THE JOURNAL OF INDUSTRIAL ECONOMICS 0022-1821
Volume L September 2002 No. 3

THE COMPETITIVE EFFECTS OF A NEW PRODUCT INTRODUCTION: A CASE STUDY*

JERRY A. HAUSMAN† AND GREGORY K. LEONARD‡

This paper analyzes the competitive effect of a new product introduction. We break the overall competitive effect into two parts: the effect on the prices of existing products due to increased competition, and the effect of having additional product variety. Using data from both before and after the introduction, we directly estimate the price effects and the additional variety effect. Then, using only the estimated post-introduction demand structure, along with an assumed model of competition, we estimate the price effects indirectly. By comparing the 'indirect' and 'direct' estimates, we assess the validity of alternative models of competition for the industry.

I. INTRODUCTION

THE CONTINUOUS DEVELOPMENT and introduction of new products is an important source of improvement in consumer welfare. New product introductions are particularly prevalent in the 'fast moving consumer goods' segment of the US economy, which encompasses products sold through high volume retail channels such as supermarkets, drug stores, and mass merchandisers. For instance, recent introductions by fast moving consumer goods manufacturers include General Mills' introduction of a 'Frosted Cheerios' line extension, Coca-Cola's introduction of a new sports beverage product ('All-Sport') to compete with Gatorade, and Kimberly-Clark's introduction of a bath tissue product ('Kleenex Bath Tissue').

An important economic question is how much consumers benefit from new product introductions or, in the language of antitrust, what competitive effects the new product introductions have.[1] In the general case, consumers are affected by new product introductions in two ways. First, they gain the surplus associated with the additional variety provided by the new product. The magnitude of this consumer surplus gain is in general a function of

* We thank two referees and the editor for helpful comments and Ling Zhang and Karen Hull for excellent research assistance.

† Authors' affiliation: Department of Economics, Massachusetts Institute of Technology, Cambridge, MA 02139, USA.
email.

‡ Lexecon Inc., 4 Cambridge Center, Cambridge, MA 02142, USA.
email:

[1] The terms 'anti-competitive' and 'pro-competitive' are usually used by economists to describe events that decrease and increase, respectively, consumer welfare. The antitrust laws are generally viewed to be consumer welfare statutes.

© Blackwell Publishers Ltd. 2002, 108 Cowley Road, Oxford OX4 1JF, UK, and 350 Main Street, Malden, MA 02148, USA.

how closely substitutable consumers view the new product and existing products. A new product that is closer to existing products will add less consumer surplus. Second, the introduction of a new product creates increased competition for existing products. If the manufacturer of the new product has no existing products in the market, the new product will typically lead to lower prices for all competing products, a result which benefits consumers.[2] The extent to which a particular existing product's price is affected by the introduction of the new product is a function of the closeness between the existing product and the new product, as well as of the form competition takes in the market. If the manufacturer of the new product has other products in the market, a possible outcome of the new product introduction is an increase in the prices of these other products which would harm consumers, see Hausman [1997]. The overall net effect on consumers of a new product introduction is the sum of the additional variety effect and the price effect.[3]

In this paper, we estimate the net benefit to consumers associated with the introduction of the Kimberly-Clark bath tissue product 'Kleenex Bath Tissue' (henceforth, KBT). Using retail scanner data from before and after the introduction, we estimate directly the reductions in price for existing products in the bath tissue market that resulted from the introduction of KBT, i.e., the price effect. Then, using retail scanner data from after the introduction, we estimate the additional consumer surplus associated with the availability of KBT (evaluated at the lower category prices), i.e., the additional variety effect. We find that consumers have been made significantly better off by the introduction.

In addition, we use the estimated post-introduction demand structure, along with an assumed model of competition, to estimate indirectly the price effects of the KBT introduction. By comparing this 'indirect' estimate of the price effects to the 'direct' estimate of the price effects that are obtained using the pre- and post-introduction data as described above, we can assess the validity of the predictions generated by the assumed model of competition. We focus in particular on the Nash-Bertrand model. Given the important role played by the Nash-Bertrand model in the economic literature on differentiated products, e.g., analyses of the competitive effects of mergers, an assessment of its validity (even for a particular industry) is valuable. We also examine several alternative models of competitive behavior.

[2] Our use of the term 'market' in this paper refers to the meaning in economics as opposed to the meaning in antitrust (i.e., 'relevant market').

[3] These welfare effects are 'static.' A new product introduction might also have 'dynamic' welfare effects. For instance, a new product might create a whole new market segment, leading to subsequent 'me-too' product introductions. Miller Lite, which created the light beer segment, is an example.

© Blackwell Publishers Ltd. 2002.

II. THE BATH TISSUE MARKET

As in many consumer product industries, bath tissue products fall into several quality tiers, 'premium,' 'economy,' and 'private label.' However, the bath tissue market is somewhat unusual in that premium brands account for a substantial share of dollar sales (typically over 70%). Premium bath tissue brands are generally produced using a base tissue that is thicker and softer than the base tissue used to produce the brands in the non-premium segments. This higher quality tissue is typically more costly to produce, due both to higher manufacturing costs and higher raw material (pulp) costs. The premium bath tissue brands are generally priced significantly higher than the brands in the other segments.[4] Prior to the KBT introduction, the major premium brands were Charmin (manufactured by Procter & Gamble), Northern (James River), Angel Soft (Georgia Pacific), and Cottonelle (Scott).

Kimberly-Clark, one of the world's largest tissue producers, was well known for its Kleenex facial tissue brand, but it did not offer a major bath tissue product prior to 1991. Kimberly-Clark believed that a bath tissue product would provide a way to extend the Kleenex brand name and make use of Kimberly-Clark's superior tissue technology without cannibalizing any existing Kimberly-Clark product. Thus, in 1991, Kimberly-Clark rolled out Kleenex Bath Tissue in selected regions of the US, positioning it as a premium brand. Kimberly-Clark subsequently increased the distribution of the product to other regions of the US.[5]

The major 'economy' brand was ScotTissue, manufactured by Scott. ScotTissue is made from a lower quality tissue than the premium brands. But, ScotTissue is considered to be an atypical economy brand in that it has substantial brand-name recognition among consumers and a loyal customer base. ScotTissue is targeted toward consumers who desire many sheets per roll. Given the large number of sheets per roll and the thinness of each sheet, ScotTissue's price (per sheet) is quite low, even below the price of private label.

As in other consumer product markets, private label products over time have taken a significant share of the bath tissue market. Private label products are produced by tissue manufacturers for supermarkets (and other retailers) who then market and sell them under their own labels. Supermarkets generally receive a higher margin on private label products than they do on branded products.

[4] Even within the premium segment, however, significant variation in quality exists. Charmin is on the higher end of the segment and Angel Soft on the lower end.

[5] After its merger with Scott in 1995, Kimberly-Clark combined the Scott Cottonelle product and its KBT product into a single product called 'Kleenex Cottonelle' (which had the characteristics of the KBT product). As a result, the Kleenex product attained national distribution.

© Blackwell Publishers Ltd. 2002.

The production technology in the bath tissue industry is characterized by sizable fixed costs, as tissue machines are a significant capital investment. Marginal costs are driven primarily by the cost of pulp, which is the main input into tissue production. Pulp prices are highly cyclical (the pattern of pulp prices is called the 'pulp cycle'). Price competition in the industry appears to be strong, with bath tissue manufacturers seeking to keep their tissue machines running at full capacity by reducing prices when necessary.

Anecdotal evidence suggests that after, and even prior to, Kimberly-Clark's entry into a region, Procter & Gamble reacted aggressively by reducing the price of Charmin. The Procter & Gamble price reductions were followed by price reductions in the other premium brands. Thus, the introduction of KBT is thought by industry participants to have increased competition in the industry and lowered industry prices. Below, we analyze this issue.

