Product Variety and Competitive Pricing in Consumer Goods Markets

by Daniel Klapper and Toker Doganoglu

Decisions on product variety are a central part of the marketing planning process of many consumer goods manufacturers. Most consumer goods markets have also seen a growth in the number of SKUs offered under the name of well-established brands. Manufacturers may view product proliferation as a possible strategy to foreclose market entry and raise prices. To date we have only limited information about the effects of changes in product variety on competitive prices, especially in markets where manufacturers sell their products through common retailers. We introduce a structural model of demand and supply where manufacturer prices and the retail price are functions of the degree of variety offered by manufacturers. Given different choices in variety, equilibrium prices are calculated. We show that manufacturers can raise prices and mark-ups if they increase variety and if competitors do not follow. In a more realistic scenario where manufacturers respond to each other and follow competitors, the effect of variety through increased prices and higher mark-ups of the manufacturers almost diminishes to zero. Nevertheless, by inducing some consumers who opted for the no purchase option to consume in the product category, firms might be able to increase their profits by introducing new variants.

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1. Introduction

Product proliferation, i.e. the offering of product variety and line extensions, is a popular strategy for many branded consumer goods. As a result, many consumer goods markets have seen a growth in the number of SKUs offered under the name of well-established brands. Firms may extend their variety in order to differentiate vertically. They may provide more variety in terms of different quality levels (usually at different prices) to better extract consumers' willingness to pay. However, in categories in which consumers regularly purchase, manufacturers often offer product lines which do not vary in quality but in other characteristics such as scent, color or flavor. In this paper, we focus on this type of horizontal product differentiation.

There are a number of strands of literature investigating the effects of product proliferation strategies on market outcomes. One branch addresses the impact of these strategies on consumer choice behavior, e.g. how variety in a brand, the product line length and the retailers' product assortment variety affect consumer choice behavior (e.g. *Boatwright/Nunes* 2001; *Broniarczyk/Hoyer/McAlister* 1998; *Kahn/Wansink* 2004). Another branch of the literature identifies supply-side effects, such as inter-product economies in production or strategic effects, as key forces which make line extensions and introduction of new variants attractive policy options for firms (e.g. *Lancaster* 1979, 1990). For example, *Schmalensee* (1978) has shown how line extensions can preempt market entry (see also *Bonanno* 1987; *Brander/Eaton* 1984).

Recent research has increasingly focused on the implications of product proliferation strategies for competitive conduct (e.g. *Bayus/Putsis* 1999; *Draganska/Jain* 2005; *Putsis* 1997; *Putsis/Bayus* 2001). In particular, *Putsis* (1997) finds that an increase in the number of brands increases the ability of national brand manufacturers to raise their prices. In a duopoly model, *Kadiyali, Vilcassim* and *Chintagunta* (1999) have shown that an increase in line length not only favors the extending brand but also the competing brand. Line extensions soften price competition among the incumbent brands and increase margins. The methodology used in these earlier papers does not account for multi-stage distribution channels where manufacturers sell their products through common retailers as is the case for frequently purchased consumer goods. Thus, the competitive effects of product proliferation strategies have not been fully elaborated until now. Especially, the economic significance of their effects on manufacturer pricing in markets where manufacturers sell their products through common retailers remains largely unknown.

In this paper, we focus on variety which yields a horizontally differentiated product line and empirically investigate the economic importance of product proliferation strategies. Our main goal is to quantify the effects of variety on manufacturer prices. In order to achieve this goal, we first posit and estimate a structural model of demand. The response of sales to prices and variety is modeled with an aggregate discrete choice model (e.g. *Berry* 1994). The utility for a consumer is affected not only by prices, product characteristics and marketing instruments but also by the number of variants offered by a brand. As in *Draganska* and *Jain* (2005) and *Kim*, *Allenby* and *Rossi* (2002), consumers first select a product line and then a variant.

