Problem Set: BLP Methodology

Attached is a table of market shares, prices, and characteristics on the top-selling brands of cereal in 1992. The data are aggregated from household-level scanner data (collected at supermarket checkout counters).

The market shares below are shares of *total cereal purchases* observed in the dataset. For the purposes of this problem set, assume that all households purchased some cereal during 1992 (so that non-purchase is not an option).* Assume that brand #51, the composite basket of "all other brands", is the outside good.

Two sets of prices are given in the table. *Shelf prices* are those listed on supermarket shelves, and do not include coupon discounts. *Transactions prices* are prices actually paid by consumers, net of coupon discounts. Estimate using the transactions prices. Note that you should subtract the price of brand #51, the "outside good", from the prices of the top fifty brands.

Assume a utility specification for u_{ij}, household i's utility from brand j:

$$u_{ij} = X_j\beta - \alpha p_j + \xi_j + \nu_{ij}$$

where X_j are characteristics of brand j, ξ_j is an unobserved (to the econometrician) quality parameter for brand j, and ν_{ij} is a disturbance term which is identicially and independently distributed (i.i.d.) over households i and brands j. As in Berry (1994), denote the mean utility level from brand j as

$$\delta_j \equiv X_j\beta - \alpha p_j + \xi_j.$$

1. Assuming that the ν_{ij}'s are distributed i.i.d. type I extreme value, derive the resulting expressions for the market shares of each brand j, $j = 1, \ldots, 51$.

Next we implement the BLP two-step estimator.

2. Invert the resulting system of demand functions to get estimates of the mean utility levels δ_j as a function of the shares s_j. (Hint: look in Berry (1994, pg. 250)).

3. Estimate the second stage regression of δ_j on X_j and p_j in different ways:

(a) OLS

(b) 2SLS: using average characteristics for all other brands produced by the same manufacturer as brand j as instruments for p_j

(c) 2SLS: using average characteristics for all other brands produced by rivals to the manufacturer as brand j as instruments for p_j

(d) 2SLS: using average characteristics for all other brands as instruments for p_j

*This is not far from the truth; from an alternative data source (the *IRI Marketing FactBook*), one finds out that in 1992, 97.1% of American households purchased at least some cereal during the year.

How do your results differ?

4. From the aggregate demand functions derived in question 1, derive the formulas for the derivatives $\frac{\partial s_j}{\partial p_{j'}}$ and the elasticities $\epsilon_{ij} \equiv \frac{\partial s_j}{\partial p_{j'}} \frac{p_{j'}}{s_j}$, where j and j' are any two pairs of brands.

What is the difference between ϵ_{ik} and ϵ_{jk}. Explain the implication of this.

5. Assuming that the manufacturers of the top fifty brands compete in Bertrand fashion, derive the fifty first-order conditions which define prices in this market, assuming constant marginal costs of production for each brand (and ignoring advertising costs). In other words, assume that the total cost function for brand j $C_j(q_j) = c_j q_j$.

These FOCs are a system of *linear* equations in the unknowns $c_1, \ldots, c_{50}$. Using the expression derived in question 4 above, rewrite these FOCs completely in terms of the known prices, shares, and parameters (in particular, α).

6. Solve for the marginal costs from this system of equations. Recall that linear equations of the form $Ax = b$ can be solved by $x = A^{-1}b$.

After deriving these costs, solve for the markup $\frac{p_j - c_j}{p_j}$ associated with each brand.

References

Berry, S. (1994): "Estimating Discrete Choice Models of Product Differentiation," *Rand Journal of Economics*, 25(2), 242–262.

