Spatial Price Discrimination in International Markets: from Models to Data

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Lunch Seminar, PSE, January 19th 2009
Plan

1. Introduction
2. Theory
   - Transport costs
   - Prices and distance (general case)
   - Prices and distance (CES case)
3. Strategy and data
   - Strategy
   - Database
4. Results
   - Pooled sample
   - Results by firm and product
5. Alternative explanations
6. Conclusion
At the product level, fob unit values increase with the distance. [Baldwin & Ito (2008), Mayer & Ottaviano (2008), Hummels & Klenow (2002), Schott (2004)]

Existing models failed to predict this positive relationship.

Theoretical explanation: quality composition effects. [Baldwin & Harrigan (2007), Hummels & Skiba (2002)]

What happens at the firm level? i.e. How does the distance impact fob trade prices?

Theory: all is possible so which are the key determinants?

Empirically: we don’t know, so what about French exporters.
About firm pricing policy and distance

- Spatial price discrimination: a well known behavior.
- International markets: countries are segmented and distance matters.
- fob data to get rid of country specific retail margins or taxes.

Strategies:
- Mill pricing (constant fob price)
- Dumping (fob price decreases with the distance)
- Reverse dumping (fob price increases with the distance)
Contributions and Results

- Pricing policy (theory) : formulation of transport costs matters.
- Pricing policy (empiric) : evidence from French exporters. ⇒ **Reverse Dumping** (prices increase with the distance)
- Pricing policy (back to theory) : existing models fail to predict this relationship, even when introducing quality.
- Pricing policy (back to theory) : we need an additive part in the trade costs. ⇒ **bad news for the iceberg cost.**
IO: mill pricing, dumping and reverse dumping might appear. All depend on the preferences. [Hoover (1937)]

Trade: dumping in a few (but important) models. [Brander & Krugman (1983), Melitz Ottaviano (2008)]

Trade: mill pricing because CES and iceberg trade costs are more tractable. [Krugman (1980), Melitz (2003)]

IO: Reverse dumping is possible! [Greenhut et al. (1985)]
Trade: iceberg vs additive transport costs [Samuelson (1954), Hummels & Klenow (2002)]
"this is a major simplifying assumption" (Krugman, 1980)
Empiric IO: spatial price discrimination is common practice [Greenhut (1981)]

Pricing policy? what about quality?
[Hallak & Sivadasan (2008), Verhoogen (2008)]
What I do

- Study iceberg, additive and 'mixed' trade costs.
- Derive the elasticity of price to distance depending on (i) the form of the preferences, (ii) the formulation of trade costs.
- Use firm level data to evaluate the role of distance on prices. (pooled sample and individual regressions)
- Discuss an alternative explanation: prices increase with the distance since quality increases with the distance.
What I don’t do

- Model firm heterogeneity
- Model a transport sector
- Structural estimation
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   - Prices and distance (CES case)
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   - Strategy
   - Database
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Iceberg transport cost

- Samuelson (1954) "as only a fraction of ice exported reaches its destination", only a fraction of the exported good reaches its destination.

\[ p_{ij}^{cif} = \tau_{ij} p_{ij}^{fob} , \quad \tau \geq 1 \]

- Drawbacks: i) technology ii) proportional to the price:

\[ p_{cif} - p_{fob} = (\tau_{ij} - 1)p_{fob} \]

- Bottazzi & Ottaviano (1996): "we wonder whether the passive devotion to the iceberg approach is covering some of the most relevant issues that arise when trying to think realistically about the liberalization of world trade"
Alternative trade costs

- Additive trade costs: Independent of the price, used with quasi linear demand

\[ p_{ij}^{cif} = p_{ij}^{fob} + f_{ij} \]

- 'Mixed' trade costs:

\[ p_{ij}^{cif} = p_{ij}^{fob} \tau_{ij} + f_{ij} \]

\[ p_{ij}^{fob} = \frac{p_{ij}^{cif} - f_{ij}}{\tau_{ij}} \]
Distance and transport costs

- Distance is highly correlated with the transport costs (Lafourcade, 2006)
- Assumptions: $f$ and $\tau$ two differentiable and increasing functions of the distances:
  
