Session: (June 4th – Product Differentiation – Applied)

"VERTICAL CONTRACTS BETWEEN MANUFACTURERS AND RETAILERS: INFERENCE WITH LIMITED DATA"

Sofia Berto Villas-Boas

UC Berkeley

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MOTIVATION

- **Why do we care?**

  Efficiency

    Double Marginalization or more efficient contracting?

  Competition

  Balance of power

  Beyond IO,

    Modeling retailer behavior , e.g. Price dynamics

      (Chevalier, Kashyap, Rossi, AER, 2003)

    International Economics (cost pass-through)

- **Why is it difficult to analyze?**

  Limited data observability (wholesale prices, costs)

  Non-marginal components

MAIN CONTRIBUTION

- Present method to analyze degree of competitive interactions between manufacturers and retailers (vertical contracts) even when wholesale prices are unobserved

- Apply methodology to a certain market (yogurt)

GENERAL STRATEGY

- Estimate brand-store level demand (using flexible functional form)

- Given demand estimates, compute price-cost margins (PCM) for retailers and manufacturers implied by different supply models (without observing wholesale prices)

    Each model implies different PCM for retailers and manufacturers

- Test between different supply models by asking which set of implied PCM is more compatible with "observed" PCM (using non-nested tests)

CONCLUSIONS

- Model that best fits the data:

  Marginal wholesale price close to marginal cost and retail price is the unconstrained profit-maximizing price

- Able to rule out Double Marginalization model

- Consistent with several scenarios, for example:

  1. Retailers have large bargaining power
  2. Non-linear pricing by manufacturers

     Two-part tariffs

     Quantity discounts
  3. Others…

     unobservable contracts (of rivals)

OUTLINE

- Related literature
- Illustrative example
- The models (demand and supply)
- Estimation method
- Testing between supply models
- The data
- The yogurt market
- Results
- Conclusions and Extensions

RELATED LITERATURE

- Extensive theoretical work on vertical contracts

  For a survey see Katz (1989).

- Empirical work:
  Bresnahan and Reiss (1985)
  Corts (2000)
  Mortimer (2002)

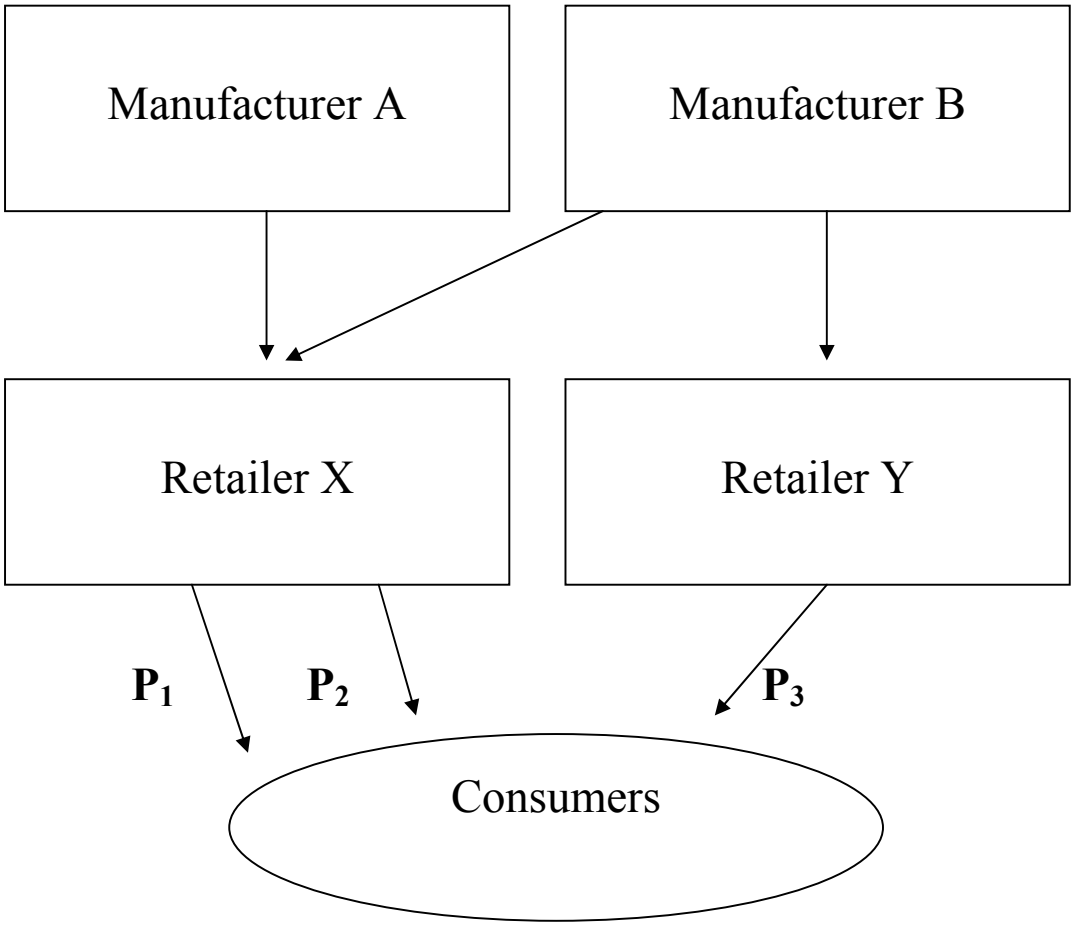
  Closer to this paper:
  Messinger and Narasimhan (95)
  Chintagunta, Bonfer and Song (2000)
  Kadiyali, Chintagunta and Vilcassim (2000)
  Main differences: use data on wholesale prices, just one retailer.