Leading National Advertisers (1990-1993): *Ad$ Summary.*

Table 1: Brand characteristics

	Name	Avg trans-action Price ($/lb)	Avg Shelf Price ($/lb)	Avg Ad Expn	In-sample Market Share	Sgmnt	Cals	Fat	Sugar
1	KG[a] Corn Flakes	1.81	1.95	7.109[b]	5.67[c]	Fam	100	0	2
2	GM Cheerios	3.16	3.47	7.287	4.38	Fam	110	2	1
3	KG Rice Krispies	2.96	3.20	6.034	4.04	Fam	120	0	3
4	KG Frosted Flakes	2.52	2.68	7.867	3.82	Fam	120	0	13
5	KG Raisin Bran	2.34	2.50	5.591	2.73	Fam	200	1.5	18
6	GM Total	3.61	4.04	3.926	2.36	Adult	110	1	5
7	GM HoneyNut Cheerios	3.14	3.41	4.030	2.26	Fam	120	1.5	11
8	KG Special K	3.48	3.78	3.531	2.16	Adult	110	0	3
9	PT Grape Nuts	2.14	2.29	6.740	2.12	Adult	200	1	7
10	NB SpoonSize ShdWt	2.81	3.05	0.025	2.08	Adult	170	0.5	0
11	QK 100% Natural	2.24	2.55	1.612	1.96	Adult	220	8	13.5
12	KG Frosted Mini Wheats	2.62	2.75	6.106	1.84	Adult	170	1	10
13	KG NutriGrain	2.87	3.10	2.508	1.55	Adult	100	1	0
14	KG Mueslix	3.31	3.58	1.975	1.53	Adult	200	4	13
15	GM Wheaties	2.55	2.86	2.257	1.52	Fam	110	1	4
16	PT Raisin Bran	2.23	2.57	4.361	1.46	Fam	190	1	20
17	RL Muesli	3.34	3.93	0.215	1.26	Adult	210	2.7	14
18	KG Corn Pops	3.51	3.69	3.198	1.46	Fam	120	0	14
19	GM Raisin Nut Bran	2.98	3.22	1.659	1.35	Adult	210	4.5	16
20	GM Basic 4	3.27	3.63	2.510	1.31	Adult	210	3	12
21	GM Cocoa Puffs	3.46	3.67	2.097	1.28	Kids	120	1	14
22	GM Golden Grahams	3.24	3.54	2.953	1.24	Kids	120	1	11
23	GM Cinn. Toast Crunch	3.36	3.56	2.963	1.23	Kids	130	3	10
24	KG Froot Loops	3.53	3.76	3.110	1.20	Kids	120	1	15
25	KG Low Fat Granola	2.68	3.10	2.327	1.17	Adult	190	3	12
26	GM Trix	3.96	4.22	3.236	1.13	Kids	120	1.5	13
27	GM Triples	2.33	2.80	3.036	1.12	Adult	120	1	6
28	KG Crispix	3.28	3.49	3.225	1.12	Adult	110	0	3
29	GM Kix	3.67	3.93	3.801	1.08	Kids	120	0.8	6
30	GM Lucky Charms	3.45	3.72	3.079	1.08	Kids	120	1	13
31	GM AppleCinn. Cheerios	3.02	3.35	3.120	1.06	Fam	120	2	13
32	KG Cracklin Oat Bran	3.19	3.51	2.279	1.06	Adult	190	6	15
33	NB Big Biscuit ShdWt	2.79	3.05	0.000	0.99	Adult	156	1.2	9.6
34	PT Honey Bunches of Oats	2.85	3.18	3.749	0.95	Adult	125	2.2	6
35	PT Great Graines	2.90	3.43	2.648	0.89	Adult	215	5.5	10.5
36	GM Otml Raisin Crisp	2.71	3.04	1.641	0.97	Adult	210	2.5	19
37	QK Oat Squares	2.43	2.71	1.472	0.94	Adult	220	3	9
38	RL Rice Chex	3.40	3.53	0.875	0.89	Adult	120	0	2
39	GM Total Raisin Bran	3.00	3.50	1.874	0.89	Adult	180	1	19
40	KG Product 19	3.38	3.70	1.408	0.89	Adult	100	0	4
41	KG Apple Jacks	3.64	3.91	1.465	0.84	Kids	120	1	16
42	QK Capt Crunch	2.55	2.86	1.714	0.83	Kids	105	1.5	11.5
43	NB Shredded Wheat	2.82	3.00	2.925	0.80	Adult	160	0.5	0
44	PT Fruity Pebbles	3.21	3.48	1.710	0.83	Kids	110	1	12
45	GM Clusters	3.14	3.52	1.425	0.78	Fam	210	3.5	14
46	KG Cinnamon MiniBuns	2.75	3.14	0.002	0.76	Fam	120	0.5	12
47	KG Double Dip Crunch	3.01	3.52	1.454	0.73	Adult	110	0	11
48	GM MultiGrain Cheerios	3.34	3.74	2.520	0.75	Fam	110	1	15
49	PT Honeycomb	3.40	3.67	2.567	0.74	Kids	110	0	11
50	QK Popeye	1.77	1.77	0.000	0.67	Kids	120	1	13.3
51	basket of all other brands	2.68		0.645[d]	24.29				

[a]KG: Kelloggs GM: General Mills PT: Post (Phillip Morris) RL: Ralston QK: Quaker Oats

[b]quarterly expns, $million. **Source:** Leading National Advertisers (1990-1993). Avg'd over 1991:ii—1993:ii

[c]Share of total in-sample purchases. **Source:** Author's calculation from IRI scanner dataset

[d]sum of average quarterly advertising expenditure for *all* the non top fifty brands