**Professor Ian Sheldon: Trade Seminar**
**CUCEA, Universidad de Guadalajara**
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# Topic 1: Firms, Trade and Product Quality

**Articles:**

**Elhanan Helpman, Marc J. Melitz, and Stephen Yeaple, "Export Versus FDI with Heterogeneous Firms", *American Economic Review*, 2004: 300-316**

**Maurice Kugler and Eric Verhoogen, "Prices, Plant Size, and Product Quality", *Review of Economic Studies*, 2012: 307-339**

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# Trade and FDI (Helpman et al., 2004)

- **Sales by multinational firms grew at higher rates than expansion of trade in manufactures over 1980s and 1990s**
- **What determines firm's choice between exports and "horizontal" foreign direct investment (FDI)?**
- **Firms invest abroad when gains from avoiding trade costs outweigh costs of maintaining capacity in domestic market**
- **Systematic relationship appears to exist between characteristics of firms and their participation in both foreign trade and investment**

## Trade and Firms

- **Relatively little attention given in traditional trade models to firms that actually drive trade flows**
- **Exporting actually quite a rare activity – in 2000, of 5.5 million firms operating in US, only 4% engaged in exporting (Bernard *et al*., 2007)**
- **Even in industries more likely to be involved in exporting, manufacturing, mining and agriculture, only 15% of firms likely to be exporters**
- **More recent data from 2002 US Census of Manufactures confirms this (see table)**

## Exporting By U.S. Manufacturing Firms, 2002

| *NAICS industry* | *Percent of firms* | *Percent of firms that export* | *Mean exports as a percent of total shipments* |
|---|---|---|---|
| 311 Food Manufacturing | 6.8 | 12 | 15 |
| 312 Beverage and Tobacco Product | 0.7 | 23 | 7 |
| 313 Textile Mills | 1.0 | 25 | 13 |
| 314 Textile Product Mills | 1.9 | 12 | 12 |
| 315 Apparel Manufacturing | 3.2 | 8 | 14 |
| 316 Leather and Allied Product | 0.4 | 24 | 13 |
| 321 Wood Product Manufacturing | 5.5 | 8 | 19 |
| 322 Paper Manufacturing | 1.4 | 24 | 9 |
| 323 Printing and Related Support | 11.9 | 5 | 14 |
| 324 Petroleum and Coal Products | 0.4 | 18 | 12 |
| 325 Chemical Manufacturing | 3.1 | 36 | 14 |
| 326 Plastics and Rubber Products | 4.4 | 28 | 10 |
| 327 Nonmetallic Mineral Product | 4.0 | 9 | 12 |
| 331 Primary Metal Manufacturing | 1.5 | 30 | 10 |
| 332 Fabricated Metal Product | 19.9 | 14 | 12 |
| 333 Machinery Manufacturing | 9.0 | 33 | 16 |
| 334 Computer and Electronic Product | 4.5 | 38 | 21 |
| 335 Electrical Equipment, Appliance | 1.7 | 38 | 13 |
| 336 Transportation Equipment | 3.4 | 28 | 13 |
| 337 Furniture and Related Product | 6.4 | 7 | 10 |
| 339 Miscellaneous Manufacturing | 9.1 | 2 | 15 |
| **Aggregate manufacturing** | **100** | **18** | **14** |

*Sources:* Data are from the 2002 U.S. Census of Manufactures.

## Trade and Firms

- Overall share of US manufacturing firms that export relatively small at 18%
- Share of firms exporting in each industry category varies widely, e.g., 38% in computers and electronic products, 23% in beverage and food products, to 8% in apparel manufacturing
- Exporters ship relatively small share of total shipments overseas, share across firms being 14%
- Again wide variation across industries, e.g., 21% in computers and electronic products, to 7% in beverage and tobacco products

# Firms and Trade Theory

- **Observation that, exporting more likely by skill-intensive as opposed to labor-intensive US firms, fits traditional model of trade**
- **Traditional model cannot explain why some firms export and others produce only for domestic market, and firms symmetric in new trade models**
- **In US, exporting firms found to be larger, more skill and capital-intensive, and pay higher wages than non-exporters (Bernard *et al*., 2007)**
- **US MNCs enjoy 15% productivity advantage over exporting firms, who in turn have 39% advantage over domestic-only suppliers (Helpman *et al*., 2004)**

