Differentiated Products: Applications

- Commonly used instrumental variables
- BLP (1995) – demand for autos using aggregate data
- Goldberg (1995) – demand for autos using consumer level data
- Nevo (2001) – testing the model of competition

Commonly used instrumental variables

- Product characteristics
  treat location in characteristic space as fixed (pre-determined);
  competition varies with location ⇒ markup varies ⇒ price varies with location;

  basic idea appears in Bresnahan;

  BLP use $E(\xi | x) = 0$, therefore we can use various functions of x.
  They propose using: (i) own characteristics;
  (ii) sum of characteristics of other products produced by the same firm;
  (iii) sum of characteristics products produced by other firms;

  most popular IV;

  There are several reasons to doubt the validity of these IV:
  – even if the characteristics are pre-determined it is likely to assume that they were set with some expectation of ξ;
  – if characteristics change a lot why are they not correlated with ξ? If they don't change why not use fixed effects (if we have enough data)?

- Prices in other cities
  assume the data includes brands, in several cities over time.

  $$p_{jct} = mc_{jct} + \text{mup}_{\text{jct}} = mc_{jt} + \Delta mc_{jct} + \text{mup}_{\text{j}} + \text{mup}_{\text{c}} + \text{mup}_{\text{t}} + \Delta\text{mup}_{\text{jct}}$$

  prices are correlated through common shocks to mc (mc_{jt});
  assume that the demand shocks (ξ_{jct}) are independent, conditional on controlling for brand, city and time fixed effects;

  Not as popular as the previous IV:
  - require more data;
  - non-intuitive;
  - several theoretical reasons why these might not work (e.g., national promotional activities or a change in brand preference)

  Note that these IV deal in some sense with a different level of endogeneity.

- Cost shifters
  "classical" demand IV;
  The main problem is that at best we will have cost data at the industry level or the market level:
  - costs of inputs
  - costs of selling

  There will not be brand-level variation. These will work only for very restrictive demand models

- Cost shifters interacted with brand dummy variables

$$mc_{jt} = f_j(\text{cost shifters}_t)$$

  Let the data determine how different brands react differently to supply shocks;

  Requires that we control for brand effects in the demand. Otherwise we might be picking up difference in the average cost pass-through.

  Weak?

Berry, Levinsohn, Pakes "Automobile Prices in Market Equilibrium" (*EMA*, 95) – BLP

Points to take away:
(1) The effect of IV;
(2) Logit versus RC Logit;

This paper develops a method for estimating demand and supply in differentiated products industries, with a focus on the auto industry;

The paper combines various elements that were known before (e.g., the supply model, the RC logit model and estimation using aggregate data) with a method of estimation that deals with endogeneity. The contribution is in the latter and even more importantly in putting all the elements together.

It is arguably the most influential paper in IO in the last decade;
It also draws a huge amount of criticism (most unjustified, in my view);

Data

20 years of annual US national data, 1971-90 (T=20): 2217 model-years;
Quantity data is by name plate (excluding fleet sales);
Price is defined as list prices;
Characteristics are gathered from *Automotive News Market Data Book*;
Price and characteristics correspond to the base model;

Note: little/no use of segment and origin information;

Model

Supply

The profits of firm *f* are

$$\Pi_f = \sum_{j \in \mathscr{F}_f} (p_j - mc_j) M s_j(p) - C_f$$

Assuming: (1) existence of a pure-strategy Bertrand-Nash equilibrium in prices ; (2) prices that support it are strictly positive; the first order conditions are

$$s_j(p) + \sum_{r \in \mathscr{F}_f} (p_r - mc_r) \frac{\partial s_r(p)}{\partial p_j} = 0 \quad j = 1, \ldots, J.$$

Define $S_{jr} = -\partial s_r / \partial p_j \quad j, r = 1, \ldots, J$, and an "ownership" structure defined by

$$H_{jr} = \begin{cases} 1, & \text{if } \exists f\text{: } \{r,j\} \subset \mathscr{F}_f; \\ 0, & \text{otherwise} \end{cases}$$

and let $\Omega_{jr} = H_{jr} * S_{jr}$.

The pricing equation now becomes

$$p - mc = \Omega^{-1} s(p).$$

Let $\ln(mc) = w\gamma + \omega$, where *w* are product characteristics;

Then the supply equation is

$$\ln(p - \Omega^{-1} s(p)) = w\gamma + \omega.$$

Demand

The indirect utility is

$$u_{ijt} = \alpha \log(y_i - p_{jt}) + x_{jt}\beta_i + \xi_{jt} + \epsilon_{ijt},$$

where:

y_i is the income of consumer *i;*
p_{jt} is the price of product *j* in market *t;*
x_{jt} is a $1\times K$ vector of observable characteristics of product *j;*
ξ_{jt} is an unobserved (by the econometrician) product characteristic;
ε_{ijt} is a mean zero stochastic term;
α is a parameter to be estimated;
β_i is $K\times 1$vector of individual specific taste-coefficients.

Note: income enters differently than before.
the paper is somewhat unclear if ξ varies over time.

Assume

$$\beta_i^k = \beta^k + \sigma^k v_i \ , \quad v_i \sim N(0,1), \quad k = 1,...K.$$

The outside option has utility

$$u_{i0t} = \alpha_i \log(y_i) + \xi_{0t} + \sigma_0 v_{i0} + \epsilon_{i0t} \ .$$

Estimation

Basically estimate as we discussed before.

Add supply-side moments to the estimation (this just changes the last step of the algorithm).