Manufacturer prices are not readily observable. Hence, we introduce a model of the retail chain in order to infer these prices. We assume that manufacturers sell their products through a common retailer, and the strategic interaction between manufacturers and retailers is explicitly modeled. We assume that the common retailer acts as local monopolist in the category (e.g. *Slade* 1995 for an argument supporting this assumption). Conditional on the demand specification and the model of the retail channel, we derive equilibrium wholesale prices of manufacturers which naturally are functions of variety.

We first estimate the demand parameters using instrumental variables techniques to control for potential endogeneity. Using the wholesale pricing formulas and the demand estimates, we estimate/impute firm-specific marginal cost parameters. We then provide an in-depth discussion about the effects of variety on profits, wholesale prices and strategic interactions among manufacturers.

We do not model the supply of variety for a number of reasons. First, aside from the costs of introducing a new variant, one can identify all components of a manufacturer's profit function with a model of demand and supply. Therefore, our model provides us with the necessary information for an analysis of the effects of variety on manufacturer pricing. Second, an appropriate model of introduction and removal of variants requires a discrete game model. Empirical investigation of such games is notoriously difficult due to the presence of multiple equilibria. Furthermore, the available methods for analyzing discrete games, such as *Bajari*, *Hong* and *Ryan* (2004), suffer from a curse of dimensionality. When the strategy sets of players contain more than a few elements, the computational burden of these methods is insurmountable [1].

Our approach is closely related to *Draganska* and *Jain* (2005). They also use a discrete choice demand model where the utility of a brand depends on the number of variants in the product line of a brand. In contrast to our approach, they do not model the manufacturer retailer interaction, but assume constant mark-ups in the channel, and they do not study the impact of variety on wholesale prices. However, they derive a number of interesting results. Line length and price are complements; hence a firm can increase prices by additionally increasing its line length to keep its market share constant. Product proliferation can also lead to losses in market shares if firms stretch their product lines too much. One important feature of *Draganska* and *Jain* (2005) is the fact that they explicitly model the supply of variety. They assume variety to be a continuous variable, and their model yields a unique equilibrium outcome. Costs of variety are increasing at an increasing rate in line length. They conclude that balancing diminishing returns with escalating costs is therefore a critical task in managing a product line.

The remainder of this paper is organized as follows. Section 2 describes the theoretical model that is used to study the effects of variety on competition in prices. We introduce the relevant estimation equations used in our empirical study here. Section 3 describes the data and the estimation results. Section 4 presents an in-depth analysis of the effects of variety on manufacturers' wholesale prices. The paper concludes with a general discussion in Section 5.

2. Model Formulation

This section develops a model of oligopolistic price competition between brands of different manufacturing firms within a product category of the consumer goods market. The analysis addresses in particular the effects of variety on demand, the interaction between manufacturers and retailers and how we can establish the impact of variety on pricing decisions.

2.1. Modeling Demand

Demand is formulated at the individual consumer or household level. It is based on a utility function which specifies the net benefits a consumer derives from an alternative. Consumers have idiosyncratic tastes for each brand. We assume that these tastes have an extreme value distribution and use the nested logit model as outlined in *McFadden* (1978) or *Berry* (1994) which introduces correlation in consumer tastes in a restricted fashion. The nested logit model allows for a wider range of possible substitution patterns compared with a logit model. In the nested logit model, a hierarchy of consumer choice is postulated and consumers choose between brands, for which they have correlated tastes, within a nest of brands.

We group the *J+1* products in two exhaustive and mutually exclusive sets, $j = 0,1, ..., J$ (*Berry* 1994, p. 252). We introduce an 'outside good' option, i.e. the consumer's choice not to purchase in the product category at all. The outside good, $j = 0$, is assumed to be the only member of group 0, while all the other products are in group 1. Consumer *i*'s utility for brand *j* in period *t* is given by

$$U_{ijt} = \delta_{jt} + \zeta_{i1t} + (1 - \sigma)\varepsilon_{ijt} \quad (1)$$

where ε_{ijt} is an identically and independently distributed extreme value random variable. As outlined in *Berry* (1994), variable ζ_{i1} is common to all products in group 1, that is, it represents a taste for the particular product category and has a distribution function that depends on σ, with $0 \le \sigma \le 1$. A σ close to one indicates that the within group correlation of utility levels approaches one. The mean utility, δ_{jt}, is

$$\delta_{jt} = \alpha_j - \beta p_{jt} + \mu \ln (v_{jt}) + \sum_{k=1}^{K} \gamma_k x_{kjt} + \xi_{jt} \,. \quad (2)$$

