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# Food Processing Firms, Input Quality Upgrading and Trade

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# Motivation - Quality Matters

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- ❖ Quality an important determinant of trade flows (Linder 1961)
  - ❖ Schott (2004) and Hummels & Klenow (2005) link exporter GDP per capita and product quality
  - ❖ Hallack (2006) links product quality demand to importer GDP per capita
  - ❖ Manova & Zhang (2012) show successful exporting firms in China use higher-quality intermediate inputs to produce higher-quality goods and firms vary quality of produces across destination markets
- ❖ Vertical product differentiation matters and should be modeled



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# Motivation - Food Markets

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- ❖ Food markets no longer characterized by homogenous products (Sexton 2013)
  - ❖ Food quality matters, and firms in food industry use vertical product differentiation strategies
  - ❖ 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
  - ❖ On average, EU voluntary food-quality standards have positive effect on rate of quality upgrading

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# Goals of Analysis

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- ❖ Use modified heterogeneous-firms framework allowing for intermediate input markets (i.e., Kugler & Verhoogen (2012))
- ❖ Extend to focus on food quality and quality of agricultural inputs (Sexton 2013)
- ❖ Extend to capture Curzi *et al.* (2014) finding that both trade liberalization and food-quality standards promote quality upgrading

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# Model - Consumers

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❖ Consumers:

❖ Utility

$$(1) \quad U = \left[ \int_{\omega \in \Omega} (\theta(\omega)q(\omega)x(\omega))^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$$

❖ Demand

$$(2) \quad x(\omega) = Xq(\omega)^{\sigma-1} \theta(\omega)^{\sigma-1} \left( \frac{p_o(\omega)}{P} \right)^{-\sigma}$$



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# Model - Firms

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- ❖ Firms

- ❖ Intermediate agricultural good  $I$  produced via production function:

$$(3) \quad F_I(A, c) = \frac{\bar{A}}{c}$$

- ❖ Since intermediate input market is perfectly competitive, then  $p_I(c) = c$

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# Model - Firms

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- ❖ Food processors (final good producers) require fixed investment cost  $f_e$  to obtain capability  $\lambda$ , where  $\lambda$  is drawn from Pareto distribution with  $G(\lambda) = 1 - \left(\frac{\lambda_m}{\lambda}\right)^k$ ,  $0 < \lambda_m \leq \lambda$
- ❖ Firms must pay fixed costs to enter market,  $f$ , and also incur fixed cost of exporting  $f_x$  in all periods

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# Model - Firms

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- ❖ Firms use inputs of capability, intermediate agricultural input and composite input  $\phi$  of specific quality
  - ❖  $\phi$ : additional *tangible* input, i.e., equipment required to meet food safety standards, quality of capital or labor
- ❖ Production function for final good is:

$$(4) \quad \begin{aligned} F(n) &= n\phi^s \lambda^a \\ MC &= \frac{p_I(c)}{\phi^s \lambda^a} \\ MC_X &= \frac{\tau p_I(c)}{\phi^s \lambda^a} \end{aligned}$$



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# Model - Firms

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

$$(5) \quad q = \frac{1}{(1+Z\tau)} \left[ \frac{1}{3} (\lambda^b)^\beta + \frac{1}{3} (\phi^3)^\beta + \frac{1}{3} (c^3)^\beta \right]$$

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# Equilibrium

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❖ Profit maximization yields following:

$$(7a) \quad c^*(\lambda) = p_I^*(\lambda) = \lambda^{\frac{b}{3}}$$

$$(7b) \quad \phi^*(\lambda) = \lambda^{\frac{b}{3}}$$

$$(7c) \quad q^*(\lambda) = \frac{\lambda^b}{1 + Z\tau}$$

$$(7d) \quad p_O^*(\lambda) = \left( \frac{\sigma}{\sigma - 1} \right) \lambda^{\frac{b}{3}(1-s)-a}$$

$$p_{O,X}^*(\lambda) = \left( \frac{\sigma}{\sigma - 1} \right) \tau \lambda^{\frac{b}{3}(1-s)-a}$$

$$(7e) \quad r^*(\lambda) = \left( \frac{\sigma - 1}{\sigma} \right)^{\sigma-1} \lambda^\eta X P^\sigma \left( \theta_1^{\sigma-1} + \theta_2^{\sigma-1} Z [\tau(1 + Z\tau)]^{1-\sigma} \right)$$