# Firms and Trade Theory

- **Two key hypotheses proposed to explain higher productivity of exporters:**
  - **exporting requires extra resources in terms of transportation, distribution and marketing costs, workers with foreign managerial skills, and modification of products for export – impose a barrier only more productive firms can bear**
  - **firms can improve productivity by capturing knowledge and technical spillovers from participation in international markets, i.e., *learning by doing* effect**

# Firms and Trade Theory

- **Role of fixed entry costs also important in both export and FDI-decisions**
- **Allowing for heterogeneous firms brings two new insights into trade models:**
  - **differences in productivity *within* industries matter**
  - **resource allocation happens within industries after trade liberalization, i.e., number of firms and volume of exports can change – *extensive* and *intensive* margins**
- **How is this captured in a simple model? Focus on Helpman *et al*. (2004)**

# Theoretical Framework

- $N$ countries that use labor to produce goods in $H$+1 sectors; one sector produces homogeneous good with a unit of labor per unit of output; $H$ sectors produce differentiated goods, $h$=1…$H$
- $\beta_h$ of income spent on $h$, remaining fraction $1-\Sigma_h\beta_h$ spent on homogeneous good which is *numeraire*
- Country $i$ endowed with $L^i$ units of labor, wage rate is $w^i$
- Consider a particular sector $h$, and drop $h$ notation