It turns out that the supply-side moments really help in pinning down the demand parameters, in the RC Logit (note how the demand parameters enter the supply-side moment). How confident are we in the supply model?

Instrumental variables. They assume $E(\xi | x) = 0$, and use (i) own characteristics; (ii) sum of characteristics of other products produced by the same firm; (iii) sum of characteristics products produced by other firms;

Efficiency. The authors spend a lot of effort to improve the efficiency of the estimates. (i) importance sampling for the simulation of market shares; (ii) discussion of optimal instruments; (iii) parametric distribution for income (log-normal);

Results

Table 3	effect of IV in Logit
Table 4	estimates from the RC Logit
Tables 5-6	elasticities
Table 7	substitution to the outside option (how far away are we from the Logit
Table 8	estimated marginal costs and markups

TABLE III

RESULTS WITH LOGIT DEMAND AND MARGINAL COST PRICING (2217 OBSERVATIONS)

Variable	OLS Logit Demand	IV Logit Demand	OLS ln (*price*) on *w*
Constant	−10.068	−9.273	1.882
	(0.253)	(0.493)	(0.119)
*HP/Weight**	−0.121	1.965	0.520
	(0.277)	(0.909)	(0.035)
Air	−0.035	1.289	0.680
	(0.073)	(0.248)	(0.019)
MP$	0.263	0.052	—
	(0.043)	(0.086)	
*MPG**	—	—	−0.471
			(0.049)
*Size**	2.341	2.355	0.125
	(0.125)	(0.247)	(0.063)
Trend	—	—	0.013
			(0.002)
Price	−0.089	−0.216	—
	(0.004)	(0.123)	
No. Inelastic Demands	1494	22	*n.a.*
(+/−2 *s.e.'s*)	(1429–1617)	(7–101)	
R^2	0.387	*n.a.*	.656

Notes: The standard errors are reported in parentheses.

*The continuous product characteristics—hp/weight, size, and fuel efficiency (*MP$* or *MPG*)—enter the demand equations in levels, but enter the column 3 price regression in natural logs.

TABLE IV

ESTIMATED PARAMETERS OF THE DEMAND AND PRICING EQUATIONS: BLP SPECIFICATION, 2217 OBSERVATIONS

Demand Side Parameters	Variable	Parameter Estimate	Standard Error	Parameter Estimate	Standard Error
Means ($\bar{\beta}$'s)	*Constant*	−7.061	0.941	−7.304	0.746
	HP/Weight	2.883	2.019	2.185	0.896
	Air	1.521	0.891	0.579	0.632
	MP$	−0.122	0.320	−0.049	0.164
	Size	3.460	0.610	2.604	0.285
Std. Deviations (σ_β's)	*Constant*	3.612	1.485	2.009	1.017
	HP/Weight	4.628	1.885	1.586	1.186
	Air	1.818	1.695	1.215	1.149
	MP$	1.050	0.272	0.670	0.168
	Size	2.056	0.585	1.510	0.297
Term on Price (α)	$\ln(y-p)$	43.501	6.427	23.710	4.079
Cost Side Parameters					
	Constant	0.952	0.194	0.726	0.285
	ln (*HP/Weight*)	0.477	0.056	0.313	0.071
	Air	0.619	0.038	0.290	0.052
	ln (*MPG*)	−0.415	0.055	0.293	0.091
	ln (*Size*)	−0.046	0.081	1.499	0.139
	Trend	0.019	0.002	0.026	0.004
	$\ln(q)$			−0.387	0.029

TABLE V

A Sample from 1990 of Estimated Demand Elasticities With Respect to Attributes and Price (Based on Table IV (CRTS) Estimates)

Model	*HP/Weight*	*Air*	*MP$*	*Size*	*Price*
	Value of Attribute/Price Elasticity of demand with respect to:				
Mazda323	0.366	0.000	3.645	1.075	5.049
	0.458	0.000	1.010	1.338	6.358
Sentra	0.391	0.000	3.645	1.092	5.661
	0.440	0.000	0.905	1.194	6.528
Escort	0.401	0.000	4.022	1.116	5.663
	0.449	0.000	1.132	1.176	6.031
Cavalier	0.385	0.000	3.142	1.179	5.797
	0.423	0.000	0.524	1.360	6.433
Accord	0.457	0.000	3.016	1.255	9.292
	0.282	0.000	0.126	0.873	4.798
Taurus	0.304	0.000	2.262	1.334	9.671
	0.180	0.000	−0.139	1.304	4.220
Century	0.387	1.000	2.890	1.312	10.138
	0.326	0.701	0.077	1.123	6.755
Maxima	0.518	1.000	2.513	1.300	13.695
	0.322	0.396	−0.136	0.932	4.845
Legend	0.510	1.000	2.388	1.292	18.944
	0.167	0.237	−0.070	0.596	4.134
TownCar	0.373	1.000	2.136	1.720	21.412
	0.089	0.211	−0.122	0.883	4.320
Seville	0.517	1.000	2.011	1.374	24.353
	0.092	0.116	−0.053	0.416	3.973
LS400	0.665	1.000	2.262	1.410	27.544
	0.073	0.037	−0.007	0.149	3.085
BMW 735i	0.542	1.000	1.885	1.403	37.490
	0.061	0.011	−0.016	0.174	3.515

Notes: The value of the attribute or, in the case of the last column, price, is the top number and the number below it is the elasticity of demand with respect to the attribute (or, in the last column, price.)

