Volume Title: The Economics of New Goods

Volume Author/Editor: Timothy F. Bresnahan and Robert J. Gordon, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-226-07415-3

Volume URL: http://www.nber.org/books/bres96-1

Publication Date: January 1996

Chapter Title: Valuation of New Goods under Perfect and Imperfect Competition

Chapter Author: Jerry A. Hausman

Chapter URL: http://www.nber.org/chapters/c6068

Chapter pages in book: (p. 207 - 248)

II Contemporary Product Studies

This Page Intentionally Left Blank

5 Valuation of New Goods under Perfect and Imperfect Competition

Jerry A. Hausman

The economic theory of the Consumer Price Index (CPI) has been well developed (see, e.g., Pollak 1989). The CPI serves as an approximation of an ideal cost-of-living (COL) index. In turn, the COL index answers the question of how much more (or less) income a consumer requires to be as well-off in period 1 as in period 0 given changes in prices, changes in the quality of goods, and the introduction of new goods (or the disappearance of existing goods). The CPI as currently estimated by the Bureau of Labor Statistics (BLS) does a reasonable job of accounting for price changes and has begun to attempt to include quality changes. However, the BLS has not attempted to estimate the effect of the introduction of new goods, despite the recognition of the potential importance of new goods on both a COL index and the CPI (see Fixler 1993).

The omission of the effect of the introduction of new goods seems quite surprising given that most commonly used business strategies can be placed in either of two categories: becoming the low-cost producer of a homogeneous good or differentiating your product from its competitors. The latter strategy has become the hallmark of much of American (and Japanese) business practice. The numbers of cars, beers, cereals, sodas, ice creams and yogurts, appliances such as refrigerators, and cable television programs all demonstrate the ability of firms to differentiate their products successfully. Furthermore, consumers demonstrate a preference for these products by buying them in suffi-

Jerry A. Hausman is the John and Jennie S. MacDonald Professor of Economics at the Massachusetts Institute of Technology.

The author thanks the NSF for research support, Z. Griliches and G. Leonard for useful conversations, and T. Bresnahan, P. Joskow, and W. Nordhaus for helpful comments. Jason Abrevaya provided excellent research assistance. This paper is given in the memory of Sir John Hicks, who first taught the author welfare economics.

cient quantities to make the expected profit positive for the new brands. As the BLS has recognized in its estimation of the CPI: "If the measurement error is systematic, then a systematic difference may exist between the computed CPI and the true [COL index], which would, in turn, affect the measured rate of price change" (Fixler 1993, 3). This paper finds evidence of such a systematic difference which causes the CPI to be overstated by a significant amount due to its neglect of new products.[1]

In this paper I first explain the theory of COL indexes and demonstrate how new goods should be included, using the classical theory of Hicks (1940) and Rothbarth (1941). The correct price to use for the good in the preintroduction period is the "virtual" price which sets demand to zero. Estimation of this virtual price requires estimation of a demand function which in turn provides the expenditure function which allows exact calculation of the COL index. The extensive data requirements and the need to specify and estimate a demand function for a new brand among many existing brands may have proved obstacles to the inclusion of new goods in the CPI up to this point.

As an example I use the introduction of a new cereal brand by General Mills in 1989—Apple-Cinnamon Cheerios. The cereal industry has been among the most prodigious in new-brand introduction. My econometric specification permits differing amounts of similarity among cereal brands, which is quite important given that Apple-Cinnamon Cheerios are closer to other Cheerios brands than to, say, Shredded Wheat. I find that the virtual price is about twice the actual price of Apple-Cinnamon Cheerios and that the increase in consumer's surplus is substantial. Based on some simplifying approximations, I find that the CPI may be overstated for cereal by about 25 percent because of its neglect of the effect of new cereal brands.

I then extend the classical Hicks-Rothbarth theory from its implicit assumption of perfect competition to the more realistic situation of imperfect competition among multiproduct firms. Imperfect competition can be important because introduction of a new brand may allow a multiproduct firm to raise the prices of its existing, closely competing brands. When I take account of the effect of imperfect competition, I find that the increase in consumer welfare is only 85 percent as high as in the perfect competition case. Nevertheless, the CPI for cereal would still be too high by about 20 percent. Thus, I conclude that the introduction of new goods is an important economic occurrence, and the BLS should attempt to develop procedures to incorporate new goods correctly into the CPI. I also find that consumers highly value new goods, which provide significant consumer's surplus despite the existence of other brands which compete closely with the new brand.

1. The BLS does include new goods after they are introduced. However, this procedure misses the additional consumer welfare which arises from the introduction of the new good compared to the welfare in the base period when the good was not being sold.

5.1 Valuation of New Goods under Perfect Competition

Sir John Hicks made one of the first attempts to develop the theory of the evaluation of new goods. In 1940 Hicks considered evaluation of social income and economic welfare, using index number theory to consider the effects of rationing and the introduction of new goods. Hicks correctly saw his approach as the basis for the evaluation of real income under these changes. Without completely working out the mathematics, Hicks stated that for rationed goods the index numbers need to be altered so that the price used would lead to the amount of the ration. This higher price can be considered the "virtual price" which, when inserted into the demand function, leads to the observed amount of rationed demand.[2] For new products Hicks stated that the virtual price for periods in which the goods did not exist would "just make the demands for these commodities (from the whole community) equal to zero" (1940, 144). Modern economists recognize this price as the shadow or reservation price which, used in the demand function, sets demand equal to zero. Of course, new products in a sense are a special case of rationing where the demand for the good is zero. Given the demand function I can solve for the virtual price and for the expenditure (or indirect utility) function and do correct evaluations of social welfare without needing to use the index number formulas discussed by Hicks.[3]

Rothbarth, in a 1941 paper on rationing, put the subject on a firm mathematical footing and introduced the notion that a virtual price arises from the "price system with respect to which the quantities actually consumed are optimum . . . the 'virtual price system'" (100).[4] I use his approach to demonstrate the effect on the price index, or real income, of the introduction of a new good. In period 1 consider the demand for the new good, x_n, as a function of all prices and income, y:

$$(1) \qquad x_n = g(p_1, \ldots, p_{n-1}, p_n, y).$$

Now if the good was not available in period 0, I solve for the virtual price, p_n^*, which causes the demand for the new good to be equal to zero:

$$(2) \qquad 0 = x_n = g(p_1, \ldots, p_{n-1}, p_n^*, y).$$

2. See Neary and Roberts (1980) for a modern treatment of rationing using this approach.

3. See Hausman (1980, 1981) who uses this approach in the context of female labor supply to do welfare calculations.

4. Rothbarth, one of Keynes's last students, faced internment in the United Kingdom during World War II because of his German nationality. Instead, he volunteered for the British army where he died during the war. G. Burtless and I (Burtless and Hausman 1978) were unaware of Rothbarth's paper when we used the term "virtual income" in solving for demands in nonlinear budget set problems. Rothbarth's paper was subsequently pointed out to us by K. Roberts.

The index number approach, used by both Hicks (1940) and Rothbarth (1941), then considers the change in real income to be the ratio $(p_n^*)(x_n) / (p_n)(x_n)$. While this approach is approximately correct, it does not account for the need to change income y as the price is increased in order to stay on the same indifference curve and thus keep the marginal value of income constant. Thus, instead of using the Marshallian demand curve in equations (1) and (2), I use the income-compensated and utility-constant Hicksian demand curve to do an exact welfare evaluation.[5] In terms of the expenditure function I solve the differential equation from Roy's identity, which corresponds to the demand function in equation (1), to find the (partial) expenditure function[6]

$$y = e(p_1, \ldots, p_{n-1}, p_n, u^1). \tag{3}$$

The expenditure function gives the minimum amount of income, y, to achieve the level of utility, u^1, that arises from the indirect utility function corresponding to the demand function of equation (1) and to the expenditure function of equation (3). To solve for the amount of income needed to achieve utility level u^1 in the absence of the new good, I use the expenditure function from equation (3) to calculate

$$y^* = e(p_1, \ldots, p_{n-1}, p_n^*, u^1). \tag{4}$$

The exact COL index becomes $P(p, p^*, u^1) = y^* / y$. Note that to use this approach one must estimate a demand curve as in equation (1), which in turn implies the expenditure function and the ability to do the exact welfare calculation of equations (3) and (4). Thus, the only assumption which is required is to specify a parametric (or nonparametric) form of the demand function.

Diewert (1992) reviews the price index literature and calls the use of the expenditure (or cost) function approach the "economic approach," which he relates back to the original paper of Konüs (1939) and compares to the "axiomatic approach," which is more often used in the price index literature. Diewert recognizes the usefulness of the economic approach, but he notes the requirement of knowing the consumer's expenditure function (1992, 18). In the case of new goods the traditional axiomatic approach offers little or no guidance so that demand curve estimation must be undertaken to estimate the virtual or reservation price. Once the demand curve is estimated, the expenditure function comes for "free," since no additional assumptions are required and new

5. In equation (2), income, y, is solved in terms of the utility level, u^1, to find the Hicksian demand curve given the Marshallian demand curve specification. Hausman (1981) demonstrates this solution procedure.

6. Hausman (1981) demonstrates how to solve the differential equation which arises from Roy's identity in the case of common parametric specifications of demand. Hausman and Newey (1995) demonstrate how to do the analysis when a nonparametric specification of demand is specified and estimated.

goods can be evaluated.[7] Thus, the economic approach seems to be the only practical approach to the evaluation of new goods.

A potentially more serious problem with the valuation of new goods is the implicit assumption of perfect competition. Indeed, I have not seen this potential problem mentioned in my review of the literature although Robinson's (1933) book on imperfect competition predates Hicks's (1940) paper. The implicit assumption of perfect competition follows from the assumption that prices of other goods remain the same at marginal cost when the new good is introduced. Under imperfect competition with significant fixed costs and free entry which leads to a zero-profit condition, introduction of a new good will lead to somewhat higher prices for existing goods whose demand decreases. This effect will usually be small. A more significant effect arises from the fact that most new products are introduced by multiproduct firms. Introduction of a new good will allow the firm to raise its price because some of the demand for its existing product, which it will lose, will not go to competitors' products, but will instead go to the firm's new product. I will develop the implications of imperfect competition in section 5.6, but first I will apply the classical theory of new products under perfect competition to data from the ready-to-eat cereal industry, perhaps the foremost industry in the introduction of new goods.

5.2 New-Product Introductions in the Ready-to-Eat Cereal Industry

The ready-to-eat (RTE) cereal industry has been among the most prodigious introducers of new brands in U.S. industries.[8] In the period 1980–92 approximately 190 new brands were introduced into a pool of about 160 existing brands. Most new cereal brands, in common with most new-product introductions, do not succeed.[9] Out of the 190 new brands introduced since 1980, over 95 have been discontinued. For instance, of the 27 new brands introduced in 1989, 14 brands had already been discontinued by 1993. Of the 190 new brands introduced during the twelve-year period, only 2 of the 190 brands have a market share (in pounds) of greater than 1 percent. Still, new brands are important in the sense that about 25 percent of all RTE cereal consumption comes from brands introduced within the past ten years. Thus, cereal company executives believe that it is quite important to continue to introduce new brands

7. Confusion sometimes arises over whether the entire expenditure function or all demand curves must be estimated. The answer is no under the usual type of separability assumptions (or Leontief aggregation assumptions) which are commonly used in empirical research and are implicit in statistical agencies' calculations of price indexes. Thus, only the demand curve for the new good needs to be estimated, not the demand curve for all other goods.

8. Recently, the beer industry has also undergone significant new-product introductions with bottled draft beers, dry beers, and ice beers, all introduced within about the past five years.

9. About 80 percent of new-product introductions in consumer goods fail. See, e.g., Urban et al. (1983).

because consumers exhibit a strong preference for continued variety among cereal brands.

