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?

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?

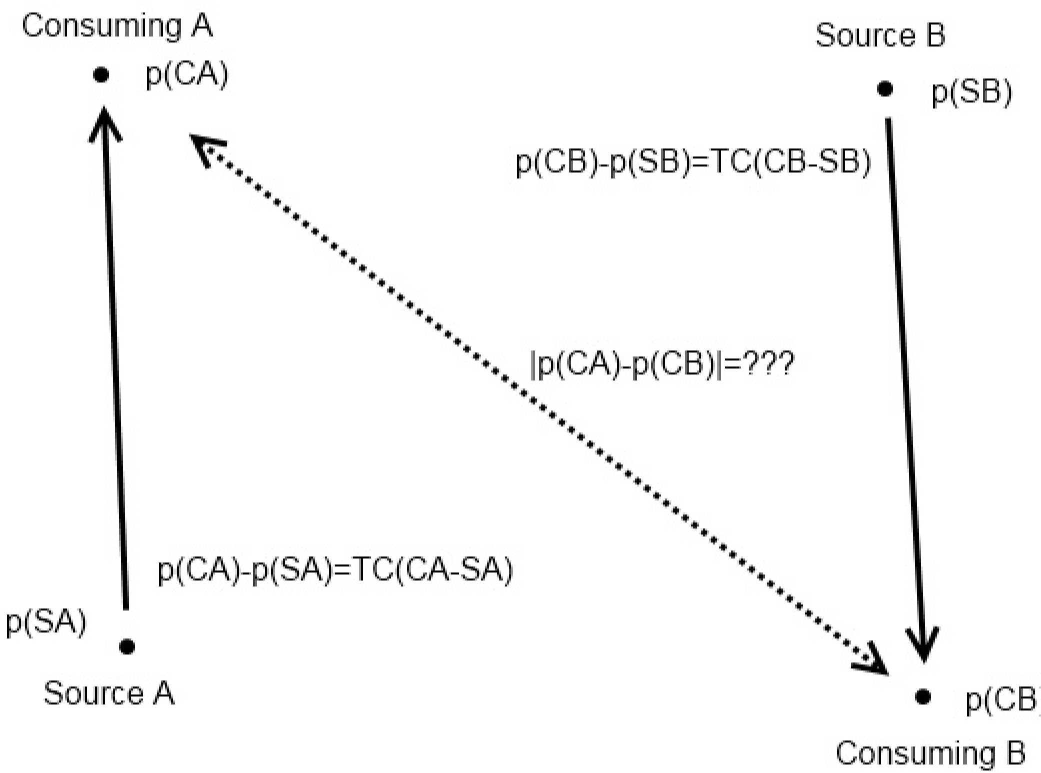
- Previous reduced form LOP exercises regress retail price differentials on distance
  - Interpretation: distance includes transportation costs, distribution costs, information costs, etc
- **Unique Data**: Using unique price data allows us to measure transportation costs
- **Control for potential biases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

Results

- Large distance effects are found
- Elasticities = 0.46 $\sim$ 0.768 (previous studies: 0.001 $\sim$ 0.3)
- Price of distance is large
- Markets are not integrated yet (geographically separated)
- Implication: Improving transporation 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?


Consuming A
p(CA)
Source B
p(SB)
p(CB)-p(SB)=TC(CB-SB)
|p(CA)-p(CB)|=???
p(CA)-p(SA)=TC(CA-SA)
p(SA)
Source A
p(CB)
Consuming B

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
- Donaldson (2010) and Kano et al (2010) use information about source region

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 prefectural head offices in prefectural capital cities.