- Tests of vertical pricing models (very few):

  Sudhir (2001), Villas-Boas and Zhao (2001)

  Main difference: just one retailer.

ILLUSTRATIVE EXAMPLE



SUPPLY MODELS CONSIDERED

- Simple Linear Pricing $\Rightarrow$ Double Marginalization
- Vertically Integrated
- Alternative (Strategic) models:

    Non-linear pricing (2 "special/extreme" cases)

        Wholesale pricing at marginal cost

        Retail margin close to zero

    Retailers vertically integrated in private labels

    Manufacturer level collusion

    Retail level collusion

THE SUPPLY MODELS

MODEL	Manufacturers: m	Retailers: r
Simple Linear Pricing	$\max_{p^w} \pi_{mj}$ given $p(p^w)$	$\max_{p} \pi_{rj}$
Zero wholesale margin	$p^w=c^w$	$\max_{p} \pi_{rj}$
Zero retail margin	$\max_{p^w} \pi_{mj}$	$p=p^w+c^r$
Private Label	$p^w=c^w$, for j=private label and otherwise $\max_{p^w} \sum_j \pi_{mj}$ given $p(p^w)$	$\text{Max}_{p} \pi_{rj}$
Manufacturer collusion	$\max_{p^w} \sum_j \pi_{mj}$ given $p(p^w)$	$\text{Max}_{p} \pi_{rj}$
Retail collusion	$\max_{p^w} \pi_{mj}$ given $p(p^w)$	$\max_{p} \sum_j \pi_{rj}$
Joint profit maximizing	$\max_{p} \sum_j \pi_j$	

SIMPLE LINEAR PRICING MODEL

- Manufacturers set wholesale prices and then given the wholesale prices retailers set retail prices

- Max $\pi_{rt} = \sum_{j \in Srt} [p_{jt} - p^w_{jt} - c^r_{jt}] \, s_{jt}(p) - FC$

  $\Rightarrow \quad s_{jt} + \sum_{k \in Srt} [p_{kt} - p^w_{kt} - c^r_{kt}] \, \partial s_{kt}(p)/\partial p_{jt} = 0 \, , \, j = 1, \ldots N \, .$

  Define

  T_r : $T_r(i,j)=1$ when $i,j \in S_{rt}$ and 0 otherwise

  Δ_r is a matrix of cross-price elasticities of demand

  Solving for the PCM of the retailers

  $$\boldsymbol{p - p^w - c^r = - (T_r \, . \, \Delta_r)^{-1} \, s(p)} \qquad \textbf{(1)}$$