III. ESTIMATING THE VALUE TO CONSUMERS OF A NEW BRAND

The total effect on consumers of the introduction of a new brand, i.e., the compensating variation, can be written as the difference in the consumers' expenditure function before and after the introduction, holding utility constant at the post-introduction level:

$$CV = e(p_1, p_N, r, u_1) - e(p_0, p_N^*(p_0), r, u_1) \tag{1}$$

where p_1 is the vector of post-introduction prices of the competing products, p_N is the post-introduction price of the new product, r is a vector of prices of products outside the industry (which are assumed to be unaffected by the introduction), and u_1 is the post-introduction utility level. The pre-introduction utility level could also be used which would yield an equivalent variation measure. The function $p_N^*(p)$ defines the 'virtual' price for the new product, i.e., the reservation price at which demand for the new product would be zero given the prices of the other products.

This total benefit to consumers can be broken into two parts,

$$\begin{aligned} CV = {} & [e(p_1, p_N, r, u_1) - e(p_1, p_N^*(p_1), r, u_1)] + \\ & [e(p_1, p_N^*(p_1), r, u_1) - e(p_0, p_N^*(p_0), r, u_1)] \end{aligned} \tag{2}$$

and written as $CV = -(VE + PE)$.[6] The first term ('VE'—the 'variety effect') represents the increase in consumer welfare due to the availability

[6] In most situations, compensating variation will be negative (since less expenditure is required to reach the reference utility level after the introduction of the new product). Since we will define VE and PE as increases in consumer welfare (i.e., positive numbers), CV is defined as the negative of the sum of VE and PE.

© Blackwell Publishers Ltd. 2002.

of the new brand, holding the prices of the existing brands constant at their post-introduction level.

The second term ('*PE*'—the 'price effect') represents the change in consumer welfare due to the change in the prices of existing brands after the introduction. By changing the competitive structure of the industry, the new brand introduction can lead to either an increase or decrease in the prices of existing brands. If the new brand competes closely with the existing brands of the same manufacturer, the manufacturer may be able to raise the price of its existing brands. If, however, the new brand competes more closely with the brands of other manufacturers (or the new brand is the first product in the industry for that manufacturer), the prices of these other brands are likely to fall. Thus, in addition to providing additional variety, the introduction of a new brand can change consumer welfare through an effect on the prices of existing brands.

We have obtained both pre-introduction and post-introduction data on the sales of bath tissue products. Given these data, we take two approaches to estimating the price effect term from equation (2) associated with the introduction of KBT. In the first, 'direct,' approach, we combine the pre- and post-introduction data to directly estimate the effect of the KBT introduction on the prices of existing bath tissue products. With the direct approach, we avoid having to estimate the structure of consumer demand for bath tissue products and we also avoid having to make assumptions about the form of competition in the industry.[7]

The second, 'indirect,' approach requires only the existence of post-introduction data. We use these data to estimate the structure of demand for bath tissue products. Then, given the structure of demand and an assumption about the form of competition between firms in the industry, we estimate what would happen to the prices of the other bath tissue products if KBT were removed from store shelves. The indirect approach is valuable because it requires only post-introduction data. However, it depends upon the assumption regarding the form of competition that prevailed in the industry both before and after the introduction.

Given the possibility here of implementing both approaches, it is natural to compare the two sets of results. This comparison provides a way to assess the validity of particular models of competition.[8] We focus on the Nash-Bertrand model. An assessment of this particular model is desirable given its important role in the economic analysis of differentiated products

[7] The increase in consumer surplus due to the price effect can be approximated to first order using these results and quantity data. However, determining the exact increase in consumer surplus still requires estimation of the demand structure.

[8] A maintained hypothesis required for this comparison is that the specification of the demand system is the same in the pre and post-introduction periods. However, because of the flexible demand specification used, this assumption is likely to be valid.

© Blackwell Publishers Ltd. 2002.

industries. For example, the Nash-Bertrand assumption is frequently employed in studies of the competitive effects of mergers, e.g., Deneckere and Davidson [1985], Hausman, Leonard, and Zona [1994], Werden and Froeb [1994], Hausman and Leonard [1997], and Werden [1997].

In addition to estimating the price effect term in equation (2), we also estimate the variety effect term. Again, only the post-introduction data and the demand structure estimated on these data are required. We sum the VE and PE terms in equation (2) to obtain the total benefit to consumers resulting from the introduction of KBT. Unlike the cereals case studied by Hausman [1997], the introduction of KBT by Kimberly-Clark is a case of essentially *de novo* entry into an industry.[9] Thus, we would expect the price effects term to be positive (i.e., the prices of existing brands are reduced, increasing consumer surplus). However, whether the variety effect is larger than the price effect, or vice-versa, is an empirical question.[10]

IV. DATA

The source for the data we use in the empirical analyses described below is AC Nielsen. In each of a number of direct marketing areas ('cities') in the US, Nielsen selects a stratified sample of supermarkets. From each sampled supermarket, Nielsen obtains computerized data gathered by in-store point-of-sale scanning devices. As each product purchased by a consumer is passed over the scanner, the price and UPC number (which identifies the brand and package type) of the sale are recorded. Nielsen projects from its sample of stores to the population of stores to estimate the quantity sales and average price by city and week for each brand.

We had access to weekly Nielsen data on the unit sales and price of the seven largest bath tissue products in 30 cities in the US for the period January 1992–September 1995 period (196 weeks). KBT was rolled out across the US in a series of 'waves'.[11] The 30 cities used in our analysis fall into three groups based on the wave to which they belonged. In 17 of our 30 cities, KBT had already been introduced by the time our data begins (i.e., January, 1992). We refer to these 17 cities as the 'first wave' cities. In three of the 30 cities, KBT was introduced in July, 1993 (the second wave). In the remaining ten cities, KBT was introduced in May, 1994 (the third wave).

[9] Prior to the introduction, Kimberly-Clark had a minor bath tissue brand with extremely small share (Delsey).

[10] If the new product were a nearly perfect substitute for an existing product, the variety effect would be close to zero. Conversely, if the new product were quite differentiated from the existing products, the price effect might well be close to zero.

[11] We suspect that Kimberly-Clark rolled out the KBT product first in cities where its Kleenex product was strongest.

© Blackwell Publishers Ltd. 2002.

Table I provides summary information on the 30 cities, grouped by wave, for the last six months of our data (April to September 1995).[12] The first seven columns of Table I give the dollar shares of the seven brands. A particular brand's share can vary substantially across cities. For instance, Charmin, the brand that generally has the largest share of bath tissue expenditures, had a 43.3% share in Nashville, but only a 22.7% share in Milwaukee.

The second seven columns of Table I give the prices for the seven brands (expressed as dollars per 28,000 sheets, which is the 'standardized' quantity unit used by Nielsen). Like the share, a particular brand's price can vary substantially across cities. Charmin's price in Omaha was $28.01, while its price in Miami was $33.99. Of the seven brands, Charmin generally carried the highest price. As noted earlier, despite its branded status, ScotTissue was often priced lower than even private label.

In the last column of Table I, we provide annual bath tissue expenditure by city. These figures give an indication of relative market sizes.

While the Nielsen data provide the best available information on retail sales by geographic area, they have several shortcomings. First, individual private label products are not broken out separately. Only an aggregate private label category is available. Thus, we cannot examine variation in quality or other forms of competitive interaction among the individual private label brands. Second, the Nielsen price data do not account for the use of manufacturers' coupons.

V. DIRECT ESTIMATES OF THE PRICE EFFECT OF THE KBT INTRODUCTION

In the 17 first wave cities, KBT had already been introduced at the start of the period covered by our data, while for the second and third wave cities, KBT was introduced at two different points during the period. The existence of staggered introductions allows us to identify any downward shift in the prices of existing brands caused by the KBT introduction separately from movements in prices caused by other factors, such as changes in cost conditions, that would be expected to affect prices in all cities.

In particular, we examine price movements in the second and third wave cities after KBT was introduced, controlling for contemporaneous price movements in the first wave cities (where KBT had already been introduced). To the extent that the KBT introduction had a downward effect on the prices of existing brands, we should see a downward shift in the prices in the second wave and third wave cities after KBT is introduced, relative to price movements in the first wave cities.

[12] We use a six month period in order to avoid the short run effects on prices and shares caused by temporary price reductions, i.e., sales, run by supermarkets.

© Blackwell Publishers Ltd. 2002.