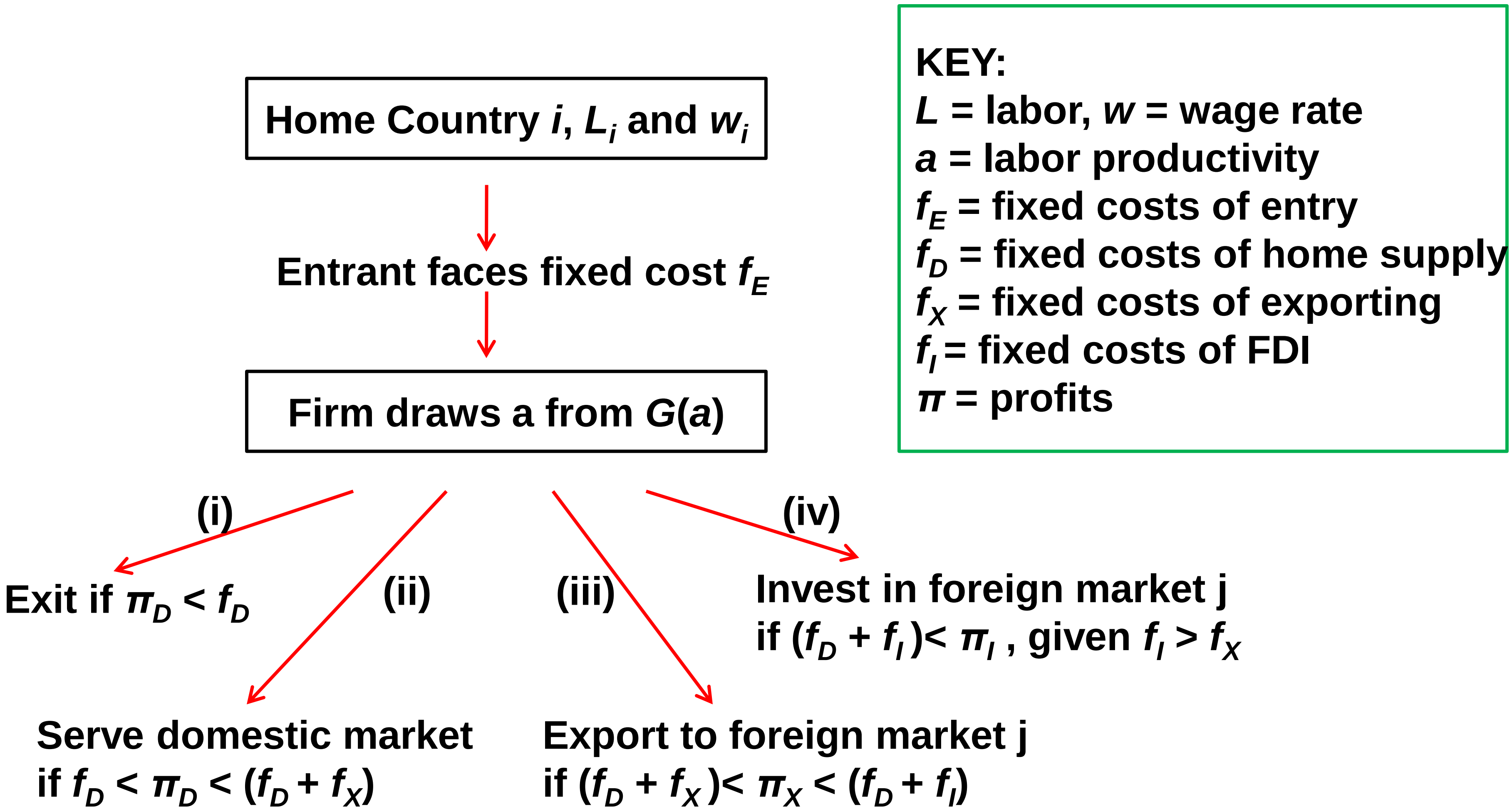
# Theoretical Framework

- **Only factor of production is labor $L$, and to enter an industry, firms incur a fixed cost, $f_E$**
- **Upon entry, firms draw labor productivity coefficient $a$ (labor per unit output) from distribution $G(a)$**
- **With given $a$, firms in country $i$ have four choices (see Figure 1):**
  - **Exit domestic market**
  - **Serve domestic market only**
  - **Export**
  - **Set up foreign production (*horizontal* FDI)**

# Theoretical Framework

- If a firm chooses to produce for domestic market, bears fixed overhead labor costs $f_D$
- If firm chooses to export, it bears additional fixed costs $f_X$ per foreign market, where $f_X$ are costs of forming distribution and servicing network in foreign country
- If firm chooses FDI, it bears $f_I$ in every foreign market, which include costs of forming subsidiary in each country, and duplicating $f_D$
- Goods transported from $i$ to $j$ subject to iceberg transport costs of $\tau^{ij} > 1$

# Figure 1: Firm Choices



# Theoretical Framework

- Firms engage in *monopolistic competition*
- Preferences across varieties of *h* modeled as CES utility with elasticity of substitution $\varepsilon = 1/(1-\alpha) > 1$
- These preferences generate demand function in *i* for every brand, $A^i p^{-\varepsilon}$, where demand level $A^i$ is treated as exogenous by individual firm
- Brand of monopolistic firm with labor coefficient *a*, offered at price $p = w^i a/\alpha$, where $1/\alpha$ is mark-up
- Effective domestic price is $w^i a/\alpha$, supplied by domestic firm or foreign affiliate, and if good is imported, effective price is $\tau^{ji} w^j a / \alpha$

# Theoretical Framework

- **Firm in country *i* that remains in industry always serves domestic market through domestic production, but it may also serve market *j* via exporting or FDI**
- **Choice driven by proximity-concentration trade-off: relative to exports, FDI saves transport costs, but duplicates production facilities, i.e., higher fixed costs**
- **In equilibrium no firm engages in both exports and FDI in a foreign market, assume:**

$$\left(\frac{w^j}{w^i}\right)^{\varepsilon-1} f_I > \left(\tau^{ij}\right)^{\varepsilon-1} f_X > f_D \qquad (1)$$

# Theoretical Framework

- **Assume unit wages $w^i = 1$, operating profits for a firm serving domestic market are:**

$$\pi_D^i = a^{1-\varepsilon} B^i - f_D \qquad (2)$$

**for a firm with productivity coefficient *a*, and also $B^i = (1-\alpha)A^i/\alpha^{1-\varepsilon}$, where $B^i$ is demand level in *i***