Some economists have claimed that this high rate of introduction of new brands is part of an anticompetitive strategy by cereal companies.[10] While both economic theory and the facts of the industry seem contrary to the preemption claim, the RTE cereal industry is highly concentrated with no successful entry by a significant manufacturer in the past fifty years. Six firms have each produced 94 percent or more of all RTE cereals (in dollar sales) over the period 1982–92. Kellogg's share has varied in the range of 37.3–41.5 percent; General Mills' share has varied from 23.0 to 29.0 percent; General Foods' share has varied in the range of 10.4–15.8 percent. Quaker, Ralston, and Nabisco have all been in the range of about 3.0–8.9 percent. Only one other company, Malt-O-Meal, has gained a share above 1 percent.[11] Recently, a move toward further consolidation has occurred. In 1992 General Mills announced a purchase of Nabisco's cereal brands, the largest of which is Nabisco Shredded Wheat. The U.S. government granted permission for this acquisition, and in 1993 General Foods (Post brands) acquired Nabisco's cereal brands. Thus, five major firms are likely to exist, although I would not be surprised if another acquisition occurred soon.[12]

However, while the three largest firms have about 80 percent of the RTE cereal market, it is important to realize that very few individual brands have significant shares. For instance, Kellogg's Frosted Flakes is the largest Kellogg brand, with a share of 5.0 percent (in 1993); Kellogg's Corn Flakes is quite close at 4.99 percent, while Cheerios is the largest General Mills brand, with a share of 5.3 percent. Most brands have quite a small share and the share movement among brands is quite dynamic.

No successful entry by a significant new manufacturer has occurred in the RTE cereal industry in the past fifty years. The RTE industry ha remained highly concentrated during this time period, despite the general perception that investments in the RTE cereal industry earn higher rates of return than in many other industries.[13] During the 1970s, some new entry did occur in the RTE

10. See Schmalensee (1978) and Scherer (1982) who claim that "brand proliferation" served as an entry deterrent in the RTE cereal industry. Both economists testified for the U.S. Federal Trade Commission (FTC) "In the matter of Kellogg Co. et al.," (docket no. 8883, available from the author). The FTC lost this "shared monopoly" case in which it was claimed that a highly concentrated oligopoly deterred entry through the introduction of new brands. Furthermore, Judd (1985) subsequently demonstrated that the preemption story implied by brand proliferation is unlikely to provide credible preemption unless exit costs are high, which is contrary to fact in the RTE cereal industry for a given brand.

11. However, no individual brand of Malt-O-Meal has ever achieved 1 percent. Furthermore, much of Malt-O-Meal's production is for private-label brands.

12. The State of New York is currently challenging General Foods' acquisition of Nabisco, so an extremely small probability exists that Nabisco may become independent again, raising the number of competitors to six.

13. See, e.g., General Mills' 1992 annual report, p. 2, which reports an average after-tax return on capital over five years of 21 percent, "which is among the best in U.S. industry"; Kellogg's 1991 annual report, p. 16, gives an after-tax return on assets of about 15.5 percent for 1991, while

cereals industry for "natural" cereals and by some substantial food-product manufacturers such as Pillsbury, Pet, and Colgate, but these firms did not last long as competitors. Thus, the prospect for actual new entry into the RTE cereal industry is very unlikely, with exit a more likely prospect than new entry. This is despite high growth rates in the 1982–92 period, when average revenue growth was 6.7 percent per year (in real terms).

Since the brand-proliferation models do not yield a credible model of entry deterrence, what is the main reason for the lack of new entry into an industry which otherwise might expect significant new entry? The main impediment to successful new entry into the RTE cereal market is the necessity for an extremely large investment in advertising, all of which is a sunk cost if the new product does not succeed.[14] Industry estimates are that for firms to launch a new brand currently costs $20–40 million for advertising and promotion in the initial year. The investment is typically continued at this level annually for one to two years, unless the brand is discontinued or allowed to decline because of a decision that it will not succeed in the long run. The cumulative investment is expected to be paid off (before any net positive return to the investment is obtained) only after a period of one to two years, although a very few brands do succeed more quickly. This investment is substantial compared to the likely success—a 1 percent share for a new brand is considered to be a great success. Yet almost no new brand achieves 1 percent. Of the approximately 190 new brands which were introduced during 1982–92, only two currently have a pound share of 1 percent or greater.

Thus, the odds of a successful new-brand introduction by an existing RTE manufacturer are daunting; a new entrant would face even longer odds because of start-up costs and the extra cost and difficulty of achieving shelf space for a new brand. An existing manufacturer can transfer shelf space from an old brand to a new brand. However, a new entrant does not have the shelf space to trade. The main "outside" competition which has arisen over the past few years has been the success of "store brands," also called private-label brands.[15] Private-label brands have doubled their market share from about 4 percent to 8 percent over the past five to ten years. For these brands the supermarket provides the shelf space and has the cereal manufactured independently. Indeed, Ralston does the majority of the private-brand manufacturing. Thus private-label corn flakes and other brands seem most successful in providing

---

Kellogg's second-quarter report for the first six months of 1992 yields an annualized return on assets of 17.7 percent (financial reports available from the author). Of course, accounting returns on assets are typically an unreliable guide to economic returns; nevertheless, the cereal industry is widely perceived to be quite profitable.

14. Sutton (1991) analyzes a model where endogenous advertising costs provide the main barrier to entry in the RTE cereal industry.

15. Sutton (1991), in his analysis of competition in the cereal industry, finds only limited competition from private-label brands, which seems contrary to recent developments within the RTE cereal industry.

competition by doing the *opposite* of the brand-proliferation model.[16] The private-label brands do little advertising and position themselves identically to existing brands, while offering a lower price to consumers and a higher profit margin to the stores. This success of the private-label brands provides limited support for the theory that large sunk costs of advertising provide the primary barrier to entry into the cereal industry.

Thus, the high rate of new-brand introduction is not part of an anticompetitive strategy in my view. Still, many economists might well doubt the social value of these new brands, the vast majority of which do not succeed. To concentrate the debate, I consider the value to consumers of the introduction of Apple-Cinnamon Cheerios by General Mills in 1989. I choose this brand because it is close to existing General Mills brands—Cheerios is the largest General Mills brand and Honey-Nut Cheerios are well established in the market. Thus, there is certainly an empirical question of whether consumers place much value on the new brand or whether it is already spanned by existing brands and so creates very little new value to consumers.

5.3 An Empirical Model of Brand Choice in the RTE Cereal Industry

I now proceed to estimate an empirical model of brand choice using a three-level model of demand. The top level is the overall demand for cereal using a price index for cereal relative to other goods. The middle level of the demand system estimates demand among various market segments, for example, the adult or the child segments. The bottom level is the choice of brand, for example, Cheerios, conditional on a given segment's expenditure. Overall price elasticities are then derived from the estimates in all three segments. While this demand structure places restrictions on the overall pattern of substitution across brands, it is considerably less restrictive than other demand approaches typically used to estimate the demand for differentiated products. Clearly, some restrictions are required given the more than one hundred brands of cereal available in the marketplace. The approach also allows for convenient tests of the overall specification of brand segments within the model (see Hausman, Leonard, and Zona 1994 for the testing methodology).

The data used to estimate the model are cash-register data collected on a weekly basis across a sample of stores in major metropolitan areas of the United States over a two-year period. Thus, exact price and quantity data are available, with considerable price variation due to promotions and coupons. The panel structure of the data—approximately 140 time series observations on each brand across seven standard metropolitan statistical areas (SMSAs)—

16. Economists for the FTC also claimed that entry was difficult due to the economies of scale in cereal manufacturing which would require an entrant to have several successful brands. They failed to consider contract manufacturing of the type done by Ralston for private-label brands.

allows for quite precise estimation. The panel data also permits identification and instrumental variable (IV) estimation under relatively weak assumptions. Thus, the estimated demand structure should allow a precise estimate of the virtual price for a new cereal brand.

In terms of actual estimation I estimate the model in reverse order, beginning at the lowest level, and then use the theory of price indexes to allow for consistent estimation at the higher (more aggregate) levels of demand. The third (or lowest) stage determines buying behavior within market segments. I use this approach because it accords with segmentation of brand-purchasing behavior, which marketing analysts claim arises with purchasing behavior, and because it limits the number of cross elasticities which will be estimated. My econometric specification at the lowest level is the "almost-ideal demand system" of Deaton and Muellbauer (1980a, 1980b) which allows for a second-order flexible demand system, that is, the price elasticities are unconstrained at the point of approximation, and also allows for a convenient specification for nonhomothetic behavior. However, my experience is that the particular form of the demand specification is not crucial here. Use of a flexible demand system allows for few restrictions on preferences, while decreasing the number of unknown parameters through the use of symmetry and adding up restrictions from consumer theory. For each brand within the market segment the demand specification is

$$(5) \qquad s_{int} = \alpha_{in} + \beta_i \log (y_{Gnt}/P_{nt}) + \sum_{j=1}^{J} \gamma_{ij} \log p_{jnt} + \varepsilon_{int}; \\ i = 1, \ldots, J; \quad n = 1, \ldots, N; \quad t = 1, \ldots, T;$$

where s_{int} is the revenue share of total segment expenditure of the ith brand in city n in period t, y_{Gnt} is overall segment expenditure, P_{nt} is a price index, and p_{jnt} is the price of the jth brand in city n. Note that a test of whether $\beta_i = 0$ allows for a test of segment homotheticity, for example, whether shares are independent of segment expenditure. The estimated γ_{ij} permit a free pattern of cross-price elasticities, and Slutsky symmetry can be imposed, if desired, by setting $\gamma_{ij} = \gamma_{ji}$. This choice of the bottom-level demand specification does not impose any restrictions on competition among brands within a given segment. In particular, no equal cross elasticity–type assumptions restrict the within-segment cross-price elasticities. Since competition among differentiated products is typically "highest" among brands within a given segment, this lack of restrictions can be an important feature of the model. An important econometric consideration is the use of segment expenditure, y_{Gnt}, in the share specification of equation (5), rather than the use of overall expenditure. Use of overall expenditure is inconsistent with the economic theory of multistage budgeting, and it can lead to decidedly inferior econometric results.

Given the estimates from equation (5), I calculate a price index for each segment and proceed to estimate the next level of demand. For exact two-stage budgeting, the Gorman results impose the requirement of additive separability on the next level.[17] To specify the middle-level demand system I use the log-log demand system:[18]

$$\log q_{mnt} = \beta_m \log y_{Bnt} + \sum_{k=1}^{k} \delta_k \log \pi_{knt} + \alpha_{mn} + \varepsilon_{mnt}; \qquad (6)$$
$$m = 1, \ldots, M; \quad n = 1, \ldots, N; \quad t = 1, \ldots, T;$$

where the left-hand-side variable q_{mnt} is the log quantity of the mth segment in city n in period t, the expenditure variable y_{Bnt} is total cereal expenditure, and the π_{knt} are the segment price indexes for city n. The segments that I use are the adult segment which includes brands such as Shredded Wheat and Grape Nuts, the child segment which includes Kix and sugar-coated cereals, and the family segment which includes Cheerios, Corn Flakes, and other similar brands. The price indexes π_{knt} can be estimated either by using an exact price index corresponding to equation (5), which is constructed from the expenditure function for each segment holding utility constant, or by using a weighted-average price index of the Stone-Laspeyres type. Choice of the exact form of the price index does not typically have much influence on the final model estimates.

Lastly, the top-level equation, which I use to estimate the overall price elasticity of cereal, is specified as

$$\log u_t = \beta_0 + \beta_1 \log y_t + \beta_2 \log \Pi_t + Z_t\delta + \varepsilon_t, \qquad (7)$$

where u_t is the overall consumption of cereal, y_t is deflated disposable income, Π_t is the deflated price index for cereal, and Z_t are variables which account for changes in demographics and monthly (seasonal) factors. To estimate equation (7) I use national (BLS) monthly data over a sixteen-year period with instrumental variables. I have found that a longer time period than may be available from store-level data is often useful to estimate the top-level demand elasticity. The instruments I use in estimation of equation (7) are factors which shift costs such as different ingredients, packaging, and labor.

I now consider the question of identification and consistent estimation of the middle-level and bottom-level equations. The problem is most easily seen in equation (5), the brand-level equation, although an analogous problem arises in equation (6), the segment-level demand equation. Equation (5) for each brand will have a number of prices included for each brand in the segment; for example, I include nine brands in the family segment in the subsequent

17. See Gorman (1971). This subject is also discussed in Blackorby, Primont, and Russell (1978), and in Deaton and Muellbauer (1980b). Note that the almost-ideal demand system is a generalized Gorman polar form (GGPF) so that Gorman's theorem on exact two-stage budgeting applies. Since the additive demand specification at the top level imposes separability restrictions, I have also used a less restrictive specification at the middle level which is not necessarily consistent with exact two-stage budgeting. The results are quite similar.