In (2), the parameters of the net utility do not depend on the individual, that is, consumer heterogeneity is only due to the tastes. Even though problems due to ignoring unobserved heterogeneity are well known, we will assume that the demand model in (2) captures the behavior of the aggregate demand sufficiently. With this caveat, α_j is the homogeneous intrinsic preference for brand *j*, β is the price sensitivity parameter, p_{jt} is the price of brand *j* in period *t*, and μ is the sensitivity for the variety v_{jt} of brand *j*. γ_k is the sensitivity to the observed characteristic x_{kjt} that varies by product (e.g. a marketing instrument other than price and variety), and ξ_{jt} is the unobserved attribute for brand *j* in period *t*.

The variety enters the consumer utility in logarithmic form. Equation (2) can be derived as the inclusive value of a brand in a three-level nested logit model where consumers first select whether to buy or not; and if so, which brand they buy; and which variant of their brand choice they select. The inclusive value of a brand in the second level is given exactly by (2) when the only dimension the variants differ on is the consumer tastes for a particular characteristic, such as scent [2]. However, based on results from *Kim*, *Allenby* and *Rossi* (2002) [3], we also tested the appropriateness of a quadratic impact of variety on utility, i.e. allowing a reduction in utility once variety has passed a certain value. However, our data (see *Table 1*) do not support this model specification.

Because the parameters of the 'outside-good' are not identified separately from the coefficients of the products inside the category, we follow the usual practice and restrict the utility of the 'no purchase' option to zero, i.e. δ_{ot} and $U_{i0t} = \zeta_{i0t}$. The unconditional market share is thus given by

$$s_{jt} = \frac{\exp(\delta_{jt}/(1-\sigma))}{[\sum_{l=1}^{J}\exp(\delta_{lt}/(1-\sigma))]^{\sigma}\,[1+\sum_{l=1}^{J}\exp(\delta_{lt}/(1-\sigma))]^{1-\sigma}} \,. \quad (3)$$

The model in (3) is a parsimonious representation of the consumer demand. As shown in *Berry* (1994), one can derive an easily estimable equation as

$$\ln\left(\frac{s_{jt}}{s_{0t}}\right) = \alpha_{\mathrm{j}} - \beta \mathrm{p}_{\mathrm{jt}} + \mu \ln(v_{jt}) + \sum_{k=1}^{K} \gamma_k\, \varkappa_{kjt} + \sigma \ln(s_{jt|g}) + \xi_{jt}. \quad (4)$$

where $s_{jt}|_g$ denotes the market share of brand *j* within group *g* and is the market share of a brand, given that consumers have decided to purchase in the product category. The market share of the outside good, s_{0t}, describes how many consumers within a period do not purchase in our product category. The necessary information to calculate the outside good share has been taken from a household panel. The unobserved product specific utility, ξ_{jt}, serves as the error term in estimating (3) by instrumental variables techniques. It captures the effect of manufacturers' marketing that is not explicitly included in the demand (e.g. *Besanko/Gupta/Jain* 1998; *Sudhir* 2001; *Villas-Boas/Winer* 1999).

2.2. Modeling the Impact of Variety on Manufacturers' Pricing Strategies

In our model, manufacturers compete in prices. Our goal is to investigate the effects of variety on these prices. Manufacturers' price decisions can be obtained from the first order conditions of the profit functions (e.g. *Bresnahan* 1989; *Kadiyali/ Sudhir/Rao* 2001).

