“Measurable Dimensions of Product Differentiation in International Trade”

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“Measurable Dimensions”

- Recent work in IO provides techniques for richly describing product space
- Unfortunately, these techniques require highly detailed data on product characteristics
- Trade data are much more sparse. At best, one can find $p$, $q$, for each bilateral partner

- Question: can we find ways to characterize product space without product characteristics?
What distinguishes major models?

• How are goods differentiated?
  – Horizontal (type) v. vertical (quality)

  – Evidence: vertical IIT (many); within-sector price differences (Schott, Hallak); quality as a demand residual (Hummels-Klenow)

• Who does the differentiation?
  – Firms (Krugman) v. Countries (Armington)

  – Evidence: variety expansion (Hummels-Klenow); home market effects (Head-Ries)
## Armington, Krugman v. Facts

<table>
<thead>
<tr>
<th>Variable</th>
<th>Armington</th>
<th>Krugman</th>
<th>Facts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Varieties</strong></td>
<td>Constant</td>
<td>Proportional to the market size</td>
<td>a 1% ?in GDP ? 0.5% ?in varieties, 0.5% ?output per variety (HK, 2004)</td>
</tr>
<tr>
<td><strong>Output per Variety</strong></td>
<td>Proportional to Market Size</td>
<td>Constant</td>
<td></td>
</tr>
<tr>
<td><strong>Cross-Importer Prices</strong></td>
<td>Same for all markets</td>
<td>Same for all markets</td>
<td>PTM: prices vary across destinations</td>
</tr>
<tr>
<td><strong>Price Elasticity of Demand</strong></td>
<td>Constant</td>
<td>Constant</td>
<td>No direct evidence</td>
</tr>
</tbody>
</table>
How do consumers value differentiation?

Dixit-Stiglitz, 1977 “love of variety” approach

– Representative consumer demands all varieties
– Marginal utility of new varieties doesn’t decline with entry.
– Product space never “fills up”

Lancaster, 1979 “ideal variety” approach

– Each consumer has strong preference for one (“ideal”) variety
– Product space is finite (circle) and fills up. MU of new varieties declines with entry.
A generalized ideal variety model

• The model generates predictions regarding quantities and number of varieties, which provide a better fit to empirical facts than “love of variety” models.

• We show theoretically that the price elasticity of demand (and therefore prices) vary systematically across importers:
  – Elasticity increases with market size
  – Elasticity decreases with productivity level

• Key empirical question: does variety space “fill up”, i.e. do goods become closer substitutes as the number of varieties grows.
Closed Economy

- Utility: \( U = q_0^{1-\mu} \left[ u(q_\omega) \right]_{\omega \in \Omega}^\mu \)

\( q_0 \) is a normalized homogeneous good produced with CRS
\( q \) is a differentiated product indexed by a continuum of varieties \( \omega \in \Omega \)

- Subutility

\[ u(q_\omega) = \frac{q_\omega}{h(q_\omega, v_\omega, \omega)} \]
Lancaster compensation function

• Assumes strength of preference for ideal variety is independent of quantities consumed

• Example:
  – Consumer chooses between his ideal variety (Apple Juice) and less preferred variety (water)

  – Price(AJ) = 5 Price(Water)

  – If consumer chooses 5 cups of water over 1 cup of AJ; he will also choose 5 gallons of water over 1 gallon of AJ
Generalized Ideal Variety Model

- Allows the strength of preference for the ideal variety to depend on quantities consumed
  - as consumption volume rises, consumers place greater value on the proximity to their ideal variety

<table>
<thead>
<tr>
<th>Lancaster</th>
<th>Generalized</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h(v) = 1 + v^\beta$</td>
<td>$h(v, q) = 1 + v^\beta q^\gamma$</td>
</tr>
<tr>
<td>$\beta &gt; 1, \ 0 \leq \gamma \leq 1$</td>
<td></td>
</tr>
</tbody>
</table>
Willingness to pay for 1 unit of $w\%$ in terms of $\omega$

Generalized compensation functions

$\gamma_2 > \gamma_1$

$\gamma_1 > 0$

Lancaster compensation function

$\gamma_0 = 0$

Figure 1. Lancaster and generalized compensation functions.
Predictions for Equilibrium Variables

- Prices:
  \[ p = c \frac{\varepsilon}{\varepsilon - 1} \]

- Quantity per variety
  \[ Q = \frac{\alpha}{c} (\varepsilon - 1) \]

- Number of varieties
  \[ n = \frac{\mu z L}{\alpha \varepsilon} \]
Equilibrium Intuition

• As economy grows larger, variety space fills up, varieties become closer substitutes ? price elasticity rises.

• As economy grows richer (cond on size), willingness to pay for ideal variety rises ? price elasticity falls.