TABLE I
AVERAGE SHARES, AVERAGE PRICES, AND BATH TISSUE EXPENDITURE FOR APRIL–SEPTEMBER 1995

	Shares							Average Prices							
	Kleenex	Cottonelle	ScotTissue	Charmin	Northern	Angel Soft	Private Label	Kleenex	Cottonelle	ScotTissue	Charmin	Northern	Angel Soft	Private Label	Bath Tissue Expenditure
First Wave Cities (KBT Introduced Prior to January 1992)															
Charlotte	10.0%	6.4%	25.8%	36.1%	7.2%	11.3%	3.2%	$25.82	$22.97	$15.06	$32.60	$25.27	$22.19	$17.23	$10,308,700
Chicago	10.5%	10.6%	23.1%	26.6%	16.2%	4.4%	8.6%	$26.01	$25.50	$14.06	$30.36	$26.05	$22.43	$15.73	$35,658,610
Dallas	10.7%	7.8%	11.1%	37.1%	14.2%	10.7%	8.4%	$25.71	$23.82	$16.23	$32.92	$25.24	$22.32	$18.83	$21,537,900
Houston	12.1%	5.1%	14.0%	36.6%	11.5%	12.3%	8.4%	$24.99	$25.10	$15.57	$31.97	$25.05	$22.67	$15.23	$20,311,590
Jacksonville	7.6%	7.3%	14.1%	38.4%	10.4%	12.7%	9.5%	$25.15	$26.00	$15.75	$32.92	$25.02	$21.88	$17.70	$6,027,665
Kansas City	8.3%	13.1%	3.9%	39.9%	22.8%	5.1%	7.0%	$25.38	$20.77	$16.88	$30.16	$22.66	$20.90	$18.64	$7,846,531
Memphis	6.2%	10.1%	8.8%	35.0%	18.9%	14.4%	6.5%	$26.34	$22.99	$18.45	$30.26	$23.40	$21.01	$17.79	$7,274,787
Miami	9.1%	5.5%	14.4%	38.4%	10.6%	10.8%	11.2%	$24.81	$26.81	$15.99	$33.99	$26.56	$22.64	$18.07	$22,377,420
Milwaukee	15.3%	17.1%	15.0%	22.7%	21.5%	3.3%	5.1%	$25.27	$25.63	$15.92	$31.49	$25.23	$21.53	$17.51	$9,404,768
Nashville	7.2%	6.5%	8.4%	43.3%	15.7%	14.7%	4.3%	$25.45	$21.68	$16.12	$30.19	$24.16	$21.04	$15.97	$8,399,963
New Orleans	9.5%	6.8%	22.1%	34.5%	10.2%	8.1%	8.8%	$24.16	$23.44	$14.91	$31.14	$25.20	$21.60	$15.64	$17,037,200
Oklahoma City	7.2%	12.9%	3.4%	37.0%	31.4%	1.2%	6.9%	$26.87	$24.56	$17.06	$33.30	$23.35	$23.88	$17.19	$9,405,713
Omaha	8.5%	8.6%	5.9%	40.9%	23.3%	3.2%	9.4%	$23.93	$23.39	$15.96	$28.01	$23.40	$22.40	$16.66	$4,413,216
Orlando	9.2%	7.9%	15.7%	32.9%	12.0%	11.7%	10.6%	$24.61	$24.80	$15.56	$31.81	$25.60	$21.86	$18.34	$9,226,082
San Antonio	13.5%	2.7%	15.8%	36.3%	9.7%	10.0%	11.9%	$24.10	$27.81	$15.69	$30.00	$24.02	$22.30	$19.10	$14,287,750
St. Louis	13.7%	12.3%	4.5%	35.8%	18.6%	10.5%	4.6%	$24.06	$25.36	$17.13	$30.78	$25.19	$22.98	$18.23	$11,116,830
Tampa	11.1%	5.4%	15.8%	31.3%	12.8%	13.3%	10.3%	$25.10	$26.24	$15.60	$32.47	$25.67	$21.84	$17.65	$17,248,630
Second Wave Cities (KBT Introduced July 1993)															
Baltimore	6.8%	8.7%	21.5%	33.8%	10.9%	7.5%	10.7%	$28.43	$24.49	$15.10	$35.97	$28.14	$22.59	$19.92	$13,355,130
Detroit	8.5%	16.3%	10.7%	21.9%	29.1%	8.6%	4.9%	$27.27	$24.57	$16.42	$33.30	$26.12	$21.56	$18.85	$22,675,920
Washington, DC	8.2%	8.1%	14.8%	34.4%	12.2%	10.1%	12.2%	$27.31	$26.52	$16.14	$33.00	$26.43	$25.45	$20.81	$25,934,260
Third Wave Cities (KBT Introduced May 1994)															
Buffalo/Rochester	5.6%	12.0%	30.4%	24.0%	9.1%	5.5%	13.3%	$25.56	$21.31	$13.31	$30.55	$26.11	$22.84	$14.66	$12,964,710
Cincinnati	8.6%	12.7%	4.2%	35.6%	22.2%	10.4%	6.3%	$24.83	$23.03	$18.23	$33.00	$25.44	$23.22	$17.09	$12,540,490
Cleveland	5.8%	12.3%	13.8%	43.0%	18.0%	3.6%	3.6%	$23.93	$22.67	$14.38	$31.66	$24.62	$22.05	$15.81	$18,891,790
Columbus	4.6%	12.1%	3.6%	34.1%	14.7%	24.6%	6.3%	$26.08	$23.70	$16.65	$34.56	$25.70	$22.05	$16.81	$10,069,940
Denver	6.6%	2.1%	11.1%	29.8%	23.2%	7.3%	19.9%	$25.99	$25.36	$15.43	$32.62	$25.62	$22.48	$20.53	$14,596,440
Los Angeles	8.2%	1.7%	21.2%	30.8%	15.6%	7.5%	15.0%	$25.71	$28.13	$15.68	$32.32	$26.82	$24.73	$23.13	$64,969,910
Louisville	5.8%	12.9%	3.5%	46.4%	19.2%	7.5%	4.8%	$22.69	$22.16	$15.29	$30.26	$22.71	$22.70	$15.12	$8,873,668
Pittsburgh	6.0%	8.6%	19.9%	36.5%	13.8%	10.9%	4.3%	$24.25	$23.16	$15.34	$31.37	$24.89	$21.82	$17.61	$18,263,740
San Diego	6.7%	1.4%	16.8%	29.8%	14.6%	8.3%	22.5%	$25.37	$30.95	$16.29	$32.03	$26.38	$24.61	$23.54	$9,917,793
Syracuse	2.4%	15.9%	32.2%	21.4%	9.4%	9.4%	9.3%	$25.16	$23.95	$13.63	$31.54	$25.68	$22.68	$14.95	$8,406,757

Notes: (1) Prices are in 1992 dollars and are for a standard quantity unit (28,000 sheets)

© Blackwell Publishers Ltd. 2002.

Specifically, for each existing bath tissue brand, we estimated an equation of the following form:

$$\log p_{it} = \alpha_i + W_t + I_{it}\delta_1 + M_{it}\delta_2 + \varepsilon_{it} \tag{3}$$

The dependent variable, $\log p_{it}$, is the log price of the existing bath tissue brand in city i and week t. The variables α_i and W_t are fixed effects for city i and week t, respectively. These variables account for city-specific effects and week-specific effects (i.e., movements in costs that would be expected to affect prices in all cities).

The variable I_{it} is a 'post-introduction' indicator variable. In other words, it equals one if KBT had been introduced in city i as of week t. The coefficient on I_{it} measures the amount by which the price of the existing brand changed after the KBT introduction, controlling for the week-specific fixed effects. This coefficient is identified separately from the week-specific effects because of the staggered waves of KBT introduction.

The variable M_{it} was included to determine whether prices in the third wave cities fell in response to the introduction of KBT in the second wave cities even though KBT had not yet actually been introduced in the third wave cities. It is possible that producers of existing brands attempted to preempt some of the KBT effect in third wave cities by lowering price in advance of the KBT entry. Thus, M_{it} equals one if city i is one of the third wave cities and t is a week in the 'interim period' between the second and third waves of introduction.