- Manufacturers

  $$\text{Max } \pi_{wt} = \sum_{j \in Swt} [p^{w}_{jt} - c^{w}_{jt}]\, s_{jt}(p) - FC^{w}$$

  given that retailers price according to

  $$\boldsymbol{p - p^{w} - c^{r} = -\,(T_r \,.\, \Delta_r)^{-1}\, s(p)} \qquad \textbf{(1)}$$

  Rearranging the first order conditions, to solve for the PCM of the manufacturers (in matrix notation)

  $$\boldsymbol{p^{w} - c^{w} = -\,(T_w \,.\, \Delta_w)^{-1}\, s(p)} \qquad \textbf{(2)}$$

  where

  $T_w(i,j)=1$ when $i,j \in S_{wt}$ and 0 otherwise and

  Δ_w has the cross-price elasticities of <u>derived</u> demand (has also effect of cost pass-through).

  Note: $S_{wt} \neq S_{rt}$.

- The PCM for the other models are obtained from **(1)** and **(2)**.

DEMAND MODEL

- Discrete choice model for differentiated products

- Indirect latent utility from consumer *i* choosing product *j* (brand-store) at time *t*

$$U_{ijt} = D_t + d_j + x_{jt}\,\beta_i - \alpha_i\,p_{jt} + \xi_{jt} + \varepsilon_{ijt}$$

d_j product dummy variables , D_t seasonal dummies

x_{jt} observed product characteristics

ε_{ijt} distribution of consumer preferences about unobserved product characteristics (will be integrated out)

- What is in ξ_{jt} ? Changes in

  -unobserved consumer preferences

  -other unobserved market specific conditions

  (e.g. unobserved promotions,
  previous sales, changes in shelf display)

- Specifying consumer heterogeneity

$$\begin{vmatrix} \alpha_i \\ \beta_i \end{vmatrix} = \begin{vmatrix} \alpha \\ \beta \end{vmatrix} + \Phi_D \quad D_i \; + \; \Phi_v \quad \nu_i$$

D_i observed and ν_i unobserved consumer characteristics

Note: if $\alpha = \alpha_i$ and $\beta = \beta_i$ (and ε extreme value) $\Rightarrow$ Logit.

- Consumer purchases one unit of the good that gives the highest utility conditional on characteristics, prices and outside good.

- Aggregate market share of product j

$$s_{jt} = \int(\{(D_i, \nu_i, \varepsilon_i) | \; U_{ijt} \geq U_{iht} \;\; h = 0, \ldots N\}) \; dF(\varepsilon) \; dF(\nu) \; dF(D)$$

DEMAND ESTIMATION

- Estimate demand parameters that produce predicted aggregate market shares close to observed ones

- Data requirements:

  Prices in different markets (weeks)
  Aggregate market shares
  Product characteristics
  Consumer characteristics

- Problem of estimation - prices are correlated with ξ_{jt}

- Solution: Use instruments for prices

- Need instruments with product level variation

- I use two instrumental variable (IV) specifications:

1. Manufacturer level input prices interacted with brand-store dummy variables & Retail level input prices

2. Manufacturer-level input prices interacted with brand dummy variables & Retail level input prices

TESTING THE SUPPLY MODELS

1. Test of each supply model:

- Starting with the accounting identity obtained by adding up the implied PCM

$$p - c^w - c^r = PCM_r + PCM_w$$

- Having information on costs ($c^r + c^w$) I can compare the implied PCM with PCM obtained from estimates of cost.

  This reduces to estimating the supply pricing equation

$$p = c\,\gamma + PCM_r\,\lambda_r + PCM_w\,\lambda_w + \varepsilon$$

and to test if the λ are jointly significantly different from 1

2. Comparing different supply models:

- Models are not particular cases of other models

- Non-nested testing procedures

  Intuition: Given a null model how "likely" is the alternative model?