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# Comparative Statics

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- ❖ Comparative statics regarding effects of parameters on input and output prices and quality choices

$$(8a) \quad \frac{\partial \ln p_o^*}{\partial \ln r^*} = \frac{1}{\eta} \left[ \frac{b}{3}(1-s) - a \right] > 0, \text{ and } \frac{\partial \ln p_I^*}{\partial \ln r^*} = \frac{b}{3\eta} > 0$$

$$(8b) \quad c^*(\lambda) = \phi^*(\lambda) = \lambda^{\frac{b}{3}}$$

$$(8c) \quad \frac{\partial \ln p_I^*}{\partial \ln \theta} = \frac{(\sigma-1)b}{3\eta\theta} > 0, \text{ and } \frac{\partial \ln p_o^*}{\partial \ln \theta} = \frac{(\sigma-1) \left[ \frac{b}{3}(1-s) - a \right]}{\eta\theta} > 0$$

$$(8d) \quad \frac{\partial q^*}{\partial \tau} = -\frac{Z\lambda^b}{(1+Z\tau^2)} < 0$$

$$\eta \equiv (\sigma-1) \left[ b - \frac{b}{3}(1-s) + a \right]$$



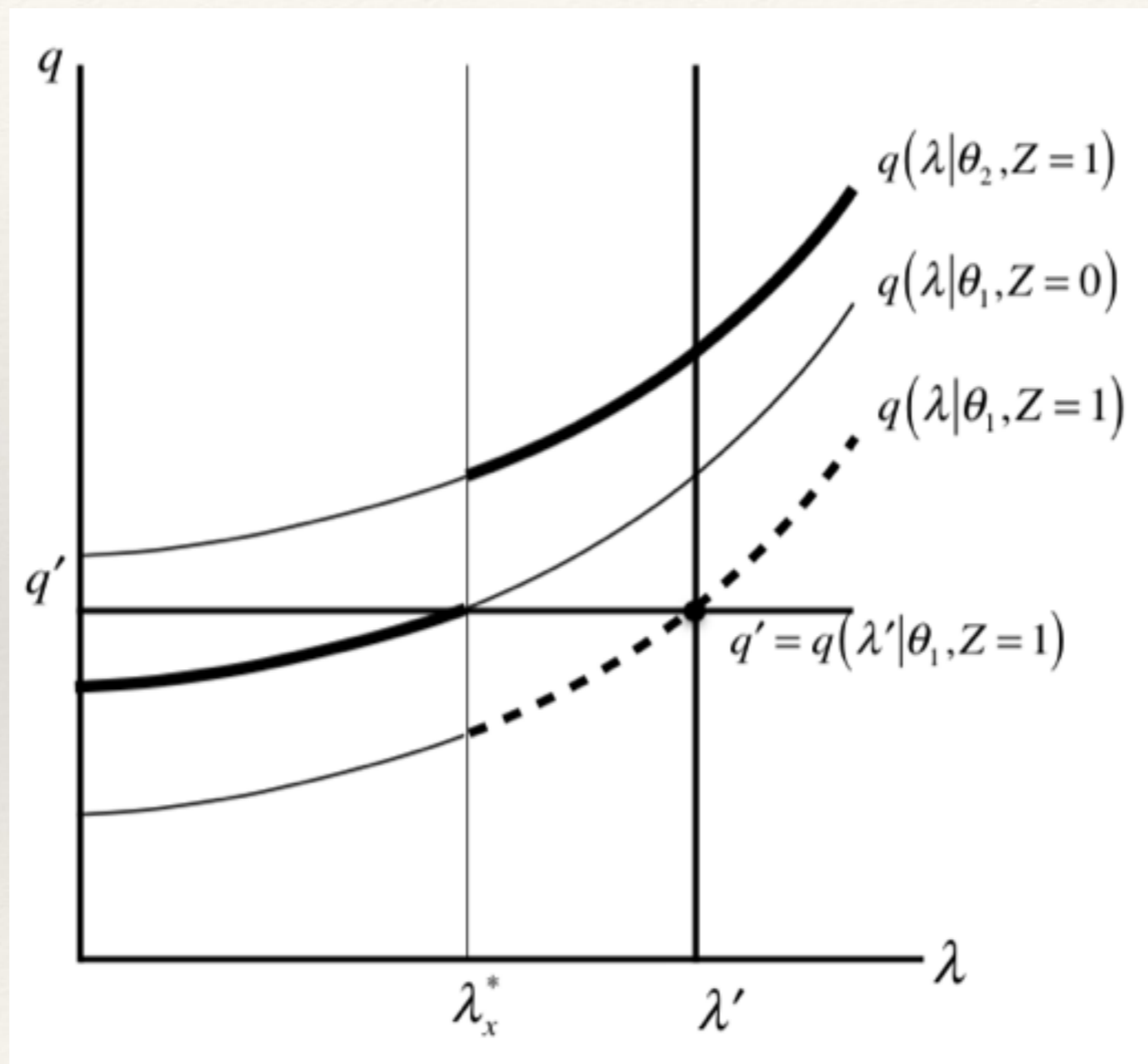
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# Comparative Statics