  $f : \mathbb{R}_+ \rightarrow \mathbb{R}_+$
  
  $\text{dist} \rightarrow f(\text{dist})$
  
  $\tau : \mathbb{R}_+ \rightarrow [1, \infty[$
  
  $\text{dist} \rightarrow \tau(\text{dist})$

- $\tau$ and $f$ are exogenous (for the producer).
Production side

- **Profit function**

\[
\pi_{ij} = \left[ p_{ij}^{fob} - w \right] q_{ij} \\
\rightarrow \pi_{ij} = \left[ \frac{p_{ij}^{cif} - f_{ij}}{\tau_{ij}} - w \right] q_{ij} \\
\Rightarrow p_{ij}^{cif} = \frac{\epsilon}{\epsilon - 1} [f_{ij} + w\tau_{ij}] \\
\Rightarrow p_{ij}^{fob} = \left( \frac{1}{\epsilon^{cif} - 1} \right) \frac{f_{ij}}{\tau_{ij}} + \left( \frac{\epsilon^{cif}}{\epsilon^{cif} - 1} \right) w
\]

- \( \epsilon \) is the elasticity of demand to \( cif \) price.
Elasticity of price to distance

\[
\frac{\partial \log(p_{fob})}{\partial \log(dist)} = \text{elasticity of trade costs to distance} - \left[ \frac{\partial \log(f)}{\partial \log(dist)} - \frac{\partial \log(\tau)}{\partial \log(dist)} \right] \left[ 1 + \frac{\tau}{f \epsilon c} \right] - \left( \frac{\partial \log(\epsilon)}{\partial \log(dist)} \right) \left( \frac{\epsilon}{\epsilon - 1} \right) \left( \frac{1}{\frac{f}{\tau} + \epsilon c} \right) \left( \frac{f}{\tau} + c \right)
\]
### CES and Quadratic utility functions

<table>
<thead>
<tr>
<th>Utility function</th>
<th>Trade costs</th>
<th>( f_{ob} ) Price</th>
<th>elasticity</th>
<th>sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>CES</td>
<td>iceberg</td>
<td>( \frac{\sigma}{\sigma-1} w )</td>
<td>0</td>
<td>nil</td>
</tr>
<tr>
<td>CES</td>
<td>additive</td>
<td>( f_{ij} \frac{1}{\sigma-1} + \frac{\sigma}{\sigma-1} w )</td>
<td>( \frac{f_{ij}}{p_{ij}^{fob}} \frac{1}{\sigma-1} )</td>
<td>+</td>
</tr>
<tr>
<td>Quadratic</td>
<td>iceberg</td>
<td>( \frac{a+cP_j}{2\tau_{ij}(b+cN)} + \frac{1}{2} w )</td>
<td>( \frac{1}{\tau_{ij}p_{ij}^{fob}} \frac{a+cP_j}{2(b+cN)} )</td>
<td>-</td>
</tr>
<tr>
<td>Quadratic</td>
<td>additive</td>
<td>( \frac{a+cP_j}{2(b+cN)} + \frac{1}{2} w - \frac{1}{2} f_{ij} )</td>
<td>( \frac{-1}{2} \frac{f_{ij}}{p_{ij}^{fob}} )</td>
<td>-</td>
</tr>
</tbody>
</table>
The CES case

- Elasticity of demand is constant!!

\[ p_{ij}^{fob} = \frac{1}{\sigma - 1} \frac{f_{ij}}{\tau_{ij}} + \frac{\sigma}{\sigma - 1} w \]

- elasticity:

\[ \frac{\partial \log(p_{ij}^{fob})}{\partial \log(dist)} = \left( \frac{\partial \log(f)}{\partial \log(dist)} - \frac{\partial \log(\tau)}{\partial \log(dist)} \right) \left( 1 + \frac{\tau \sigma w}{f} \right) \] (2)