18. Note that this specification is second-order flexible. However, the Slutsky restrictions have not been imposed on the specification.

estimation. It may be difficult to implement the usual strategy of estimating demand equations where the cost function includes factor-input prices (e.g., material prices), which are excluded from the demand equations to allow for identification and for the application of instrumental variables. There may be an insufficient number of input prices, or they may not be reported with high enough frequency to allow for IV estimation. To help solve this problem, I exploit the panel structure of my data. For instance, suppose $N = 2$, so that weekly or monthly data from two cities is available. Note that I have included brand (or segment) and city fixed effects in the specification of equations (5) and (6). Now suppose I can model the price for a brand i in city n in period t as

$$\log p_{jnt} = \delta_j \log c_{jt} + \alpha_{jn} + w_{jnt}, \tag{8}$$

where p_{jnt} is the price for brand j in city n in period t. The determinants of the brand price for brand j are c_{jt}, the cost which is assumed not to have a city-specific time-shifting component (which is consistent with the national shipments and advertising of most differentiated products); α_{jn}, which is a city-specific brand differential that accounts for transportation costs or local wage differentials; and w_{jnt}, which is a mean zero stochastic disturbance that accounts for sales promotions for brand j in city n in time period t. The specific identifying assumption that I make is that the w_{jnt} are independent across cities.[19] Using fixed effects the city-specific components are eliminated, and I am basically applying the Hausman-Taylor (1981) technique for instrumental variables in panel-data models.[20] The idea is that prices in one city (after elimination of city- and brand-specific effects) are driven by underlying costs, c_{jt}, which provide instrumental variables that are correlated with prices but uncorrelated with stochastic disturbances in the demand equations. For example, w_{jnt} from equation (8) is uncorrelated with ε_{i1t} from equation (5) when the cities are different, $n \neq 1$. Thus, the availability of panel data is a crucial factor which allows for estimation of all the own-price and cross-price brand elasticities.

However, another interpretation can be given to equation (8) and the question of whether w_{jnt} from equation (8) is uncorrelated with ε_{i1t} from equation (5). To the extent that supermarkets set their prices p_{jnt} under an assumption of constant marginal cost (in the short run) and do not alter their prices to equilibrate supply and demand in a given week, prices p_{jnt} may be considered predetermined with respect to equation (5). If prices can be treated as predetermined, then IV methods would not necessarily be needed. IV methods might still be required for the segment-expenditure variable y_{Gnt} in equation (5), however. The need for instruments under these hypotheses can be tested in a

19. Note that w_{jnt} are permitted to be correlated within a given city.

20. See also Breusch, Mizon, and Schmidt (1989). With more than two cities, tests of the assumptions can be done along the lines discussed in Hausman and Taylor (1981).

Table 5.1 **Segmentation of the Brands**

Adult	Child	Family
Shredded Wheat Squares	Trix	Cheerios
Special K	Kix	Honey-Nut Cheerios
Fruit Wheats	Frosted Flakes	Apple-Cinnamon Cheerios
Shredded Wheat	Froot Loops	Corn Flakes
Shredded Wheat & Bran		Raisin Bran (Kellogg)
Spoon-Size Shredded Wheat		Rice Krispies
Grape Nuts		Frosted Mini-Wheats
		Frosted Wheat Squares
		Raisin Bran (Post)

standard procedure using specification tests for instruments, as in Hausman (1978).

5.4 Data and Results

The data used to estimate the empirical model of brand choice in the RTE cereal industry are panel data from Nielsen Scantrak. The time series consists of 137 weekly observations from January 1990 to August 1992.[21] The cross section is from seven SMSAs, including Boston, Chicago, Detroit, Los Angeles, New York City, Philadelphia, and San Francisco. In each SMSA Nielsen's sample frame is a stratified random sample of supermarkets which captures the vast majority of all cereal sold. The data are collected on a stock-keeping unit (SKU) basis so that the volume of sales is recorded for each package size of each brand at an average weekly price. I aggregate the data across packages so that the quantity variable is weekly sales, in pounds, for each brand at a weekly average price per pound.

The empirical specification requires specification of brand segments. I choose three brand segments which correspond to the segmentation commonly used in the cereal industry by marketing analysts.[22] Apple-Cinnamon Cheerios is placed in the family segment. The other two segments used are adults' cereals and children's cereals. Some common brands which are placed into the three segments are given in table 5.1. To estimate the model for Apple-Cinnamon Cheerios, I focus on the family segment. The family segment represents about 26.4 percent of sales in the RTE cereal market.

To highlight further the family segment, I include some descriptive statistics

21. Estimation was also undertaken using monthly, rather than weekly, data. The estimated elasticities based on monthly data are quite similar to the weekly-data estimates, although the precision of the estimates is lower.

22. Some choice of segmentation is required to apply the demand system discussed above. However, I have applied the tests of segmentation discussed in the last section with the specification used and it was not rejected by the Hausman specification tests.

Table 5.2 **Descriptive Statistics for the Family Segment, 1992**

Brand	Company	Average Price ($)	Segment Share (%)
Cheerios	General Mills	2.644	21.62
Honey-Nut Cheerios	General Mills	3.605	15.03
Apple-Cinnamon Cheerios	General Mills	3.480	6.19
Corn Flakes	Kellogg	1.866	14.24
Raisin Bran	Kellogg	3.214	13.11
Rice Krispies	Kellogg	2.475	13.54
Frosted Mini-Wheats	Kellogg	3.420	9.07
Frosted Wheat Squares	Nabisco	3.262	1.48
Raisin Bran	Post	3.046	5.72

for the family segment in table 5.2. This table demonstrates the overall popularity of Cheerios—the three brands have a 42.84 percent share of the family segment, or about an 11.3 percent share of overall cereal sales. However, Apple-Cinnamon Cheerios has a 6.19 percent share of the family segment, or a 1.6 percent share of overall cereal sales. Thus, the introduction of Apple-Cinnamon Cheerios was quite successful by industry standards.

I now turn to estimation of the bottom level of the demand system, which is brand choice for family-segment brands. The results are shown in table 5.3, where fixed effects are used for each SMSA, along with expenditures in this segment, prices for each of the brands, and a display variable. Hausman-Taylor (1981) IV estimation is used along with an unrestricted variance matrix for the stochastic disturbances (seemingly unrelated regression). Note that own-price coefficient estimates are generally precisely estimated. Most of the cross-price effects are also of the expected sign and are generally precisely estimated. Homotheticity of brand choice, which would be a zero coefficient on the expenditure variable, is rejected and not imposed. However, Slutsky symmetry is not rejected so it is imposed on the model specification.

In table 5.4 I now turn to segment estimates with a similar model specification including SMSA effects, overall cereal expenditure, and Stone price indexes for each segment along with a display variable for that segment. Here the dependent variable is sales in pounds, so that I find that adults' cereals have an expenditure elasticity less than unity, children's cereals have an expenditure elasticity which exceeds unity, and family cereals are not different from unity. Segment own-price elasticities are found to be sizable, around −2.0, while segment cross-price elasticities are also found to be large and significant. Thus, overall I find significant competition across cereal brands.

In table 5.5 I calculate the conditional elasticities for the family segment, where I condition on expenditure in this segment. Note that the three brands of Cheerios provide significant brand competition for each other, which is consistent with the "cannibalization" fears of brand managers. In table 5.6 I estimate overall brand elasticities for the family segment after I estimate the top

Table 5.3 **Estimates of Demand for Family Segment Brands (seemingly unrelated regression)**

	Cheerios (1)	Honey-Nut Cheerios (2)	Apple-Cinnamon Cheerios (3)	Corn Flakes (4)	Kellogg's Raisin Bran (5)	Rice Krispies (6)	Frosted Mini-Wheats (7)	Frosted Wheat Squares (8)
Constant	0.68009	0.38053	0.17563	−0.17958	0.31830	−0.24203	0.25375	0.05343
	(0.07668)	(0.05890)	(0.04212)	(0.07112)	(0.07000)	(0.08851)	(0.05257)	(0.01448)
Time	−0.00038	−0.00024	−0.00001	−0.00002	0.00045	0.00066	−0.00016	−0.00009
	(0.00007)	(0.00005)	(0.00004)	(0.00007)	(0.00007)	(0.00008)	(0.00005)	(0.00001)
$Time^2$	0.00000	0.00000	−0.00000	−0.00000	−0.00000	−0.00000	0.00000	0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Boston	0.06345	−0.00014	0.00872	−0.02327	−0.00377	−0.01844	0.01415	−0.00761
	(0.00417)	(0.00319)	(0.00229)	(0.00389)	(0.00377)	(0.00470)	(0.00282)	(0.00080)
Chicago	0.02883	0.00079	0.01412	−0.00418	−0.01810	0.00546	0.01309	−0.00651
	(0.00398)	(0.00306)	(0.00221)	(0.00367)	(0.00363)	(0.00450)	(0.00278)	(0.00076)
Detroit	0.01412	−0.02172	0.02120	−0.01417	−0.00511	0.00149	0.03371	−0.00042
	(0.00327)	(0.00256)	(0.00186)	(0.00304)	(0.00307)	(0.00374)	(0.00230)	(0.00064)
Los Angeles	0.01962	0.03309	−0.00038	0.01656	0.01923	−0.02906	0.00775	0.00338
	(0.00609)	(0.00468)	(0.00335)	(0.00571)	(0.00555)	(0.00702)	(0.00412)	(0.00113)
New York	0.06180	0.00971	0.01102	−0.00468	−0.00371	−0.02386	0.01465	−0.00379
	(0.00783)	(0.00599)	(0.00430)	(0.00726)	(0.00712)	(0.00898)	(0.00525)	(0.00145)
Philadelphia	0.05204	0.01302	0.01625	−0.02970	−0.02025	−0.01361	0.02708	−0.00122
	(0.00488)	(0.00377)	(0.00272)	(0.00453)	(0.00447)	(0.00558)	(0.00337)	(0.00094)
$\log(Y/P)$	−0.03853	−0.01552	−0.00854	0.02003	−0.01391	0.02685	−0.01258	−0.00246
	(0.00630)	(0.00485)	(0.00346)	(0.00585)	(0.00575)	(0.00726)	(0.00435)	(0.00120)
$\log(DISP + 1)$	0.00313	0.00231	0.00297	0.00579	0.00425	0.00051	0.00261	0.00088
	(0.00052)	(0.00040)	(0.00039)	(0.00059)	(0.00049)	(0.00058)	(0.00043)	(0.00025)

$\log(P_1)$	−0.18855							
	(0.00736)							
$\log(P_2)$	0.02087	−0.13165						
	(0.00477)	(0.00756)						
$\log(P_3)$	0.00842	0.01849	−0.07070					
	(0.00345)	(0.00371)	(0.00446)					
$\log(P_4)$	0.04805	0.00268	0.00772	−0.14438				
	(0.00551)	(0.00522)	(0.00389)	(0.00825)				
$\log(P_5)$	0.02071	0.02285	0.01208	0.03957	−0.12861			
	(0.00542)	(0.00534)	(0.00385)	(0.00579)	(0.00873)			
$\log(P_6)$	0.02916	0.03561	0.01431	0.01812	−0.00791	−0.14195		
	(0.00487)	(0.00416)	(0.00301)	(0.00480)	(0.00494)	(0.00708)		
$\log(P_7)$	0.03010	0.00239	−0.00142	0.01656	0.03966	0.02135	−0.13658	
	(0.00465)	(0.00569)	(0.00391)	(0.00544)	(0.00545)	(0.00381)	(0.00950)	
$\log(P_8)$	0.00372	0.00587	−0.00172	0.00418	0.00779	0.00008	0.01208	−0.03206
	(0.00131)	(0.00178)	(0.00121)	(0.00158)	(0.00158)	(0.00107)	(0.00236)	(0.00202)

Note: Numbers in parentheses are asymptotic standard errors.