Equation (3) was estimated via OLS and a modified Newey-West procedure was used to estimate the standard errors taking account of the possibility of correlation in the error term across cities and weeks. The coefficient estimates and standard errors are provided in Table II.[13]

The estimated post-introduction coefficients are negative for all brands, indicating that the prices of existing brands fell after the KBT introduction. The price of the leading bath tissue brand Charmin experienced a 3.5% reduction. This effect is estimated quite precisely with a standard error of 0.9%. Thus, although KBT achieved a share generally only one-quarter to one-third of Charmin's (see Table I), its introduction had a significant effect on Charmin's price. The brand with the largest estimated price reduction (8.2%) was Cottonelle. The other two premium brands, Angel Soft and Northern, also experienced significant price reductions of 3.5% and 2.3%, respectively.

In contrast to the price behavior of the premium brands, the price of ScotTissue, an economy brand, was estimated to fall by only 0.6% (estimated standard error of 0.5%). Thus, Scott apparently made only a small change in the pricing of ScotTissue in response to the KBT entry.

[13] Table II actually reports the estimated percentage effect on price, i.e., $\exp(\delta_1) - 1$, instead of the regression coefficient δ_1 itself.

© Blackwell Publishers Ltd. 2002.

TABLE II
DIRECT ESTIMATES OF THE PRICE EFFECTS OF THE KBT INTRODUCTION

Brand	Post-Introduction	Interim	R-Squared
Cottonelle	−8.2% (1.3%)	−5.8% (1.4%)	0.37
Charmin	−3.5% (0.9%)	−3.1% (0.7%)	0.43
Northern	−2.3% (0.8%)	−0.4% (0.9%)	0.38
Angel Soft	−3.5% (0.6%)	−0.5% (0.7%)	0.37
ScotTissue	−0.6% (0.5%)	−1.2% (0.6%)	0.67
Private Label	−3.8% (0.9%)	−4.6% (1.1%)	0.72

Notes: (1) Dependent variable is log price.
(2) Fixed effects for city and week also included in the specification.
(3) Standard errors in parentheses.

The effect of the KBT introduction for private label was more similar to the effect for the premium brands than for ScotTissue. The private label price was estimated to fall by 3.8%, even though private label brands *a priori* might be expected to compete less closely with KBT than Northern and Angel Soft.

The estimated interim period coefficients indicate that the producers of the existing brands adopted different strategies as to when to reduce their prices in the third wave cities.[14] Northern and Angel Soft prices did not decline in the third wave cities until KBT was actually introduced in those cities (i.e., their interim variable coefficients are not statistically significantly different from zero). In contrast, essentially all of the Charmin and private label price reductions in the third wave cities occurred at the time of the second wave of introduction (their estimated interim period coefficients are approximately the same size as their estimated post-introduction coefficients). For Cottonelle, part of the price reduction occurred during the interim period, with the rest coming after the KBT introduction.

Given the price effects estimated in Table II, the second term in equation (2), i.e., the increase in consumer surplus due to the price reductions in existing brands due to the KBT introduction (evaluated at the KBT virtual

[14] These results suggest that our estimates of the price effects of the KBT introduction may be understated to the extent that producers of existing products reduced their prices in the second and third wave cities in response to the first wave of introductions, before the start of our data.

© Blackwell Publishers Ltd. 2002.

price), can be estimated. A first order approximation to the consumer surplus gain could be obtained by multiplying the respective brands' quantities by their price declines and summing. An exact calculation, however, requires knowledge of the demand structure. We now turn to estimating this structure.

VI. ESTIMATION OF THE VARIETY EFFECT OF THE KBT INTRODUCTION

VI(i). *Demand System Estimation*

To estimate the additional consumer surplus associated with the availability to consumers of the KBT brand, we estimate the structure of the demand for bath tissue using the Nielsen data. Our approach to estimation is one we have used previously (Hausman, Leonard, and Zona [1994] and Hausman [1997]).

1. Demand System Specification

We employ a two-stage demand system based on Gorman's two-stage budgeting approach (see, e.g., Gorman [1995]). The basic idea is to have the top level correspond to overall demand for the product, here bath tissue. The second, or bottom, level of the demand system corresponds to competition among brands, e.g., KBT and Charmin. We estimate both levels of the demand system and, by combining the estimates from the two levels together, we are able to estimate the overall own and cross price elasticities for each brand.

The second (or lower) stage determines buying behavior with respect to the brands, conditional on total bath tissue expenditure. For this level, we use the 'almost ideal demand system' specification of Deaton and Muellbauer which allows for a second order flexible demand system, i.e., the price elasticities are unconstrained at the point of approximation, and also allows for a convenient specification for non-homothetic behavior (Deaton and Muellbauer [1981]).

Let the bath tissue expenditure share of brand i in city n in time t be defined as

$$s_{int} = \frac{p_{int} Q_{int}}{Y_{nt}} \tag{4}$$

where Q_{int} is the quantity of brand i in city n and week t, p_{int} is the price of brand i in city n and week t, and Y_{nt} is the total expenditure on bath tissue in city n and week t.

Under the almost ideal demand system specification, the lower level demand specification for the share of brand i is:

© Blackwell Publishers Ltd. 2002.

$$s_{int} = \alpha_{in} + \beta_i \log \frac{Y_{nt}}{P_{nt}} + \sum_{j=1}^{I} \gamma_{ij} \log p_{jnt} + Z_{nt}\theta_i + \varepsilon_{int}$$

(5) $$n = 1, ..., N$$
$$t = 1, ..., T$$
$$i = 1, ..., I$$

P_{nt} is an overall price index for bath tissue; we use the Stone index

(6) $$\log P_{nt} = \sum_{i=1}^{I} w_{in} \log p_{int}$$

where the weight for brand i in city n is the average (over all weeks) of the expenditure share of brand i in city n. The parameters α_{in} in (5) are city-brand-specific fixed effects to capture time-invariant differences in demographics and consumer preferences across cities and brands. The vector Z_{nt} includes variables intended to account for changes in demographics and preferences. For this purpose, we use monthly indicator variables (to capture seasonal effects) and a linear time trend.

In the top level equation, total bath tissue expenditure is determined as a function of the overall bath tissue price index and consumers' total expenditure. We use the following specification for the top level demand equation:

(7) $$\log u_{nt} = \mu_n + \lambda \log X_{nt} + \delta \log P_{nt} + Z_{nt}\phi + \eta_{nt}$$

where u_{nt} is overall bath tissue quantity in city n in time, μ_n is a fixed effect for city n (again representing time-invariant demographics and preferences), X_{nt} is total disposable income for city n and week t (obtained on an MSA basis from the BLS), P_{nt} is the bath tissue price index, and Z_{nt} is the vector of seasonal and time trend variables.

2. *Instruments*

We use an instrumental variable technique to account for the potential simultaneity problem, i.e., the existence of factors unobserved to the econometrician that affect both consumer demand and the price-setting of firms. One possibility for developing instruments is to obtain data on cost variables that do not appear in the demand equations. However, to be useful instruments, such variables would have to be measured with a great degree of frequency and specificity (i.e., separately for the individual manufacturers). For instance, a paper pulp price variable, measured monthly and at a national level, would not ultimately be very helpful in estimating a demand equation based on the prices of eight individual bath tissue brands, measured weekly in a large number of cities. While plant-specific variable cost data for each manufacturer would be more helpful, having access to such data is rare and indeed, we did not have access to such data.

© Blackwell Publishers Ltd. 2002.

To get around this problem, we attempt to utilize the panel structure of the underlying data. After allowing for the brand-city fixed effects, we use the prices from one city as instruments for other cities, following the approach of Hausman and Taylor [1981]. The intuition is that prices in each city reflect both underlying product costs and city-specific factors that vary over time as supermarkets run promotions on a particular product. To the extent that the stochastic city-specific factors are independent of each other, prices from one city can serve as instruments for another city.

