Firms, Quality Upgrading and Trade

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- **Sutton (2001, 2007) refers to *capabilities* of firms, consisting of two elements:**
  - **Maximum level of quality firms can achieve**
  - **Cost of production (productivity)**
- **To survive in export markets, Sutton argues firms' capabilities must lie within a "window"**
- **Competition among firms to enhance capability relies on escalation of fixed outlays such R&D**
- **Raising/maintaining food quality recognized as important in both domestic (Sexton, 2012), and international markets – especially developing countries with comparative advantage (Swinnen, 2007)**

- **Flamm and Helpman (1987), *inter alia*, formalized Linder's (1961) observation that quality affects direction of trade**
- **Schott (2004) finds export unit values at product level increase with exporter per capita income and relative endowments of human capital**
- **Hummels and Klenow (2005) argue that product quality differences are necessary to explain observed differences in unit values across trading partners**
- **Successful exporters use higher-quality inputs to produce higher-quality products (Manova and Zhang, 2012)**
- **Empirical results suggest firm level trade models need to explicitly incorporate vertical product differentiation**

- **Kugler and Verhoogen (2012) find output price-plant size and input price-plant size elasticities increase in scope for quality differentiation**
- **Extend Melitz (2003) beyond standard interpretation of monopolistic competition with horizontal product differentiation**
- **Entrepreneurs pay fixed costs *ex ante* to receive "capability" draw, firms are heterogeneous *ex post*, to which is added:**
  - **Competitive quality-differentiated input sector**
  - **Two versions of final good production function:**
    - **input quality/plant capability complementary, upgrading quality requires no fixed costs**
    - **high quality requires both fixed costs and high-quality inputs**

- **Demand Side**

Representative consumer has CES utility:

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

ω indexes product varieties; Ω is set of all available varieties; σ is elasticity of substitution; $x(\omega)$ is quantity consumed; $q(\omega)$ is observable quality

Demand for each variety is:

$$x(\omega) = Xq(\omega)^{\sigma-1} \left(\frac{p_O(\omega)}{P} \right)^{-\sigma} \qquad (2)$$

$p_o(\omega)$ is output price of variety ω, P is an aggregate quality-adjusted price index, and X is quality-adjusted aggregate of available varieties

- **Intermediate Inputs**

Intermediate input sector transforms homogeneous labor hours ℓ into intermediate inputs that vary in quality c

Intermediate prices equal to marginal cost, $p_I(c) = c$, with linear relationship between quality of intermediate and its price

- **Final Goods Sector**

To enter final goods sector, firms pay investment cost, f_e in order to get capability draw λ, and there is exogenous probability of exit of δ – focus on steady-state where new entrants replace exiting firms

There are fixed costs of production f, and additional fixed costs of exporting where $fx > f$; each plant in final goods sector produces distinct good, λ indexing plants/varieties

Final goods production assumed to be:

$$F(n) = n\lambda^{a} \qquad (3)$$

n = number of units of input used; a = parameter reflecting extent to which capability lowers unit costs

Depending on how quality is produced, q will depend on different combinations of productivity draw λ, input quality c and fixed investment in quality f_q

Plants in final goods sector optimize over c, f_q, p_O, and which markets to enter (Z = 1 if plant is in export market), profit function being:

$$\pi(p_O, c, f_q, Z, \lambda) = \left(\frac{p_I(c)}{\lambda^{a}}\right)x - f_q - f + Z\left[\left(\frac{p_I(c)}{\lambda^{a}}\right)x - f_x\right] \qquad (4)$$

- **Complementarity of Input Quality-Plant Capability**

λ and c are complements in generating quality:

$$q = \left[\frac{1}{2}(\lambda^b)^\theta + \frac{1}{2}(c^2)^\theta \right]^{\frac{1}{\theta}} \qquad (5)$$

θ reflects degree of complementarity between capability and input quality, $\theta < 0$; b reflects scope of quality differentiation, $b \geq 0$; also fixed investment in quality ineffective $f_q = 0$