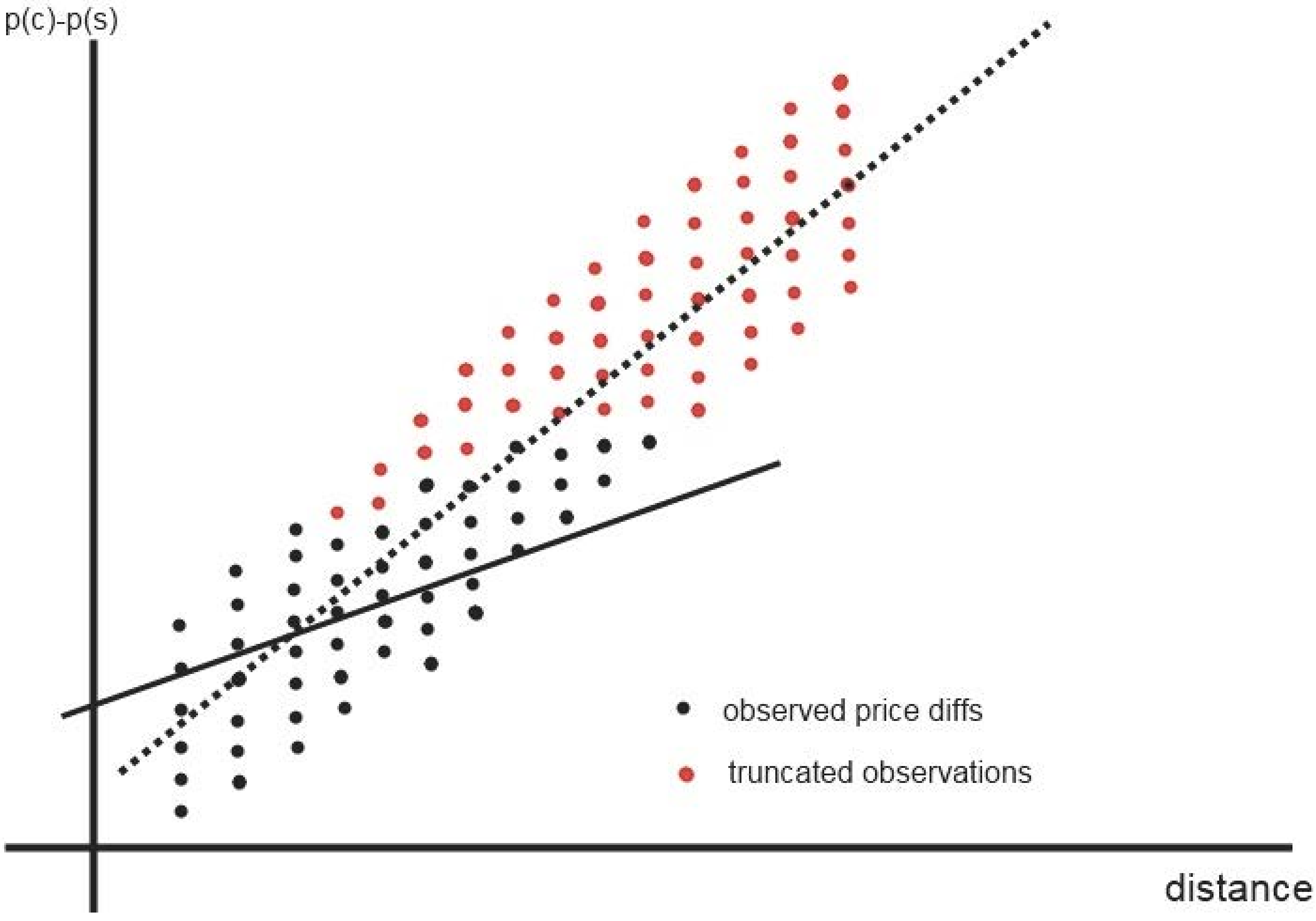
Data description

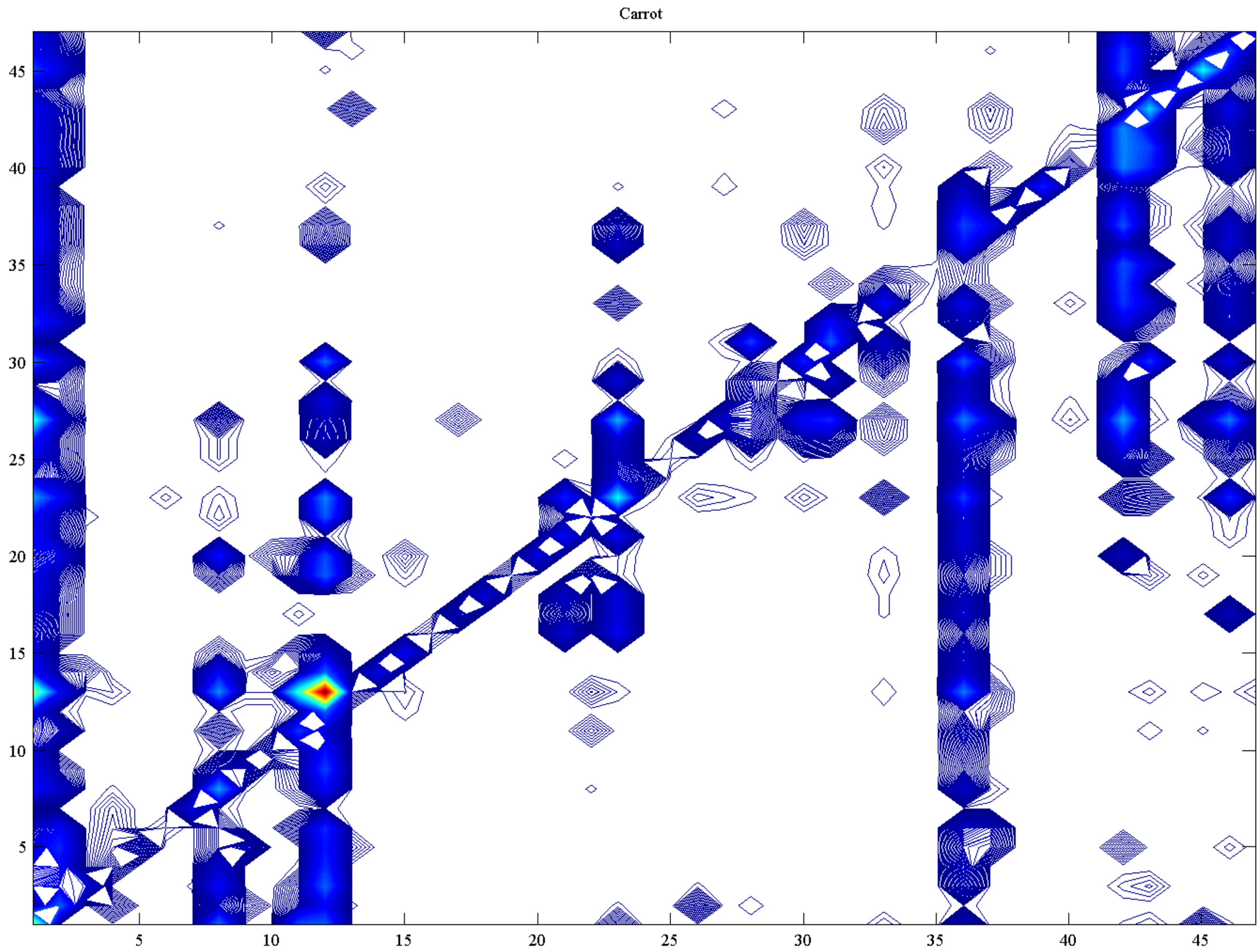
	Cabbage	Carrot
Product entry		
No. of Varieties	3	10
No. of size categories	63	62
No. of grade categories	34	66
No. of distinct product entries	1027	1186
Data truncation		
No. of $T_{ij}(l)$ = 0 or 1	369,343	198,129
No. of $T_{ij}(l)$ = 1	15,841	8,395
Mean of log distance over $T_{ij}(l)$ = 0 or 1	5.939	6.027
Mean of log distance of $T_{ij}(l) = 1$	3.705	3.99
Price differential		
Mean log price differenetial $q_{ij}(l)$	0.039	0.075
SD. Log price differential $q_{ji}(l)$	0.167	0.285

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.