- iceberg case: \( f = 0 \)
<table>
<thead>
<tr>
<th>additive part (f)</th>
<th>iceberg part ($\tau$)</th>
<th>elasticity to distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f=0$</td>
<td>$\frac{\partial \log(\tau)}{\partial \log(\text{dist})} &gt; 0$</td>
<td>0</td>
</tr>
<tr>
<td>$\frac{\partial \log(f)}{\partial \log(\text{dist})} = 0$, $f &gt; 0$</td>
<td>$\frac{\partial \log(\tau)}{\partial \log(\text{dist})} &gt; 0$</td>
<td>-</td>
</tr>
<tr>
<td>$\frac{\partial \log(f)}{\partial \log(\text{dist})} &gt; 0$</td>
<td>$\tau = 1$</td>
<td>+</td>
</tr>
<tr>
<td>$\frac{\partial \log(f)}{\partial \log(\text{dist})} &gt; 0$</td>
<td>$\frac{\partial \log(\tau)}{\partial \log(\text{dist})} &gt; 0$</td>
<td>sign of $\frac{\partial \log(f)}{\partial \log(\text{dist})} - \frac{\partial \log(\tau)}{\partial \log(\text{dist})}$</td>
</tr>
</tbody>
</table>
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linear regression:
\[
\log(\text{uv}_{fkjt}) = \alpha \log(\text{dist}_{fj}) + FE_{fkt} + \text{controls} + \epsilon_{fkjt}
\]

by interval regressions:
\[
\log(\text{uv}_{fkjt}) = \beta D[1, 1500] + \gamma D[1500, 3000] + \eta D[3000, 6000] + \nu D[6000, \ldots] + FE_{fkt} + \epsilon_{fkjt}
\]

market specificity controls (GDP, GDPC, mean uv, nb of French competitors..)
non linearity (squared terms)
clustered variance
- French custom data: 305,661 firms, 13,507 CN8 products, over 1995-2005
- Value of French exports: 3.16 trillion euro
- Data: firm, CN8 product, destination country, year
- Price proxy: unit value \( p_{fjkt}^{\text{fob}} = \frac{v_{fjkt}^{\text{fob}}}{q_{fjkt}} \)
- CEPII’s distance measures (Mayer & Zignago)
- BACI, to compute mean unit values (Gaulier & Zignago)
Top 20 of French partners (2005)

Exports, (billions of Euro)

Distances in kilometers

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   - Strategy
   - Database
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Julien MARTIN (CREST, Paris1-PSE) Spatial Price Discrimination in International Markets
# Basic regression (FE regressions)

<table>
<thead>
<tr>
<th>Dep. var.</th>
<th>Price (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dist.</td>
<td>0.030(^a)</td>
</tr>
<tr>
<td></td>
<td>(54.33)</td>
</tr>
<tr>
<td>GDP</td>
<td>-0.004(^a)</td>
</tr>
<tr>
<td></td>
<td>(-9.76)</td>
</tr>
<tr>
<td>GDPc</td>
<td>0.017(^a)</td>
</tr>
<tr>
<td></td>
<td>(32.54)</td>
</tr>
<tr>
<td>Cons.</td>
<td>-0.001(^a)</td>
</tr>
<tr>
<td></td>
<td>(-2.61)</td>
</tr>
<tr>
<td>Obs.</td>
<td>14196464</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.002</td>
</tr>
</tbody>
</table>
Controlling for the mean uv (FE regressions)

<table>
<thead>
<tr>
<th>Dep. var.</th>
<th>Price (log)</th>
<th>OECD</th>
<th>Eurozone</th>
<th>OECD</th>
<th>Eurozone</th>
<th>OECD</th>
<th>Eurozone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dist.</td>
<td>0.035&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.013&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.035&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.013&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.041&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.026&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(91.91)</td>
</tr>
<tr>
<td>Mean uv</td>
<td>0.015&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.005&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.011&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.004&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(38.90)</td>
<td>(9.03)</td>
<td>(28.56)</td>
</tr>
<tr>
<td>GDP</td>
<td>-0.003&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.002&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(-14.86)</td>
<td>(-7.81)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDPc</td>
<td>0.043&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.029&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(75.84)</td>
<td>(24.19)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cons.</td>
<td>2.548&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.597&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.509&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.583&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.681&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.636&lt;sup&gt;a&lt;/sup&gt;</td>
<td>(944.75)</td>
</tr>
</tbody>
</table>
### Results by firm and product