THE DATA

- Scanner data collected at several retail stores in two markets over two years - Source: IRI

  Weekly UPC-store level data on prices and quantities for 24 product categories (used yogurt category)

- Demographics at Zip Code level - Source: Census 1990

- Product characteristics - Source: Label reads

THE INPUT DATA

- **Manufacturer level input prices**

Input Prices	Sources
-Citric acid	Chemical Week
-Plastic	Chemical Marketing Reporter
-Sugar	Coffee,Sugar & Cocoa Exchange
-Non-fat Grade A milk	Cheese Market News, USDA
-Whey Protein	Cheese Market News, USDA
-Strawberry	Nat. Agric. Stats, USDA
-Interest rate	Federal Reserve
-Wages	CPS Annual Earning File-NBER 50
- Ohio (plant Dannon)	
- Illinois (plant Kraft, Private Label store 3, retailers)	
- Michigan (plant Yoplait)	
- Oregon (plant Private Label store 2)	
-Gasoline prices	Petroleum Marketing Monthly
-Industrial energy prices for states OH,IL,MI, OR	EIA – 826, Table 53

- **Retail level input prices**

Input Prices	Sources
- Real Estate Indices	CB Richard Ellis
- Commercial energy prices	EIA – 826, Table 53
- Chain size	
Number employees	Human Resources Chains
Number stores	Human Resources Chains
- Gasoline prices	Petroleum Markt. Monthly

YOGURT MARKET

- Why yogurt?

  Short time storable good (ignore dynamic aspects)

  Not heavily promoted by retailers (implications for IV)

  Small number of key industry players

  Reasonably established private labels

- Why should we care about yogurt?

  Application of the general method to a local market

- Manufacturers

  Dannon and General Mills (Yoplait) 62% yogurt sales

  Private labels 15%

  Kraft 5%

  All others have individual shares less than 2%

- Retailers in local market

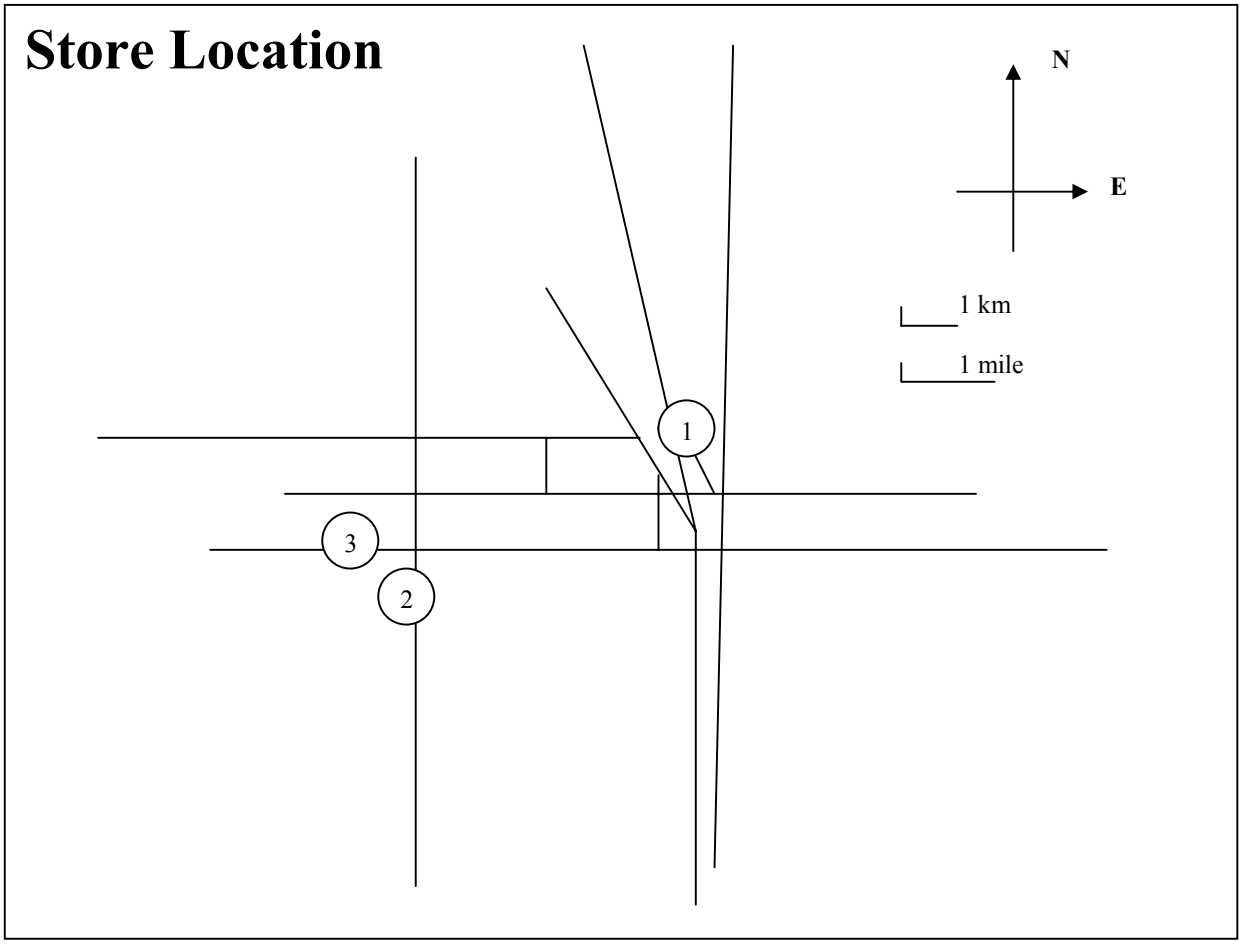
  Three retail chains have jointly 75% sales

