QUALITY UPGRADING, TRADE, AND MARKET STRUCTURE IN FOOD PROCESSING INDUSTRIES

Eric Tseng and Ian Sheldon, October 22\textsuperscript{nd} 2015
**Motivation – Quality Matters**

- Quality an important determinant of trade flows (Linder 1961)
  - Manova and Zhang (2012) show successful exporting firms in China use higher-quality intermediate inputs to produce higher-quality goods and firms vary quality of products across destination markets
  - Vertical product differentiation matters!
Motivation – Food Markets

- Food markets no longer characterized by homogenous products (Sexton 2013)
  - Food quality matters for both consumers and producers
  - Sunk costs related to production capacity and product quality matter

- Curzi, Raimondi and Olper (2014) investigate impact of trade liberalization on food product quality
  - Trade liberalization in exporting countries leads to faster upgrading of product quality for products closer to technology frontier
Goals of Analysis

- Use modified heterogeneous-firms framework (Kugler and Verhoogen 2012) to focus on:
  - Food quality and quality of agricultural inputs (Sexton 2013)
  - Impact of trade liberalization on food product-quality (Curzi et al. 2014)
  - Ability of firms to upgrade quality of final goods
- Evaluate in both theoretical and empirical context
Model – Consumers and Firms

- Consumers maximize CES utility with quality preferences
- The intermediate agricultural good market is perfectly competitive, so \( p_I(c) = c \)
- Food processors (final good producers) require fixed costs to obtain a capability draw, enter market, and export. Capability \( \lambda \) follows Pareto distribution

\[
G(\lambda) = 1 - \left( \frac{\lambda_m}{\lambda} \right)^k, \quad 0 < \lambda_m \leq \lambda
\]
Firms use inputs of capability, intermediate agricultural input and composite input $\phi$ of a specific quality

$\phi$: additional *tangible* input that affects firm quality choice, i.e., capital equipment required to ensure quality control

Final good producers also incur trade costs $\tau$ when they export
Food processors constrained by quality choice

Inputs as complements in determining quality of good (Kremer 1993; Kugler and Verhoogen 2012)

\[ q = \left[ \frac{1}{3} (\lambda^b) ^\beta + \frac{1}{3} (\phi^3)^\beta + \frac{1}{3} (c^3)^\beta \right] \]

Importance of \( b \):

- \( b \) is the scope of product-quality differentiation, approximating fixed costs of investment required to translate capability into quality
  - Additional channel impacting firms’ quality choices
Profit maximization subject to quality constraint yields the following comparative statics:

(1a) \( \frac{\partial \ln q^*}{\partial \tau} = \frac{b(1-\sigma)Z\tau^{-\sigma}}{\eta(1+Z\tau^{1-\sigma})^2} < 0 \)

(1b) \( \frac{\partial \ln q^*}{\partial b} = \ln \lambda > 0 \)

(1c) \( c^*(\lambda) = \phi^*(\lambda) = \lambda^3 \)
Comparative Statics

- Impact of various parameters on firm’s quality choice:
  - Falling trade costs allow firms to produce higher-quality goods
  - Firms better able to translate capability into quality produce higher-quality goods
  - All inputs are complementary: to increase final good quality, all input qualities must be increased
Comparative Statics

- Impact of trade liberalization on export entry cutoff point

\[
\frac{\partial \lambda^*}{\partial \tau} = \frac{k(1-\sigma)}{\eta} \lambda^m \frac{f \eta}{\delta f_e (k-\eta)} \left( \frac{f}{f_x} \right)^{\frac{k-\eta}{\eta}} \frac{k(1-\sigma)-\eta}{\tau^\frac{\eta}{\eta}} < 0
\]

\[
\frac{\partial \lambda^*_x}{\partial \tau} = \frac{\sigma-1}{\eta} \lambda^* \left( \frac{f_x}{f} \right)^{\frac{1}{\eta}} \frac{(\sigma-1)-\eta}{\tau^\frac{\eta}{\eta}} > 0
\]

- (2a-b) state that falling trade costs induce most productive non-exporting firms to enter export market, and least productive firms forced out of market, as exporting firms now capture larger market share

- Classic heterogeneous-firms result (see Melitz 2003)
Comparative Statics

- Impact of ability to translate capability on export entry cutoff point

\[
\frac{\partial \lambda^*}{\partial b} = 3k \tau^3 \left( \frac{-k}{b^{a+1}} \left( \frac{\lambda_m f}{\delta f_e} \right) \right) \left[ \ln \left( \frac{f}{f_X} \right) - (\sigma - 1) \ln (\tau) \right] \left( \frac{f}{f_X} \right)^k \Lambda - \rho \left( \frac{f}{f_X} \right)^{k-\eta} + \tau^{3a+b} \right] \rho \Lambda^2
\]