Essentially marginal increase in output quality for given increase in input quality is greater for more capable entrepreneurs – rules out capability and input quality being substitutes

Equilibrium one where, given $f_x > f$, $\lambda^* < \lambda_x^*$, i.e., to enter export market, firm must have higher level of capability

- **Fixed Costs of Upgrading**

Key here is that fixed costs of quality upgrading matter:

$$q = \min(f_q^{\alpha}, c^2) \qquad (6)$$

$\alpha \geq 0$ reflects extent to which quality increases with fixed quality investment – Sutton's (1998) "escalation parameter"; α is bounded from above, $\alpha < \frac{2}{\sigma - 1}$

Parameter characterizes effectiveness of R&D spending in improving quality or effectiveness of advertising expenditures in raising perceived quality (Sutton, 1991; 1998)

Again, equilibrium cut-off values for capabilities are $\lambda^* < \lambda_x^*$

- **Key to both approaches is that as long as there is scope for quality differentiation, firms with higher capability use higher-quality inputs and produce higher-quality outputs**
  - **<u>Either</u> more capable entrepreneurs have a comparative advantage in using higher-quality inputs**
  - **<u>Or</u> more capable plants produce at a larger scale and spread fixed quality costs over more units – hence pay higher fixed costs and use higher quality inputs**
- **Important implication of model is that quality upgrading may require upgrading of entire system of suppliers – lack of locally available high-quality inputs could hinder ability of firms to upgrade quality**

- **Alternative approach is to consider how competition (trade liberalization) could affect firm's incentive to upgrade quality**
- **Drawing on Aghion and Howitt (2005), Amit and Khandelwal (2013) argue this depends on how far firms are from global technology frontier**
- **Increase in competition has one of two effects:**
  - **Firms close to frontier innovate more – pre-innovation profits reduced more than post-innovation profits (*escape competition*)**
  - **Firms far from frontier innovate less – ex-post innovation profits eroded by competition (*discouragement*)**
- **Allows for possibility of non-monotonic relationship between competition and quality upgrading**

- **Curzi, Raimondi and Olper (2013) apply approach to food industry using EU import data at 8-digit level for 1995-2007**
- **They estimate following:**

$$\Delta ln\phi^{F}_{cht} = \alpha_{iht} + \alpha_{ct} + \beta_1 D_{ch,t\text{-}5} + \beta_2 tariff_{ch6,2\text{-}5} + \beta_3 (D_{ch,t\text{-}5}.tariff_{ch6,2\text{-}5}) + \varepsilon_{cht}$$

where $\beta_2 > 0$, and $\beta_3 < 0$ (Aghion *et al.*, 2005; 2009)

- **A major challenge is to measure quality**
- **Khandelwal (2010) suggests taking account of market shares, such that for two products with identical unit values, that with the greater market share is higher quality**
- **Empirical method follows Berry (1994) based on a nested logit demand system embedding consumer preferences for horizontal and vertical product attributes**

- **Distance to frontier defined as ratio of measured quality of variety to highest quality of variety at 8-digit level:**

$$D_{cht} = \frac{\phi_{cht}^{F}}{max_{c \in ht}(\phi_{cht}^{F})}$$

where $D_{cht} \in [0,1]$, with varieties closer to frontier, value of D_{cht} approaches 1

- **Curzi *et al.* (2013) find strong support for existence of non-monotonic relationship between competition and quality upgrading**
- **Also find that EU voluntary standards, on average, have a positive effect on rate at which quality is upgraded – support for view that standards are a "catalyst to trade"**

- **Vertical product differentiation matters in food industry, both in domestic and international markets**
- **Currently two approaches to modeling effects of trade liberalization/increased competition on quality: an adaptation of Melitz (2003) and application of Aghion and Howitt (2005)**
- **Former has clear theoretical implications, but requires extensive data at plant-level in order to test, while latter relies on methodology for measuring quality**
- **Link to Sutton's (1991, 1998) work on endogenous fixed costs argument is useful, but does generate inconsistency between market structure of monopolistic competition of Kugler and Verhoogen (2012) and Sutton's lower bound to market structure**

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