The Price of Distance: Producer Heterogeneity, Pricing to Market, and Geographic Barriers

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Comments Welcome
Price of Distance: How much do you pay to a distant market?

- Transportation costs (measured by distance) increase price differentials across regions (countries): but how much?

- Regression exercises reveal statistically significant positive effect (the Law of One Price (LOP) literature, e.g., Broda and Weinstein 2008, Engel et al. 2007, Crucini et al. 2010).

- However, the size of the distance elasticity of price differential is estimated economically subtle less than 3 % ... the price of distance is too small?

- Good transportation infrastructure?
The Price of Distance: Producer Heterogeneity, Pricing to Market, and Geographic Barriers

Introduction

Distance Effect

- Empirical trade literature observes decent size of the distance elasticity of transportation costs using data of trade volumes and trade directions approximately 20-30% (Anderson and van Wincoop (2003)).

- Even under the same specification of iceberg-type transportation costs as in the LOP literature.

- Distance elasticity is an important parameter (Crozet and Koening 2010; Balistreri, et al, 2011)

- The LOP literature (using price data) has identification problems of distance effect
What’s new?

- Previous reduced form LOP exercises regress retail price differentials on distance
  - Interpretation: distance includes transportation costs, distribution costs, information costs, etc
- **Unique Data**: Using unique price data allows us to measure transportation costs
- **Control for potential biases caused by producer heterogeneity and pricing to market**
Results

- Large distance effects are found
- Elasticities = 0.46 ∼ 0.768 (previous studies: 0.001 ∼ 0.3)
- Price of distance is large
- Markets are not integrated yet (geographically separated)
- Implication: Improving transportation infrastructure have a large welfare impact
  - Intelligent Transport System: solve traffic jams, reduce traffic accident, ...
What’s new in this paper: data

- Focus on distance effect: **regional price differentials within country** (no effect of trade barriers and exchange rates (Parsely and Wei 1996))
- Unique daily data set of **wholesale prices** of agricultural products in Japan.
- Why unique? We can identify two crucial data aspects
  1. **Source regions**: in which regions are products made?
  2. **Product delivery patterns**: to which regions are products delivered from the sources?
- Why important?
p(CB) - p(SB) = TC(CB-SB)

|p(CA) - p(CB)| = ???

p(CA) - p(SA) = TC(CA-SA)
What’s new in this paper: source regions

- Need to know source regions of products in order to measure transportation costs correctly (Anderson and van Wincoop 2004).

- However, retail price data are not accompanied by information of the sources of products.

- Using wholesale prices and information on source regions, we can eliminate other costs associated with distance.

Data description

- “Daily Wholesale Market Information on Fresh Fruits and Vegetables (Seikabutsu Hinmokubetsu Shikyo Joho).”
- Selected vegetables in 2007: cabbage, carrot, Chinese cabbage, lettuce, potato, shiitake mushroom, spinach, and welsh onion.
- High product categorization by sources, brands, sizes, and grades: “Identical” product shares the same brand, same size, same grade, same source, and same date.
- 55 wholesale markets across 47 prefectures in Japan: each prefecture has at least one wholesale market.
- Distances between prefectoral head offices in prefectoral capital cities.
## Data description

<table>
<thead>
<tr>
<th></th>
<th>Cabbage</th>
<th>Carrot</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product entry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of Varieties</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>No. of size categories</td>
<td>63</td>
<td>62</td>
</tr>
<tr>
<td>No. of grade categories</td>
<td>34</td>
<td>66</td>
</tr>
<tr>
<td>No. of distinct product entries</td>
<td>1027</td>
<td>1186</td>
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<tr>
<td><strong>Data truncation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of $T_{ij}(l) = 0$ or $1$</td>
<td>369,343</td>
<td>198,129</td>
</tr>
<tr>
<td>No. of $T_{ij}(l) = 1$</td>
<td>15,841</td>
<td>8,395</td>
</tr>
<tr>
<td>Mean of log distance over $T_{ij}(l) = 0$ or $1$</td>
<td>5.939</td>
<td>6.027</td>
</tr>
<tr>
<td>Mean of log distance of $T_{ij}(l) = 1$</td>
<td>3.705</td>
<td>3.99</td>
</tr>
<tr>
<td><strong>Price differential</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean log price differential $q_{ij}(l)$</td>
<td>0.039</td>
<td>0.075</td>
</tr>
<tr>
<td>SD. Log price differential $q_{ji}(l)$</td>
<td>0.167</td>
<td>0.285</td>
</tr>
</tbody>
</table>
Product-delivery patterns (also done in KKT(2010))

- Two roles of transportation costs:
  1. **intensive margin**: increase price differential
  2. **extensive margin**: decrease chance of product delivery

- Transportation costs make product delivery concentrated around local areas neighboring source regions: Data truncation of price differentials.