Table 5.4 Estimates for RTE Segment Demand

	Child (1)	Adult (2)	Family (3)
Constant	−5.17119	3.25706	−0.28328
	(0.57034)	(0.45800)	(0.27096)
Time	−0.00053	−0.00005	0.00008
	(0.00037)	(0.00031)	(0.00018)
Time^2	−0.00000	0.00001	0.00000
	(0.00000)	(0.00000)	(0.00000)
Boston	0.00626	−0.24011	0.07987
	(0.03127)	(0.02874)	(0.01517)
Chicago	0.29489	−0.45990	0.01861
	(0.02627)	(0.02352)	(0.01275)
Detroit	0.19954	−0.45975	0.06424
	(0.01948)	(0.01740)	(0.00939)
Los Angeles	0.32056	−0.13663	−0.08183
	(0.03067)	(0.02743)	(0.01514)
New York	0.01482	−0.11560	0.04898
	(0.03350)	(0.02903)	(0.01647)
Philadelphia	0.16905	−0.39635	0.07388
	(0.02317)	(0.02149)	(0.01128)
$\log(Y)$	1.19080	0.72567	0.99868
	(0.03562)	(0.02874)	(0.01700)
$\log(P_1)$	−2.08314	−0.09422	0.38217
	(0.06571)	(0.05058)	(0.02967)
$\log(P_2)$	0.96607	−2.02602	0.20740
	(0.12117)	(0.11479)	(0.05797)
$\log(P_3)$	1.03553	0.33294	−1.82906
	(0.07465)	(0.06014)	(0.03688)
$\log(DISP + 1)$	0.01054	0.04398	−0.00983
	(0.00365)	(0.00401)	(0.00221)

Notes: Dependent variable is segment sales in pounds. Numbers in parentheses are asymptotic standard errors.

level of the demand specification. I estimate the overall price elasticity for RTE cereal from the top-level demand equation to be −0.90 (asymptotic standard error [ASE] = 0.10).

Using these estimates I now calculate the virtual price for Apple-Cinnamon Cheerios as the price at which its market share is zero. I use two methods to calculate the virtual price in which I draw graphs of the conditional demand curves using predicted values from the bottom-level segment of the demand model. The results vary somewhat depending on the aggregation technique chosen.[23] The results are found in figures 5.1 and 5.2. The estimated virtual, or

23. The first method uses the average of the right-hand-side variables for the demand function across all 959 observations to solve for the virtual price. The second method solves for the virtual prices of each of the 959 observations and the average of these prices is used. The results differ because of the nonlinearity of the demand system specification used.

Table 5.5 **Conditional Elasticities for Family Segment of RTE Cereal**

	Cheerios	Honey-Nut Cheerios	Apple-Cinnamon Cheerios	Corn Flakes	Kellogg's Raisin Bran	Rice Krispies	Frosted Mini-Wheats	Frosted Wheat Squares	Post Raisin Bran
Cheerios	−1.73851	0.16166	0.07110	0.19818	0.15355	0.09268	0.18649	0.02593	0.02716
	(0.04635)	(0.02520)	(0.01759)	(0.02776)	(0.02789)	(0.03008)	(0.02309)	(0.00628)	(0.02951)
Honey-Nut Cheerios	0.21637	−1.83838	0.14169	0.00390	0.18550	0.21253	0.04330	0.04414	0.09425
	(0.03686)	(0.05397)	(0.02562)	(0.03613)	(0.03750)	(0.03263)	(0.03967)	(0.01197)	(0.03863)
Apple-Cinnamon Cheerios	0.23945	0.34899	−2.11677	0.10597	0.23973	0.19848	0.01366	−0.02100	0.12936
	(0.06477)	(0.06330)	(0.07406)	(0.06451)	(0.06614)	(0.05520)	(0.06708)	(0.01993)	(0.06930)
Corn Flakes	0.23185	−0.03254	0.02883	−1.99465	0.23222	0.16056	0.07898	0.02246	0.13165
	(0.04859)	(0.04108)	(0.02952)	(0.06003)	(0.04533)	(0.03831)	(0.04307)	(0.01186)	(0.04444)
Kellogg's Raisin Bran	0.23744	0.21291	0.11121	0.28729	−1.94608	−0.08546	0.33045	0.06454	−0.10626
	(0.04839)	(0.04354)	(0.03084)	(0.04597)	(0.07233)	(0.04318)	(0.04474)	(0.01248)	(0.05031)
Rice Krispies	0.06656	0.19055	0.06997	0.16068	−0.12272	−2.00148	0.10508	−0.00909	0.34211
	(0.05873)	(0.04259)	(0.02824)	(0.04122)	(0.04759)	(0.06512)	(0.03707)	(0.00990)	(0.04614)
Frosted Mini-Wheats	0.43609	0.07708	0.00939	0.16386	0.48235	0.20255	−2.46950	0.14003	0.09692
	(0.05608)	(0.06460)	(0.04498)	(0.06371)	(0.06381)	(0.04921)	(0.11340)	(0.02669)	(0.06562)
Frosted Wheat Squares	0.37740	0.45906	−0.08636	0.26062	0.58179	−0.03396	0.86314	−3.16485	−0.09011
	(0.09617)	(0.12191)	(0.08357)	(0.11035)	(0.11175)	(0.08260)	(0.16566)	(0.13832)	(0.11552)
Post Raisin Bran	−0.10461	0.11474	0.08315	0.23661	−0.35988	0.73072	0.07025	−0.03721	−2.51416
	(0.12414)	(0.10689)	(0.07742)	(0.11177)	(0.12199)	(0.11060)	(0.10844)	(0.03036)	(0.15731)
Mean shares	0.21617	0.15026	0.06193	0.14243	0.13117	0.13539	0.09067	0.01475	0.05722

Note: Numbers in parentheses are asymptotic standard errors.

Table 5.6 **Overall Elasticities for Family Segment of RTE Cereal**

	Cheerios	Honey-Nut Cheerios	Apple-Cinnamon Cheerios	Corn Flakes	Kellogg's Raisin Bran	Rice Krispies	Frosted Mini-Wheats	Frosted Wheat Squares	Post Raisin Bran
Cheerios	−1.92572	0.01210	0.04306	−0.02798	0.03380	−0.20642	0.23990	0.18758	−0.51019
	(0.05499)	(0.04639)	(0.07505)	(0.06123)	(0.05836)	(0.07398)	(0.06455)	(0.10703)	(0.14309)
Honey-Nut Cheerios	0.03154	−1.98037	0.21247	−0.21316	0.07136	0.00079	−0.05929	0.32712	−0.16719
	(0.03080)	(0.05808)	(0.06808)	(0.04805)	(0.04861)	(0.05199)	(0.06752)	(0.12496)	(0.11643)
Apple-Cinnamon Cheerios	0.01747	0.08317	−2.17304	−0.04561	0.05287	−0.00824	−0.04682	−0.14074	−0.03304
	(0.01919)	(0.02690)	(0.07525)	(0.03144)	(0.03224)	(0.03111)	(0.04591)	(0.08462)	(0.08000)
Corn Flakes	0.07484	−0.13069	−0.02343	−2.16585	0.15311	−0.01918	0.03460	0.13556	−0.03062
	(0.03008)	(0.03850)	(0.06503)	(0.06155)	(0.04759)	(0.04555)	(0.06405)	(0.10926)	(0.11573)
Kellogg's Raisin Bran	0.03995	0.06155	0.12056	0.07455	−2.06965	−0.28837	0.36331	0.46661	−0.60598
	(0.03184)	(0.04109)	(0.07011)	(0.05064)	(0.07614)	(0.05456)	(0.06673)	(0.11558)	(0.13005)
Rice Krispies	−0.02457	0.08459	0.07548	−0.00219	−0.21300	−2.17246	0.07967	−0.15285	0.47670
	(0.03109)	(0.03368)	(0.05384)	(0.04071)	(0.04308)	(0.06354)	(0.04854)	(0.07886)	(0.11284)
Frosted Mini-Wheats	0.10797	−0.04239	−0.06872	−0.03001	0.24504	−0.00943	−2.55178	0.78352	−0.09987
	(0.02567)	(0.04189)	(0.06978)	(0.04629)	(0.04735)	(0.04162)	(0.11603)	(0.16839)	(0.11360)
Frosted Wheat Squares	0.01315	0.03020	−0.03440	0.00473	0.05064	−0.02772	0.12664	−3.17781	−0.06489
	(0.00656)	(0.01217)	(0.02015)	(0.01216)	(0.01274)	(0.01045)	(0.02682)	(0.13863)	(0.03082)
Post Raisin Bran	−0.02239	0.04018	0.07738	0.06288	−0.16016	0.26985	0.04499	−0.14035	−2.62151
	(0.02908)	(0.03840)	(0.06837)	(0.04415)	(0.04953)	(0.04521)	(0.06495)	(0.11447)	(0.15447)

Note: Numbers in parentheses are asymptotic standard errors.

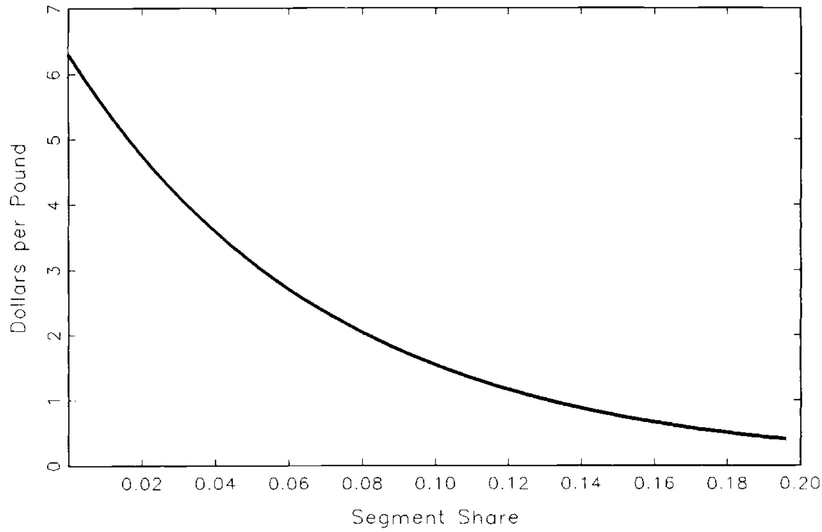


Fig. 5.1 Almost-ideal demand curve for Apple-Cinnamon Cheerios (method 1)

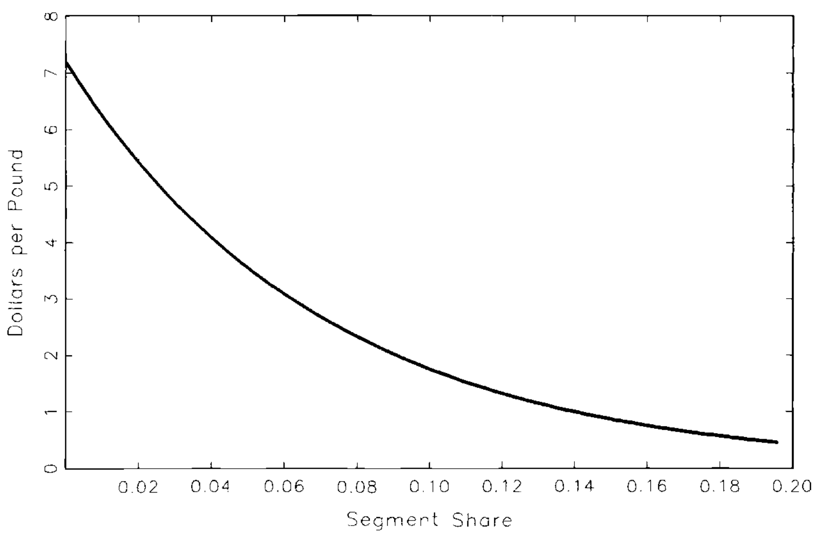


Fig. 5.2 Almost-ideal demand curve for Apple-Cinnamon Cheerios (method 2)

reservation, prices vary across cities from about $6.00 to about $7.50. My best estimate of the aggregate reservation price is $7.14. The ASE of the virtual-price estimate is $1.33, with the lower bound of an (approximate) 95 percent confidence interval estimated at $4.75—35 percent greater than the average price of Apple-Cinnamon Cheerios.