**Additional profits from exporting to country j are:**

$$\pi_X^{ij} = (\tau^{ij} a)^{1-\varepsilon} B^j - f_X \qquad (3)$$

- **Profits from FDI in *j* are:**

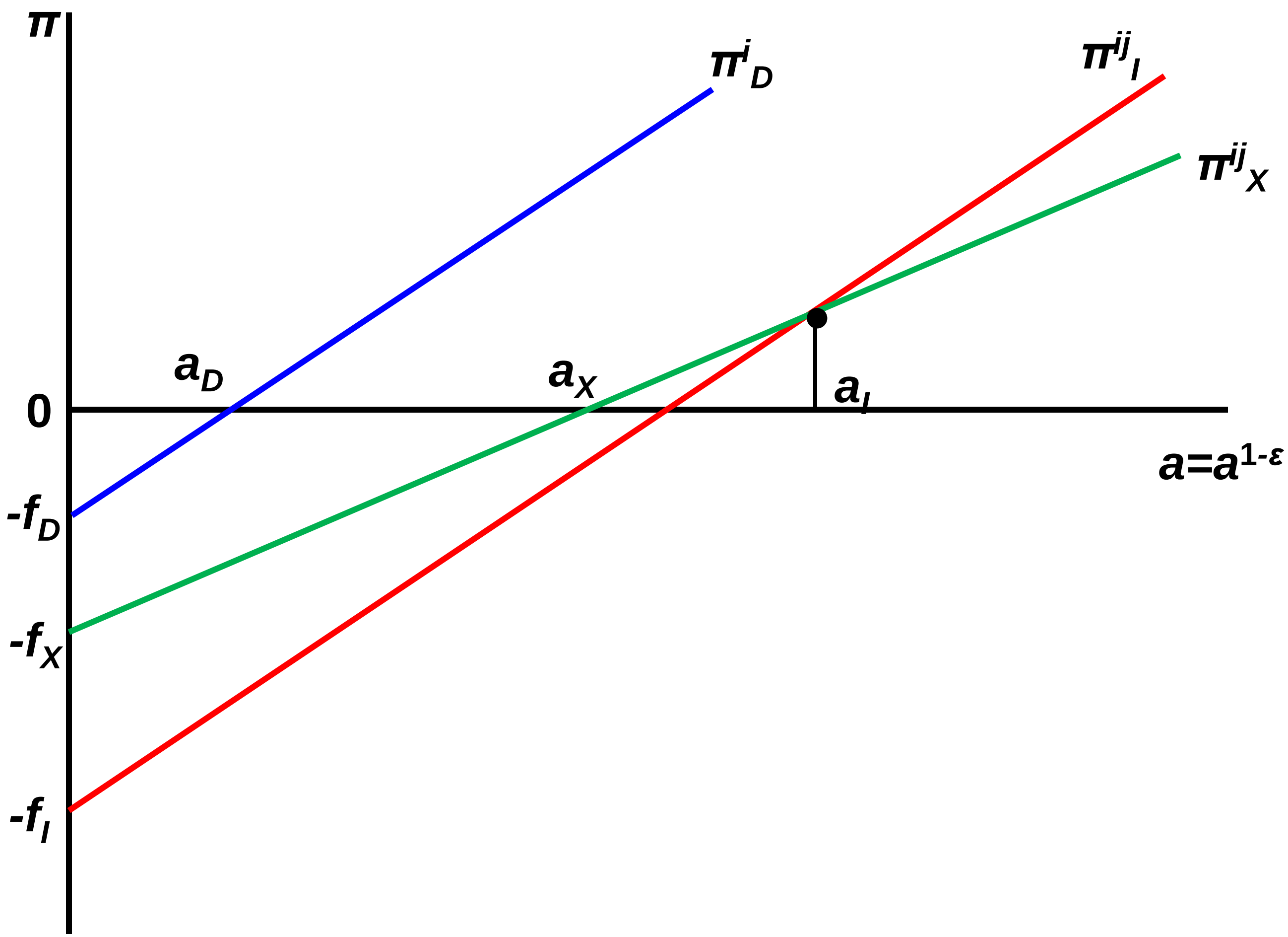
$$\pi_I^j = a^{1-\varepsilon} B^j - f_I \qquad (4)$$

- **Profit functions are increasing and linear: more productive firms are profitable in all three activities**

# Theoretical Framework

- **In Figure 2, along horizontal axis, firm productivity (*a*=*a*$^{1-\varepsilon}$) increases, while profits *π* are measured on vertical axis**
- **Domestic and FDI profit functions have same slope, as countries *i* and *j* are assumed to be same in terms of demand, labor endowment and wages, $B^i=B^j$**
- **Profits from exporting scaled by existence of trade costs *t*, so slope of export profit function is shallower**
- **Sorting pattern of firms is consistent with empirical evidence (Helpman *et al*., 2004)**