- Estimates of distance elasticity using price data alone could be biased downwards due to sample selection.
Data truncation due to delivery choice might result in a sample selection bias.
What’s new in this paper: a simple heterogeneity model

- A simple model of monopolistically competitive, heterogeneous producers facing local demand curves (Helpman, Melitz, and Rubinstein (2008)).

- They produce products in the source regions and choose which consuming regions to deliver their products with fixed costs (KKT (2010)).

- CES-monopolistic competition = constant markups → variable markups
Previous Literature

- Preference: non-homothetic preference $\rightarrow$ pricing-to-market
  - Melitz and Ottaviano (2008)
  - Simonovska (2010)
- The positive relationship between price and income per capita
  - Balassa-Samuelson
  - Variable markups
- Our focus is on the relationship between price differentials and distance... but in fact the positive relationship exits
Pricing Behavior and Transportation Costs

- Pricing to market → price differentials reflect local market conditions (in CES, only transportation cost)
- The relationship between price differentials and distance can be biased by the presence of producer heterogeneity and market characteristics
- Transportation costs reduce profitability in a remote market
  - As the productivity threshold increases, only highly productive and thus low-price-setting firms supply
- The increase in price differentials are relatively lower for remote markets
  - This may create biases
Non-homothetic Preference

Simonovska (2010)'s framework

\[ u_i = \int_{\omega \in \Omega} \ln(q(\omega) + \bar{q})d\omega \]

Then the demand function is:

\[ q(\omega) = \frac{w_i + \bar{q} \int p(\omega)}{N_i p(\omega)} - \bar{q}, \]
Producers

- Each producer: monopolistic competition
- Producer’s profit maximization problem:

\[ \max \pi_{ij}(\phi) = p_{ij}q_{ij} - \frac{\tau_{ij}w_j}{\phi} q_{ij} \]

- The optimal price:

\[ p_{ij} = \left( \frac{\tau_{ij}w_j(w_i + \bar{q}P_i)}{\phi N_i\bar{q}} \right)^{1/2} \]

- Cut-off value (zero demand):

\[ \phi^*_{ij} = \frac{\tau_{ij}w_jN_i\bar{q}}{w_i + \bar{q}P_i} \rightarrow p_{ij} = \frac{\tau_{ij}w_j}{\phi^{1/2}\phi^*_{ij}^{1/2}} \]
Reminder: optimal price in a CES case

- Profit = $p_{ij}x_{ij} - (\tau_{ij}w_j/\phi)x_{ij} - f_{ij}$
- Optimal price is given by mark-up price

$$p_{ij} = \tau_{ij}\frac{w_j}{\phi\alpha}$$
Price Differentials

- Nonhomothetic: price depends on threshold value (heterogeneity matters)

\[ \frac{p_{ij}}{p_{jj}} = \tau_{ij} \frac{\phi_{jj}^{1/2}}{\phi_{ij}^{1/2}} = \tau_{ij}^{1/2} \frac{(w_i + \bar{q}P_i)^{1/2} N_j}{(w_j + \bar{q}P_j)^{1/2} N_i} \]

- CES:

\[ \frac{p_{ij}}{p_{ii}} = \tau_{ij} \]

- In a CES framework, productivity does not affect price differential

- \( \phi_{ij}^* \) depends on \( \tau_{ij} \): omitted variable bias (Helpman, Melitz, and Rubinstein (2008))
Profits and Heterogeneity

- Price differential is observed only when there is delivery
- Timing: pay fixed cost to draw \( \phi \), then decide to deliver after realization
- Assuming that productivity follows Patero distribution
  \( G(\phi) = 1 - b^\theta / \phi^\theta \)
- Expected profit
  \[
  (1 - G(\phi^*)) \int \pi \mu d\phi = \frac{b^\theta \tau_{ij} w_{ij} \bar{q}}{(2\theta + 1)(\theta + 1)\phi^{*\theta+1}}
  \]
- Delivery decision
  \[
  Z_{ij} = \left( b^\theta \frac{\tau_{ij} w_{ij} \bar{q}}{(2\theta + 1)(\theta + 1)\phi_{ij}^{*\theta+1}} \right) / f_{ij} > 1
  \]
Profits: CES case