Estimating the (exact) consumer's surplus from the relevant expenditure functions, which is approximately equivalent to calculating the area under the demand curve to the average price of $3.48, yields an estimate of $32,268 on a per city, weekly average. The ASE of the estimate of $32,268 is $3,384, which yields a precise estimate of the consumer-welfare measure.[24] For the United States the annual consumer's surplus is approximately $78.1 million from the introduction of a new brand of cereal. This amount equals about $0.3136 per person per year which is a sizable amount of consumer's surplus. Note that the virtual price of about $7.00 is about twice the actual sales price of $3.50, which seems to be a reasonable estimate. Since the own-price elasticity is about −2.2, the reservation price seems to be in about the correct range.[25]

The estimate of the virtual price of $7.14 depends on the behavior of the estimated demand curve at the vertical axis (zero quantity). While significant price variation is observed in the data, on the order of 50 percent, prices as high as the virtual price are not observed. However, a lower-bound estimate of the virtual price arises from constructing the supporting hyperplane (tangent) to the demand curve in figures 5.1 and 5.2 at the actual average price of $3.48 and observing the implied virtual price. So long as the demand curve is convex, this approach provides a lower-bound estimate to the virtual price. Using this approach I find that the estimated lower-bound virtual price varies between about $5.55 and $5.94 with an ASE of about $0.15. Thus, using the estimated lower bound I find that the average lower-bound reservation price is about 65 percent higher than the average price of $3.48. Thus, a significant amount of consumer's surplus remains, even when a lower-bound estimate is used.

Note that neglecting the effect of the new brand leads to an overstatement of the price index for cereal. If Apple-Cinnamon Cheerios is aggregated with Honey-Nut Cheerios so that they are considered to be a single brand, little effect is found beyond the slightly lower price of the new brand in the estimated average price of the two types of Cheerios. As a simple example, assume contrary to fact that all of Apple-Cinnamon Cheerios' share was taken from that of Honey-Nut Cheerios. Before the introduction of the new brand the price index would be about $4.60, while after its introduction the price index would be about $3.57, for a decrease of about 22 percent—a sizable reduction within the family segment. The decrease in the price index for the family segment is from $3.10 to $2.88, a decrease of 7.1 percent. In the overall price index for cereal the effect would be a reduction of about 0.017 (or $0.052) which is again significant. This estimate of about 1.7 percent would stay approximately

24. These exact welfare estimates and ASEs use the method developed by Hausman and Newey (1995).

25. Use of this same estimation technique for other highly differentiated products often leads to significantly higher estimated elasticities. For instance, in Hausman, Leonard, and Zona (1994) we estimate own-price elasticities for brands of beer, e.g., Budweiser, Miller, and Miller Lite, in the range of about −4.0 to −6.2. Thus, the data source and estimation technique do not seem to lead to too-small elasticity estimates.

the same when the assumption is relaxed that Apple-Cinnamon Cheerios takes all its share from Honey-Nut Cheerios. The approximate change in the price index can be calculated by taking Apple-Cinnamon Cheerios' share of about 1.6 percent and multiplying by the difference between the virtual price (about $7.00) and the actual price (about $3.50). The results will differ depending on price differences between Apple-Cinnamon Cheerios and the brands it takes share away from. If all brands had the same price the overall change in the price index would be about 1.5 percent, or approximately the share of the new brand. Thus, to the extent that about 25 percent of cereal demand was from new brands over the past ten years, and under the (perhaps unrealistic) assumptions that the new brands sell for about the same average price as existing brands and that the estimate here would generalize to a reservation price of about two times the actual price, the overall price index for cereals which excludes the effects of new brands would be too high by about the overall share of new brands—25 percent.[26]

5.5 Alternative Model Specifications for New-Brand Introduction

An alternative model of brand choice is the Hotelling-Gorman-Lancaster model of brand choice by attributes. Here a product, such as a car, is described by its attributes, for example, size, weight, and features such as air-conditioning.[27] A discrete-choice model, either a logit model or probit model, is estimated and the demand for new brands is predicted as a function of the attributes. In distinct contrast to these attribute models, I describe each brand uniquely by an indicator (dummy) variable. Indeed, it is difficult to conceive how I would describe Apple-Cinnamon Cheerios in terms of its attributes—perhaps the volume of apples and cinnamon along with other ingredients. Thus, it is readily recognized that for highly differentiated products, the discrete-choice model specification based on product attributes may not be usable.[28] Many economists find appealing the notion of "distance" incorporated in the attribute model. However, it is clear that no reasonable metric exists to describe "how close" attributes are; and, moreover, no aggregator across attributes exists. The commonly used assumptions of linearity seem ad hoc at best. Instead, the appropriate measure of distance between two goods is really

26. This estimate is too high to the extent that the exit of existing brands decreases consumer's surplus for consumers still buying those brands. However, cereal brands are typically removed only when their market shares become extremely small because of the significant margins between price and marginal cost. Thus, the loss in consumer's surplus due to exit will be extremely small. However, I cannot estimate this decrease in consumer's surplus due to lack of data.

27. An empirical specification of this model applied to new brands is given by Pakes, Berry, and Levinsohn (1993).

28. While I have often applied probit models to brand choice (see Hausman and Wise 1978), I realized the limitation of these models when I tried applying them to the choices among French champagnes. Somehow, the bubble content could never be made to come in significant in the probit specifications.

their cross-price elasticities, which relate to what extent consumers find the two goods to be close substitutes. Furthermore, the usual discrete-choice model used, the logit model, suffers from the well-known independence of irrelevant alternatives (IIA) problem. The IIA problem typically leads to a vast overestimate of the consumer's surplus from a new good because the model does not incorporate sufficiently the similarities to existing goods. Alternatively, the cross-price elasticities of all goods with a given good are equal; see, for example, Hausman (1975). A more sophisticated specification, the nested logit model, can solve some of these problems but still suffers from the IIA problem at each level of choice. Thus, I consider another continuous demand specification, which bears quite remarkable similarities to the logit model, that has sometimes been used for the estimation of new-product demand.

The most widely used specification in theoretical models of product differentiation is the constant elasticity of substitution (CES) utility function used by Dixit and Stiglitz (1977). The CES utility function takes the form

$$U(x_1, \ldots, x_n) = \left(\sum_{i=1}^{n} x_i^{\rho}\right)^{1/\rho} \tag{9}$$

The form of the CES utility function makes clear that all goods are treated equally so that the IIA property is still present implicitly in the CES demand function.[29] Economic theorists have found the CES function to be analytically quite useful in studying product differentiation. However, the so-called symmetry property seems a poor guide to empirical reality, where I know that Apple-Cinnamon Cheerios are a much closer substitute to Honey-Nut Cheerios than they are to Nabisco Shredded Wheat or to Total.[30]

Given the implicit IIA property of the CES model, similar to the logit model, it will tend to overvalue variety. This overvaluation arises because the CES demand function does not recognize that some products are closer substitutes to other products. The CES demand function takes the form

$$x_k = \left[\frac{\sum_{i=1}^{n} x_i^{\rho}}{\sum_{i=1}^{n} p_i^{-\rho/(1-\rho)}}\right]^{1/\rho} p_k^{-1/(1-\rho)} + \varepsilon_k, \tag{10}$$

where the single parameter ρ estimates substitution across goods. Indeed, solving for the cross-price elasticities from equation (10) yields the finding that

$$\frac{\partial x_i}{\partial p_j}\frac{p_j}{x_i} = \frac{\partial x_k}{\partial p_j}\frac{p_j}{x_k}, \text{ or } e_{ij} = e_{kj} \text{ for all } i, k, j, \tag{11}$$

29. See Anderson, de Palma, and Thisse (1992) for an insightful analysis of the similarities of the CES model and the logit model.

30. The CES model has been applied to new-product introduction situations; see, e.g., Feenstra (1994).

which demonstrates the restrictiveness of the CES demand specification. The equality of cross-price elasticities demonstrates that the CES demand function treats all goods similarly (symmetrically), and it cannot provide a reliable basis on which to evaluate new goods. Furthermore, the own-price elasticities depend only on the share of the particular good and the single parameter ρ, a property without any empirical foundation.[31]

I now proceed to estimate the CES demand model of equation (10) using instrumental variables together with nonlinear least squares (NL-2SLS). I estimate $\rho = .580$ (ASE = .00001). The estimated CES is $1/(1 - \rho) = 2.13$. The CES demand curve is plotted in figure 5.3. The virtual price is infinite, but I can still calculate the consumer's surplus approximately as the area under the demand curve. The consumer's surplus estimate is about three times as high as my previous estimate of $78.1 million per year. Thus, as I expected, the CES model leads to an unrealistically high estimate of consumer welfare from a new-brand introduction. Neither the CES model nor the logit model distinguish sufficiently the similarities and differences among brands. Thus, a more flexible demand model of the type I estimated above, which allows for an unrestricted pattern of own-price and cross-price elasticities at the segment level, appears to lead to much more realistic estimates of the virtual price and welfare effects of new-brand introduction.

5.6 New-Brand Introduction with Imperfect Competition

Up to this point I have followed the classical Hicks-Rothbarth approach to the evaluation of a new product. However, the implicit assumption in that approach that price equals marginal cost need not hold in most new-product situations. Combined with the fact that most new-brand introductions are undertaken by multiproduct firms with existing competing brands, the introduction of imperfect competition seems necessary for a more realistic evaluation. The basic reason a new product may change other products' prices is that when a firm solves for the profit-maximizing price of its current brands it chooses the price at which marginal revenue from a price increase equals marginal cost. When a multiproduct firm introduces a new brand, some of the demand it would lose if it attempted to raise the price of its existing brands will now be lost to the new brand. Thus, while multibrand firms always worry that a new brand will "cannibalize" the demand for an existing brand, the new brand allows the firm to raise the prices on its existing brands.[32]

31. These properties of the own-price and cross-price elasticities are exactly analogous to the properties of the logit demand elasticities, cf. Hausman (1975). Thus, the IIA property holds for both logit models and for CES demand models.

32. A counteracting effect can be that the new brand will cause the price of other firms' brands to decrease because the new brand increases the own-price elasticity of existing brands. The complicated interactions here are currently beyond the scope of economic theory to solve, although Tirole (1988) discusses many interesting examples which appear in the literature.

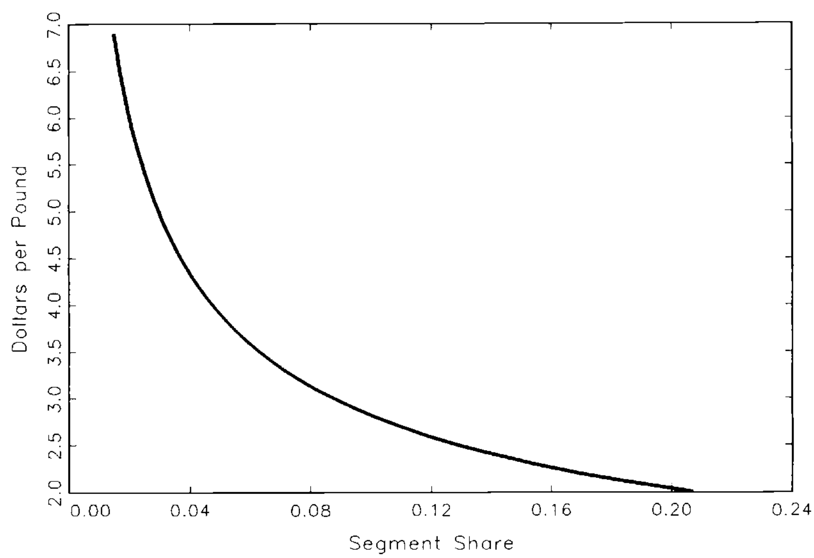


Fig. 5.3 CES demand curve for family-segment brands

Once imperfect competition is allowed, the possibility of different outcomes becomes quite large. I adopt the most widely used solution concept for my analysis, Nash-Bertrand pricing. Thus, a single-product firm is assumed to set the price for a given product according to the "marginal revenue equals marginal cost" rule:

$$\frac{p_1 - mc_1}{p_1} = -\frac{1}{e_{11}}. \tag{12}$$

Equation (12) is the familiar equation in which the markup of price over marginal cost is set equal to the inverse of the magnitude of the demand elasticity. Now in a multiproduct-firm setting, when a firm changes the price of one good, it takes into account the effect on its other brands as well. Letting π be the firm's profit function, the first-order conditions for the multiproduct firm become

$$\left[\frac{p_j}{\sum_{k=1}^{m} p_k q_k}\right]\frac{\partial \pi}{\partial p_j} = s_j + \sum_{k=1}^{m}\left[\frac{p_k - mc_k}{p_k} s_k\right] e_{kj} = 0 \tag{13}$$

$$\text{for } j = 1, \ldots, m,$$

where q_k is the demand for brand k, s_k is its share, and e_{kj} are the cross-price elasticities. Thus equation (13) makes clear the dependence of a price change on how close a given multiproduct firm's brands are in terms of their cross-price elasticities.