Consider the case of two cities, indexed by $n = 1$ or 2, and the estimation of the share equation (5) for city 1. The reduced form equations for the prices of brand j in the two cities are

$$\begin{aligned} \log p_{j2t} &= \Pi_1 \log c_{jt} + \mu_{j2} + Z_{2t}\Pi_2 + v_{j2t} \\ \log p_{j1t} &= \Pi_1 \log c_{jt} + \mu_{j1} + Z_{1t}\Pi_2 + v_{j1t} \end{aligned} \tag{8}$$

A common determinant of the prices in the two cities is c_{jt}, a non-city-specific cost element that arises because of the regional or national manufacture and shipping of bath tissue products. Also appearing in the reduced form equation are the demand shifter variables (Z_{nt}), a city-specific brand differential due to transportation costs or local wages (μ_{jn}), and an error term (v_{jnt}). In general, the error term ε_{j1t} from share equation (5) for city 1 will be correlated with v_{j1t}. If so, then OLS would yield inconsistent estimates of the parameters in equation (5).

However, as long as v_{j2t} is uncorrelated with v_{j1t}, city 2's price satisfies the first requirement to be a valid instrument for city 1's price, i.e., it is uncorrelated with the error term in equation (5). Moreover, since city 2's price, after elimination of city- and brand-specific effects and the demand shifter variables, is driven by the same underlying costs, $\log c_{jt}$, as city 1's price, city 2's price also satisfies the second requirement to be a valid instrument for city 1's price.

We now examine the conditions under which v_{j2t} would be uncorrelated with v_{j1t}. For that purpose, it is useful to consider the error term from the share equation (5), ε_{j1t}. This error term will contain demand-shifting factors not accounted for by Z_{1t}. These demand-shifting factors can be divided into three categories. First, since supermarket shelf prices are generally set and posted in advance of the realization of demand, some factors in ε_{j1t} are not observed when prices are set. Such factors would not appear in the reduced form equations (8) and thus would not cause correlation between v_{j1t} and v_{j2t}. Second, some factors in ε_{j1t} are purely city-specific, e.g., the effects of local advertising and promotion. These factors also would not cause correlation between v_{j1t} and v_{j2t}. Third, some part of ε_{j1t} may arise from a factor that is both present across cities and not already picked up by Z_{1t}. Only this third category of factors could cause a correlation between v_{j1t} and v_{j2t}.

© Blackwell Publishers Ltd. 2002.

An example of such a factor might be a national advertising campaign, which might both affect demand in all cities and be taken into account when retail prices are set. The variables we included in Z_{1t} may well capture the effects of national advertising. However, to better capture national advertising or any other such nationwide factor, we implemented an additional specification that allows for a more flexible effect of time on demand than our initial specification and thus would be expected to pick up more of any nationwide factors. In particular, we included in the specification separate indicator variables for each month-year period in the data. Since manufacturers' national advertising plans are often broken into monthly segments, the specification has the potential to capture the effects on demand of national advertising, eliminating the correlation that might exist among the v_{jnt}. However, we find that the results of this more flexible specification are quite similar to our original specification.[15]

Thus, while we cannot completely rule out the existence of some nationwide factor that causes correlation among the v_{jnt}, the results of the alternative specification do not indicate any serious problem with the instruments.

3. *Elasticity Estimates*

We applied the econometric approach outlined above to the Nielsen Scantrak data to estimate the bath tissue demand model. For the 17 wave three cities, the number of weeks of data available after KBT had been introduced and its share had stabilized was sufficient to estimate the demand system. The underlying demand system parameter estimates are provided in Appendix Table I, which is available in the Supplementary Materials section of the Journal's editorial website. However, elasticities are more easily interpretable and we discuss the estimates of the elasticities in the main text.

The equation for the elasticity of brand i with respect to brand j's price is

$$e_{ij} = \frac{1}{s_i}\left[\gamma_{ij} - \beta_i w_j\right] - 1[i = j] + \left(1 + \frac{\beta_i}{s_i}\right)(1 + \delta)w_j \tag{9}$$

where the variables and parameters are defined in the discussion of equations (4)–(7). For the purposes of the presentation in Table III, we estimated the elasticities at the averages of the data across city and time. Table III is organized so that the first row of the elasticity matrix gives the KBT own elasticity (column 1) and the cross elasticities of KBT with respect to the other brands' prices (columns 2–8).

[15] The results are presented in Appendix Table II, which is available in the Supplementary Materials section of the Journal's editorial website.

© Blackwell Publishers Ltd. 2002.

TABLE III
OWN AND CROSS PRICE ELASTICITIES

		With Respect To The Price Of						
		Kleenex	Cottonelle	Charmin	Northern	Angel Soft	ScotTissue	Private Label
	Kleenex	−3.293	0.502	0.679	0.707	0.207	0.086	0.016
		(0.103)	(0.068)	(0.089)	(0.080)	(0.072)	(0.059)	(0.049)
	Cottonelle	0.560	−3.304	0.737	0.360	0.621	−0.147	0.129
Elasticity		(0.075)	(0.098)	(0.086)	(0.082)	(0.072)	(0.058)	(0.048)
	Charmin	0.255	0.242	−2.292	0.471	0.262	0.280	0.079
Of		(0.026)	(0.023)	(0.042)	(0.028)	(0.025)	(0.021)	(0.017)
	Northern	0.493	0.230	0.933	−3.078	0.391	0.065	0.021
The		(0.053)	(0.050)	(0.064)	(0.078)	(0.051)	(0.041)	(0.034)
	Angel Soft	0.326	0.765	1.132	0.804	−4.066	0.378	0.172
Demand		(0.090)	(0.082)	(0.099)	(0.094)	(0.127)	(0.081)	(0.064)
	ScotTissue	0.098	−0.079	0.656	0.097	0.204	−1.803	0.027
For		(0.043)	(0.039)	(0.052)	(0.045)	(0.049)	(0.069)	(0.036)
	Private Label	0.024	0.165	0.233	0.023	0.146	0.012	−1.685
		(0.070)	(0.062)	(0.081)	(0.073)	(0.073)	(0.069)	(0.073)

© Blackwell Publishers Ltd. 2002.

The KBT own elasticity is −3.3. Among the KBT cross elasticities, the largest are with respect to the prices of Northern (0.71), Charmin (0.68), Cottonelle (0.50), and Angel Soft (0.21). These results are consistent with consumers viewing these other premium brands as the closest substitutes for KBT.

Charmin has a somewhat lower own elasticity of demand than KBT, −2.3, reflecting its position as the strongest brand in the industry. Charmin's largest cross elasticity is with Northern (0.47), followed by ScotTissue (0.28) and the three other premium brands, Angel Soft (0.26), KBT (0.26), and Cottonelle (0.24). The own elasticities for the other premium brands are all quite high, over −3.0. Overall, the cross elasticity results are consistent with the idea that a premium segment exists and that the brands within that segment compete more closely with each other than they do with brands outside the segment.

ScotTissue has an own elasticity of −1.8, which is below even that of Charmin. This result is at first surprising given that ScotTissue is a lower tier brand. However, as discussed above, industry marketing personnel consider ScotTissue to be a strong and profitable brand because its attributes ('1000 sheets per roll') appeal to a particular consumer segment and no other bath tissue product is close to it in attribute space. Thus, while charging a lower price than other brands, ScotTissue achieves a higher gross margin (its marginal cost of production is significantly lower than the premium brands). Thus, the elasticity results are, in fact, quite consistent with qualitative information from the industry.

The own elasticity of private label is −1.69, which seems quite low for what is essentially a non-branded product. However, recall that Nielsen provides data only on the overall private label category, aggregating individual private label products. As such, the estimated elasticity reflects the elasticity of the category, not the elasticity of individual private label product. The individual products would be expected to have a higher own elasticity of demand than the category.

We estimate the top level elasticity, i.e., the own elasticity of demand for the bath tissue segment as a whole, to be −0.89 (asymptotic standard error = 0.07), which is consistent with the nature of the product and the generally low level of prices in the industry which have resulted from the intense competition between manufacturers.