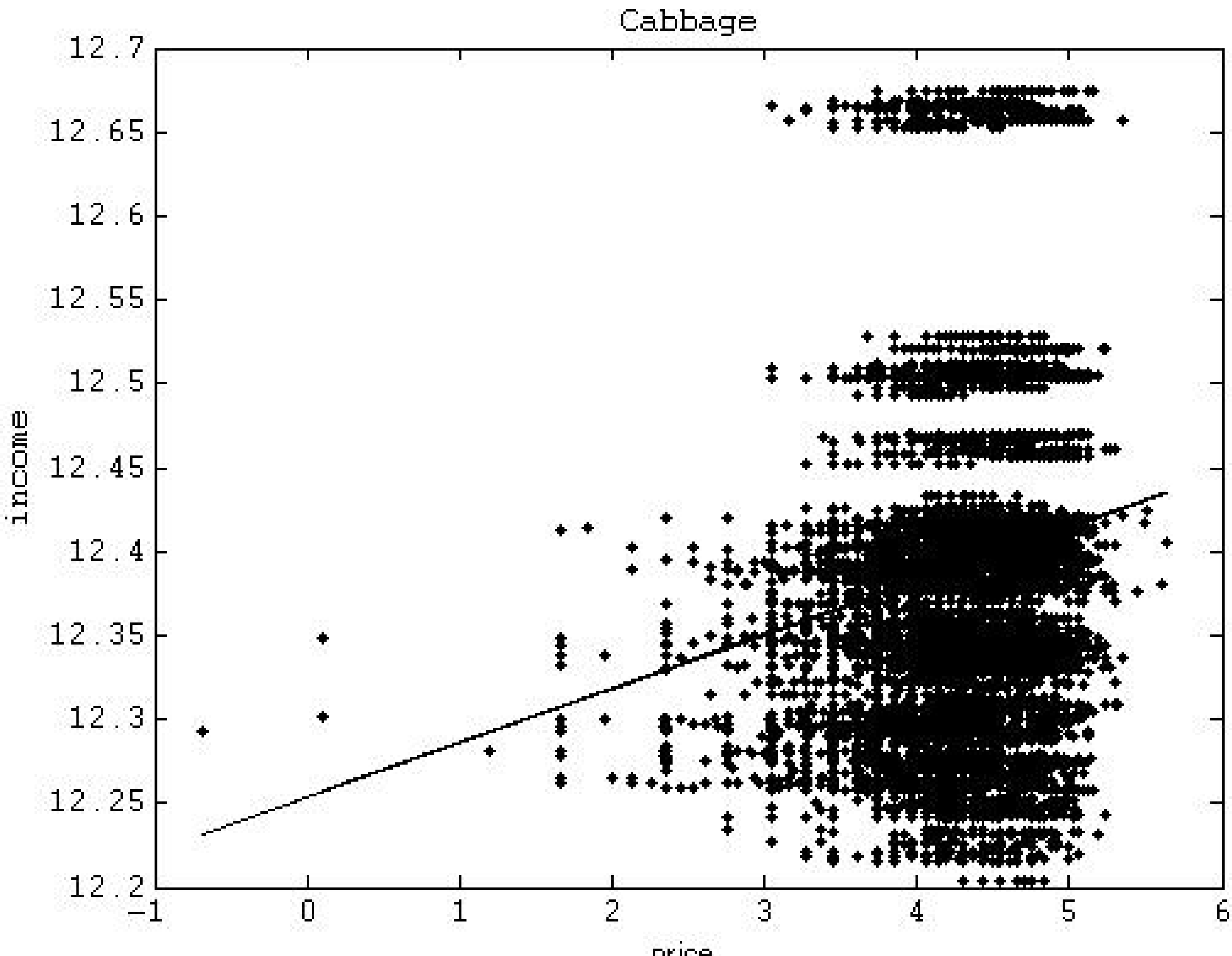

Carrot
45
40
35
30
25
20
15
10
5
5
10
15
20
25
30
35
40
45

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

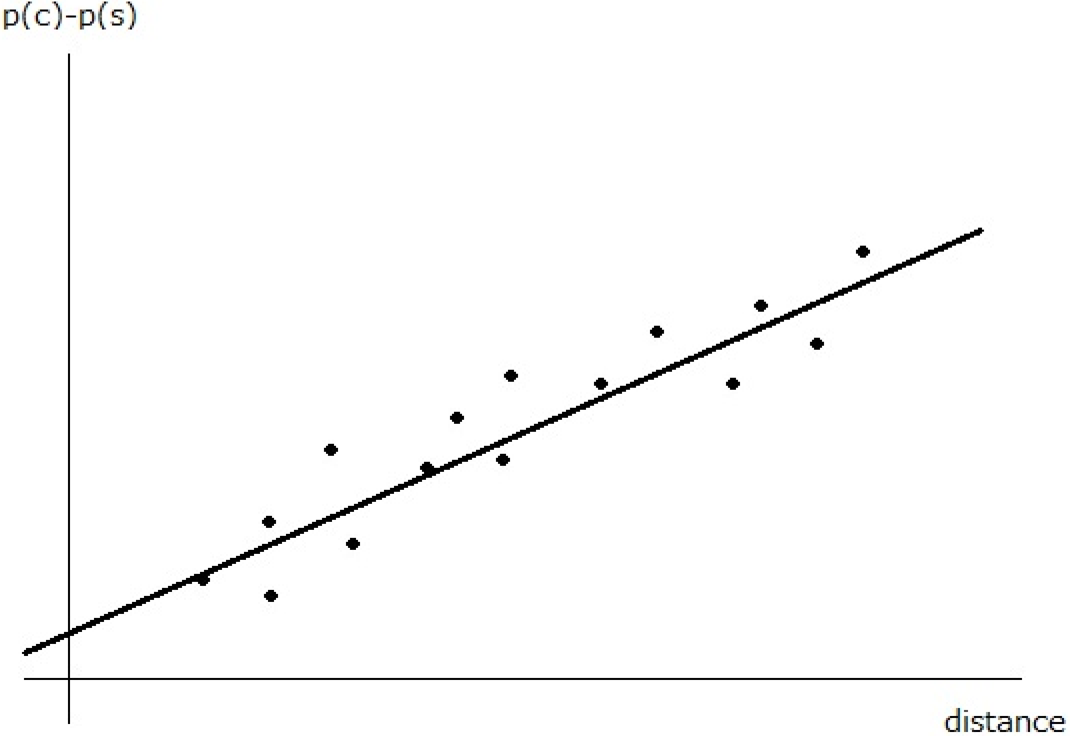
Previous Literature

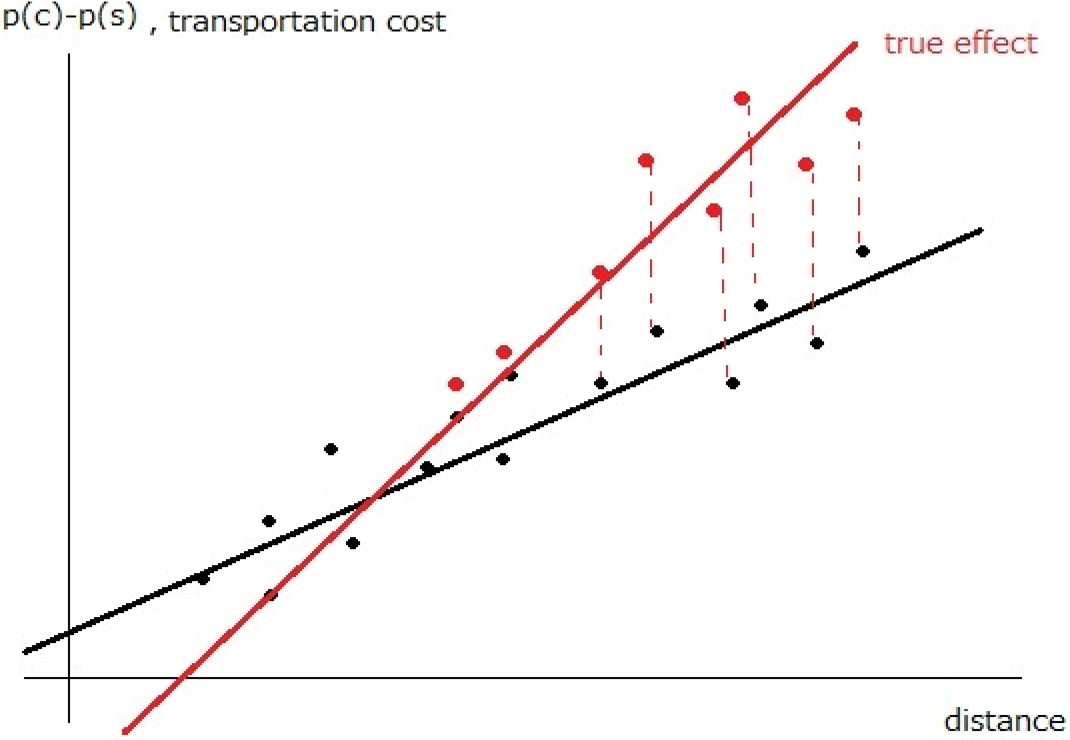
- Preference: non-homethetic preference → pricing-to-market
  - Melitz and Ottaviano (2008)
  - Simonovska (2010)
- The positive relationship between price and income per capita
  - Balassa-Samuelson
  - Variable markups
- Our focus is on the relationship between price differentials and distance... but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