- Local market

  Mid-west metropolitan area between 1991-93

  2 Zip Code areas

Store Location



DATA

- **Definition of variables**

Price: in cents per serving, 1 serving = 6 ounce cup

Mean	Median	Std	Min	Max	Brand Variation	Week Variation
49	48	9.2	24	72	68.3%	2.4%

Potential market: half a serving per capita a week

$\Rightarrow$ half the population in two Zip Code areas

International patterns (per capita servings/week)

Bulgaria: 3.4 (Lactobacillus bulgaricus)

France: 1.9; Germany: 1.2; USA: 0.53; Canada: 0.3

Market shares: servings sold / total potential servings

Combined Shares	Mean	Min	Max
Dannon	17%	5%	50%
General Mills	9%	4%	31%
Store 1	2%	1%	9%
Store 2	20%	58%	10%
Store 3	13%	7%	24%

DATA

Outside good: products sold at other retailers

- Demographics

  Median household income: US$ 30,000/year

  Median household size: 2.5 persons

- Product Characteristics

  Store 2 dummy

  Store 3 dummy

  Total calories

  Vitamin A and C content dummy

  Calcium content

  Aspartame content dummy

  Available in different sizes dummy

RESULTS

- **Demand**

Results from Random Coefficients model

Variable	Mean	Interaction with		
		Log(Income)	Age	Unobserv.
Constant	-7.91* (0.25)	0.07 (0.55)	5.55 (1.43)	0.35 (0.26)
Price	-5.69 (0.70)	1.25 (0.28)	-2.43 (2.14)	0.93 (0.48)
Store 2	3.03* (0.04)	1.56 (0.41)	-6.11 (0.55)	0.07 (0.13)
Store 3	1.21* (0.04)	1.43 (0.51)	-5.54 (0.59)	0.15 (0.15)
Calories	-0.25* (0.01)	0.002 (0.002)	-0.006 (0.007)	0.08 (0.05)
Calcium	5.81* (0.14)	0.44 (0.16)	0.25 (0.02)	0.28 (0.11)
Aspartame	-5.81* (0.21)			
Different Sizes	4.65* (0.13)			

Standard errors are in parenthesis. Regression included brand dummy variables, seasonal dummy variables and allows for a non-linear interaction of price with log income. * Estimates from minimum distance procedure.

RESULTS

- **Demand - Are IV working?**

  First Stage
  R^2=0.82
  Wald test{instruments' coefficients=0}=1809 (421)

  Sample coefficients (first stage)

Product	Plastic	Milk	Wage IL	Wage MI
Retail Price of Yoplait Custard Low-fat Fruit	0.006 (0.002)	0.128 (0.058)	0.031 (0.012)	0.015 (0.007)
			Retail Location	Plant Location

  Alternative Specification

  NNLS: not instrumenting for price
  - coefficients change considerably
  - PCM change also

- **Demand - Additional Specification Tests**

  1. set $\nu_i = 0$ - estimates, PCM unchanged
  2. robust to potential market definition

  3. Demand specification with feature
     IV versus OLS
     PCM and ranking of models unchanged
     Cannot reject exogeneity test for feature