- Gross profits/delivery costs:

\[ Z_{ij} = \frac{(1 - \alpha)[\tau_{ij}w_j]{\alpha P_i\phi}}{f_{ij}}^{1-\varepsilon} w_i \]

- Deliver to market i:

\[ Z_{ij} \geq 1 \]
Transportation Costs

- Iceberg type
- Parametric specification of transportation costs $\tau_{i,j}$ with distance $D_{i,j}$
  \[ \tau_{i,j} = D_{i,j}^\gamma \exp(\mu + u_{i,j}), \quad u_{i,j} \sim N(0, \sigma^2_u) \]
- $\gamma$ is the distance elasticity parameter
Empirical Framework: sample selection

- **Price differential**
  \[
  \ln p_{ij} - \ln p_{jj} = \left(\frac{1}{2}\right)\mu + \left(\frac{1}{2}\right)\gamma \ln D_{ij} + \left(\frac{1}{2}\right) \ln(1 + N_i) - \left(\frac{1}{2}\right) \ln(1 + N_j) + \left(\frac{1}{2}\right)c_4\text{dum}_j - \left(\frac{1}{2}\right)c_5\text{dum}_i + \left(\frac{1}{2}\right)u_{ij}
  \]

- **Delivery decision**
  \[
  z_{ij} = -\ln f_e + \theta(\ln b - \bar{q}) - \theta\mu - \ln(2\theta + 1)(\theta + 1) + \theta\gamma \ln D_{ij} - \theta \ln w_j - (\theta + 1) \ln N_i + (\theta + 1) \ln(w_i + \bar{q}P_i) = c_0 + \theta c_1 + \theta\gamma \ln D_{ij} - \theta \ln w_i - (\theta + 1) \ln N_j + (\theta + 1)c_2\text{dum}_j + c_3\text{dum}_i + \eta_{ij}
  \]

- **Estimate by maximum likelihood**
### Estimation results

<table>
<thead>
<tr>
<th>Point estimates and s.e.</th>
<th>Cabbage</th>
<th>Carrot</th>
<th>Lettuce</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \hat{\gamma}_{\text{non-homo}} )</td>
<td>0.46</td>
<td>0.627</td>
<td>0.687</td>
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<tr>
<td>(s.e.)</td>
<td>(0.003)</td>
<td>(0.006)</td>
<td>(0.006)</td>
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<tr>
<td>( \hat{\theta} )</td>
<td>2.013</td>
<td>1.169</td>
<td>1.203</td>
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<tr>
<td>(s.e.)</td>
<td>(0.011)</td>
<td>(0.009)</td>
<td>(0.008)</td>
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<tr>
<td>( \hat{\rho} )</td>
<td>-0.83</td>
<td>-0.868</td>
<td>-0.854</td>
</tr>
<tr>
<td>(s.e.)</td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.003)</td>
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<tr>
<td>log likelihood</td>
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<td>-17034.691</td>
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<tr>
<td>No. of observations</td>
<td>369,343</td>
<td>198,129</td>
<td>239,703</td>
</tr>
<tr>
<td>( \hat{\gamma}_{\text{CES}} )</td>
<td>0.301</td>
<td>0.362</td>
<td>0.426</td>
</tr>
<tr>
<td>( \hat{\gamma}_{\text{OLS}} )</td>
<td>0.033</td>
<td>0.051</td>
<td>0.022</td>
</tr>
</tbody>
</table>
Estimation Results

- Large distance effect
- Ignoring producer heterogeneity and pricing to market causes biased estimates of distance
- The price of geographic barriers (distance) is still large for regional transportation
Conclusions

- Conventional estimate of distance effects only using retail price data is heavily biased downwards due to 3 flaws:
  
  1. misspecification inevitable by no information and identification of the source regions of products.
  2. ignoring the underlying delivery choice that has to be affected by transportation costs too.
  3. pricing-to-market behavior

- After correcting these flaws, we observe the large price of distance (geographic barriers) on regional price differentials.
Policy Implications

- Geographic barriers still large
- New type of transportation system: ITS
- Automakers start doing research
- More efficient, safe road is required.