TABLE VI

A SAMPLE FROM 1990 OF ESTIMATED OWN- AND CROSS-PRICE SEMI-ELASTICITIES: BASED ON TABLE IV (CRTS) ESTIMATES

	Mazda 323	Nissan Sentra	Ford Escort	Chevy Cavalier	Honda Accord	Ford Taurus	Buick Century	Nissan Maxima	Acura Legend	Lincoln Town Car	Cadillac Seville	Lexus LS400	BMW 735i
323	−125.933	1.518	8.954	9.680	2.185	0.852	0.485	0.056	0.009	0.012	0.002	0.002	0.000
Sentra	0.705	−115.319	8.024	8.435	2.473	0.909	0.516	0.093	0.015	0.019	0.003	0.003	0.000
Escort	0.713	1.375	−106.497	7.570	2.298	0.708	0.445	0.082	0.015	0.015	0.003	0.003	0.000
Cavalier	0.754	1.414	7.406	−110.972	2.291	1.083	0.646	0.087	0.015	0.023	0.004	0.003	0.000
Accord	0.120	0.293	1.590	1.621	−51.637	1.532	0.463	0.310	0.095	0.169	0.034	0.030	0.005
Taurus	0.063	0.144	0.653	1.020	2.041	−43.634	0.335	0.245	0.091	0.291	0.045	0.024	0.006
Century	0.099	0.228	1.146	1.700	1.722	0.937	−66.635	0.773	0.152	0.278	0.039	0.029	0.005
Maxima	0.013	0.046	0.236	0.256	1.293	0.768	0.866	−35.378	0.271	0.579	0.116	0.115	0.020
Legend	0.004	0.014	0.083	0.084	0.736	0.532	0.318	0.506	−21.820	0.775	0.183	0.210	0.043
TownCar	0.002	0.006	0.029	0.046	0.475	0.614	0.210	0.389	0.280	−20.175	0.226	0.168	0.048
Seville	0.001	0.005	0.026	0.035	0.425	0.420	0.131	0.351	0.296	1.011	−16.313	0.263	0.068
LS400	0.001	0.003	0.018	0.019	0.302	0.185	0.079	0.280	0.274	0.606	0.212	−11.199	0.086
735*i*	0.000	0.002	0.009	0.012	0.203	0.176	0.050	0.190	0.223	0.685	0.215	0.336	−9.376

Note: Cell entries i, j, where i indexes row and j column, give the percentage change in market share of i with a $1000 change in the price of j.

TABLE VII

SUBSTITUTION TO THE OUTSIDE GOOD

Model	Given a price increase, the percentage who substitute to the outside good (as a percentage of all who substitute away.) Logit	BLP
Mazda 323	90.870	27.123
Nissan Sentra	90.843	26.133
Ford Escort	90.592	27.996
Chevy Cavalier	90.585	26.389
Honda Accord	90.458	21.839
Ford Taurus	90.566	25.214
Buick Century	90.777	25.402
Nissan Maxima	90.790	21.738
Acura Legend	90.838	20.786
Lincoln Town Car	90.739	20.309
Cadillac Seville	90.860	16.734
Lexus LS400	90.851	10.090
BMW 735*i*	90.883	10.101

TABLE VIII

A SAMPLE FROM 1990 OF ESTIMATED PRICE-MARGINAL COST MARKUPS AND VARIABLE PROFITS: BASED ON TABLE 6 (CRTS) ESTIMATES

	Price	Markup Over MC $(p - MC)$	Variable Profits (in $'000's) $q*(p - MC)$
Mazda 323	$5,049	$ 801	$18,407
Nissan Sentra	$5,661	$ 880	$43,554
Ford Escort	$5,663	$1,077	$311,068
Chevy Cavalier	$5,797	$1,302	$384,263
Honda Accord	$9,292	$1,992	$830,842
Ford Taurus	$9,671	$2,577	$807,212
Buick Century	$10,138	$2,420	$271,446
Nissan Maxima	$13,695	$2,881	$288,291
Acura Legend	$18,944	$4,671	$250,695
Lincoln Town Car	$21,412	$5,596	$832,082
Cadillac Seville	$24,353	$7,500	$249,195
Lexus LS400	$27,544	$9,030	$371,123
BMW 735*i*	$37,490	$10,975	$114,802

Comments

Clearly show: effect of IV
RC logit versus logit

Powerful method with potential for many applications

Common complaints:
– innovation/application
– RC Logit/Nested Logit – use of all the information
– instruments
– supply side: static, not tested, driving the results
– demand side dynamics

Goldberg "Product Differentiation and Oligopoly in International Markets: The Case of the Automobile Industry" (*EMA*, 95)

This paper is really a trade paper we will focus on the method and not the applications.

Points to take away:

(1) Endogeneity with household-level date;
(2) Nested Logit versus RC Logit;

General Strategy

- Estimate demand using micro data;
- Use weights to get aggregate demand;
- Match with "standard" supply model;

Model

Demand

Nested Logit where the nests are determined by buy/not buy, new/used, county of origin (foreign vs domestic) and segment (sub-compact, compact, etc.)

This model can be viewed as using segment and county of origin as (dummy) characteristics, and assuming a particular distribution on their coefficients.