I now express the first-order conditions of equation (13) as a system of linear equations:

$$s + E'w = 0, \tag{14}$$

where s is the vector of revenues shares, E is the matrix of cross-price elasticities, and w is the vector of price/cost markups multiplied by the share (the term in brackets on the right-hand side of equation [13]) which arise under the Nash-Bertrand assumption in equation (12). I solve for these individual terms of the markup equation by inversion of the matrix of cross elasticities:

$$w = -(E')^{-1}s. \tag{15}$$

I can then use the individual elements of w to determine the change in price after the new-brand introduction to the extent that marginal costs remain constant. Note that while I have derived the change in price under Nash-Bertrand assumptions, my analysis does not require this assumption. To the extent that pricing constraints will be decreased after the new brand is introduced, the analysis provides a lower bound on expected price changes, absent new entry by competitors.

I now apply the Nash-Bertrand model to the introduction of Apple-Cinnamon Cheerios. Remember that General Mills was already selling regular Cheerios and Honey-Nut Cheerios when it introduced Apple-Cinnamon Cheerios in 1989. Thus, when deciding on a possible new brand, General Mills had to take into account the negative effect ("cannibalization") that the introduction of Apple-Cinnamon Cheerios would have on the demand for its other brands. However, introduction of new brands also allows General Mills to price its existing brands higher because when it raises their prices part of the demand that it loses will go to the new brand, Apple-Cinnamon Cheerios. Thus, the welfare analysis must also be adjusted to take into account the imperfect competition which exists in the cereal market. Using the Nash-Bertrand assumption, this effect tends to lead to higher pricing for each of the other General Mills brands.

Using own and cross elasticities and pound shares for General Mills brands in the family segment given in table 5.3, I calculate table 5.7. These calculations are done using equations (12)–(15), which calculate the markups over marginal cost that are profit maximizing for General Mills under the Nash-

Table 5.7 Nash-Bertrand Pricing of General Mills Family-Segment Brands

	Cheerios	Honey-Nut Cheerios
Price-cost margin	.5268	.5203
Price-cost margin without Apple-Cinnamon Cheerios	.5251	.5096
Price-cost margin if brand were independent	.5193	.5050

Bertrand assumption that other firms, such as Kellogg, will not change their prices in response to the introduction of Apple-Cinnamon Cheerios. The values from the first two rows imply a hypothetical price change of \$0.0095 for Cheerios and \$0.0787 for Honey-Nut Cheerios. The increase in the markup for Cheerios is only 0.32 percent while the markup for Honey-Nut Cheerios increases by 3.0 percent, which is expected because Apple-Cinnamon Cheerios is a closer substitute for Honey-Nut Cheerios than for regular Cheerios.

I now account for the increase in price of the other two Cheerios brands when Apple-Cinnamon Cheerios are introduced by General Mills. The average (per city, weekly) pound sales for Cheerios and Honey-Nut Cheerios are 93,738 and 47,215, respectively. This effect implies a first-order decrease in consumer's surplus (per city, weekly) of \$890 + \$3,715 = \$4,605 (as compared to the \$32,000–44,000 consumer's surplus estimates). Therefore, the net gain in consumer's surplus is \$32,000 − \$4,605 = \$27,395, or an amount 85.6 percent as high as the Hicksian calculation. On an annual basis the gain in consumer's surplus is \$66.8 million (equivalently, \$0.268 per person). Thus, while the gain from the new-brand introduction is still sizable, it must be adjusted downward. In terms of overall new-brand introduction, instead of the CPI for cereals being too high on the order of 25 percent under the perfect-competition assumption, the introduction of imperfect competition would reduce the overstatement of the cereal CPI to about 20 percent. This amount is still large enough to be important and demonstrates the importance of considering new-brand introduction in the calculation of economic welfare and consumer price indexes.

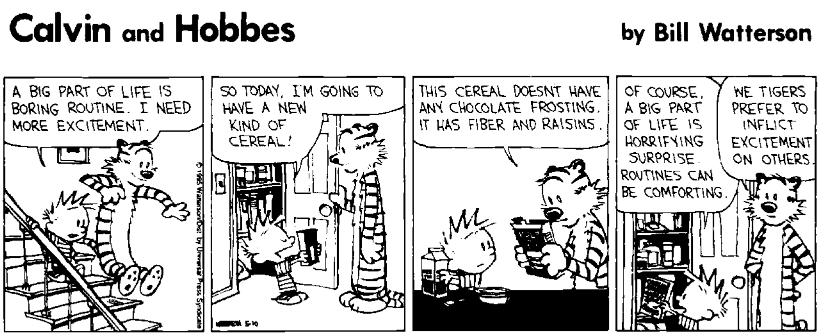
The introduction of imperfect competition in evaluating new goods is a marked departure from the classical Hicks-Rothbarth approach. Imperfect competition brings with it supply (cost) considerations that are typically absent from COL theory, which is typically concerned only with demand factors. The approach I have taken is to calculate the theoretical effect of imperfect competition under a particular model assumption, Nash-Bertrand competition. Another approach, left for future research, is to analyze the actual effect on prices of the introduction of a new brand. Data considerations do not permit the analysis here, because the Nielsen data I have does not cover the period prior to the introduction of Apple-Cinnamon Cheerios. However, now that detailed store-level microdata are available, such a study would be extremely interesting for the current subject of welfare effects of new-product introduction, as well as for the broader area of competitive interaction in industrial organization theory.

5.7 Conclusion

The correct economic approach to the evaluation of new goods has been known for over fifty years, since Hicks's pioneering contribution. However, it has not been implemented by government statistical agencies, perhaps because of its complications and data requirements. Data are now available. The impact of new goods on consumer welfare appears to be significant according to the demand estimates of this paper. According to the rough calculations in this paper, the CPI for cereal may be too high by about 25 percent because it does not account for new cereal brands. An estimate this large seems worth worrying about.

However, the classical theory propounded by Hicks leaves out an important potential element. In imperfect competition, which characterizes all differentiated-product industries, introduction of a new brand may permit a multiproduct firm to raise the prices of its other brands. The price increases for existing brands will decrease the welfare-increasing effects of the new brand. According to my estimate for the example of Apple-Cinnamon Cheerios, the imperfect-competition effect will reduce consumer welfare by about 15 percent compared to the perfect-competition situation. Nevertheless, the welfare effect of new-brand introduction under imperfect competition is still significant—about 20 percent according to my rough calculations. Thus, I find that new-brand introduction should often be considered favorable by most economists given its significant welfare-increasing effects.

Why do consumers spend their income on new brands? A classical reference may be in order: "The love of novelty manifests itself equally in those who are well off and in those who are not. For . . . men get tired of prosperity, just as they are afflicted by the reverse. . . . This love of change . . . opens the way to every one who takes the lead in any innovation in any country" (Machiavelli, *Discourses,* chap. 21, suggested to me by Stanley Lebergott). Alternatively, I include the following Calvin and Hobbes cartoon in which Calvin states, "A big part of life is boring routine. I need more excitement. So today, I'm going to have a new kind of cereal!" (suggested to me by my daughter Claire Hausman).



References

Anderson, S. P., A. de Palma, and J.-F. Thisse. 1992. *Discrete choice theory of product differentiation.* Cambridge: MIT Press.

Blackorby, C., D. A. Primont, and R. R. Russell. 1978. *Duality, separability, and functional structure.* New York: North-Holland.

Breusch, T. S., G. E. Mizon, and P. Schmidt. 1989. Efficient estimation using panel data. *Econometrica* 57:695–700.

Burtless, G., and J. Hausman. 1978. The effect of taxation on labor supply: Evaluating the Gary negative income tax experiment. *Journal of Political Economy* 86 (December): 1103–30.

Deaton, A., and J. Muellbauer. 1980a. An almost ideal demand system. *American Economic Review* 70:312–26.

———. 1980b. *Economics and consumer behavior.* Cambridge: Cambridge University Press.

Diewert, W. E. 1992. Essays in index number theory: An overview of volume 1. Discussion Paper no. 92-31, University of British Columbia, Vancouver.

Dixit, A., and J. E. Stiglitz. 1977. Monopolistic competition and optimum product diversity. *American Economic Review* 67:297–308.

Feenstra, R. C. 1994. New product varieties and the measurement of international prices. *American Economic Review* 84:157–77.

Fixler, D. 1993. The Consumer Price Index: Underlying concepts and caveats. *Monthly Labor Review* 116 (December): 3–12.

Gorman, W. 1971. Two stage budgeting. Nuffield College, Oxford. Mimeographed.

Hausman, J. 1975. Project independence report: A review of U.S. energy needs up to 1985. *Bell Journal of Economics* 6:517–51.

———. 1978. Specification tests in econometrics. *Econometrica* 46:1251–71.

———. 1980. The effect of wages, taxes, and fixed costs on women's labor force participation. *Journal of Public Economics* 14:161–94.

———. 1981. Exact consumer surplus and deadweight loss. *American Economic Review* 71:662–76.

Hausman, J., G. Leonard, and J. D. Zona. 1994. Competitive analysis with differentiated products. *Annales D'Economie et de Statistique* no. 34:159–80.

Hausman, J., and W. Newey. 1995. Nonparametric estimation of exact consumers surplus and deadweight loss. *Econometrica* 63:1445–76.

Hausman, J., and W. Taylor. 1981. Panel data and unobservable individual effects. *Econometrica* 49:1377–98.

Hausman, J., and D. Wise. 1978. A conditional probit model for qualitative choice. *Econometrica* 46:403–26.

Hicks, J. R. 1940. The valuation of the social income. *Economica* 7:105–24.

Judd, K. L. 1985. Credible spatial preemption. *Rand Journal of Economics* 16 (2): 153–66.

Konüs, A. A. 1939. The problem of the true index of the cost-of-living. *Econometrica* 7:10–29. First published (in Russian) in *The Economic Bulletin of the Institute of Economic Conjuncture* no. 9/10: 64–71 (Moscow, 1924).

Neary, J. P., and K. W. S. Roberts. 1980. The theory of household behavior under rationing. *European Economic Review* 13:25–42.

Pakes, A., S. Berry, and J. Levinsohn. 1993. Price indexes and the analysis of environmental change. *American Economic Review* 83:240–46.

Pollak, R. 1989. *The theory of the cost-of-living index.* Oxford: Oxford University Press.

Robinson, J. 1933. *The economics of imperfect competition.* London: Macmillan.

Rothbarth, E. 1941. The measurement of changes in real income under conditions of rationing. *Review of Economic Studies* 8:100–107.
Scherer, F. M. 1982. The breakfast cereal industry. In *The structure of American industry,* ed. W. Adams. 6th ed. New York: Macmillan.
Schmalensee, R. 1978. Entry deterrence in the ready-to-eat breakfast cereal industry. *Bell Journal of Economics* 9:305–27.
Sutton, J. 1991. *Sunk costs and market structure.* Cambridge: MIT Press.
Tirole, J. 1988. *The theory of industrial organization.* Cambridge: MIT Press.
Urban, G. L., G. M. Katz, T. E. Hatch, and A. J. Silk. 1983. The ASSESSOR pretest market evaluation system. *Interfaces* 13:38–59.

Comment Timothy F. Bresnahan

It is easy to see that whole new industries and whole new product categories are economically important. They expand consumers' range of choice in a very substantial way. It is harder to be sure that the steadily increasing variety in many branded consumer product industries is equally important. There are a great many new brands, new varieties, and new packages available on the supermarket shelves. (*Brandweek* counted over 22,000 new-product introductions for 1994.) How important are these new goods individually? How large is their aggregate contribution to social welfare?