# Figure 2: Profits from Domestic Sales, Exports and FDI



# Theoretical Framework

- **Least productive firms exit industry, i.e., all firms with productivity $a < (a^i_D)^{1-\varepsilon}$**
- **Firms with $(a^i_D)^{1-\varepsilon} < a < (a^{ij}_X)^{1-\varepsilon}$ profitably operate in domestic market but are not productive enough to export or undertake FDI**
- **Firms with $(a^{ij}_X)^{1-\varepsilon} < a < (a^{ij}_I)^{1-\varepsilon}$ export, while those with higher productivity levels of $a > (a^{ij}_I)^{1-\varepsilon}$ build subsidiaries in $j$**
- **Cutoff coefficients in Figure 2 are:**

$$a_D = (a^i_D)^{1-\varepsilon} B^i = f_D, \forall_i, \quad (5)$$

$$a_X = (\tau^{ij} a^{ij}_X)^{1-\varepsilon} B^j = f_X, \forall_j \neq i, \quad (6)$$

$$a_I = [1-\tau^{ij}]^{1-\varepsilon} (a^{ij}_X)^{1-\varepsilon} B^j = f_X, \forall_j \neq i \quad (7)$$

# Exports vs. FDI

- Let $s^{ij}_X$ be market share in *j* of *i*'s exporters, and $s^{ij}_I$ is market share in *j* of affiliates of *i*'s multinationals

- Relative size of market shares is:

$$\frac{s_X^{ij}}{s_I^{ij}} = \tau^{1-\varepsilon}\left[\frac{V(a_X)}{V(a_I)} - 1\right] \qquad (8)$$

In the symmetric country case:

$$V(a) = \int_0^a y^{1-\varepsilon} dG(y) \qquad (9)$$

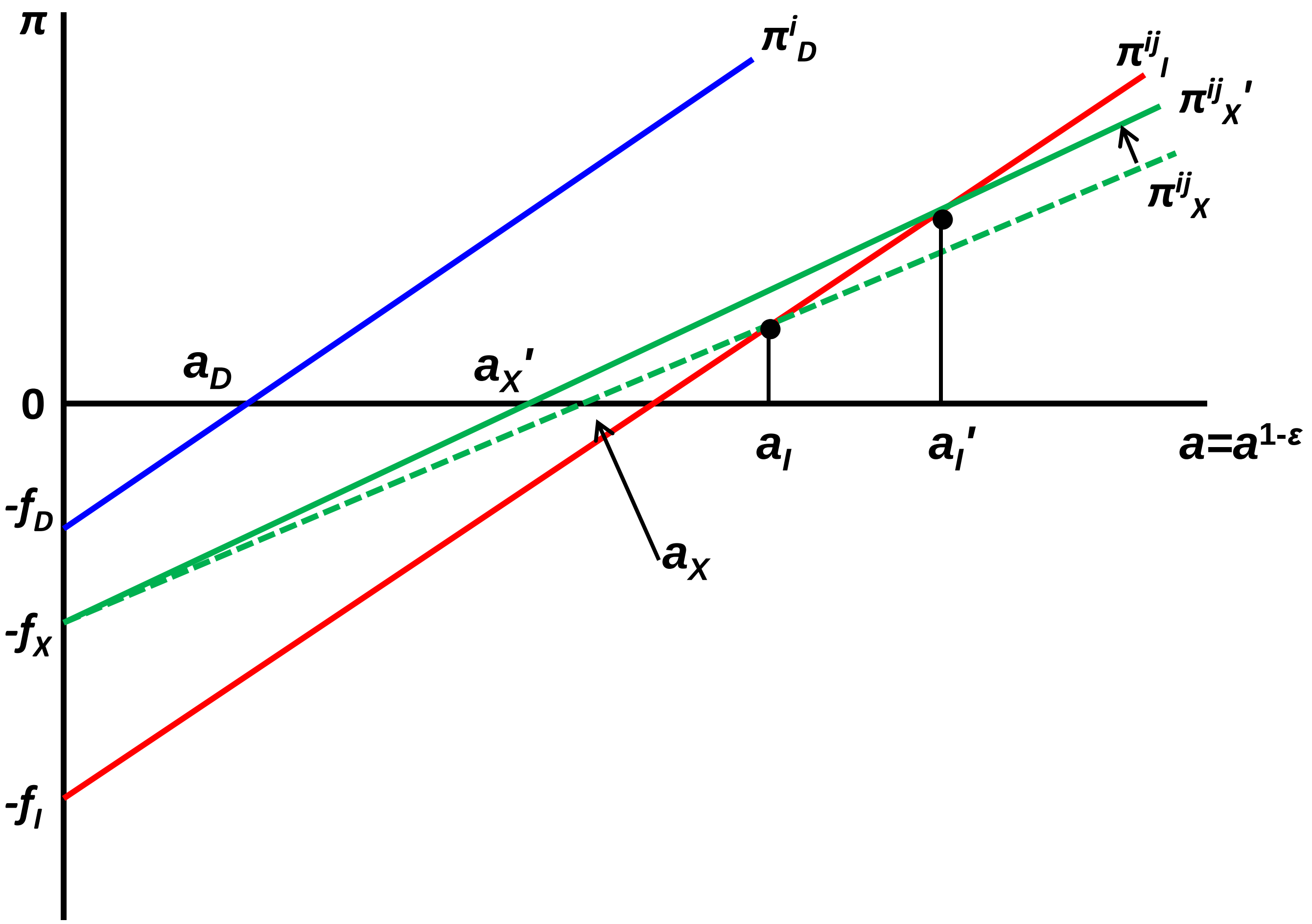
Ratio rises with $a_X$ and falls with $a_I$