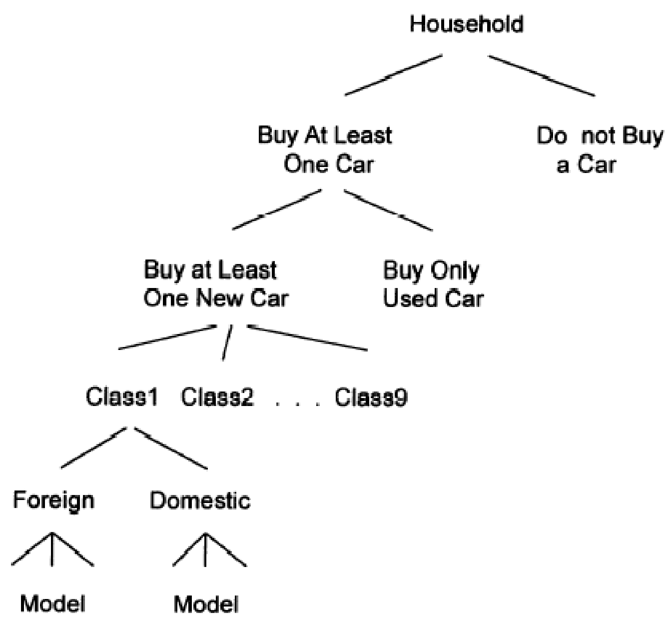

FIGURE 1.—Automobile choice model.

Data

Household-level survey from the Consumer Expenditure Survey:

20,571, HH between 83-87,
6,172 (30%) bought a car,
1,992 (33%) new car,
1,394 (70%) domestic and 598 foreign

Prices (and characteristics) are obtained from *Automotive News Market Data Book;*

Estimation
The model is estimated by ML.

The likelihood is partitioned and estimated recursively:
At the lowest level the choice of model conditional on origin, segment and neweness, based on the estimated parameters an "inclusive value" is computed and used to estimate the choice of origin conditional on segment and neweness, etc.

$$P^h_{i_s/j_{s-1}} = \exp\left(X^h_{i_s}\theta_s/\lambda_{j_{s-1}} + I^h_{i_s}\lambda_{i_s}/\lambda_{j_{s-1}}\right) \Big/ \sum_{k \in C_{j_{s-1}}} \exp\left(X^h_{k_s}\theta_s/\lambda_{j_{s-1}} + I^h_{k_s}\lambda_{k_s}/\lambda_{j_{s-1}}\right)$$

where

$$I^h_{i_s} = \log\left[\sum_{p \in C_{i_s}} \exp\left(X^h_{p_{s+1}}\theta_{s+1}/\lambda_{i_s}\right)\right].$$

Does not deal with endogeneity. Origin and segment fixed effects are included, but these do not fully account for brand unobserved characteristics.

Results

Table II: price elasticities by class
Table III: price semi-elasticities
Table IV: implied markups

TABLE II
PRICE ELASTICITIES OF DEMAND (AVERAGE BY CLASS)

Class	Origin	Elasticity	Elasticity (first time buyer)	Elasticity (repeat buyer)
Subcompacts	DOM	−3.2857	−3.6245	−2.9816
	FOR	−3.6797	−5.2531	−2.9488
Compacts	DOM	−3.419	−4.8722	−3.1546
	FOR	−4.0319	−5.7229	−3.3733
Intermediate	DOM	−4.1799	−5.3153	−2.8420
	FOR	−5.1524	−6.2232	−4.9274
Standard	DOM	−4.7121	−5.932	−4.3730
Luxury	DOM	−1.9121	−2.5981	−1.1137
	FOR	−2.7448	−3.1272	−1.9959
Sports	DOM	−1.0654	−2.3468	−1.3959
	FOR	−1.5254	3.0211	−1.1429
Pick-ups	DOM	−3.5259	−5.1391	−3.1647
	FOR	−2.6883	−3.9822	−2.1483
Vans	DOM	−4.3633	−5.4977	−3.9790
	FOR	−4.6548	−4.8837	−2.4376
Other	DOM	−4.0884	−4.3185	−3.5694
	FOR	−3.0271	−3.3185	−2.3345

TABLE III

CROSS PRICE SEMI-ELASTICITIES FOR SELECTED MODELS

	Chevette	Civic	Tercel	Escort	Accord
Chevette	−3.2	49.1E − 07	16.4E − 07	0.9E − 07	9.0E − 07
Civic	7.6E − 07	−3.4	35.5E − 07	0.8E − 07	14.9E − 07
Tercel	7.7E − 07	109.8E − 07	−3.4	0.8E − 07	11.6E − 07
Escort	6.3E − 07	34.6E − 07	11.3E − 07	−3.4	12.5E − 07
Accord	6.1E − 07	66.2E − 07	16.2E − 07	1.3E − 07	−3.4
Mazda 626	6.4E − 07	50.1E − 07	15.3E − 07	1.7E − 07	72.2E − 07
Century	5.5E − 07	28.0E − 07	9.6E − 07	0.8E − 07	7.1E − 07
Skylark	5.5E − 07	28.6E − 07	9.9E − 07	0.8E − 07	7.1E − 07
Audi 5000	5.7E − 07	48.6E − 07	16.6E − 07	0.8E − 07	10.1E − 07
Diplomat	4.9E − 07	25.5E − 07	8.7E − 07	0.8E − 07	6.6E − 07
Cad. Fleetwood	0.3E − 07	2.1E − 07	0.7E − 07	0.1E − 07	0.5E − 07
Park Avenue	0.3E − 07	2.1E − 07	0.7E − 07	0.1E − 07	0.5E − 07
Jaguar	0.3E − 07	3.2E − 07	1.0E − 07	0.0E − 07	0.6E − 07
Fiero	0.4E − 07	3.0E − 07	1.0E − 07	0.1E − 07	0.7E − 07
Ferrari	0.4E − 07	4.0E − 07	1.3E − 07	0.1E − 07	0.8E − 07