By interval regressions (FE regressions)

<table>
<thead>
<tr>
<th>Dep. var.</th>
<th>Price (log)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &lt; km &lt; 1000</td>
<td>-0.002(^a)</td>
<td>-0.002(^a)</td>
<td>-0.002(^a)</td>
<td>-0.002(^a)</td>
</tr>
<tr>
<td></td>
<td>(-96.50)</td>
<td>(-96.51)</td>
<td>(-107.90)</td>
<td>(-116.20)</td>
</tr>
<tr>
<td>1000 &lt; km &lt; 3000</td>
<td>-0.001(^a)</td>
<td>-0.001(^a)</td>
<td>-0.002(^a)</td>
<td>-0.002(^a)</td>
</tr>
<tr>
<td></td>
<td>(-46.19)</td>
<td>(-35.16)</td>
<td>(-50.34)</td>
<td>(-44.34)</td>
</tr>
<tr>
<td>3000 &lt; km &lt; 6000</td>
<td>0.001(^a)</td>
<td>0.001(^a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(17.58)</td>
<td>(26.59)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6000 &lt; km &lt; 9000</td>
<td>0.003(^a)</td>
<td>0.005(^a)</td>
<td>0.004(^a)</td>
<td>0.005(^a)</td>
</tr>
<tr>
<td></td>
<td>(58.47)</td>
<td>(56.89)</td>
<td>(73.48)</td>
<td>(55.43)</td>
</tr>
<tr>
<td>9000 &lt; km</td>
<td>0.005(^a)</td>
<td>0.008(^a)</td>
<td>0.005(^a)</td>
<td>0.008(^a)</td>
</tr>
<tr>
<td></td>
<td>(89.78)</td>
<td>(99.59)</td>
<td>(90.15)</td>
<td>(96.70)</td>
</tr>
<tr>
<td>GDP (log)</td>
<td></td>
<td>-0.004(^a)</td>
<td>-0.004(^a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-30.11)</td>
<td>(-24.56)</td>
<td></td>
</tr>
<tr>
<td>Gdpc (log)</td>
<td></td>
<td>0.011(^a)</td>
<td>0.012(^a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(46.45)</td>
<td>(35.39)</td>
<td></td>
</tr>
</tbody>
</table>

Sample : all, OECD
Pooled sample
Results by firm and product

- only the firms serving at least 15 (30) markets.
- 56% of the coefficients are positive.
- GDP and GDPc do not change the main result: more than 50% of the coefficients are positive.
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1 Introduction
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Spatial quality discrimination

- Models where firms quality-discriminate. [Verhoogen (2008), Hallak & Sivadasan (2008)]
- Iceberg trade costs: quality (so prices) decrease with the distance.
- Add an additive costs in the Hallak Sivadasan model leads to a positive relationship between quality (so prices) and distance.
Alchian Allen effect modeled by Hummels and Skiba 2002 might be modeled at the firm level.

- The firm produces at least two grade of a given good, the relative price of the high quality version of the good decreases with the distance (with additive trade costs).
- Assumption 1: trade costs are the same whatever the quality.
- Assumption 2: perfect competition
Quality stories assumes that firm level unit values (8-digit) measure different quality.

Hummels & Skiba: estimation of the elasticity of price to distance in pure PTM: 0.007. Their product level data reject PTM in favor of Alchian Allen effect. Firm level data lead me to accept PTM.

Price discrimination seems more relevant than quality discrimination when thinking about the whole exports.

Anyway one needs additive trade costs.
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2. Theory
   - Transport costs
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   - Strategy
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Theoretically, the choice of the transport cost formulation is essential to determine firm pricing policy.

French exporters are likely to adopt reverse dumping strategy.

The most popular models of international trade (DSK and Ottaviano et al models) are not convenient to describe firm pricing behavior.

Recent models with quality also fail to generate such stylized fact.

Additive costs seem necessary to replicate this fact.