The high own elasticities of demand for bath tissue brands reflects the view of industry marketing personnel that the market is fiercely competitive with low margins. With the high fixed costs of operation, bath tissue producers have strong incentives to keep their plants running at full capacity, even if that requires keeping their prices low. The magnitudes of the elasticities are also consistent with the gross margins for bath tissue brands we have seen. Under the Nash-Bertrand differentiated products model (discussed in more detail below), the price-to-marginal cost markup on a manufacturer's brand

© Blackwell Publishers Ltd. 2002.

is a function of the own elasticity of that brand as well as the cross elasticities between that brand and the manufacturer's other brands. Thus, a comparison of actual gross margins to the margins implied by the elasticities and the Nash-Bertrand assumption can provide a test of the Nash-Bertrand assumption. However, the difficulties associated with using accounting variables to measure economic variables are well known.

In estimating the demand system, we imposed the homogeneity and symmetry restrictions implied by demand theory. These restrictions are required to perform welfare calculations because an indirect utility function (and, by duality, an expenditure function) cannot be recovered from a demand system that does not satisfy the restrictions. However, in our case, a Wald test rejected the null hypothesis that the restrictions are valid at the 5% significance level.[16] Because the restrictions are necessary to proceed, we investigated the economic significance of the rejection and the economic effect of imposing the restrictions. Appendix Table III, which is available in the Supplementary Materials section of the Journal's editorial website, provides the elasticity estimates based on the parameter estimates obtained from unrestricted estimation of the demand system. A comparison between these results and the results in Table III reveals that in most cases the restricted and unrestricted elasticity estimates are quite similar. The only major exception (and the likely cause for the rejection of the restrictions) is the cross elasticity of KBT with respect to ScotTissue's price, for which the unrestricted estimate is negative and sizable—a result that does not make economic sense. Thus, the major effect of imposing the demand theory restrictions is to push a single estimated cross elasticity toward a more economically plausible value. Given the necessity of the restrictions for the welfare calculations that follow and the negligible effect of the restrictions on most of the estimated cross elasticities, we proceed by imposing the restrictions.

VI(ii). *The variety effect*

From equation (2), the variety effect associated with KBT, evaluated at the post-introduction prices of the other brands, is the increase in the expenditure function that would result from raising the price of KBT from its actual level to its virtual level, i.e., the price level that sets KBT demand to zero,

$$VE = e[p_1, p_K^*(p_1), u_1] - e[p_1, p_K, u_1] \tag{10}$$

where we have suppressed the dependence of the expenditure function on prices outside the bath tissue industry.

[16] Rejection of the homogeneity and symmetry restrictions is a common finding in demand studies (Deaton [1986]).

© Blackwell Publishers Ltd. 2002.

The first step in the *VE* calculation is determining the virtual price for KBT. We use the demand system represented by equations (5) and (7) to calculate the price that would set the KBT share to zero, holding the prices of the other brands at their actual level. We estimated the KBT virtual price separately for each city, with the other variables appearing in equations (5) and (7) set to their city-specific means for the six-month period April to September 1994. Asymptotic standard errors were calculated using the delta method.

Table IV summarizes the results of these calculations, presenting the results for the cities with the largest variety effect (as a percentage of bath tissue expenditure), the smallest variety effect, and the median variety effect. Table IV also provides the total welfare effect added up over all 30 cities.[17] In column (2), the estimated virtual price for KBT is provided. In column (1), the actual KBT price is provided for comparison. Substantial variation exists across cities in the percentage amount by which the virtual price exceeds the actual price. In general, the greater the wedge between the virtual price and actual price, the more consumers value the additional variety provided by the brand.

Given the virtual price for KBT, *VE* can be calculated using equation (10). Under the two-stage budgeting specification, the appropriate expression for *VE* is derived by application of the Hausman [1981] techniques to the top level equation (7):

(11)

$$VE=\left[\frac{1-\lambda}{(1+\delta)X_1^{\lambda}}(P(p_1, p_k^*(p_1))\exp(\delta_0+\delta\log P(p_1, p_k^*(p_1)))-y_1)+X_1^{1-\lambda}\right]^{\frac{1}{1-\lambda}}-X_1$$

where $P(p_1, p_K^*(p_1))$ is the bath tissue industry price index evaluated at the existing brands' actual prices and KBT's virtual price, X_1 is post-introduction personal disposable income, y_1 is actual bath tissue expenditure, λ is the coefficient on log personal disposable income in the top level equation (7), δ is the coefficient on the bath tissue industry price index in the top level equation, and δ_0 captures the remainder of the variables in the top level equation.

We calculated *VE* for each city, setting the other brands' prices to their city-specific averages and the personal disposable income variable to its annual city-specific value.[18] The resulting estimates of the annual welfare effects due to increased variety are given in column (4) of Table IV (an asymptotic standard error, calculated via the delta method in provided in

[17] The results for each individual city are provided in Appendix Table IV, which is available in the Supplementary Materials section of the Journal's editorial website.

[18] To annualize the personal disposable income figure, we doubled its value for the six-month period April–September 1995.

© Blackwell Publishers Ltd. 2002.

TABLE IV
VARIETY EFFECT

	(1) Actual Price	(2) Virtual Price	(3) % Difference	(4) Additional Annual Consumer Welfare	(5) Standard Error	(6) % of Annual Bath Tissue Expenditure
City with the smallest effect relative to its annual bath tissue expenditure	$25.16	$27.75	10.3%	$40,929	$1,868	0.2%
City with the median effect relative to its annual bath tissue expenditure	$25.71	$35.88	39.6%	$3,767,335	$173,654	2.9%
City with the largest effect relative to its annual bath tissue expenditure	$25.27	$46.78	85.1%	$1,930,798	$90,711	10.3%
Total over all cities				$33,395,190		3.5%

© Blackwell Publishers Ltd. 2002.

column (5)). In column (6), the variety effect as a percentage of annual bath tissue expenditure is presented. The estimates of *VE* range from as little as 0.2% of annual bath tissue expenditure in the city with the minimum *VE* effect to as much as 10.3% of annual bath tissue expenditure in the city with the maximum *VE* effect.

VII. 'INDIRECT' ESTIMATION OF THE PRICE EFFECTS OF THE KLEENEX BATH TISSUE INTRODUCTION, TESTING MODELS OF COMPETITION, AND ESTIMATING THE OVERALL EFFECT ON CONSUMER SURPLUS OF THE KBT INTRODUCTION

VII(i). *Indirect Estimates of the Price Effects of the KBT Introduction*

In Section V, we discussed the 'direct' estimates of the effects on existing brands' prices of the KBT introduction. The direct estimates were based on pre and post-introduction data and did not require any assumptions concerning the form of competition in the bath tissue industry. In many circumstances, however, data from the period prior to the new product introduction are not available. Thus, a method for estimating the price effects of a new product in the absence of pre-introduction data would be useful.

In this section, we use the estimated demand system (which is based on post-introduction data only), along with an assumed model of competition, to estimate the price effects of the KBT introduction 'indirectly.' In addition, because we also have the direct estimates, we can compare the indirect estimates derived under alternative assumed models of competition to see how well the various models predict what actually happened to prices.

We start by describing how the indirect method works. Three steps are involved. First, we specify the equilibrium conditions for the assumed model of competition for the post-introduction world. We focus here on the Nash-Bertrand model. The equilibrium conditions are a function of the prices and marginal costs of the brands as well as the parameters of the demand structure. While we observe the equilibrium prices and have estimated the demand structure parameters, the marginal costs are unknown. Thus, in the second step, we solve the equilibrium conditions for the marginal costs. In the third step, we use the marginal costs and the demand structure parameters to determine the equilibrium prices that would prevail if KBT were absent, a situation analogous to the pre-introduction period.