Cabbage
income
price
12.7
12.65
12.6
12.55
12.5
12.45
12.4
12.35
12.3
12.25
12.2
−1
0
1
2
3
4
5
6

Pricing Behavior and Transportation Costs

- Pricing to market $\rightarrow$ 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


p(c)-p(s)
distance


p(c)-p(s) , transportation cost
true effect
distance

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:

$$p_{ij} = (\frac{\tau_{ij}w_j(w_i + \overline{q}P_i)}{\phi N_i \overline{q}})^{1/2}$$

- Cut-off value (zero demand):

$$\phi_i^* j = \frac{\tau_{ij}w_j N_i \overline{q}}{w_i + \overline{q}P_i} \rightarrow p_{ij} = \frac{\tau_{ij}w_j}{\phi^{1/2}\phi_{ij}^{*\,1/2}}$$

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)

$$p_{ij}/p_{jj} = \tau_{ij}{\phi^*_{jj}}^{1/2}/{\phi^*_{ij}}^{1/2} = \tau_{ij}^{1/2}\frac{(w_i + \bar{q}P_i)^{1/2}}{(w_j + \bar{q}P_j)^{1/2}}(\frac{N_j}{N_i})^{1/2}$$

- CES:

$$p_{ij}/p_{ii} = \tau_{ij}$$

- In a CES framework, productivity does not affect price differential
- ϕ^*_{ij} depends on τ_{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 ϕ, then decide to deliver after realization
- Assuming that productivity follows Patero distribution $(G(\phi) = 1 - b^\theta/\phi^\theta)$
- Expected profit

$$(1 - G(\phi^*)) \int \pi \mu d\phi = \frac{b^\theta \tau_{ij} w_i \bar{q}}{(2\theta + 1)(\theta + 1){\phi^*}^{\theta+1}}$$

- Delivery decision

$$Z_{ij} = (b^\theta \frac{\tau_{ij} w_j \bar{q}}{(2\theta + 1)(\theta + 1){\phi^*_{ij}}^{\theta+1}})/f_{ij} > 1$$

Profits: CES case

- Gross profits/delivery costs:

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

- Deliver to market i:

$$Z_{ij} \geq 1$$

Transportation Costs

- Iceberg type
- Parametric specification of transportation costs τ_{ij} with distance D_{ij}

$$\tau_{ij} = D_{ij}^{\gamma} \exp(\mu + u_{ij}), \quad u_{ij} \sim N(0, \sigma_u^2)$$

- γ is the distance elasticity parameter

Empirical Framework: sample selection

- Price differential

$$\ln p_{ij} - \ln p_{jj} = (1/2)\mu + (1/2)\gamma \ln D_{ij} + (1/2)\ln(1+N_i) \\ - (1/2)\ln(1+N_j) + (1/2)c_4 dum_j - (1/2)c_5 dum_i + (1/2)u_{ij}$$

- Delivery decision

$$\begin{aligned} z_{ij} = & -\ln f_e + \theta(\ln b - \bar{q}) - \theta\mu - \ln(2\theta+1)(\theta+1) \\ & + \theta\gamma \ln D_{ij} - \theta \ln w_j - (\theta+1)\ln N_i + (\theta+1)\ln(w_i + \bar{q}P_i) \\ = & c_0 + \theta c_1 + \theta\gamma \ln D_{ij} - \theta \ln w_i \\ & - (\theta+1)\ln N_j + (\theta+1)c_2 dum_j + c_3 dum_i + \eta_{ij} \end{aligned}$$

- Estimate by maximum likelihood

Estimation results

Point estimates and s.e.	Cabbage	Carrot	Lettuce
$\hat{\gamma}_{non-homo}$	0.46	0.627	0.687
(s.e.)	(0.003)	(0.006)	(0.006)
$\hat{\theta}$	2.013	1.169	1.203
(s.e.)	(0.011)	(0.009)	(0.008)
$\hat{\rho}$	-0.83	-0.868	-0.854
(s.e.)	(0.003)	(0.003)	(0.003)
log likelihood	-19646.143	-17034.691	-21025.084
No. of observations	369,343	198,129	239,703
$\hat{\gamma}_{CES}$	0.301	0.362	0.426
$\hat{\gamma}_{OLS}$	0.033	0.051	0.022

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.