RESULTS

- **Demand - Price Elasticities**

  Within store

  Mean Cross Price Elasticity

Product Average	0.035
Store 1 Average	0.009
Store 2 Average	0.055
Store 3 Average	0.034

  Example

	Changes in price of Dannon	
	Classic Fruit	Lowfat Plain
Dannon Light Fruit	0.175	0.006

  Across stores

  Mean Cross Price Elasticity

Product Average	0.030
Store 1 Average	0.025
Store 2 Average	0.035
Store 3 Average	0.032

  Persistent substitution patterns

- **Demand - flexible? Comparison to Logit**

  Overcome Logit restrictions in terms of cross-elasticities (Variance of cross-price elasticities is not zero)

RESULTS

- **Price Cost Margins**

Model	Wholesale Margin		Retail Margin	
	Mean	Std	Mean	Std
Double Marginalization	38.3%	8.2	37.9%	8.7
Zero wholesale margin	0	0	37.9%	8.7
Zero retail margin	37.3%	8.0	0	0
Vertical Integration Private labels	30.8%	14.6	37.9%	8.7
Wholesale collusion	46.4%	11.3	37.9%	8.7
Retail collusion	39.8%	8.4	42.0%	9.6
Efficient vertical pricing	Mean		Std	
	42.0%		9.6	

Recovered Costs

Estimated Costs / Model	Percent Negative	Mean	Std. Dev.	Min	Max
Simple Linear Pricing	8.4%	0.132	0.091	-0.164	0.377
Zero Wholesale Margin	0 %	0.316	0.089	0.049	0.548
Zero Retail Margin	0 %	0.314	0.091	0.043	0.550
Hybrid Model	1.8 %	0.161	0.089	-0.163	0.422
Wholesale Collusion	14 %	0.094	0.095	-0.233	0.354
Retail collusion	13 %	0.105	0.090	-0.195	0.351
Monopolist	0 %	0.294	0.091	0.021	0.530

- **Hypothesis Testing**

  Comparisons between models

RESULTS

- **Non-Nested Tests**

Intuition: Given a null model how likely is the alternative?

Models	1	2.1	2.2	3	4	5	6
1 Double Marginaliz.	-	**1.88**	1.26	1.75	2.55	1.58	2.11
2.1 $PCM_w=0$	**0.93**	-	**0.16**	**0.58**	**0.68**	**0.85**	**0.12**
2.2 $PCM_r=0$	1.09	**3.77**	-	0.56	0.76	1.19	2.15
3 Private label	0.40	**3.26**	0.16	-	0.39	0.28	2.08
4 Wholesale collusion	2.05	**1.88**	0.55	1.15	-	1.06	2.29
5 Retail collusion	0.99	**4.04**	2.43	0.58	0.82	-	2.13
6 Vertical efficient	0.13	**2.08**	0.02	0.22	0.19	0.09	-

One side tests, critical value of 1.65 at 5% significance.

Conclusions:

Model 2.1 provides the best fit

Results similar in alternative demand specifications

EXTENSIONS / APPLICATIONS

- Extensions

  1. Look at vertical contracts across different markets

  2. Look at more than one category (in progress)

- Applications

  1. Vertical merger analysis

     Does a potential merger affect horizontal competition?
     Future project (dairy industry)
     See also Manuszak (2001)

  2. Pass-through of trade policies (tariffs, depreciations)
     Who absorbs most of policy change - foreign or domestic margins? (See Hellerstein, N,Y. Fed working paper, 2004)

  3. Measure marginal cost advantages from exclusive dealing (see Asker, Harvard working paper, 2004)

  4. Price discrimination:
     Fair wholesale price legislation in Gasoline markets in California (as a motivation for future project)
     Test for wholesale price discrimination (in progress)

CONCLUSIONS

- Method to analyze vertical contracts without wholesale prices

- Empirical model of competing manufacturers' and retailers' decisions (related literature does not model retailers' decisions)

- Rule out Double Marginalization model

- Model that best fits the data:

  Marginal wholesale pricing close to marginal cost and retailers choose profit-maximizing prices

- Consistent with several scenarios, for example:

  1. Retailers having large bargaining power

  2. Non-linear pricing by manufacturers
     Two-part tariffs
     Quantity discounts

  3. Others...