Manufacturer-retailer interactions in the channel are modeled as a manufacturer Stackelberg game, where a retailer is assumed to act as a local monopolist. The manufacturers are leaders in the vertical channel. In this model, retailers take wholesale prices as given when determining retail prices to optimize category profits. The manufacturers take retailers' reactions into account when choosing their optimal wholesale prices. This type of vertical strategic interaction has been found to fit the data well in a number of product categories (e.g. *Besanko/Dube/Gupta* 2003; *Che/Seetharaman/Sudhir* 2003; *Cotterill/Putsis* 2001; *Sudhir* 2001). Unobserved wholesale prices can be inferred from the data by explicitly solving the first order condition of each manufacturer in terms of the respective wholesale prices (*Sudhir* 2001).

The profit maximization problem for a manufacturer who produces brand *j* and sells through *R* retailers is given by

$$\Pi_j^m = \max_{w_{jt}^r} \sum_{r=1}^{R} M_t^r\, s_{jt}^r\, (w_{jt}^r - c_{jt}), \quad (5)$$

where w_{jt}^r is the wholesale price that the retailer *r* has to pay for brand *j* in *t*, c_{jt} denotes the marginal cost of brand *j* in *t*, M_t^r is the market size of retailer *r* in *t* and s_{jt}^r is the market share of manufacturer *j* at retailer *r*. Since we assume that retailers are local monopolists, the manufacturers simply try to maximize profits at each retailer [4]. This implies that manufacturers compete at each retail chain independently. Hence, we will develop the wholesale pricing formulas using only one retailer [5]. Accordingly, the manufacturer of brand j selling through a single retailer has to solve

$$\Pi_j^m = \max_{w_{jt}} M_t\, s_{jt}\,(w_{jt} - c_{jt})\,, \tag{6}$$

with w_{jt}, M_t, s_{jt} and c_{jt} defined as above.

In a manufacturer Stackelberg world, one starts with the retailer which sells J products in a category whose objective is to maximize

$$\Pi_t^R = \max_{p_{jt}} \left[\sum_{j=1}^{J} (p_{jt} - w_{jt}) s_{jt}\right] M_t\,. \tag{7}$$

The first order condition for brand j's price is given by

$$\frac{\partial \Pi^R}{\partial p_{jt}} = s_{jt} + \sum_{k=1}^{J} (p_{kt} - w_{kt}) \frac{\partial s_{kt}}{\partial p_{jt}} = 0, \tag{8}$$

which after simplifications implies that

$$p_{jt} = w_{jt} + \frac{1}{\beta(1 - Z_t)}\,. \tag{9}$$

Here, $Z_t = \sum_{j=1}^{J} s_{jt}$ is the share of the category sales in the market. Equation (9) provides a simple rule for the retailer's mark-up. This mark-up depends on the role of the category (i.e. the share of the outside good) and the response of a brand's utility to the price.

Each manufacturer takes the pricing rule of the retailer in equation (9) as given and selects its wholesale price in order to maximize its profits. The first order condition implied by (6) is given by

$$\frac{\partial \Pi^M}{\partial w_{jt}} = s_{jt} + (w_{jt} - c_{jt}) \frac{\partial s_{jt}}{\partial w_{jt}} = 0\,, \tag{10}$$

where

$$\frac{\partial s_{jt}}{\partial w_{jt}} = \sum_{k=1}^{J} \frac{\partial s_{jt}}{\partial p_{kt}} \frac{\partial p_{kt}}{\partial w_{jt}}\,.$$

One can derive $\frac{\partial s_{jt}}{\partial p_{kt}}$ from the demand and $\frac{\partial p_{kt}}{\partial w_{jt}}$ can be obtained from (9). The equilibrium wholesale prices are characterized by

$$w_{jt} = c_{jt} + \frac{1 - \sigma}{\beta} \frac{1}{1 - s_{jt|g}\,(1 - (1 - \sigma)(1 - Z_t)^2)}\,, \tag{11}$$

where Z_t is again the share of product category sales in the market and $s_{jt|g}$ is the within group share of brand j.