(3a)

\[
\frac{\partial \lambda_x^*}{\partial b} = -\lambda^* \left[ \frac{\sigma - 1}{3\eta^2} \left( \frac{f}{f_X} \right)^{1/\eta} \left( \frac{\sigma - 1}{\tau} \right) \ln \left( \frac{f}{f_X} \right) + (\sigma - 1) \ln (\tau) \right]
\]

(3b)

\[
\rho = \left( \frac{f}{f_X} \right)^{(3a+b)}, \Lambda = 3(\eta-k)
\]

- Results are ambiguous in sign due to other parameters
Comparative Statics

- (3a) sign dependent on
  - When \( k < \eta + \gamma \), then \( \frac{\partial \lambda^*}{\partial b} < 0 \), \( \gamma > 0 \)
  - When \( k > \eta + \gamma \), then \( \frac{\partial \lambda^*}{\partial b} > 0 \)

- Impact of \( b \) depends on the shape of the distribution of firms, \( k \), i.e., market structure
  - When \( k \to \infty \), market shares become concentrated; majority of market share held by few firms, with many low-productivity firms occupying rest of market. Thus \( \frac{\partial \lambda^*}{\partial b} > 0 \) and vice versa
Comparative Statics

- (3b) sign dependent on
  - When \( \ln \left( \frac{f}{f_x} \right) + (\sigma - 1) \ln(\tau) > 0 \), then \( \frac{\partial \lambda^*_X}{\partial b} < 0 \).
  - When \( \ln \left( \frac{f}{f_x} \right) + (\sigma - 1) \ln(\tau) < 0 \), then \( \frac{\partial \lambda^*_X}{\partial b} > 0 \).

- Impact of \( b \) depends on extent that \( f_x > f \). If \( f \to f_x \), then export rents outweigh fixed costs given increased \( b \). If \( f_x \gg f \), then fixed costs of exporting outweigh export rents, leading to export exit.
Data

- Sources: Chile’s *Encuesta Nacional Industrial Annual* (ENIA), an unbalanced panel data set. Industry-level tariff rates from TRAINS database (WITS).
- Sample years: 2001-2007
- Sample size: 11,196 observations, approximately 1,600 food-processing firms per year in the sample.
## Table 1 – Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exporter Status</td>
<td>11196</td>
<td>0.0417</td>
<td>0.200</td>
</tr>
<tr>
<td>Quality (q)</td>
<td>11196</td>
<td>0.388</td>
<td>0.301</td>
</tr>
<tr>
<td>Freight Costs</td>
<td>11196</td>
<td>0.0126</td>
<td>0.198</td>
</tr>
<tr>
<td>Tariff Costs</td>
<td>11196</td>
<td>0.0417</td>
<td>0.0265</td>
</tr>
<tr>
<td>Productivity</td>
<td>11196</td>
<td>20.708</td>
<td>281.359</td>
</tr>
<tr>
<td>Export Share</td>
<td>11196</td>
<td>0.114</td>
<td>0.2705</td>
</tr>
<tr>
<td>b</td>
<td>11196</td>
<td>0.0459</td>
<td>0.2201</td>
</tr>
<tr>
<td>c</td>
<td>11196</td>
<td>0.114</td>
<td>0.0426</td>
</tr>
<tr>
<td>φ</td>
<td>11196</td>
<td>0.0179</td>
<td>0.382</td>
</tr>
<tr>
<td>ln(LaborCost)</td>
<td>11196</td>
<td>11.20</td>
<td>1.541</td>
</tr>
<tr>
<td>Size</td>
<td>11196</td>
<td>13.513</td>
<td>1.899</td>
</tr>
</tbody>
</table>

Note: Size is constructed as the $\ln\left(\text{Gross Value of Production}\right)$
Empirical Specifications

- Export Entry

\[ \Pr(\text{Export}_{i,t} = 1|\text{Export}_{i,t-1} = 0) = \alpha + \beta_1 c + \beta_2 \phi + \gamma b + \delta \Delta \tau + \mu \lambda + \kappa X + \varepsilon \]