	Mazda 626	Century	Skylark	Audi 5000	Diplomat
Chevette	18.0E − 07	0.3E − 07	0.1E − 07	7.8E − 07	0.1E − 07
Civic	21.8E − 07	0.2E − 07	0.1E − 07	10.2E − 07	0.1E − 07
Tercel	20.7E − 07	0.3E − 07	0.1E − 07	10.7E − 07	0.1E − 07
Escort	32.4E − 07	0.3E − 07	0.1E − 07	7.1E − 07	0.2E − 07
Accord	140.9E − 07	0.3E − 07	0.1E − 07	9.2E − 07	0.1E − 07
Mazda 626	−3.4	0.3E − 07	0.1E − 07	8.1E − 07	0.2E − 07
Century	16.0E − 07	−4.8	0.3E − 07	11.1E − 07	0.2E − 07
Skylark	15.9E − 07	0.7E − 07	−3.8	11.4E − 07	0.2E − 17
Audi 5000	17.0E − 07	0.5E − 07	0.2E − 07	−4.0	0.2E − 07
Diplomat	18.2E − 07	0.4E − 07	0.1E − 07	7.1E − 07	−3.8
Cad. Fleetwood	1.2E − 07	0.0E − 07	0.0E − 07	0.5E − 07	0.0E − 07
Park Avenue	1.2E − 07	0.0E − 07	0.0E − 07	0.5E − 07	0.0E − 07
Jaguar	1.1E − 07	0.0E − 07	0.0E − 07	0.6E − 07	0.0E − 07
Fiero	2.2E − 07	0.0E − 07	0.0E − 07	0.6E − 07	0.0E − 07
Ferrari	1.5E − 07	0.0E − 07	0.0E − 07	0.7E − 07	0.0E − 07

	Fleetwood	Park Avenue	Jaguar	Fiero	Ferrari
Chevette	3.0E − 07	3.4E − 07	6.8E − 07	1.0E − 07	0.7E − 07
Civic	3.0E − 07	3.4E − 07	11.0E − 07	1.2E − 07	1.2E − 07
Tercel	3.2E − 07	3.5E − 07	11.3E − 07	1.2E − 07	1.2E − 07
Escort	3.1E − 07	3.4E − 07	6.2E − 07	1.1E − 07	0.7E − 07
Accord	2.9E − 07	3.4E − 07	9.4E − 07	1.2E − 07	1.0E − 07
Mazda 626	3.9E − 07	4.6E − 07	9.8E − 07	2.0E − 07	1.0E − 07
Century	3.8E − 07	4.7E − 07	7.0E − 07	0.9E − 07	0.5E − 07
Skylark	3.9E − 07	4.8E − 07	7.2E − 07	0.9E − 07	0.5E − 07
Audi 5000	3.6E − 07	3.9E − 07	10.7E − 07	1.0E − 07	1.1E − 07
Diplomat	4.8E − 07	5.0E − 07	8.1E − 07	1.0E − 07	0.5E − 07
Cad. Fleetwood	−0.9	38.9E − 07	1.6E − 07	0.1E − 07	0.0E − 07
Park Avenue	33.5E − 07	−0.9	1.5E − 07	0.1E − 07	0.0E − 07
Jaguar	0.6E − 07	0.7E − 07	−0.9	0.1E − 07	0.1E − 07
Fiero	0.3E − 07	0.3E − 07	0.6E − 07	−0.9	0.1E − 07
Ferrari	0.2E − 07	0.2E − 07	0.9E − 07	0.1E − 07	−1.0

Note: Each entry (i, j), where i is the row and j is the column, refers to the percent change in the demand for model i

TABLE IV

MARGINAL COSTS AND MARKUPS

Class	Origin	Cost	Price	Markup	(Price − Cost)
1	DOM	3906	6628	0.36	2722
1	FOR	5688	7840	0.27	2152
2	DOM	3213	6391	0.43	3178
2	FOR	5430	6610	0.19	1180
3	DOM	4773	7134	0.33	2361
3	FOR	9300	12781	0.30	3421
4	DOM	4866	8632	0.40	3766
5	DOM	7247	13458	0.46	6301
5	FOR	10379	18499	0.43	8129
6	DOM	3715	10105	0.69	6390
6	FOR	5822	12823	0.56	7001
7	DOM	5101	8229	0.37	3128
7	FOR	2758	5611	0.41	2583
8	DOM	6937	9634	0.30	2697
8	FOR	12691	15291	0.17	2600
9	DOM	8333	10121	0.15	1788
9	FOR	2750	5174	0.44	2424

Model	Cost	Price	Markup	(Price − Cost)
Civic	4884	5680	0.14	796
Escort	3068	4565	0.33	1497
Lynx	3069	4325	0.29	1256
Accord	5286	5854	0.10	567
Audi 5000	7353	14165	0.48	6812
Oldsmobile 98	5372	11295	0.52	5923
Jaguar	10768	19091	0.44	8323
Mercedes 300	13188	22662	0.42	9474
Porsche 944	5714	13136	0.56	7422
Ferrari	7679	19698	0.61	12018

Nevo, "Measuring Market Power in the Ready-to-Eat Cereal Industry" (*EMA*, 2001)

Points to take away:
- effects of various IV's
- testing the model of competition
- comparison to alternative demand models (later)

The RTE cereal industry is characterized by:
- high concentration (C3≈75%, C6≈90%),
- high price-cost margins (≈45%),
- large advertising to sales ratios (≈13%),
- numerous introductions of brands (67 new brands by top 6 in 80's).

This has been used to claim that this is a perfect example of collusive pricing.