The costs, c_{jt}, in (11) can be replaced by $c_{jt} = c_j + \eta_{jt}$ assuming constant marginal costs. Here, η_{jt} is a cost shock which could serve as an error term when estimating equation (11). However, we collected detailed information regarding several components of marginal costs. In the product category we are examining, these are the raw material costs (MAT_t), the cost of the packaging material (CP_{jt}), an extra fee that is related to the environmental suitability of the package (green point: GP_{jt} which is observed) and the cost of aromatic substances (AS_{jt}). We have had numerous informal talks with product managers in this category and obtained very precise cost information regarding these cost components. Thus we know the cost of the green point, the cost of aromatic substances for all brands, the raw material costs and the costs of the packaging. Only brand-specific cost components remain unobserved and must be estimated from the data. Thus, we allow for idiosyncracies in the costs that have been verified by brand managers.

In summary, the marginal cost of brand j at time t can be written as

$$c_{jt} = \gamma_{j0} + MAT_{jt} + CP_{jt} + GP_{jt} + AS_{jt} + \eta_{jt}\,. \tag{12}$$

Substituting the specification in (12) in (11), we obtain

$$w_{jt} = \gamma_{j0} + MAT_{jt} + CP_{jt} + GP_{jt} + AS_{jt} + \frac{1 - \sigma}{\beta} \frac{1}{1 - s_{jt|g}\,(1 - (1 - \sigma)(1 - Z_t)^2)} + \eta_{jt}\,. \tag{13}$$

Further substitution of (13) in (9), we arrive at an estimable equation

$$p_{jt} = \gamma_{j0} + MAT_{jt} + CP_{jt} + GP_{jt} + AS_{jt} + \frac{1 - \sigma}{\beta} \frac{1}{1 - s_{jt|g}\,(1 - (1 - \sigma)(1 - Z_t)^2)} + \frac{1}{\beta(1 - Z_t)} + \eta_{jt}, \tag{14}$$

where only the γ_{j0} parameters are estimated from the data. We use (14) to compute firm specific cost components assuming $E(\eta_{jt}) = 0$. Alternatively, equation (14) can also be estimated jointly with the demand [6].

The impact of variety on manufacturers' wholesale prices can be identified from (13). Given the cost estimates and the demand parameter estimates, the impact of variety on manufacturers' pricing behavior can be studied through the direct effect of variety on category demand, the demand effect on brands' shares and the impact of these on the mark-ups of manufacturers.

3. The Data and Estimation Results

The data are from a subcategory of the laundry detergent market in Germany, and have been provided by IRI Germany. Four national brands cover approximately 95 percent of the data we observe [7]. The rest are private label sales and sales of generic brands. We concentrate our analysis on the four national brands. The data cover a period of 174 weeks. Across this period, all brands engaged in product proliferation. They introduced a number of new variants under the name of their well-established brands. These introductions may have caused competitive reactions. First, we studied whether the inclusion of private labels into our system of demand equations is justified. A demand analysis with the four national brands and the private label gives a different price response parameter than when the estimation is done only with the national brands. A demand analysis with any three of the four national brands and no private label revealed no differences in price response. Thus it seems that the private labels attract different consumers who show different price response. We therefore restricted our parameter estimation to the four national brands. However, we take private label sales into account when calculating the within-group market shares. The competitive effect of private labels on national brands is still in the data and the estimation results.

These data come from different retail chains which belong to four of the six leading German retail corporations. Hence, they represent the main part of the laundry detergent market in Germany. They have already been aggregated to the chain-level by our data provider. We could not get access to data from all of the leading national chains. For example, Aldi, a discount store, refuses (like most discounters) to provide data about its retail sales. Fortunately, Aldi is a discount store that carries only private labels. Hence, competition among national brands is only influenced by the fact that consumers must first decide whether to purchase in Aldi or in a chain that carries national brands. Once a consumer has decided to shop in Aldi, this consumer can only select from Aldi's own brands. In our model, we cannot focus on discounter sales due to the lack of data.