Existing research has not answered this question. There is a large and stimulating theoretical literature. It treats the question of whether the market, working through the free entry of new products, will supply too many marginal product varieties. The purely theoretical approach is ultimately inconclusive.[1] Empirical work has so far not pushed much further. For want of a better assumption, many policy and academic studies treat new goods as irrelevant or as perfect substitutes for existing goods. The official COL indexes, by linking in new goods only after they have been around for a while, treat them as irrelevant in their early stages.[2] Attempts to view new goods as quality improvements to existing goods, for example in hedonic pricing studies, involve the implicit assumption of perfect substitutability.

Each of these assumptions plausibly leads to an underestimate of the value

Timothy F. Bresnahan is professor of economics at Stanford University and a research associate of the National Bureau of Economic Research.

1. Eaton and Lipsey (1989) write that "in addition, the problem of optimal product diversity arises. . . . We showed in our discussion of that [address] model that there is no general relationship between product diversity in free-entry equilibrium and optimal product diversity. . . . The awkward problem is that we do not even know the nature of the bias—whether there is likely to be too much or too little diversity in equilibrium" (760).

2. The two problems are not unrelated. If a new good is a perfect substitute for existing goods, the law of one price is likely to hold. Then a delay in linking in a new good will not make an important difference to price indexes.

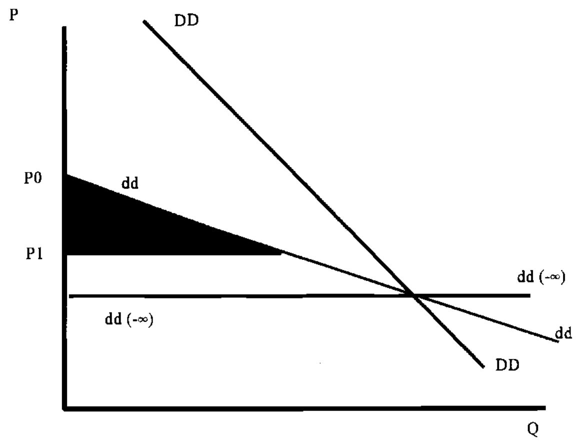


Fig. 5C.1 Consumers' gain from lowering one product's price

of new goods. The irrelevance assumption obviously understates the value of the new good, and the later the new good is incorporated, the worse the underestimate. The perfect substitutability assumption is less obvious. However, examine figure 5C.1, which I reproduce from the introduction to this volume. The assumption of perfect substitutability amounts, in the figure, to assuming that the demand curve for a new variety is flat, like $dd(-\infty)$. If the new good is in fact a less-than-perfect substitute for existing products, this ignores a consumer's surplus triangle. The worse the substitutability, the bigger the triangle and therefore the underestimate.

Following Trajtenberg (1989), Hausman takes on the question of the slope of *dd* and the consumer's surplus that results directly from a new good.[3] He estimates the demand system for the RTE breakfast cereals at the level of individual products. The estimated demand system is used to calculate the consumer's surplus of a single new good, Apple-Cinnamon Cheerios.

The analysis can serve as an example of the broader problem of variety-increasing new products in branded consumer product industries. Apple-Cinnamon Cheerios has some nice features for this purpose. Since there are other cereals available, and even others that are types of Cheerios, it is clear that the product represents only an incremental increase in the range of choice at breakfast. If, as Hausman reports, it has a large value of consumer's surplus, that is an important finding. In the absence of other systematic evidence about new product varieties (and of any particular reason to suspect RTE cereals are

3. Trajtenberg measured the improvement in buyer welfare for a whole new class of medical diagnostic products, computerized tomography scanners, and for fundamental improvements in them, such as the "body scanner." Trajtenberg used an "address" model of product differentiation like an important class in the Eaton-Lipsey survey. This led him to the conjecture that a new good's distance from existing products in the address space is an important determinant of the slope of *dd* and therefore of a product's consumer's surplus contribution to welfare.

much unlike other things sold in grocery stores) we should revise upward our assessment of the economic importance of incremental variety improvements. For example, existing methods for calculating price indexes for branded consumer products might be making a large error in assessing their rate of growth. At a minimum, accepting Hausman's finding means we should revise upward the potential value of research like that presented here for learning about branded consumer product valuation in general.

The introduction of new goods can also change the conditions of competition in an industry or, more simply, competitive outcomes. Existing products' market power may be reduced by competition from new goods. The transitory monopoly accruing to a new good may be an important incentive for inventors. A new good may complete the product-line strategy of an existing firm. All of these issues are related to imperfect competition, Hausman's second topic. Looking again at figure 5C.1, we see that a new product that generates considerable consumer's surplus is one that has a steep demand curve. Thus, if the new product is supplied by only one firm, it may be associated with considerable market power. The two topics of consumer's surplus and imperfect competition are closely linked.

Hausman offers two main substantive conclusions based on considerable econometric investigation. The consumer's surplus associated with the introduction of Apple-Cinnamon Cheerios was substantial. Second, imperfect competition considerations mean that the introduction tended to raise prices on other products, lowering the gain in consumer's surplus but not reversing it.

In this comment, I take up two general issues raised by Hausman's analysis. First, what is the evidence for substantial consumer's surplus gains from incremental product introductions in mature consumer-product industries? This question is largely econometric; the issue is the statistical finding of a steep single-product demand curve in figure 5C.1. Second, what role does imperfect competition play in determining the economic value of a new good? This is a question of economic interpretation of estimates.

Econometric Specification and Estimation Issues

It is natural to doubt the surprisingly large consumer's surplus values estimated by Hausman. How can it be true that Apple-Cinnamon Cheerios—surely a "me, too" product—is this poor a substitute for existing products?

Very Unrestricted Specification

In my opinion, Hausman's specification decisions are carefully made to overcome skepticism on this score. One might suspect that preexisting Cheerios products or other family-segment cereals already satisfy pretty much any palate. The result that there is large consumer's surplus must arise because this is empirically false. Hausman finds a steep *dd* for Apple-Cinnamon Cheerios because he finds relatively poor substitutability between Apple-Cinnamon

Cheerios and the other preexisting cereals in the family segment. What did the data do and what did the specification do in producing this result? Hausman is careful to impose very little structure on the pattern of own- and cross-price elasticities within segments. His estimates are very unrestrictive in this regard.[4]

To be sure, Hausman does assume that products within categories are closer substitutes than are products in different categories. But it is not interesting to question whether the elasticity of substitution between two children's cereals is higher than that between one of them and Special K. There is very little chance that the key assumptions are the segment separability (or "budgetability") ones. We and Hausman can trust the marketing people at the RTE cereal companies to have done that work already. Their research is not reported to us in any quantitative detail, but the origin of the segmentation assumptions is surely based on the analysis of much more detailed data than we have in this paper, including consumer microdata. Also, there is not a great deal of ambiguity in the segment structure.[5]

At the key juncture, which because of the special structure of the cereals market comes at the within-category level, the specification is unrestricted. Thus, the paper does a good job of convincing us that the finding of large consumer's surplus is not an artifact of specification.

Sources of Instruments

There is another set of econometric assumptions in this (or any other) analysis of product-differentiated demand. In measuring the degree of substitutability among products, the econometric treatment of the endogeneity of prices is very important (see Berry 1994 for a recent treatment). This is the other part of the econometric specification of the paper where the conclusions might have been accidentally assumed.

In this paper, the origins of the identifying assumptions are in a variance-components model of the errors. The analysis draws on the general theoretical results of Hausman and Taylor (1981) for estimation with variance-components identification assumptions. In the present analysis, Hausman assumes that the reduced-form equation for price (his equation [8]),

$$\log p_{jnt} = \delta_j \log c_{jt} + \alpha_{jn} + w_{jnt},$$

4. He also shows that a more restrictive functional form leads to a much larger estimated consumer's surplus.

5. In many industries, there are multiple, competing segmentation schemes that arise from the marketing studies. In automobiles, for example, there are segments (like "subcompact") that clearly matter for the structure of substitution elasticities. There is also evidence that brand names and even country product-quality reputations matter for the structure of elasticities of substitution. In many other branded consumer product markets, there is a natural question of "private label" products versus brand names as well as some named segments. Thus, several principles of differentiation, each with a distinct set of close-substitute products, compete for the analyst's attention in deciding what to cluster together a priori. The comparatively simple structure of RTE cereals is an exception in this regard.

has a particular structure. The cost error c_{jt} varies with time t and good j but not with city n. Thus, there are common cost shocks across cities. The city-related but time-independent effects α_{jn} could be differences either in demand or in cost (Hausman suggests cost), but their interpretation does not matter. The specific identifying assumption Hausman makes is that the error w_{jnt} is uncorrelated across cities. This means that all shocks to demand over time are assumed to be independent across cities.

Hausman has one and a half justifications for this assumption. First, it might really be true that there are no nationwide shocks to the demand for one brand of cereal relative to another. I don't know much about RTE breakfast cereals, but in branded consumer product industries in general I would be very doubtful of this assumption. It rules out too many important real-world phenomena. For example, for Hausman's assumption to be true, there can be no successful nationwide advertising campaigns which shift the demand for individual brands or products.[6] There can be no fads shifting demand temporarily to a particular product, or if there are fads, they must be geographically local. There can be no slow acceptance of new brands. And so on. Alternatively, such common demand shocks might not be incorporated in prices, because they are predetermined in the relevant run (cf. the last paragraph in section 5.3). Economically, this is the assumption that the common demand shocks cannot be foreseen when prices are set. This seems unlikely as well, given the nature of the nationwide demand shocks just mentioned.

If these assumptions fail, and if supply is upward sloping, the nationwide demand shock will mean that the error w_{jnt} is correlated across cities, counter to Hausman's identifying assumption.[7] The interesting question is, What happens to the finding of poor substitutability among products and therefore of a steep *dd* in figure 5C.1?

I examine this issue in a simple case: linear demand, Bertrand supply by single-product firms, and constant marginal cost.[8] The demand system is

$$Q_{jnt} = y\beta_j + P_{nt}\gamma_j + \varepsilon_{jnt},$$

where Q_{jnt} is the quantity of product j in market n at time t, y are regressors, and P_{nt} are the prices of all the different products in that market at that time. The demand error ε_{jnt} is assumed to have both a local and a national component. Finally, β_j and γ_j are the parameters of the jth product's demand system; I will use γ_{jj} to denote the own-price coefficient, and γ to denote the matrix of

6. Adding advertising stocks or flows to the demand system does not necessarily solve this problem. The issue of the econometrician not observing the success of competitive advertising campaigns remains.

7. Supply could be upward sloping in the one-week run either because inventories cannot adjust or because of market power. The pricing equations (13) later assumed by Hausman imply an upward-sloping supply, for example.

8. The extensions to Hausman's case of approximately log-linear demand and multiproduct firms do not change anything important in the analysis.

all price coefficients in all products' demand curves. The simplest possible supply curve with market power is the single-product Bertrand-equilibrium one, assumed by almost all authors studying this problem (including Hausman and, here, me):

$$P_{jnt} = Q_{jnt}\,(-\gamma_{jj})^{-1} + c_{jnt}.$$

In the appendix, I perform the simple algebra to get the formula for the asymptotic bias to Hausman's estimator. The sign and order of magnitude of the bias are determined by the matrix

$$\sigma_{\varepsilon-nat}[\operatorname{diag}(-\gamma)-\gamma]^{-1}$$

Where $\sigma_{\varepsilon-nat}$ is the variance-covariance matrix of the national portion of the demand shock.

Hausman assumes $\sigma_{\varepsilon-nat}$ to be all zeros, in which case there is no bias. If there are nationwide demand shocks, the own-price coefficients are biased upward, toward zero. This is completely intuitive and familiar; with nationwide demand shocks, Hausman's estimator is like doing ordinary least squares on a supply and demand system; of course the estimates are biased toward too-steep demand curves.[9]

Unfortunately, this means that γ is biased in the direction of the finding reported by Hausman. The estimates will tend to report substitution patterns leading to a large consumer's surplus for new products, not because there are such substitution patterns, but because there are nationwide demand shocks not acknowledged in the estimation.

To believe Hausman's finding, then, one must be prepared to assume (1) that there are no nationwide shocks to demand which shift consumers among the products within segments, or (2) that shocks are not reflected in prices because they are unanticipated. That is a simple matter of econometric logic. It is a matter of scholarly taste whether one is prepared to make these assumptions. But assuming that there are no brand-specific advertising shocks in a consumer product category, or that these shocks are not communicated in advance to retailers, seems unwise without further investigation.