1. Equilibrium Conditions for the Nash-Bertrand Model

Suppose there are M firms producing N products in the industry. Consider the firm controlling the first n products. Under the Nash-Bertrand

© Blackwell Publishers Ltd. 2002.

assumption, the firm will set the prices of its n products, taking the prices of the other $N - n$ products as given, so as to maximize its profits,

$$\max_{p_1,\ldots,p_n} \sum_{i=1}^{n} (p_i - c_i)\, Q_i(p_1, \ldots, p_N) \tag{12}$$

where the p_i, $i = 1, \ldots, n$, are the prices of the brands sold by the firm, the c_i are marginal costs, and the $Q_i(.)$ are the demand functions which depend in general on the prices of all N products. The first order conditions for the maximization problem are, after re-arranging,

$$s_i(p_1, \ldots, p_N) + \sum_{j=1}^{n} \frac{p_j - c_j}{p_j} s_j(p_1, \ldots p_N)\, e_{ji}(p_1, \ldots, p_N) = 0 \qquad i = 1, \ldots, n \tag{13}$$

where $s_i(.)$ is the expenditure share of brand i and $e_{ji}(.)$ is the elasticity of brand j with respect to brand i's price. Note that both the shares and the elasticities are functions of the prices of all N brands. Each of the M firms has a set of first order conditions of form (13). The Nash-Bertrand equilibrium prices simultaneously solve the system of N equations obtained by stacking the N first order conditions of the M firms.

We pause here to note a complication that arises. The first order conditions described above are for the bath tissue manufacturers. Our data, however, reflect retail sales. Another level of distribution, consisting of the supermarkets, lies between the manufacturers and retail consumers. Since we do not observe wholesale prices and sales, we must make an assumption about supermarket price-setting behavior so that we can use the retail sales data in conjunction with the first order conditions for the producer. Under certain assumptions, we can proceed as if the manufacturers directly set retail prices. For instance, suppose supermarkets set retail prices as a fixed markup over the corresponding wholesale price. Then, for a manufacturer choosing wholesale price w and supermarkets charging a constant markup over w, $p = (1 + \alpha)w$, the manufacturer's profit is

$$(w - c)Q(w(1 + \alpha)) \tag{14}$$

The manufacturer's first order condition is

$$Q(w(1 + \alpha)) + (w - c)Q'(w(1 + \alpha))(1 + \alpha) = 0 \tag{15}$$

which simplifies to

$$Q(p) + (p - (1 + \alpha)c)Q'(p) = 0 \tag{16}$$

Thus, redefining the manufacturer's cost to be $(1 + \alpha)c$, the retail prices and retail demand elasticities can be used in conjunction with the manufacturer's first order condition. A similar result is obtained under the

© Blackwell Publishers Ltd. 2002.

TABLE V
ESTIMATED PRICE-COST MARGINS

	Kleenex	Cottonelle	ScotTissue	Charmin	Northern	Angel Soft	Private Label
Minimum	8.9%	2.4%	19.7%	31.8%	17.8%	4.3%	38.7%
Median	25.1%	25.7%	54.8%	44.4%	30.8%	26.7%	62.5%
Maximum	38.5%	42.4%	75.7%	52.5%	49.5%	50.0%	83.0%

assumption that supermarkets charge a constant dollar margin over the wholesale price. For more complicated retailer behavior, a distortion might arise, but its importance would be limited by the size of supermarkets' gross margins on bath tissue.

2. Solving for the Marginal Costs

Prices and shares from the post-introduction period represent the post-introduction equilibrium (assuming an equilibrium has been reached). The own and cross elasticities of demand at the equilibrium can be estimated given the parameters of the demand structure. Only the marginal costs c_i in equation (13) are unknown. Thus, the N first order conditions, evaluated at the known prices and shares and the estimated demand structure parameters, represent a set of N equations in N unknowns (the c_i). Solving these equations yields estimates of the c_i.

We performed this exercise separately for each city and calculated price-cost margins by city and brand.[19] Table V contains the minimum (across cities), maximum, and median price-cost margin estimates for each brand.[20]

3. Estimating the Price Effects of the KBT Introduction

Now, given the c_i and the estimates of the demand system parameters, we can estimate the prices that would exist in the absence of KBT. Specifically, we find the vector of brand prices such that (1) the first order conditions (13) of the firms other than Kimberly-Clark are satisfied and (2) the demand for KBT is set to zero.[21] This exercise involves solving a nonlinear system of N equations in terms of the N brand prices.[22] The

[19] As in our other calculations, the variables appearing in first order conditions (13) are set to their city-specific averages for the six month period April–September 1995. The system of equations is linear in the price-cost margin and thus are easily solved.

[20] The price-cost margin estimates for each city are provided in Appendix Table V, which is available in the Supplementary Materials section of the Journal's editorial website.

[21] We assume that the c_i for the brands other than KBT remain constant over the relevant range of output.

[22] We solved the system of equations using a numerical iterative procedure, which converged easily and rapidly to the solution.

© Blackwell Publishers Ltd. 2002.

TABLE VI
COMPARISON OF DIRECT AND INDIRECT ESTIMATES OF THE PRICE EFFECTS OF THE KLEENEX BATH TISSUE INTRODUCTION

Brand	(1) Direct Estimate	(2) Indirect Estimate Nash-Bertrand Model	(3) *t*-test	(4) Indirect Estimate Premium Cartel w/o KC	(5) *t*-test	(6) Indirect Estimate Premium Cartel w/ KC
Cottonelle	−8.2%	−3.6%	3.4	−7.8%	0.2	−1.8%
	(1.3%)	(0.3%)		(1.2%)		
Charmin	−3.5%	−2.8%	0.7	−6.8%	2.3	−1.5%
	(0.9%)	(0.1%)		(1.1%)		
Northern	−2.3%	−3.4%	1.4	−7.6%	3.8	−1.3%
	(0.8%)	(0.2%)		(1.2%)		
Angel Soft	−3.5%	−2.4%	1.6	−6.9%	2.7	−1.1%
	(0.6%)	(0.3%)		(1.1%)		
ScotTissue	−0.6%	−1.5%	1.3	−3.1%	3.1	−1.4%
	(0.5%)	(0.4%)		(0.6%)		
Private Label	−3.8%	−0.7%	2.7	−1.5%	1.9	−0.5%
	(0.9%)	(0.7%)		(0.8%)		

Notes: (1) Standard errors in parentheses.
(2) For the column (6) estimates, the delta method did not provide reliable standard errors.

price effects of the KBT introduction are then estimated as the percentage difference between the observed prices (i.e., the post-introduction prices) and the prices that would exist in the absence of KBT (i.e., the pre-introduction prices). These estimates are the 'indirect' estimates of the price effects.

We performed the calculations described above separately for each of the second and third wave cities, then averaged across cities to derive an average percentage price change for each brand. These average percentage price changes are comparable to the direct estimates of the price effects. In addition, we calculated asymptotic standard errors for the indirect estimates using the delta method.

In column (2) of Table VI, we provide the indirect estimates obtained under the Nash-Bertrand assumption along with their asymptotic standard errors. The largest estimated price effects are for the premium brands Cottonelle (−3.6%), Northern (−3.4%), Charmin (−2.8%), and Angel Soft (−2.4%). Lesser effects were estimated for ScotTissue (−1.5%) and private label (−0.7%).

VII(ii). *Assessing Alternative Models of Competition*

The comparison between the direct estimates discussed in Section V and the indirect estimates corresponding to an assumed model of competition provides a way to assess the validity of the assumed model. The two sets of estimates should be approximately equal if the demand system is

© Blackwell Publishers Ltd. 2002.

correctly specified, the firms' marginal costs are constant over the relevant range of output, and the assumed model of competition is correct. Because of the flexible functional form used for the demand system and because of the relatively small price changes involved, misspecification of the demand system, to the extent that it exists at all, is unlikely to be substantial. Likewise, for the relatively small quantity changes involved, changes in marginal cost are unlikely to be large (unless firms are operating at near full capacity). Thus, neither of these potential problems should lead to a substantial divergence between the indirect and direct estimates of the price impacts. Consequently, the finding of a substantial difference between the two sets of estimates would suggest a failure of the assumed model of competition to accurately describe firms' behavior.

In column (1) of Table VI, we transcribe the direct estimates of the price effects of the KBT introduction from Table II. In column (3) of Table VI, we provide t-statistics for testing the (individual) hypotheses that the direct and indirect estimates are the same apart from statistical variation. For Charmin, Northern, Angel Soft, and ScotTissue, the direct and indirect estimates obtained under the Nash-Bertrand model assumption are reasonably close in magnitude and not statistically significantly different from zero according to the individual t-tests. For Cottonelle and private label, however, the indirect estimates are well below the direct estimates and the individual t-statistics reject the hypothesis of equality.[23] Thus, the results for the Nash-Bertrand model are mixed.