The data cover information on quantities sold of brands, volume-weighted prices of the brands, volume-weighted promotional activities of the brands and the number of items offered under the name of a brand. *Table 1* provides the mean values as well as the range for within-group shares, prices, promotion and variety across the 4 brands and the 4 chains. Prices are DM prices per unit laundry detergent (all detergents are sold with identical volume), whereas promotion indicates percentage sales based on display and/or featuring. We combined display and featuring into one variable due to the high collinearity among both. An attractive feature of our data is the fact that the manufacturers of the 4 national brands directly negotiate wholesale prices and their promotional support with the 4 retail corporations. Hence, the wholesale price that we will estimate reflects the price that the

		Chain A	Chain B	Chain C	Chain D
Within-group share					
Brand 1	mean	14.32	21.90	11.81	24.48
	min-max	7.12-31.61	5.45-62.27	2.74-60.68	7.14-69.62
Brand 2	mean	35.08	33.27	41.02	32.51
	min-max	22.62-58.90	16.39-72.04	18.60-73.55	13.46-61.43
Brand 3	mean	22.27	17.72	16.17	17.55
	min-max	9.17-38.73	5.26-53.77	1.99-46.22	5.86-65.34
Brand 4	mean	28.33	27.11	31.00	25.46
	min-max	13.74-48.91	8.32-63.71	10.58-54.37	8.12-57.58
Price					
Brand 1	mean	3.34	3.30	3.69	3.22
	min-max	2.34-3.76	2.53-3.93	2.63-4.02	2.16-3.70
Brand 2	mean	3.36	3.38	3.70	3.52
	min-max	3.02-3.58	2.81-3.99	2.64-4.04	2.84-3.83
Brand 3	mean	3.14	3.35	3.53	3.31
	min-max	2.65-3.58	2.56-3.85	3.05-3.99	2.07-3.83
Brand 4	mean	3.23	3.34	3.46	3.32
	min-max	2.37-3.56	2.64-3.83	2.54-3.78	2.64-3.60
Promotion					
Brand 1	mean	12.99	23.93	8.33	20.36
	min-max	0.00-42.28	0.00-91.87	0.00-65.32	2.26-65.63
Brand 2	mean	13.96	29.38	12.97	15.11
	min-max	0.27-47.18	0.00-95.65	0.00-60.63	1.79-48.27
Brand 3	mean	11.22	15.89	7.37	16.57
	min-max	0.00-36.83	0.00-90.83	0.00-52.19	2.23-45.53
Brand 4	mean	15.23	21.83	9.66	14.18
	min-max	0.82-41.87	0.00-98.24	0.00-57.16	0.46-46.37
Variety					
Brand 1	mean	4.09	3.87	4.34	4.28
	min-max	3.00-6.00	3.00-6.00	3.00-6.00	3.00-6.00
Brand 2	mean	4.83	4.83	4.83	4.83
	min-max	4.00-5.00	4.00-5.00	4.00-5.00	4.00-5.00
Brand 3	mean	5.06	4.47	4.93	5.17
	min-max	4.00-7.00	300-7.00	300-7.00	4.00-7.00
Brand 4	mean	5.38	5.20	5.28	5.70
	min-max	4.00-6.00	4.00-6.00	4.00-7.00	4.00-7.00

Table 1: Descriptives of the 4 brands across the 4 chains

retailers have to pay to the manufacturer. There are no further wholesalers in the distribution channel. This adds support to our theoretical model.

Another important question to answer is how to deal with the data across retail corporations. One possible strategy is to separately analyze each demand and supply model for each retailer. We performed several such a priori studies. They mainly focused on the demand parameter estimates and especially on the price parameters. Our prior studies revealed that price sensitivity across the 4 different retail corporations are not significantly different from one another. Therefore we decided to jointly estimate demand parameters. The effects of price, promotion and variety on sales are assumed to be identical across chains, but we introduce chain specific brand constants. Thus each consumer weighs brands according to the type of store he or she is going to shop at. This may not be an unrealistic assumption knowing that retailers follow different strategies in categories such as the laundry detergent. We also adjusted for serial correlation in the estimation within each retailer and adjusted for heteroscedasticity using a generalized method of moment estimator. Instruments are promotional activities of the brands, lagged quantities and cost information, e.g. material costs, costs of aromatic substances, packaging costs and costs of the green point (environmental suitability of the packaging). These instruments have been interacted with brand constants following *Villas-Boas* (2002). We also tested for the exogeneity of promotion and variety following the procedure outlined in *Sudhir* (2001) and *Villas-Boas* and *Winer* (1999) and look at the correlation between estimated residuals (assuming promotion and variety as exogenous) and promotion and variety. The correlations were not significant, indicating the absence of an endogeneity bias. In order to verify that the effects of variety are not biased by collinearity, which could appear due to the moderate changes in variety of all brands across time, we have calculated the condition index. It yields a value of 26.53, which indicates the absence of serious collinearity.