I do not mean to imply that the research program taken up here is impossible, only that the specific econometric methodology brought to the problem by Hausman seems particularly inappropriate to it. There is a wide variety of econometric models available for estimating the degree of substitutability in product-differentiated industries. I have reviewed some of them in Bresnahan (1989), and many different scholars are at work advancing the methods today.[10]

9. Similarly, if less familiarly, the cross-price coefficients are also likely to be biased upward, though this finding depends on the covariances of the shocks to demand across products. See equation A1 and following text.

10. This volume is not the place for a careful review of these methods. See Berry (1994) for a recent method contribution.

Imperfect Competition

Imperfect competition and new goods are linked through at least three major lines of causation. A new good in an imperfectly competitive environment can create market power for its inventor. It can destroy market power for competitive products. The equilibrium transitory market power these two forces imply contributes to the incentive to invent.

This is an interesting and important area of inquiry. In the paper at hand, "imperfect competition" means the analysis of a multiproduct firm with market power. In these remarks, I want first to point out some other useful and important implications of these estimates, and then turn to the question of how general Hausman's main analytical point might be.

Private Return to New Goods

A new product with a steep demand curve is involved with substantial consumer's surplus as Hausman in his paper and Trajtenberg (1989) point out. Let me point out that if the new product is proprietary to a single firm, it will also involve a monopoly rent to that firm. Exactly the same condition for large consumer's surplus—a not-too-flat *dd* in figure 5C.1—is the condition for a profitable single-product monopoly. Thus, demand measurement papers like this one are useful in assessing the private return to firms' introduction of new products as well as the social return that results from the introduction, Hausman's focus.

Of course, in the real world of multiproduct firms and competitive responses from other firms, more-complex calculations are needed. That is why, in this paper and others, it is valuable to estimate the entire demand system. Estimates of the supply system, not provided here, would obviously be needed as well.[11]

Prices in Imperfect Competition

Under imperfect competition among single-product firms, the impact of new-product introductions on pricing incentives is clear. The new product lowers the market power of existing products, lowering the overall level of prices.[12] This is one of the classical benefits of competition.

With multiproduct firms, the story changes slightly. Introduction of a new product by one firm lowers the market power of all other firms. This applies to all the other firms' products in varying degrees, depending on the demand

11. Assuming that the oligopoly solution concept is known, as here it is known to be Bertrand, and that the slope of marginal cost is known, here known to be flat, makes estimation of the supply system irrelevant. All the supply parameters which are not demand parameters are assumed to be known.

12. Peculiar values of the elasticities—as when the new good makes the demand curve for the old good steeper—can reverse this general theoretical finding.

elasticities and cross elasticities.[13] A new product in an imperfectly competitive industry makes demand curves at the single-product and single-firm levels flatter, thereby leading to a general lowering of prices.

Why, then, does Hausman find that the prices of other products rise in response to an introduction? There is a two-part answer. First, he assumes that the prices of other firms do not change, calculating "the markups over marginal cost that are profit maximizing for General Mills under the Nash-Bertrand assumption that other firms, such as Kellogg, will not change their prices in response to the introduction of Apple-Cinnamon Cheerios" (section 5.6). This is a common error among those who are new to models of imperfect competition, but an important one. The Bertrand solution concept has firms maximizing their postentry profits, taking one another's postentry prices as given.

For the analyst to calculate the equilibrium effect of entry, however, the other firms' postentry prices cannot be taken as given. The fact of entry changes the "game," and equilibrium prices will change in response. Typically, they will fall. What Hausman's analysis does is examine the price-discrimination problem for General Mills under the assertion that it is a monopoly, ruling out any equilibrium competitive response from the other firms. Hausman's assertion that he has a "lower bound" is wrong.

This observation also clarifies the calculations Hausman actually does make. By holding the prices of all other firms set, he examines the pricing problem of a multiproduct monopolist. Will a multiproduct monopolist raise prices on other goods? Hausman uses equation (13), the first-order condition for product j's prices:

$$\left[\frac{p_j}{\sum_{k=1}^{m} p_k q_k}\right] \frac{\partial \pi}{\partial p_j} = s_j + \sum_{k=1}^{m} \left[\frac{p_k - mc_k}{p_k} s_k\right] e_{kj} = 0.$$

The index k goes over all the firm's other products. What happens to this expression if we add a new product, $m + 1$? Two things: (1) the summation expression grows larger, by the term

$$\frac{(p_{m+1} - mc_{m+1})\, s_{m+1}}{p_{m+1}} e_{m+1,j},$$

and (2) the firm has a higher marginal revenue for product j because it owns $m + 1$—shares are held constant. This is the effect emphasized by Hausman.

13. Furthermore, under the Bertrand (Nash equilibrium with prices as strategic variables) solution concept used by Hausman, the story does not stop there. If a product introduction by firm A causes firms B and C to lower prices in response, what is the impact of those lower prices in turn? They represent more competition, and lower firm-B prices will cause lower firm-C prices, etc. Thus, the indirect effects of a competitive product introduction reinforce the direct effects. Most other equilibrium product-differentiated competition theories have similar competitive equilibrium effects.

The offsetting effect is that the terms s_j and s_k are smaller, to the extent that the existing products lose share to the new product. Thus, there are three effects on the existing product j's price. First, there is a new, positive, term in the summation. Second, s_j has fallen because of cannibalization. Third, s_k falls for all the firms' existing products, lowering each term in the summation. The net effect is to either raise or lower equation (13), calling for a new price of product j that can be either higher or lower.

In general, it is not possible to tell which of these effects is larger. But Hausman's assertion that we should expect one effect to dominate the other is clearly wrong. For the case of linear demand and a two-product firm, for example, the two effects exactly offset. Thus, any tendency of one effect to dominate the other does not arise from the fundamental economics of the problem, but instead from higher-order derivatives. And the paper at hand contains no evidence that those are important.

Imperfect Competition's Implications

Let me summarize the logical possibilities for imperfectly competitive analysis of new goods in a simple diagram. In figure 5C.2, the columns represent the mechanism by which a new good has impacts on industry pricing more generally, through the prices of competitive products or through the prices of other products of the same firm. The rows represent the welfare impacts that the new good can have. I have shaded the box where Hausman focuses his effort.

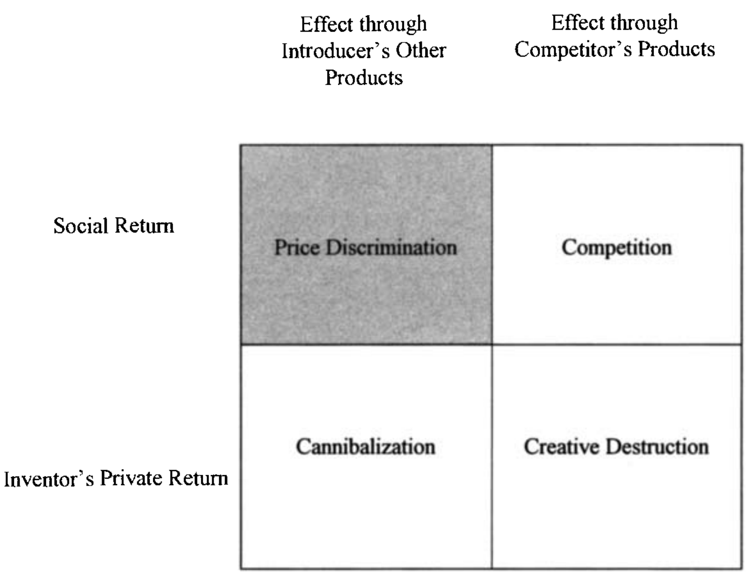


Fig. 5C.2 Imperfect competition and new goods

It seems to me that the focus is off. If we agree that the "social return" row is the interesting one, then Hausman has quantified the generally far less important effect. In general, the impact on pricing incentives for other imperfect competitors must be much more important. If we look at the overall picture, the problem involved in the conflict between incentives to introduce new goods and the value of those new goods looms large. And Hausman offers no analysis of this, though his estimates could easily be interpreted as having a bearing on it. The important topic of imperfect competition and new goods waits for analysis.

Conclusion

The topic of this paper is important for assessing the economic importance of new goods in mature, product-differentiated consumer goods industries. This reader was, unfortunately, left unconvinced by key econometric assumptions and found the imperfect-competition portion of the analysis off point. To remain unconvinced by the conclusion that single-product consumer's surplus was large may simply be to believe that there are nationwide brand-name demand shocks. The puzzle of the value of this incremental product introduction remains unsolved.

Appendix

The supply and demand system for each product in each city is

$$Q_{jnt} = y\beta_j + P_{nt}\gamma_j + \varepsilon_{jnt};$$

$$P_{jnt} = Q_{jnt}(-\gamma_{jj})^{-1} + c_{jnt}.$$

Solving out the quantities leaves

$$P_{jnt} = (y\beta_j + P_{nt}\gamma_j + \varepsilon_{jnt})(-\gamma_{jj})^{-1} + c_{jnt},$$

so that this equation system is the one solved by the prices of *all* the products in city n at time t:

$$P_{nt}[\mathrm{I} - \gamma\,\mathrm{diag}(-\gamma)^{-1}] = (y\beta + \varepsilon_{nt})\,\mathrm{diag}(-\gamma)^{-1} + c_{nt}.$$

The instruments are functions of the prices in other cities. Assume that the vector ε_{nt} consists of a national variance component plus independent draws for each city. Then the matrix of correlations of the prices in any particular city to the errors, ε_{nt}, in any other city will be proportional to

$$\sigma_{\varepsilon-nat}[\mathrm{diag}\,(-\gamma) - \gamma]^{-1} = \sigma_{\varepsilon-nat}\begin{bmatrix} -\gamma_{11} - \gamma_{11} & -\gamma_{12} \\ -\gamma_{21} & -\gamma_{22} - \gamma_{22} \end{bmatrix}^{-1}.$$

It is easy to see the assertions in the text in the two-product case:

$$\sigma\begin{bmatrix}1 & \rho \\ \rho & 1\end{bmatrix}\begin{bmatrix}-2\gamma_{11} & -\gamma_{21} \\ -\gamma_{12} & -2\gamma_{22}\end{bmatrix}^{-1} =$$

$$\sigma\begin{bmatrix}1 & \rho \\ \rho & 1\end{bmatrix}\begin{bmatrix}-2\gamma_{22} & -\gamma_{21} \\ -\gamma_{12} & -2\gamma_{11}\end{bmatrix}\frac{1}{4\gamma_{11}\gamma_{22} - \gamma_{12}\gamma_{21}} =$$

$$\sigma\begin{bmatrix}-2\gamma_{22} + \rho\gamma_{21} & \gamma_{12} - 2\rho\gamma_{11} \\ -2\rho\gamma_{22} + \gamma_{21} & \rho\gamma_{12} - 2\gamma_{12}\end{bmatrix}\frac{1}{4\gamma_{11}\gamma_{22} - \gamma_{12}\gamma_{21}}.$$

This gives the following results:

1. The on-diagonal bias has sign $(-2\gamma_{22} + \rho\gamma_{12})$, and
2. The off-diagonal bias has sign $(\gamma_{12} - 2\rho\gamma_{11})$.

At $\rho = 0$, the on-diagonal bias has sign $(-\gamma_{22})$, that is, positive (toward zero), and the off-diagonal bias has sign (γ_{12}), that is, positive (away from zero).

References

Berry, Steven. 1994. Estimating discrete choice models of product differentiation. *Rand Journal of Economics* 25, no. 2 (summer): 242–62.

Bresnahan, Timothy. 1989. Empirical studies of industries of market power. In *Handbook of industrial organization,* ed. Richard Schmalensee and Robert Willig. Amsterdam: North-Holland.

Eaton, B. Curtis, and Robert G. Lipsey. 1989. Product differentiation. In *Handbook of industrial organization,* ed. Richard Schmalensee and Robert Willig. Amsterdam: North-Holland.

Hausman, Jerry, and William Taylor. 1981. Panel data and unobservable individual effects. *Econometrica* 49, no. 6 (November): 1377–98.

Trajtenberg, Manuel. 1989. The welfare analysis of product innovation, with an application to computed tomography scanners. *Journal of Political Economy* 97, no. 2 (April): 444–79.

This Page Intentionally Left Blank