Hence, rise in $f_X$ or $\tau$, or decrease in $f_I$, induce increase in $a_I$ and decrease in $a_X$ – relative sales of exporters decrease

# Firms and Trade Liberalization

- **Suppose productivity pattern same as in Figure 2**
- **If trade liberalization is fall in $\tau$, raises profits of existing exporters, and lowers their productivity cutoff (Figure 3)**
- **Firms previously only supplying domestic market may become exporters (extensive margin), and volume of exports also increases (intensive margin)**
- **Labor demand increases due to increase in both exports and number of firms exporting – wages bid up, reducing profits of non-exporting firms**

# Figure 3: Trade Liberalization



# Firms and Trade Liberalization

- **Higher average industry productivity due to turnover of firms from domestic to export markets (Melitz, 2003; Bernard *et al*., 2007)**
- **Even though there are within industry gains, the gains are greater in any industry that has stronger comparative advantage – i.e., greater export opportunities intensify impact on wages, driving out more low-productivity firms**
- **Differential productivity growth across industries magnifies factor-abundance-based gains from trade**

# Conclusions

- **Role of firms in traditional and new trade models limited – Ricardian/Heckscher-Ohlin models focus on industries, while monopolistic competition model of Krugman assumes identical firms**

- **Empirical evidence indicates firms differ across and within industries of a country in multiple dimensions such as productivity**

- **Implies comparative advantage (disadvantage) does not mean all firms in an industry export (import)**

- **Additional gains from trade from increased within-industry productivity is critical**

## Motivation (Kugler and Verhoogen, 2012)

- **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 as R&D**
- **Raising/maintaining product quality recognized as important in both domestic and international markets**

## Motivation

- **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**

## Motivation

- **Melitz (2003) and others assume a single input, labor, which is homogeneous**
- **Kugler and Verhoogen extend Melitz (2003) to include endogenous choice of input and output quality – assuming two different specifications of production function for quality**
- **Model yields equilibrium where more capable entrepreneurs purchase higher-quality inputs to produce higher-quality outputs**
- **Basic model assumes two symmetric countries, and in each, there is a monopolistically competitive final-good sector and a competitive, constant-returns-to-scale input sector**

# Model

- **Representative consumer has CES utility:**

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

**$\omega$ indexes product varieties; $\Omega$ is set of all available varieties; $\sigma$ is elasticity of substitution; $x(\omega)$ is quantity consumed; $q(\omega)$ is observable quality**

**Demand for each variety is:**

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

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

# Model

- **Assume inelastic supply of labor *L*, measured in labor-hours, with hourly wage normalized to one**

**Add intermediate input sector that transforms homogeneous labor hours $\ell$ into intermediate inputs that vary in quality *c*, production function being:**

$$F_{\mathrm{I}}(\ell, c) = \frac{\ell}{c} \qquad (3)$$

**i.e., producing one unit of intermediate good of quality *c* requires *c* labor hours, entailing cost of *c***

**Final goods producers assumed price takers in intermediate market, hence prices equal to marginal cost, $p_{\mathrm{I}}(c) = c$, with linear relationship between quality of intermediate and its price**