This paper asks:
- Is pricing in the industry collusive?
- What portion of the markups in the industry is due to:
  - Product differentiation?
  - Multi-product firms?
  - Potential price collusion?

The strategy is:
- Estimate brand level demand
- Compute PCM predicted by different industry structures\models of conduct:
  - Single-product firms
  - Current ownership (multi-product firms)
  - Fully collusive pricing (joint ownership)
- Compare predicted PCM to observed PCM

Model

Supply

The profits of firm *f* are

$$\Pi_f = \sum_{j \in \mathcal{F}_f} (p_j - mc_j) M s_j(p) - C_f$$

Assuming: (1) existence of a pure-strategy Bertrand-Nash equilibrium in prices ; (2) prices that support it are strictly positive; the first order conditions are

$$s_j(p) + \sum_{r \in \mathcal{F}_f} (p_r - mc_r) \frac{\partial s_r(p)}{\partial p_j} = 0.$$

Define $S_{jr} = -\partial s_r / \partial p_j \quad j, r = 1, \ldots, J,$

$$\Omega^*_{jr} = \begin{cases} 1, & \text{if } \exists f\text{: } \{r,j\} \subset \mathcal{F}_f; \\ 0, & \text{otherwise} \end{cases}$$

and $\Omega_{jr} = \Omega^*_{jr} * S_{jr}$.

Then the first order conditions become

$$s(p) - \Omega(p - mc) = 0.$$

Which implies a pricing equation

$$p - mc = \Omega^{-1} s(p).$$

Therefore by: (1) assuming a model of conduct; and (2) using estimates of the demand substitution; we are able to compute price-cost margins under different "ownership" structures (i.e., different Ω^*).

Demand

i=1,...,I consumers

$$u_{ijt} = x_j \beta_i^* - \alpha_i^* p_{jt} + \xi_j + \Delta\xi_{jt} + \epsilon_{ijt},$$

$$i = 1,...,I_t \quad j = 1,...,J, \quad t = 1,...,T$$

where:

- p_{jt} is the price of product j in market t;
- x_{jt} is a $1\times K$ vector of observable characteristics of product j;
- ξ_j is the mean of an unobserved (by the econometrician) product characteristic;
- $\Delta\xi_{jt}$ is the deviation around the mean of the an unobserved product characteristic;
- ε_{ijt} is a mean zero stochastic term;
- α_i is the marginal utility from income;
- β_i is $K\times 1$vector of individual specific taste-coefficients.

Let

$$\begin{pmatrix} \alpha_i^* \\ \beta_i^* \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta \end{pmatrix} + \Pi D_i + \Sigma v_i \ , \quad v_i \sim N(0, I_{K+1}),$$

The distribution of demographics is going to be estimated non-parametrically from the Consumer Population Survey.

Allow for outside option

$$u_{i0t} = \xi_{0t} + \pi_0 D_i + \sigma_0 v_{i0} + \epsilon_{i0t} \ .$$

Data

- IRI Infoscan scanner data
  market shares – defined by converting volume to servings
  prices – pre-coupon real transaction per serving price
- 25 brands (top 25 in last quarter), in 67 cities (number increases over time) over 20 quarters (1988-1992); 1124 markets, 27862 observations;
- LNA advertising data
- Characteristics from cereal boxes
- Demographics from March CPS
- Cost instruments from Monthly CPS

- Market size – one serving per consumer per day

Estimation

Follows the method we discussed before;

Instruments explore various options:

- characteristics of competition (used by previous work); problematic for this sample, with brand FE.
- prices in other cities

$$p_{jt} = mc_{jt} + f(\xi_{jt},...) = (mc_j + f_j) + (\Delta mc_{jt} + \Delta f_{jt}) \ .$$

- proxies for city level costs: density, earning in retail sector, and transportation costs.

Brand fixed effects

- control for unobserved quality (instead of instrumenting for it).
- identify taste coefficients by minimum distance

TABLE 5
RESULTS FROM LOGIT DEMAND

	OLS			IV						
Variable	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
Price	-4.96 (0.10)	-7.26 (0.16)	-7.97 (0.15)	-8.17 (0.11)	-17.57 (0.50)	-17.12 (0.49)	-22.56 (0.51)	-23.77 (0.53)	-23.37 (0.47)	-23.07 (1.17)
Advertising	0.158 (0.002)	0.026 (0.002)	0.026 (0.002)	0.157 (0.002)	0.020 (0.002)	0.020 (0.002)	0.018 (0.002)	0.017 (0.002)	0.018 (0.002)	0.013 (0.002)
log of median income	–	–	0.89 (0.02)	–	–	–	1.06 (0.02)	1.13 (0.02)	1.12 (0.02)	–
log of median age	–	–	-0.423 (0.052)	–	–	–	-0.063 (0.059)	0.003 (0.062)	-0.007 (0.061)	–
median HH size	–	–	-0.126 (0.027)	–	–	–	-0.053 (0.029)	-0.036 (0.031)	-0.038 (0.031)	–
Fit/Test of over identification: [a]	0.54	0.72	0.74	436.9 (26.30)	168.5 (30.14)	181.2 (16.92)	83.96 (30.14)	82.95 (16.92)	85.87 (42.56)	15.06 (42.56)
1[st] Stage R^2	–	–	–	0.889	0.908	0.908	0.910	0.909	0.913	0.952
1[st] Stage F-test	–	–	–	5119	124	288	129	291	144	180