- Market Exit

\[ \Pr(\text{Exit}_{i,t} = 1|\text{Exit}_{i,t-1} = 0) = \alpha + \beta_1 c + \beta_2 \phi + \gamma b + \delta \Delta \tau + \mu \lambda + \Theta(\Delta \tau \cdot \lambda) + \Gamma(b \cdot \Psi) + \kappa X + \varepsilon \]

- Quality Choice

\[ q = \alpha + \beta_1 c + \beta_2 \phi + \gamma b + \delta \Delta \tau + \mu \lambda + \Gamma(b \cdot \Psi) + \kappa X + \varepsilon \]
## Results

Table 3 - Summarized Results

<table>
<thead>
<tr>
<th>Dependent Variable: Export Entry</th>
<th>[1]</th>
<th>[2]</th>
<th>[3]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freight</td>
<td>-0.0641**</td>
<td>-0.000644</td>
<td>-0.0000477</td>
</tr>
<tr>
<td>(0.0275)</td>
<td>(0.00284)</td>
<td>(0.00140)</td>
<td></td>
</tr>
<tr>
<td>Freight ( \cdot \lambda )</td>
<td>0.000375</td>
<td>(0.00172)</td>
<td></td>
</tr>
<tr>
<td>Tariff</td>
<td>-8.227***</td>
<td>6.959***</td>
<td>-0.104</td>
</tr>
<tr>
<td>(0.534)</td>
<td>(0.461)</td>
<td>(0.0662)</td>
<td></td>
</tr>
<tr>
<td>Tariff ( \cdot \lambda )</td>
<td>-0.150*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.0788)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( c )</td>
<td>1.305**</td>
<td>0.419</td>
<td>-0.290**</td>
</tr>
<tr>
<td>(0.605)</td>
<td>(0.328)</td>
<td>(0.128)</td>
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</tr>
<tr>
<td>( c \cdot b )</td>
<td>-2.699**</td>
<td>0.554**</td>
<td></td>
</tr>
<tr>
<td>(1.170)</td>
<td>(0.260)</td>
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<td></td>
</tr>
<tr>
<td>( \phi )</td>
<td>0.0273</td>
<td>-0.0163</td>
<td>0.151***</td>
</tr>
<tr>
<td>(0.0303)</td>
<td>(0.0406)</td>
<td>(0.00685)</td>
<td></td>
</tr>
<tr>
<td>( \phi \cdot b )</td>
<td>0.0106</td>
<td>0.0588***</td>
<td></td>
</tr>
<tr>
<td>(0.0361)</td>
<td>(0.00610)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( b )</td>
<td>0.153**</td>
<td>0.295***</td>
<td>0.00837</td>
</tr>
<tr>
<td>(0.0702)</td>
<td>(0.111)</td>
<td>(0.0242)</td>
<td></td>
</tr>
<tr>
<td>TFP (( \lambda ))</td>
<td>0.000129***</td>
<td>0.000028</td>
<td>2.80E-06</td>
</tr>
<tr>
<td>(0.0000466)</td>
<td>(0.0000487)</td>
<td>(0.00483)</td>
<td></td>
</tr>
<tr>
<td>( \lambda \cdot b )</td>
<td>-0.00770</td>
<td>0.000771**</td>
<td></td>
</tr>
<tr>
<td>(0.00642)</td>
<td>(0.000371)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( N )</td>
<td>11196</td>
<td>11196</td>
<td>11196</td>
</tr>
<tr>
<td>LR ( \chi^2 ) = 996.86</td>
<td>LR ( \chi^2 ) = 350.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LR ( F ) = 102.82</td>
<td>LR ( \chi^2 ) = 28.36</td>
<td></td>
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</tr>
<tr>
<td>R(^2)</td>
<td>0.257</td>
<td>0.0301</td>
<td>0.138</td>
</tr>
</tbody>
</table>
Model adapts heterogeneous-firms framework to food-industry context

- Firms that remain in market select higher quality given falling trade costs and increased ability to upgrade quality, and use concurrently higher-quality inputs
- Trade liberalization forces least productive firms out of market while most productive non-exporters enter export market
- Impact of ability to upgrade quality dependent on market structure: distribution of firms in the market and structure of fixed costs matter

Empirical analysis currently provides evidence generally supporting model. The quality constraint is typically supported and the estimation of $b$ tells us about market structure of food-processing industries
Appendix - Comparative Statics

Figure 1: Impact of tariffs and ability to upgrade quality on quality choice
Appendix - Comparative Statics

Figure 2: Cumulative distribution of the Pareto distribution, based on $k$. 

Note:
$k_1 < k_2 < k_3 < \infty$
Appendix - Data

Cumulative Distribution of Lambda, All Years