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

Eric Tseng & Ian Sheldon, Dec. 14th 2015

Motivation – Quality Matters

- Quality an important determinant of trade flows (Linder 1961)
  - Schott (2004), Hummels & Klenow (2005), Hallack (2006)
  - Manova & 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 & 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 & 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
- Test in both the 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 λ follows Pareto distribution $G(\lambda) = 1 - \left(\frac{\lambda_m}{\lambda}\right)^k$, $0 < \lambda_m \leq \lambda$.

Model – Firms

- Firms use inputs of capability, intermediate agricultural input and composite input ϕ of a specific quality
  - ϕ : additional *tangible* input that affects firm quality choice, i.e., capital equipment required to ensure quality control
- Final good producer also incurs trade costs τ when they export

Model - Firms

- Food processors constrained by quality choice
  - Inputs as complements in determining quality of good (Kremer 1993; Kugler & Verhoogen 2012)

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

- 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

Comparative Statics from Equilibrium

- Profit maximization subject to quality constraint yields the following comparative statics:

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

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

$$\text{(1c)} \qquad c^*(\lambda) = \phi^*(\lambda) = \lambda^{\frac{b}{3}}$$

Comparative Statics

- Impact of various parameters on the 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

- Comparative statics examining impact of trade liberalization and ability to translate capability on export and market entry cutoff points

$$\text{(2a)} \quad \frac{\partial \lambda^*}{\partial \tau} = \frac{k(1-\sigma)}{\eta} \lambda_m \frac{f\eta}{\delta f_e (k-\eta)} \left(\frac{f}{f_x} \right)^{\frac{k-\eta}{\eta}} \tau^{\frac{k(1-\sigma)-\eta}{\eta}} < 0$$

$$\text{(2b)} \quad \frac{\partial \lambda_x^*}{\partial \tau} = \frac{\sigma - 1}{\eta} \lambda^* \left(\frac{f_x}{f} \right)^{\frac{1}{\eta}} \tau^{\frac{(\sigma-1)-\eta}{\eta}} > 0$$

- (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

- Comparative statics examining impact of trade liberalization and ability to translate capability on export and market entry cutoff points

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

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

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

- These 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 $\frac{\partial \lambda^*}{\partial b} > 0$.
- The 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: 11,195 observations, approximately 1,600 food-processing firms per year in the sample

Data

Table 1 – Summary Statistics

Variable	N	Mean	St. Dev
Exporter Status	11195	0.0417	0.200
Quality (q)	11195	0.388	0.301
Freight Costs	11195	0.0126	0.198
Tariff Costs	11195	0.0417	0.0265
Productivity	11195	0.9988	4.520
Export Share	11195	0.114	0.2705
b (ability to translate capability into quality)	11195	0.0459	0.2201
c (quality of agricultural input)	11195	0.114	0.0426
ϕ **(quality of composite input)**	11195	0.0179	0.382
$\ln(LaborCost)$	11195	11.20	1.541
Size	11195	13.513	1.899

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

Empirical Specifications

- Quality Choice

$$q = \alpha + \beta_1 c + \beta_2 \phi + \gamma b + \delta \Delta\tau + \mu\lambda + \Gamma\left(b \cdot \Psi\right) + \kappa X + \xi_j + \psi_t + \varepsilon$$

- Export Entry

$$\Pr(Export_{i,t+1} = 1 \mid Export_{i,t} = 0) = \alpha + \beta_1 c + \beta_2 \phi + \gamma b + \delta \Delta\tau + \mu\lambda + \kappa X + \varepsilon$$

- Market Exit

$$\Pr(Exit_{i,t+1} = 1 \mid Exit_{i,t} = 0) = \alpha + \beta_1 c + \beta_2 \phi + \gamma b + \delta \Delta\tau + \mu\lambda + \Theta\left(\Delta\tau \cdot \lambda\right) + \Gamma\left(b \cdot \Psi\right) + \kappa X + \varepsilon$$