# Model

- In order to enter final goods sector, firms pay investment cost, $f_e$ which gets them capability draw $\lambda$

Capability draw from Pareto distribution with c.d.f. of

$$G(\lambda) = 1 - \left(\frac{\lambda_m}{\lambda}\right)^k \quad \text{with} \quad 0 < \lambda_m \leq \lambda$$

There is exogenous probability of exit of $\delta$ – 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, $\lambda$ indexing plants/varieties

# Model

- **Final goods production assumed to be:**

$$F(n) = n\lambda^{a} \qquad (4)$$

**$n$ = 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 $\lambda$, 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:**

$$\pi(p_O, c, f_q, Z, \lambda) = \left(\frac{p_I(c)}{\lambda^{a}}\right)x - f_q - f + Z\left[\left(\frac{p_I(c)}{\lambda^{a}}\right)x - f_x\right] \qquad (5)$$

# Complementarity of Input Quality-Plant Capability

- $\lambda$ and $c$ are complements in generating quality:

$$q = \left[ \frac{1}{2}(\lambda^b)^\theta + \frac{1}{2}(c^2)^\theta \right]^{\frac{1}{\theta}} \qquad (6)$$

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

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:**

$$q = \min(f_q^{\alpha}, c^2) \qquad (7)$$

**$\alpha \geq 0$ reflects extent to which quality increases with fixed quality investment – Sutton's (1998) "escalation parameter"; $\alpha$ 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 $\lambda^* < \lambda_x^*$**

# Comparison of Approaches

- **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**

# Example: Quality Production Variant 1

- 1985-2000 observed Mexico experienced expanding trade and rising wage inequality
- Puzzling from standpoint of Heckscher-Ohlin model: wage inequality should have fallen as Mexican production shifted towards unskilled-labor-intensive industries, raising unskilled wages
- Verhoogen (2008) assumes consumers differ in terms of income, and hence willingness to pay for quality, i.e., poor country produces higher-quality goods for export
- Producing higher-quality goods assumed to require higher-quality workers who have to be paid higher wages (Kremer, 1993)

# Example: Quality Production Variant 1

- Increase in incentive to export in developing country generates differential quality upgrading, such that more productive plants:
  - increase exports
  - produce higher share of high-quality goods
  - raise wages relative to initially less productive plants
- As initially more productive plants also pay higher wages initially, trade increases within-industry wage dispersion
- Verhoogen (2008) uses 1994/95 Mexican peso devaluation to investigate mechanism

