

## NEVO (Rand, 2000)

“Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry”

### Demand Structure

- Estimates parameters of differentiated product demand structure a la BLP and simulates effects of actual and hypothetical mergers of multiproduct firms selling differentiated products (brands) on prices and consumer welfare across brands

There are  $J$  ( $j = 1, \dots, J_t$ ) brands (products), sold in  $T$  ( $t = 1, \dots, T$ ) markets (cities) to  $i$  ( $i = 1, \dots, I_t$ ) consumers. Each brand is characterized by a set of observable product characteristics (e.g. sugar, fiber, advertising, kids) and unobserved characteristics (e.g. market-specific advertising).

The indirect utility function of consumer  $i$  for product  $j$  in market  $t$  is given by:

$$U_{ijt} = x_{jt}\beta_i^* + \alpha_i^* p_{jt} + \xi_{jt} + \varepsilon_{ijt} \equiv V_{ijt} + \varepsilon_{ijt},$$

$x_{jt}$  are the observable characteristics for product  $j$  in city  $t$

$p_{jt}$  are the prices for product  $j$  in city  $t$

$\beta_i^*$  and  $\alpha_i^*$  are individual specific coefficients

$\varepsilon_{ijt}$  is a mean zero stochastic error term

$\xi_{jt}$  is an unobservable (to the econometrician) component for product  $j$  in city  $t$  which can be decomposed into a brand-specific component and a market specific component.

$$\xi_{jt} = \xi_j + \xi_t + \Delta\xi_{jt}$$

The brand-specific component is captured by brand dummies and the market-specific effect is an econometric error term.

Both firms and consumers are assumed to observe and react to both the observable and non-observable characteristics of each brand and take them into account in decisions.

The distribution of consumers' taste parameters ( $\beta_i^*$  and  $\alpha_i^*$ ) for the product characteristics is assumed to be multivariate normal with a mean that is a function of a set of demographic variables and parameters to be estimated. (Note: A significant difference from AIDs and simple logit in that the heterogeneity of the population is introduced directly into the analysis.

Let:

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

where  $K$  is the dimension of the observed characteristics vector,  $D_i$  is a  $d \times 1$  vector of demographic variables,  $\Pi$  is a  $(K + 1) \times d$  matrix of coefficients that measure how

the taste characteristics vary with demographics, and  $\Sigma$  is a scaling matrix. This specification allows individual characteristics to consist of demographics that are “observed” and additional characteristics that are “unobserved,” denoted  $D_i$  and  $v_i$  respectively.<sup>10</sup>

The demand system is completed with the specification of an outside good (o) which consumers may purchase if they purchase no brands of cereal. The indirect utility function for the outside good is:

$$U_{i0t} = \xi_0 + \pi_0 D_t + \sigma_0 v_{i0} + \varepsilon_{i0t}$$

Where  $D$  and  $v$  are individual “observed” and “unobserved” demographic characteristics.

Consumers are assumed to purchase one unit of the good that gives the highest utility (does this make any sense?). This implicitly defines the set of individual-specific variables that lead to the choice of good  $j$ .

The market share of the  $j^{\text{th}}$  product as a function of the mean utility levels of all  $J+1$  goods (including the outside good) is then:

$$s_{jt}(x_{jt}, p_{jt}, \xi_{jt}; \theta) = \int_{A_{jt}} dP^*(D, v, \epsilon) = \int_{A_{jt}} dP^*_\epsilon(\epsilon) dP^*_v(v) dP^*_D(D), \quad (2)$$

Where  $P^*(\cdot)$  denotes population distribution functions.

The full “mixed-logit” model is a more general version of the multinomial logit model (assume that consumer heterogeneity enters the model only through the additive shocks  $(\varepsilon_{ijt})$  which are iid with an extreme value distribution) or the nested logit model. It allows for flexible patterns of own-price and cross-price elasticities. The cross-price elasticities are driven by product characteristics and are not constrained a priori, though “segments” (e.g. children’s or adults cereal) can be introduced as observable product characteristics using dummy variables.

### Supply Side and Equilibrium Conditions

The paper does not measure costs directly, but infers (constant) marginal costs from equilibrium first-order conditions which yield markups over marginal cost.

There are  $F$  firms each of which produces a (unique) subset  $\mathcal{J}$  of the  $J$  different brands. The profits of firm  $f$  are:

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

Where  $s_j(p)$  is the market share of brand  $j$ , which is a function of the prices of all brands,  $M$  is the size of the market,  $mc_j$  is the marginal cost of production, and  $C_f$  is the fixed cost of production. (Note the market size here includes the share of outside goods --- the market size is

effectively fixed, though the aggregate quantity of cereal can change).