Results

Dependent Variable	**q**	**Export Entry**	**Market Exit**
ΔFreight	-0.000205	-0.0869**	-0.0025
ΔTariff	-0.000834	-0.0742***	0.00977
ΔFreight · TFP	0.000248	0.0222	-0.0303**
ΔTariff · TFP	-0.000702	-0.0021	-0.000745
c	-0.279**	1.791***	-0.6075
c · b	0.594**		-3.959**
ϕ	0.151***	0.0291	-0.0133
ϕ **· b**	0.059***		0.00393
b	0.00761	0.178**	0.437***
TFP	0.00131	0.016***	-0.00439
TFP · b	0.00797**		-0.4**

Conclusion

- Theoretical 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 that generally supports the model. The quality constraint is typically supported and the estimation of b tells us about market structure of food-processing industries

Appendix - Comparative Statics

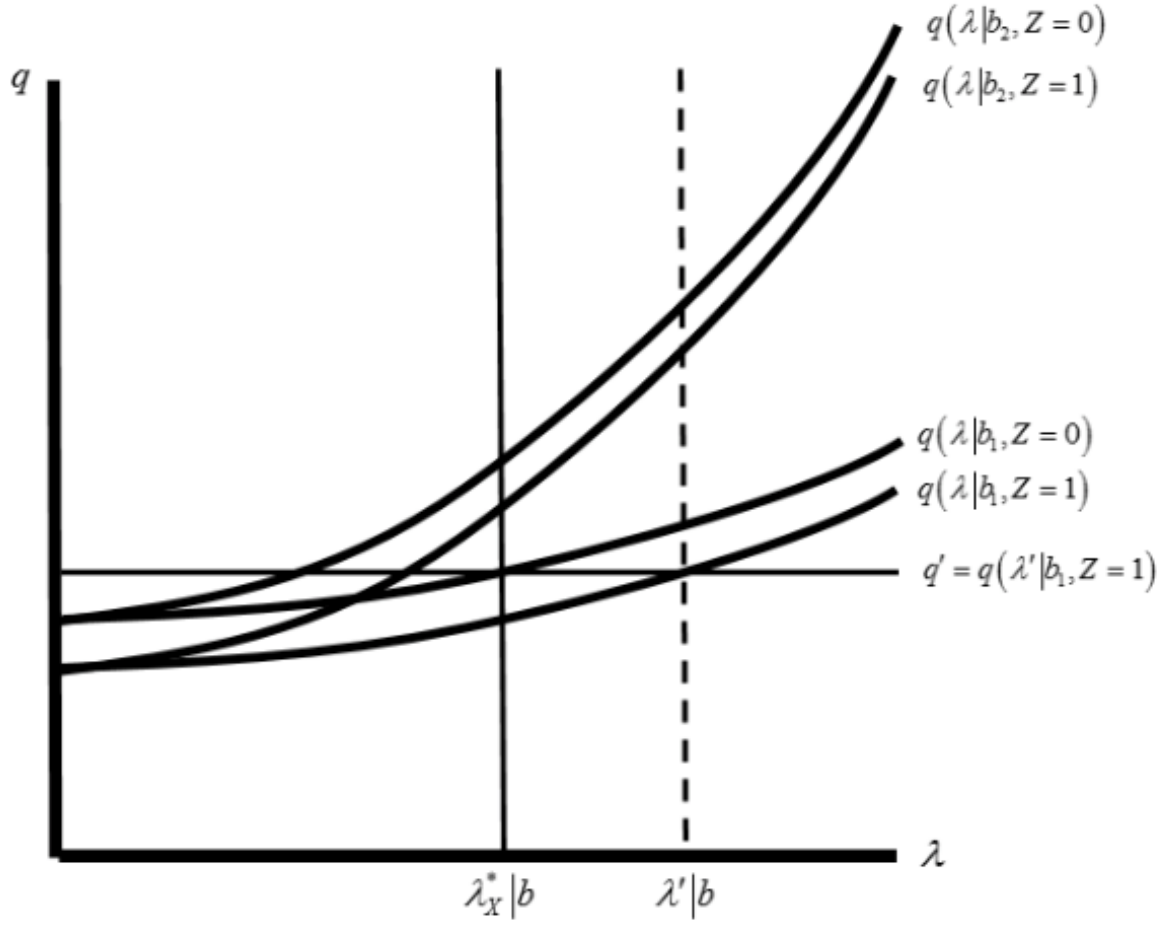

Figure 1: Impact of tariffs and ability to upgrade quality on quality choice

Appendix - Comparative Statics

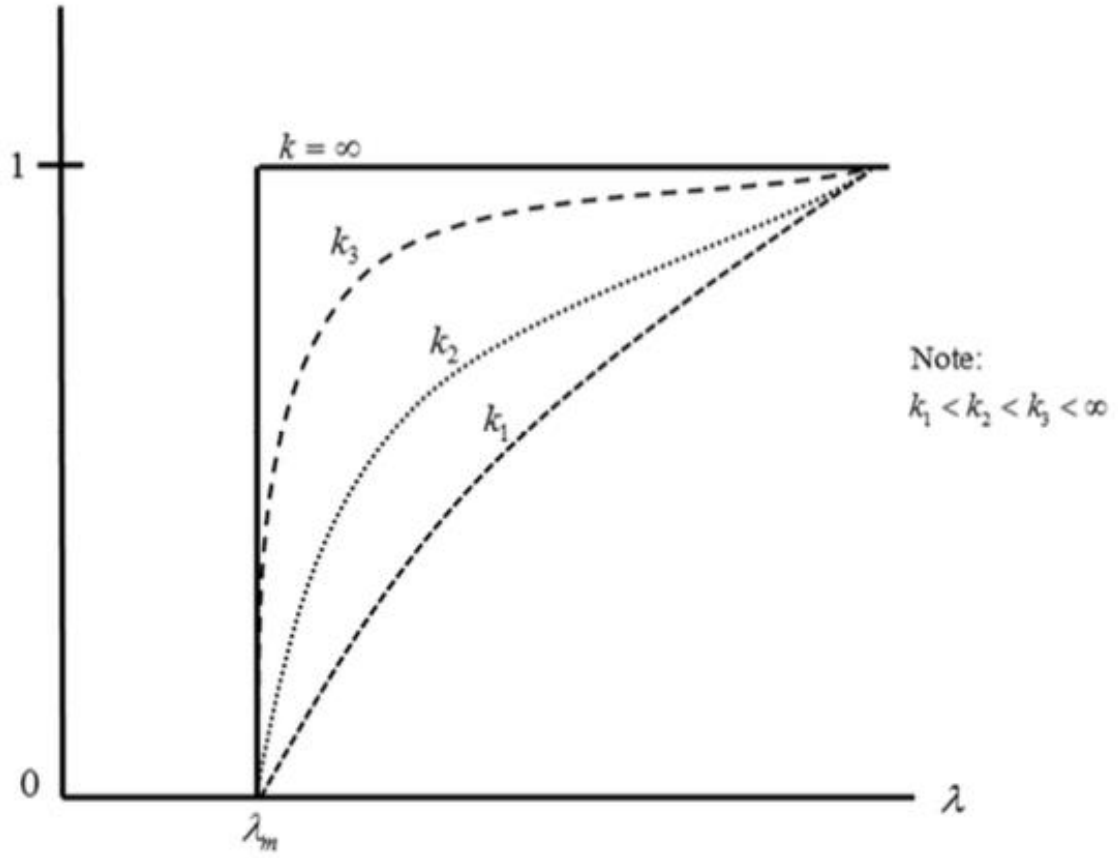

Figure 2: Cumulative distribution of the Pareto distribution, based on *k*.

Appendix - Data