We also assess several alternative models of competition to see whether they produce indirect estimates closer to the direct estimates than the Nash-Bertrand model.[24] We first employed the following model. Pre-introduction, the premium brands are assumed to act as a perfect cartel, i.e., set their prices as if they were controlled by a single seller. Post-introduction, Kimberly-Clark refuses to participate in the cartel and the cartel disintegrates, leading to the Nash-Bertrand outcome.[25]

Under this model of competition, we estimate the pre-introduction prices by forming first order conditions like (13) for the assumed premium brand cartel and solving for the brand prices that jointly set the first order conditions for the cartel to zero, the first order conditions for the non-premium brands to zero, and the demand for KBT to zero.

The resulting indirect price effect estimates are provided in column (4) of Table VI. The premium cartel model predicts much larger price effects

[23] A chi-square test of the hypothesis of joint equality across brands is rejected at the 5% level.

[24] We recognize that a large number of possible alternatives exist beyond the ones we discuss.

[25] This feature of the model conforms with the informal observation that Kimberly-Clark and Procter & Gamble engage in tough competition across the many markets in which they both participate.

© Blackwell Publishers Ltd. 2002.

than the Nash-Bertrand model because the KBT introduction is assumed to break up the premium cartel. With the exception of Cottonelle, the premium cartel estimates are also substantially larger than the direct estimates. In addition, the individual t-tests reject equality of the direct and indirect estimates for every brand except Cottonelle. Thus, the Nash-Bertrand model is superior to the premium cartel model.

Finally, we assess a model of competition in which Kimberly-Clark is assumed to join the premium cartel post-introduction. The indirect price effect estimates under this model are provided in column (6) of Table VI.[26] These estimates are generally smaller than both the Nash-Bertrand estimates and the direct estimates. Thus, the Nash-Bertrand model appears to be superior to this alternative model as well.

In conclusion, while the evidence is mixed, the Nash-Bertrand model provides indirect estimates of the price effects that are reasonably close to the direct estimates. The alternative models we examined were inferior to the Nash-Bertrand model. Overall, we find these results to provide cautious support for the use of the Nash-Bertrand assumption to describe firms' competitive behavior in the bath tissue industry.[27]

VII(iii). *Overall Effect on Consumer Welfare of the KBT Introduction*

From equation (2), the overall effect of the KBT introduction on consumer welfare is the sum of the variety effect and the price effect. It can be calculated as

(17)

$$CV = \left[\frac{1-\lambda}{(1+\delta)X_1^{\lambda}}(P(p_0, p_K^*)\exp(\delta_0 + \delta \log P(p_0, p_K^*)) - y_1) + X_1^{1-\lambda}\right]^{\frac{1}{1-\lambda}} - X_1$$

where $P(p_0, p_K^*)$ is the bath tissue industry price index evaluated at the pre-introduction prices for the existing brands and the virtual price for KBT. We performed the calculation by city using the indirect estimates of the pre-introduction prices. The results are summarized in Table VII, which provides the welfare results for the city with the smallest welfare effect (relative to its bath tissue expenditure), the city with the largest welfare effect, and the city with the median welfare effect. In addition,

[26] For this model of competitive behavior, application of the delta method failed to provide estimates of the standard errors because small changes in the demand structure parameters caused the price change calculations to 'blow up.' Thus, we do not report standard errors for this model in Table VI.

[27] A further reason for caution is due to the pre-introduction effect found in Section V. This effect suggests the existence of dynamic strategic behavior that would be inconsistent with the static Nash-Bertrand model.

© Blackwell Publishers Ltd. 2002.

TABLE VII
TOTAL CONSUMER WELFARE EFFECT

	Additional Annual Consumer Welfare	Standard Error	% of Annual Bath Tissue Expenditure
City with the smallest effect relative to its annual bath tissue expenditure	$196,926	$9,843	1.2%
City with the median effect relative to its annual bath tissue expenditure	$3,309,137	$92,868	6.4%
City with the largest effect relative to its annual bath tissue expenditure	$3,357,554	$110,936	17.9%
Total over all cities	$69,151,179		7.3%

Table VII shows that the total welfare effect added up across the 30 cities is $69.2 million.[28]

A comparison between the total consumer welfare effect in Table VII and the variety effect in Table IV demonstrates that approximately half of the total consumer welfare increase is due to the variety effect, with the remaining half due to the price effects. The total welfare effect amounts to approximately 7% of bath tissue expenditure in the cities in our data.

VIII. CONCLUSIONS

We have demonstrated how to estimate the two consumer welfare effects of a new product introduction—the variety effect and the price effect—using data from the period after the introduction. We applied this framework to estimate the consumer welfare effects of the KBT introduction. We found the total consumer welfare effect to be approximately 7% of consumer bath tissue expenditure in the cities we studied. This gain to consumers was roughly evenly split between the effect of additional variety and the price-reducing effect of additional competition.

The demand system parameters estimated on data from the post-introduction period, along with an assumed model of competition, allowed us to estimate the price effects of the KBT introduction indirectly. Given that we also had data from the pre-introduction period, we were able to estimate the price effects directly as well, by comparing post-introduction prices to pre-introduction prices. We compared the direct and indirect

[28] To investigate the extent of 'aggregation bias', we calculated the total welfare effect as if we only had data on an aggregate basis, rather than separately for individual cities. We then compared this estimate of the total welfare effect to the estimate described in the text (which was obtained by using the disaggregated data). The estimate of the welfare effect based on the aggregated data was $67.0 million. Thus, the aggregation bias appears to be small in this situation.

© Blackwell Publishers Ltd. 2002.

estimates to evaluate alternative assumed models of competition. We found that the Nash-Bertrand model produced indirect estimates reasonably similar to the direct estimates and superior to the indirect estimates produced by the two alternative models we studied.

REFERENCES

Deaton, A., 1986, 'Demand Analysis', in Griliches, Z. and Intriligator, M. (eds.), *Handbook of Econometrics*, Vol. III, (Elsevier, New York).

Deaton, A. and Muellbauer, J., 1981, 'An Almost Ideal Demand System', *American Economic Review*, 70, pp. 312–326.

Deneckere, R. and Davidson, C., 1985, 'Incentives to Form Coalitions with Bertrand Competition', *Rand Journal of Economics*, 16, pp. 473–486.

Gorman, W., 1995, *Separability and Aggregation: Collected Works of W. M. Gorman, Volume I*, Blackorby, C. and Shorrocks, A. F. (eds.), (Clarendon Press, Oxford).

Hausman, J., 1997, 'Valuation of New Goods Under Perfect and Imperfect Competition', in Bresnahan, T. and Gordon, R. (eds.), *The Economics of New Goods* (University of Chicago Press, Chicago).

Hausman, J., 1981, 'Exact Consumer's Surplus and Deadweight Loss', *American Economic Review*, 71, pp. 662–676.

Hausman, J. and Leonard, G., 1997, 'Economic Analysis of Differentiated Products Mergers Using Real World Data', *George Mason Law Review*, 5, pp. 321–361.

Hausman, J., Leonard, G. and Zona, J. D., 1994, 'Competitive Analysis with Differentiated Products', *Annales d'Economie et de Statistique*, 34, pp. 159–180.

Hausman, J. and Taylor, W., 1981, 'Panel Data and Unobservable Individual Effects', *Econometrica*, 49, pp. 1377–1398.

Werden, G., 1997, 'Simulating the Effects of Differentiated Products Mergers: A Practical Alternative to Structural Merger Policy', *George Mason Law Review*, 5, pp. 363–386.

Werden, G. and Froeb, L., 1994, 'The Effects of Mergers in Differentiated Products Industries: Logit Demand and Merger Policy', *Journal of Law, Economics, and Organizations*, 10, pp. 407–426.

© Blackwell Publishers Ltd. 2002.