX$
    - All exporters have chosen to innovate (no $AX$ firms)
    - Some non-exporters choose to innovate ($ABBD$ firms)

- Post-liberalization: $\tau = 1.05$
  - Proportion of exporters rises dramatically
  - Typical transition for growing firm: $AD \rightarrow AX \rightarrow BX$
    - No innovation before export: no $ABBD$ flows

- Across the transition: large flows out of $AD$ and into $BX$
  - How do firms proceed along this transition?
  - When do they innovate, and when do they enter the export markets?
  - What is the relative timing of these decisions?
- Overlap of $AD$ and $BD$: no option to un-innovate
- Overlap of $BD$ and $BX$ firms: export market hysteresis
Unanticipated, Abrupt Trade Liberalization

<table>
<thead>
<tr>
<th>UA year</th>
<th># firms</th>
<th>Firm Distribution</th>
<th>Transitions</th>
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<tr>
<td></td>
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<td>AD    BD    AX    BX</td>
<td>ADBD   ADAX   ADBX   BDBX   AXBX</td>
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<tr>
<td>0</td>
<td>203</td>
<td>77%   8%    0%    15%</td>
<td>4%     0%    0%    5%     0%</td>
</tr>
<tr>
<td>1</td>
<td>203</td>
<td>77%   8%    0%    15%</td>
<td>4%     0%    0%    5%     0%</td>
</tr>
<tr>
<td>2</td>
<td>203</td>
<td>77%   8%    0%    15%</td>
<td>4%     0%    0%    5%     0%</td>
</tr>
<tr>
<td>3</td>
<td>203</td>
<td>77%   8%    0%    15%</td>
<td>4%     0%    0%    5%     0%</td>
</tr>
<tr>
<td>4</td>
<td>166</td>
<td>60%   2%    3%    35%</td>
<td>0%     14%   7%    8%     9%</td>
</tr>
<tr>
<td>5</td>
<td>148</td>
<td>53%   2%    3%    42%</td>
<td>0%     10%   2%    1%     7%</td>
</tr>
<tr>
<td>6</td>
<td>149</td>
<td>52%   2%    3%    42%</td>
<td>0%     9%    2%    1%     6%</td>
</tr>
<tr>
<td>7</td>
<td>150</td>
<td>52%   3%    3%    42%</td>
<td>0%     9%    2%    1%     6%</td>
</tr>
<tr>
<td>8</td>
<td>151</td>
<td>52%   3%    3%    42%</td>
<td>0%     9%    2%    1%     6%</td>
</tr>
</tbody>
</table>

- Since liberalization is unanticipated, nothing happens before $\tau$ suddenly drops

- Immediately following liberalization (year 4):
  - Virtually all $BD$ firms export ($BDBX$ transition)
  - Substantial transitions from $AD$ into exporting ($ADAX$ and $ADBX$ transitions)
    - (greater flows than in new steady state, generated by idiosyncratic productivity transitions)
  - There is no innovation ahead of export market entry
Anticipation Effects: Exit Cutoffs

- Anticipation of trade liberalization reduces option values of waiting
  - True for exit, export, and innovation decisions
### Anticipated, Abrupt Trade Liberalization

<table>
<thead>
<tr>
<th>AA</th>
<th>Firm Distribution</th>
<th>Transitions</th>
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<tbody>
<tr>
<td></td>
<td># firms</td>
<td>AD</td>
</tr>
<tr>
<td>0</td>
<td>203</td>
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<td>78%</td>
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<td>140</td>
<td>49%</td>
</tr>
<tr>
<td>6</td>
<td>144</td>
<td>50%</td>
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<tr>
<td>7</td>
<td>147</td>
<td>51%</td>
</tr>
<tr>
<td>8</td>
<td>149</td>
<td>51%</td>
</tr>
</tbody>
</table>

- Anticipation of trade liberalization (year 3) induces:
  - *BD* firms to export (ahead of change in trade cost): *BDBX* transitions
  - *AD* firms to innovate (ahead of future export decision): *ADBD* transitions

- After trade liberalization occurs: very similar transitions to unanticipated case
  - Large transitions into exporting from *AD* and *BD*
## Anticipated, Gradual Trade Liberalization

<table>
<thead>
<tr>
<th>AG year</th>
<th># firms</th>
<th>Firm Distribution</th>
<th>Transitions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AD  BD  AX  BX</td>
<td>ADBD  ADAX  ADBX  BDBX  AXBX</td>
</tr>
<tr>
<td>0</td>
<td>203</td>
<td>77%  8%  0%  15%</td>
<td>4%  0%  0%  5%  0%</td>
</tr>
<tr>
<td>1</td>
<td>212</td>
<td>78%  8%  0%  14%</td>
<td>3%  0%  0%  5%  0%</td>
</tr>
<tr>
<td>2</td>
<td>214</td>
<td>78%  8%  0%  14%</td>
<td>3%  0%  0%  5%  0%</td>
</tr>
<tr>
<td>3</td>
<td>217</td>
<td>78%  8%  0%  14%</td>
<td>4%  0%  0%  5%  0%</td>
</tr>
<tr>
<td>4</td>
<td>207</td>
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<td>6%  0%  0%  10% 0%</td>
</tr>
<tr>
<td>5</td>
<td>184</td>
<td>68%  5%  0%  27%</td>
<td>8%  1%  1%  10% 1%</td>
</tr>
<tr>
<td>6</td>
<td>154</td>
<td>57%  3%  1%  39%</td>
<td>2%  6%  5%  4%  3%</td>
</tr>
<tr>
<td>7</td>
<td>142</td>
<td>50%  2%  3%  45%</td>
<td>0% 10%  2%  1%  6%</td>
</tr>
<tr>
<td>8</td>
<td>146</td>
<td>51%  2%  3%  44%</td>
<td>0%  9%  2%  1%  6%</td>
</tr>
</tbody>
</table>

- Once liberalization begins, anticipation of future reductions in trade costs induces substantial innovation ahead of exporting: $ABDB$ transitions.
Anticipation and Pace of Liberalization: Equilibrium Effects

UA Scenario

AA Scenario

AG Scenario
Conclusion

- Pace and anticipation of trade liberalization can fundamentally affect the perceived causation between export status and productivity (based on relative timing of activities).

- Current industrial response not only depends on concurrent trade costs, but also, inextricably, on the firms’ prior expectations about those current trade costs, and their expectations for changes in the future.
Steady States

![Graph showing the change in parameter v from pre to post, with a peak at around v=1.2 and a steady decrease afterwards.](image)
Anticipation Effects: Price Index

UA Scenario

$V_t^E < 0$

AA Scenario

$V_t^E < 0$
Anticipation and Pace of Liberalization: Equilibrium Effects

UA Scenario

AA Scenario

AG Scenario