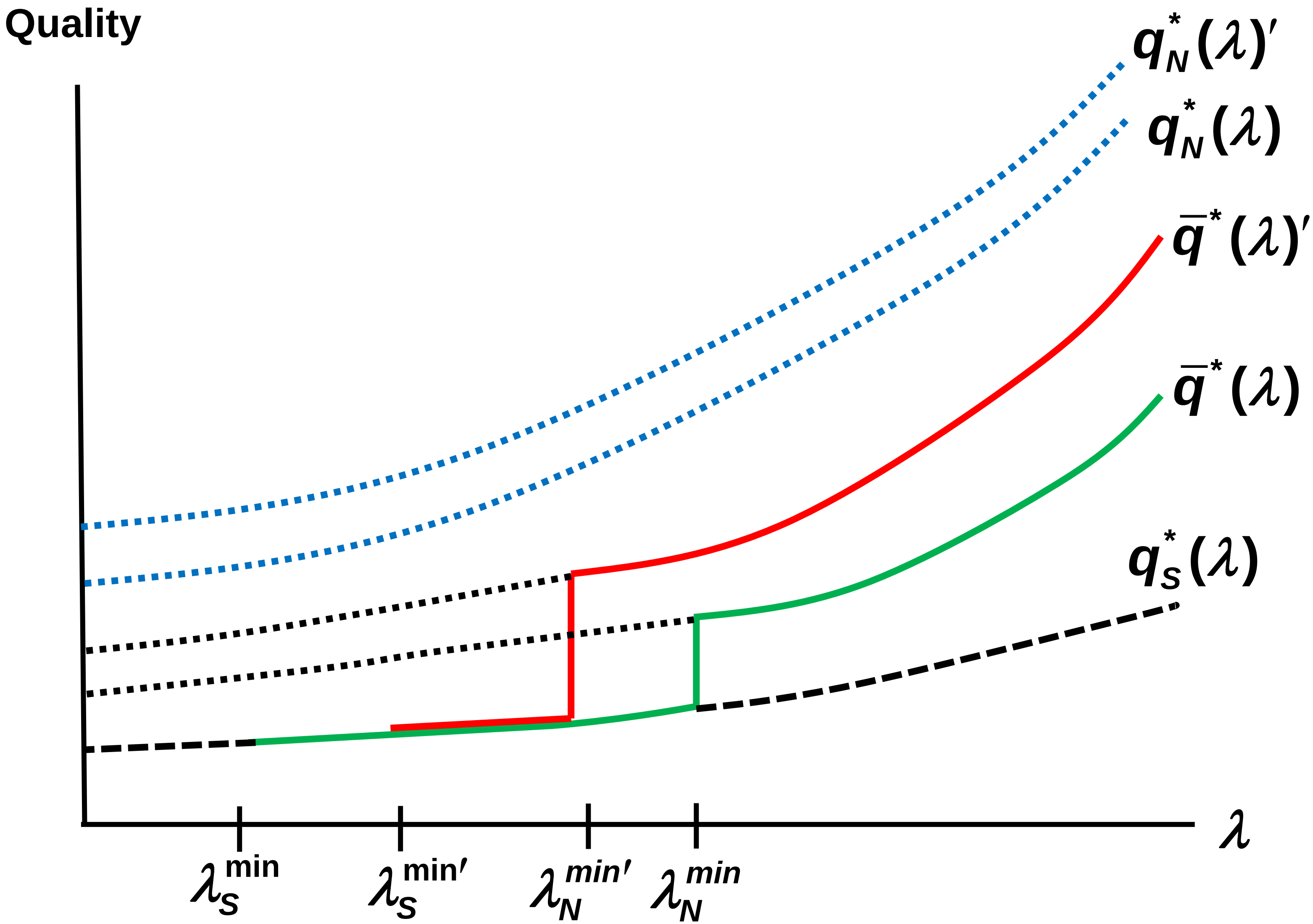
# Mexican Peso Devaluation

- Peso devaluation resulted in contraction of Mexican GDP, and average wage of male Mexican workers with 9 years of education fell from US$1.50/hour to US$0.90/hour
- Larger shock to Mexican economy than NAFTA – latter was commitment to program of liberalization begun in mid-1980s
- How did firms respond to peso crisis? Example: Volkswagen plant in Puebla started exporting higher share of production (increase in exports and decline in domestic sales), and share of higher quality varieties (Jetta and New Beetle) in production increased

# Effects on Volkswagen Production

- **Production technology for New Beetle and Jetta state-of-art compared to Original Beetle – plant opened in 1964 based on 1950s German technology**
- **Technological upgrading occurred due to greater use of available newer technology**
- **Demand for *especialistas* (skilled workers with starting wage of US$18/day) relative to *técnicos* (low-skilled workers with starting wage of US$11/day) rose with shift in product mix**
- **Volkswagen example seems to generalize: increase in exports to US accompanied by increase in average quality and upgrading of workforce in exporting plants**

# Response to Exchange Rate Devaluation



## Response to Exchange Rate Devaluation

- **If all plants enter all markets, average quality is given by $\bar{q}^*(\lambda)$, based on weighted average of domestic and export production, $q_S^*(\lambda)$ and $q_N^*(\lambda)$, with weights given by export share of output of each plant**
- **Only plants with $\lambda > \lambda_N^{\min}$ enter export market, solid green curve showing average quality as a function of $\lambda$**
- **Devaluation has two effects: an increase in the real exchange rate and a decline in number of domestic consumers**
- **Quality on domestic production line $q_S^*(\lambda)$ does not change**

# Response to Exchange Rate Devaluation

- **Quality on export production line increases to $q_N^*(\lambda)'$ - currency devaluation reduces cost of developing country plants' costs relative to developed country demand**
- **Average quality line shifts up to red curve $\bar{q}^*(\lambda)'$ , both because curve shifts up, but also because export share of output increases – cutoff value for exporting also decreases to $\lambda_N^{min'}$**
- **Plants that switch into exporting see large increase in average quality, i.e., $\lambda_N^{min'}$ to $\lambda_N^{min}$**
- **Wages raised in plants that switch to exporting, relative to less-productive plants**