Note: in this case, higher income alters consumer perceptions of variety space
Equilibrium Price Elasticity of Demand

\[ \varepsilon = 1 + \frac{1}{2\beta} \left( \frac{p}{\mu z} \right)^\gamma (2n)^\beta + \frac{1-\gamma}{2\beta} \]

<table>
<thead>
<tr>
<th></th>
<th>DS</th>
<th>Lancaster</th>
<th>Generalized</th>
<th>Empirical facts</th>
</tr>
</thead>
<tbody>
<tr>
<td>(?e/?L)</td>
<td>0</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>(?e/?z)_{zL=Const}</td>
<td>0</td>
<td>0</td>
<td>?</td>
<td>?</td>
</tr>
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</table>
Intuition (2)

• Sign predictions for prices are inverse of price elasticity
• Implies: output per variety must rise in order to cover fixed costs of entry.

• Implies: number of varieties increases with market size, but less than proportionally.
Equilibrium Quantity per Variety

\[ Q = \frac{\alpha}{c} (\varepsilon - 1) \]

<table>
<thead>
<tr>
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<th>Empirical facts (HK, 2004)</th>
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</thead>
<tbody>
<tr>
<td>( \frac{\partial Q}{\partial L} )</td>
<td>0</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>( \frac{\partial Q}{\partial z} \bigg</td>
<td>_{zL=\text{Const}} )</td>
<td>0</td>
<td>0</td>
<td>?</td>
</tr>
</tbody>
</table>
Equilibrium Number of Varieties

\[ n = \frac{\mu zL}{\alpha \varepsilon} \]

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<tr>
<td>( \frac{n}{\varepsilon} )</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>proportionally</td>
<td>Less than proportionally</td>
<td>Less than proportionally</td>
<td>Less than proportionally</td>
</tr>
<tr>
<td>( \frac{n}{\varepsilon} \mid _{zL=\text{Const}} )</td>
<td>0</td>
<td>0</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td></td>
<td>Less than proportionally</td>
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Empirical Exercise

• We know from existing empirical literature that generalized ideal variety framework matches predictions on how varieties, output per variety expand with size, income.

• Can we find direct evidence that
  – variety space fills up, i.e. larger markets have higher price elasticity of demand
  – perceptions of variety space vary by income; richer markets have lower price elasticity of demand
Data

- UNCTAD TRAINS database: 59 importers; all exporters worldwide

- Bilateral trade value, tariff measured at 6 digit level of the Harmonized Classification System (5000+ categories) in 1999

- GDP, GDP per capita from WDI
Estimating Technique

• Estimate commodity-level import demand as a function of relative prices
  – All variables are differenced with respect to their exporter x commodity means; takes out exporter size, quality effects.
  – Price variation comes from bilateral variation in tariff rates in cross-section
  – If price elasticity is constant, it is given by the coefficient on price (tariff)

• Interact tariffs with Y, Y/L to see if elasticity varies across importer characteristics
### Fixed Effect Estimates of Import Demand

\[ \ln M_{ijk} = \delta_{jk} + b_0 + b_1 \ln tar_{ijk} + b_2 \ln Y_i + b_3 \ln \left( \frac{Y}{L} \right)_i \]
\[ + b_4 \ln tar_{ijk} \ln Y_i + b_5 \ln tar_{ijk} \ln \left( \frac{Y}{L} \right)_i + e_{ijk} \]

<table>
<thead>
<tr>
<th>Dependent variable: ( \ln(\text{import}) )</th>
<th>Tariff rate ( t_{ijk} )</th>
<th>GDP (importer) ( Y_i )</th>
<th>GDP per capita (importer) ( \left( \frac{Y}{L} \right)_i )</th>
<th>GDP and tariff interaction term ( Y_i \times \text{tar}_{ijk} )</th>
<th>GDP per capita and tariff interaction term ( \left( \frac{Y}{L} \right)<em>i \times \text{tar}</em>{ijk} )</th>
<th>( R^2 )</th>
<th>Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>coeff (se)</td>
<td>13.2** (.29)</td>
<td>.45** (.001)</td>
<td>-.08** (.002)</td>
<td>-.68** (.001)</td>
<td>.35** (.002)</td>
<td>.16</td>
<td>986,756</td>
</tr>
</tbody>
</table>

Estimated price elasticity of demand (evaluated at means) = -1.43
Industry Regressions: Distribution of the Interaction Terms

GDP (by value)

GDP Per Capita (by value)

GDP (by count)

GDP Per Capita (by count)
Both interaction terms are significant + correct signs

30 industries, 56% of the total value of trade
Price Elasticity of Demand (at GDP means)

HS 2 categories ordered by the average elasticity
Price Elasticity of Demand (selected industries)

22 industries
50% of the value of trade

10th percentile
Average
90th percentile

HS 2 categories ordered by the average elasticity
Conclusions

- Love of variety models incorrectly predict variation in:
  - Prices
  - Import per variety
  - Number of imported varieties
- We generalize ideal variety framework to match existing empirical facts regarding:
  - Import per variety
  - Number of imported varieties
- New facts (matching ideal variety theory):
  - (Absolute value of) price elasticity of demand *increases* with importer GDP and *decreases* with importer income per capita.

? Variety space fills up.