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- ❖ Comparative statics imply:
  - ❖ Larger firms charge higher price for outputs, but pay more for intermediate agricultural inputs, choose to produce final good at higher quality
  - ❖ Similar results for firms producing for destinations with higher  $\theta$
  - ❖ Trade costs negatively impact quality choice

# Comparative Statics



# Comparative Statics

- ❖ Comparative statics examining impact of trade liberalization and changes in quality standards

$$(11a) \quad \frac{\partial \ln \lambda_x^*}{\partial \ln \tau} = \frac{\sigma - 1}{\eta} [\tau(1 + \tau)]^{\frac{\sigma - \eta - 1}{\eta}} [1 + 2\tau] \lambda^* \left( \frac{\theta_1}{\theta_2} \right)^{\frac{\sigma - 1}{\eta}} \left( \frac{f_x}{f} \right)^{\frac{1}{\eta}} > 0$$

$$(11b) \quad \frac{\partial \ln \lambda^*}{\partial \ln \tau} = \frac{(1 - \sigma)}{\eta} [1 + 2\tau] \left[ \left( \frac{f_x}{f} \right)^{\frac{k - \eta}{\eta}} \left( \frac{\theta_1}{\theta_2} \right)^{\frac{k(1 - \sigma)}{\eta}} \right] [\tau(1 + \tau)]^{\frac{k(1 - \sigma) - \eta}{\eta}} \lambda_m \rho^{\frac{1 - k}{k}} < 0$$

$$(12a) \quad \frac{\partial \lambda_x^*}{\partial \theta_2} = \left( \frac{1 - \sigma}{\eta} \right) \lambda^* \left( \frac{f}{f_x} \right)^{\frac{1}{\eta}} \theta_1^{\frac{\sigma - 1}{\eta}} \theta_2^{-\frac{\sigma}{\eta}} [\tau(1 + \tau)]^{\frac{\sigma - 1}{\eta}} < 0$$

$$(12b) \quad \frac{\partial \lambda^*}{\partial \theta_2} = \left( \frac{\sigma - 1}{\eta} \right) \lambda_m \rho^{\frac{1 - k}{k}} \left( \frac{f}{f_x} \right)^{\frac{k - \eta}{\eta}} \theta_1^{\frac{k(1 - \sigma)}{\eta}} \theta_2^{\frac{k(\sigma - 1) - \eta}{\eta}} [\tau(1 + \tau)]^{\frac{k(1 - \sigma)}{\eta}} > 0$$

$$\rho \equiv \left( \frac{f\eta}{\delta f_e(k - \eta)} \right) \left[ 1 + \left( \frac{f}{f_x} \right)^{\frac{k - \eta}{\eta}} \left( \frac{\theta_1}{\theta_2} [\tau(1 + \tau)] \right)^{\frac{k(1 - \sigma)}{\eta}} \right] > 0$$



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# Comparative Statics

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- ❖ (11) states 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 heterogenous-firms result (see Melitz (2003))
- ❖ (12) states that increases in export destination's consumer preference for quality yields similar effect as above

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# Conclusion

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- ❖ Two observations in food industry captured in model:
  - ❖ Interaction between agricultural input quality and food quality matters (Sexton 2013)
  - ❖ Food export quality increases with trade liberalization and higher standards (Curzi, Raimondi and Olper 2014)
  - ❖ Food quality choices in developing countries impacted by  $b$ ,  $\phi$  parameters