TABLE 6
RESULTS FROM THE FULL MODEL

Variable	Means (β's)	Standard Deviations (σ's)	Interactions with Demographic Variables: Income	Income Sq	Age	Child
Price	-27.198	2.453	315.894	-18.200	–	7.634
	(5.248)	(2.978)	(110.385)	(5.914)		(2.238)
Advertising	0.020	–	–	–	–	–
	(0.005)					
Constant	-3.592[a]	0.330	5.482	–	0.204	–
	(0.138)	(0.609)	(1.504)		(0.341)	
Cal from Fat	1.146[a]	1.624	–	–	–	–
	(0.128)	(2.809)				
Sugar	5.742[a]	1.661	-24.931	–	5.105	–
	(0.581)	(5.866)	(9.167)		(3.418)	
Mushy	-0.565[a]	0.244	1.265	–	0.809	–
	(0.052)	(0.623)	(0.737)		(0.385)	
Fiber	1.627[a]	0.195	–	–	–	-0.110
	(0.263)	(3.541)				(0.0513)
All-family	0.781[a]	0.1330	–	–	–	
	(0.075)	(1.365)				
Kids	1.021[a]	2.031	–	–	–	
	(0.168)	(0.448)				
Adults	1.972[a]	0.247	--	--	–	
	(0.186)	(1.636)				
GMM Objective (degrees of freedom)			5.05 (8)			
MD χ^2			3472.3			
% of Price Coefficients >0			0.7			

Based on 27,862 observations. Except where noted, parameters are GMM estimates. All regressions include brand and time dummy variables. Asymptotically robust standard errors are given in parentheses. [a] Estimates from a minimum-distance procedure.

TABLE 7
MEDIAN OWN AND CROSS-PRICE ELASTICITIES

#	Brand	Corn Flakes	Frosted Flakes	Rice Krispies	Froot Loops	Cheerios	Total	Lucky Charms	P Raisin Bran	CapN Crunch	Shredded Wheat
1	K Corn Flakes	-3.379	0.212	0.197	0.014	0.202	0.097	0.012	0.013	0.038	0.028
2	K Raisin Bran	0.036	0.046	0.079	0.043	0.145	0.043	0.037	0.057	0.050	0.040
3	K Frosted Flakes	0.151	-3.137	0.105	0.069	0.129	0.079	0.061	0.013	0.138	0.023
4	K Rice Krispies	0.195	0.144	-3.231	0.031	0.241	0.087	0.026	0.031	0.055	0.046
5	K Frosted Mini Wheats	0.014	0.024	0.052	0.043	0.105	0.028	0.038	0.054	0.045	0.033
6	K Froot Loops	0.019	0.131	0.042	-2.340	0.072	0.025	0.107	0.027	0.149	0.020
7	K Special K	0.114	0.124	0.105	0.021	0.153	0.151	0.019	0.021	0.035	0.035
8	K Crispix	0.077	0.086	0.114	0.034	0.181	0.085	0.030	0.037	0.048	0.043
9	K Corn Pops	0.013	0.109	0.034	0.113	0.058	0.025	0.098	0.024	0.127	0.016
10	GM Cheerios	0.127	0.111	0.152	0.034	-3.663	0.085	0.030	0.037	0.056	0.050
11	GM Honey Nut Cheerios	0.033	0.192	0.058	0.123	0.094	0.034	0.107	0.026	0.162	0.024
12	GM Wheaties	0.242	0.169	0.175	0.025	0.240	0.113	0.021	0.026	0.050	0.043
13	GM Total	0.096	0.108	0.087	0.018	0.131	-2.889	0.017	0.017	0.029	0.029
14	GM Lucky Charms	0.019	0.131	0.041	0.124	0.073	0.026	-2.536	0.027	0.147	0.020
15	GM Trix	0.012	0.103	0.031	0.109	0.056	0.026	0.096	0.024	0.123	0.016
16	GM Raisin Nut	0.013	0.025	0.042	0.035	0.089	0.040	0.031	0.046	0.036	0.027
17	GM Cinn Toast Crunch	0.026	0.164	0.049	0.119	0.089	0.035	0.102	0.026	0.151	0.022
18	GM Kix	0.050	0.279	0.070	0.101	0.106	0.056	0.088	0.020	0.149	0.025
19	P Raisin Bran	0.027	0.037	0.068	0.044	0.127	0.035	0.038	-2.496	0.049	0.036
20	P Grape Nuts	0.037	0.049	0.088	0.042	0.165	0.050	0.037	0.051	0.052	0.047
21	P Honey Bunches of Oats	0.100	0.098	0.104	0.022	0.172	0.109	0.020	0.024	0.038	0.033
22	Q 100% Natural	0.013	0.021	0.046	0.042	0.103	0.029	0.036	0.052	0.046	0.029
23	Q Life	0.077	0.328	0.091	0.114	0.137	0.046	0.096	0.023	0.182	0.029
24	Q CapNCrunch	0.043	0.218	0.064	0.124	0.101	0.034	0.106	0.026	-2.277	0.024
25	N Shredded Wheat	0.076	0.082	0.124	0.037	0.210	0.076	0.034	0.044	0.054	-4.252
26	Outside good	0.141	0.078	0.084	0.022	0.104	0.041	0.018	0.021	0.033	0.021

TABLE 8
MEDIAN MARGINS

	Logit (Table 5 column ix)	Full Model (Table 6)
Single Product Firms	33.6% (31.8% – 35.6%)	35.8% (24.4% – 46.4%)
Current Ownership of 25 Brands	35.8% (33.9% – 38.0%)	42.2% (29.1% – 55.8%)
Joint Ownership of 25 Brands	41.9% (39.7% – 44.4%)	72.6% (62.2% – 97.2%)
Current Ownership of All Brands	37.2% (35.2% – 39.4%)	–
Monopoly/Perfect Price Collusion	54.0% (51.1% – 57.3%)	–

Margins are defined as (p-mc)/p. Presented are medians of the distribution of 27,862 (brand-city-quarter) observations. 95% confidence intervals for these medians are reported in parentheses based on the asymptotic distribution of the estimated demand coefficients. For the Logit model the computation is analytical, while for the full model the computation is based on 1,500 draws from this distribution.