Bertrand-Nash equilibrium assumption yields the following  $j$  first order conditions for any product  $j$  produced by firm  $f$ :

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

These  $J$  equations imply price-costs margins for each product. The markups can be solved for explicitly by defining

$$s(p) - \Omega^{pre}(p)(p - mc) = 0.$$

This implies a markup equation and implied marginal costs

$$p - mc = \Omega^{pre}(p)^{-1}s(p) \Rightarrow mc = p - \Omega^{pre}(p)^{-1}s(p). \quad (4)$$

Equation (4) yields the pre-merger markups and the associated marginal costs. These pre-merger marginal costs are then used along with the estimated demand structure to simulate post-merger prices assuming the aggregation of two or more products to form the merged firm ---- in (5).

$$p^* = \widehat{mc} + \Omega^{post}(p^*)^{-1}s(p^*), \quad (5)$$

Note assumptions:

(a) Bertrand competition, (b) marginal costs don't change post-merger, (c) demand elasticities do not change post-merger, (d) price of outside good does not change.

## DATA

Market shares and prices are from the IRI scanner data base. The data are aggregated by brand, city, and quarter (note consumers in a city are all assumed to see the same prices).

Note that the brands in the sample account for 42% to 63% of the cereal sold in cities. It appears that the "outside" good's share is actually the share of the remaining cereal purchases that are not represented in the sample (does this make sense?).

Advertising data come from the Leading National Advertising data base.

Product characteristics were read off of the cereal boxes and taste tests (mushiness).

Information on the distribution of demographics is from the Current Population Survey.

Instrumental variables also rely on average wages paid in the supermarket sector for each city (CPS), city density (BLS) and regional price indices (BLS).

## Identification and Instruments

Prices are a function of marginal costs and the markup terms (from FOCs). Once brand dummy variables are included in the regression, the error term is the unobserved city-quarter deviation from the overall mean valuation of the brand denoted above as  $\Delta\xi_{jt}$ . This error is assumed to be correlated with prices so that least-squares (non-linear) will be biased and inconsistent.

Following Hausman, the identifying assumption is that, controlling for brand-specific means and demographics, city-specific valuations are independent across cities. Given this assumption, prices of the brand in other cities are valid instruments for the price of a brand in a specific city since the prices in the two cities will be correlated due to common marginal costs, but uncorrelated with market specific valuations, due to the independence assumption.

The instruments use 20 quarters of regional (what does this mean? Why not cities?) prices in other cities as instruments for the prices in a specific city.

## Estimation

See BLP (1995). Non-linear GMM estimator.

## Estimation Results

See Table 2 for estimates of “mixed-logit” demand structure explaining variation in market shares. The first

column are the mean of the estimated taste parameters and the next five are the parameters that measure heterogeneity in the population (interactions with demographic variables and standard deviation of estimates of taste parameters).

Individual price sensitivity is heterogeneous. Most of the heterogeneity is explained by the demographics

Table 3 displays median elasticities across 900 city-quarter combinations (Note: each city can have a different set of price elasticities due to differences in demographics and prices across cities. Also, substitution patterns across brands (cross-elasticities) are driven by product characteristics.

Table 4 displays the median pre-merger implied estimates of marginal costs for different brands (would like to see min/max as well to see if the implied estimates make any sense across cities. Also presents results for a simple logit specification (see Appendix B). (Results for Rice Krispies are strange --- MC too low)

Note: Retail level costs must be assumed to be reflected in marginal cost estimates. Need to consider interactions between cereal producer and supermarket owners.

### Merger Analysis

Examines 5 mergers simulated using estimated demand system and implied pre-merger marginal costs:



- (a) Post's acquisition of Nabisco (real merger with concerns raised about substitution between Post Grape Nuts and Nabisco Shredded Wheat. See Table 5.
- (b) General Mills earlier attempted acquisition of Nabisco. See Table 5
- (c) General Mills and Chex. See Table 5
- (d) Quaker Oats and Kellogs. Table 5
- (e) Quaker Oats and General Mills. Table 5

(Note: The outside good is "other RTE cereals" and it is assumed not to be affected by the merger)

Table 6 examines the reductions in marginal costs required to mitigate any price increase.

Table 7 examines merger profits and consumer welfare