TABLE 3
DETAILED ESTIMATES OF PRODUCTION COSTS

Item	$/lb	% of mfr price	% of retail price
Manufacturer Price	2.40	100.0	80.0
Manufacturing Cost:	1.02	42.5	34.0
Grain	0.16	6.7	5.3
Other Ingredients	0.20	8.3	6.7
Packaging	0.28	11.7	9.3
Labor	0.15	6.3	5.0
Manufacturing Costs (net of capital costs)*	0.23	9.6	7.6
Gross Margin		57.5	46.0
Marketing Expenses:	0.90	37.5	30.0
Advertising	0.31	13.0	10.3
Consumer Promo (mfr coupons)	0.35	14.5	11.7
Trade Promo (retail in-store)	0.24	10.0	8.0
Operating Profits	0.48	20.0	16.0

*Capital costs were computed from ASM data.

Source: Cotterill (1996) reporting from estimates in CS First Boston Reports "Kellogg Company," New York, October 25,1994.

TABLE B2
ADDITIONAL RESULTS FROM THE FULL MODEL

	Variable	(i) Est.	(i) s.e	(ii) Est.	(ii) s.e	(iii) Est.	(iii) s.e	(iv) Est.	(iv) s.e
Means (β's)	Price	-25.595	2.673	-4.291	0.143	-7.407	0.164	-9.856	3.039
	Advertisin	0.022	0.004	0.171	0.002	0.027	0.002	0.180	0.016
	g	-4.265[a]	0.074	-3.220	0.040	-	0.027	-5.663	2.376
	Constant	0.716[a]	0.112	-0.398	0.035	3.706[a]	0.026	-0.100	0.174
	Fat Cal	10.344[a]	0.434	2.761	0.110	-	0.078	-4.004	3.243
	Sugar	-0.325[a]	0.031	-0.181	0.011	0.037[a]	0.007	-12.774	5.350
	Mushy	1.880[a]	0.126	0.180	0.063	2.453[a]	0.044	0.557	1.964
	Fiber	0.935[a]	0.069	0.242	0.021	-	0.014	-0.913	0.613
	All-family	-0.044[a]	0.136	0.187	0.018	0.004[a]	0.012	0.106	0.581
	Kids	1.194[a]	0.175	0.134	0.018	0.608[a]	0.013	-0.343	0.747
	Adults					0.488[a]			
						0.411[a]			
						0.352[a]			
Standard Deviations (σ's)	Price	–		0.153	0.064	0.124	0.053	1.757	6.479
	Constant	–		0.036	0.013	0.029	0.011	0.580	1.515
	Fat Cal	1.427	2.928	0.087	0.071	0.094	0.068	0.035	6.703
	Sugar	–		0.296	0.119	0.342	0.098	3.962	12.613
	Mushy	–		0.006	0.020	0.024	0.016	15.071	5.377
	Fiber	–		0.028	0.093	0.086	0.075	3.057	5.824
	All-family	0.144	0.988	0.006	0.031	0.015	0.023	2.551	0.911
	Kids	1.888	0.275	0.009	0.019	0.007	0.017	1.067	2.212
	Adults	0.304	0.893	0.042	0.028	0.024	0.025	1.339	0.965
Interaction w\ Income	Price	311.101	61.797	34.565	1.455	8.552	0.974	21.575	96.912
	Constant	4.786	1.078	-2.027	0.041	-0.187	0.040	-0.913	3.484
	Sugar	-29.449	6.581	-5.013	0.221	-2.334	0.172	-12.035	9.658
	Mushy	0.817	0.594	0.653	0.023	0.011	0.020	0.021	6.452
Interaction w\ Income^2	Price	-17.610	3.217	-1.206	0.072	-0.312	0.050	-1.075	5.741
Interaction w\ Age	Constant	0.208	0.215	0.060	0.035	0.055	0.026	5.794	0.988
	Sugar	3.949	2.501	-0.696	0.253	-0.045	0.202	6.133	12.380
	Mushy	-0.805	0.256	0.165	0.031	0.083	0.024	-3.380	2.563
Interaction w\ Child	Price	5.158	1.813	1.011	0.315	1.633	0.248	42.207	13.993
	Fiber	-4.909	3.316	1.256	0.334	0.563	0.261	-4.692	8.648
% of Price Coefficients >0		0		16.1		0		22.4	
single-product PCM		36.1%		67.6%		75.7%		48.2%	
multi-product PCM		41.9%		75.6%		84.5%		54.0%	
collusive PCM		67.4%		103.9%		117.6%		88.9%	

Comments/Issues

1) Is choice discrete?

Discuss timing.

2) Ignores the retailer – uses retailer prices to study manufacturer competition

retail margins go into marginal cost;
marginal costs do not vary with quantity, therefore this restricts the retailers pricing behavior;
which direction will this bias the finding? Most likely towards finding collusion where there is none (the retailer behavior might take into account effects across products).

3) Why not use conduct parameters? How would one introduce them? Are they identified? See Nevo (*Economics Letters*, 1998)