Estimation results are provided in *Table 2*. We performed a sequential estimation. Thus, first the demand parameters from (4) are estimated. Given these parameters the marginal costs are then estimated from (14). A first glance at the demand parameters reveals that all marketing instruments significantly affect sales. The price parameters can be used to estimate chain specific price elasticities as reported in *Table 3*. They show that sales of all 4 brands are similarly elastic and that the price elasticities across chains are comparable. If we treat variety as a continuous variable, we can also derive elasticities with respect to variety (see *Table 4*). To do this, the demand equation (4) has to be differentiated with respect to variety. As expected, variety elasticities are – in absolute terms – lower than price elasticities but increasing variety has a positive effect on sales. Across chains, elasticities in variety are comparable. In addition, promotion significantly affects sales, and correlation of the brands within the category is moderate $\sigma = 0.174$. The chain specific constants show that Brand 2 has the highest brand attractiveness, followed by Brand 4 and then brands 3 and 1. This result holds in general across chains, but the brand specific constants also show that brand attractiveness differs across chains.

	Estimate	Approx. Std Err
Demand Parameter		
α_1 in chain A	-2.5786	0.1593
α_2 in chain A	-1.8996	0.1693
α_3 in chain A	-2.4568	0.1614
α_4 in chain A	-2.2374	0.1664
α_1 in chain B	-2.8038	0.1516
α_2 in chain B	-2.4824	0.1672
α_3 in chain B	-2.8717	0.1560
α_4 in chain B	-2.6620	0.1689
α_1 in chain C	-2.5394	0.3664
α_2 in chain C	-0.9593	0.1806
α_3 in chain C	-2.3560	0.3510
α_4 in chain C	-1.4603	0.1815
α_1 in chain D	-2.6314	0.1526
α_2 in chain D	-2.0867	0.1692
α_3 in chain D	-2.8616	0.1684
α_4 in chain D	-2.5849	0.1780
σ	0.1740	0.0249
β_{Price}	0.9059	0.0422
$\mu_{Variety}$	0.4684	0.0825
$\gamma_{Promotion}$	0.0102	0.0006
Cost Parameter		
γ_{10}	0.65831	0.0086
γ_{20}	0.67905	0.0054
γ_{30}	0.56433	0.0096
γ_{40}	0.58923	0.0062

Table 2: Parameter estimates

Brand	Chain A	Chain B	Chain C	Chain D
1	-3.560	-3.472	-3.935	-3.369
2	-3.418	-3.461	-3.683	-3.615
3	-3.287	-3.547	-3.734	-3.511
4	-3.337	-3.466	-3.530	-3.459

Table 3: Price elasticities of the 4 brands across retail chains

Brand	Chain A	Chain B	Chain C	Chain D
1	0.550	0.542	0.551	0.539
2	0.655	0.688	0.587	0.614
3	0.696	0.665	0.627	0.668
4	0.741	0.753	0.661	0.732

Table 4: Variety elasticities of the 4 brands across retail chains with respect to sales

4. An Empirical Analysis of the Impact of Variety on Manufacturers' Pricing

Next the impact of variety on manufacturers' pricing strategies (wholesale prices and mark-ups) is studied. We perform two analyses. First, manufacturers' wholesale price elasticities with respect to variety are derived. Second, we solve the market equilibrium given in equations (9) and (11) for prices and various degrees of variety. This will enable us to study the effects of variety on manufacturer pricing.

The effect of variety on wholesale prices is reflected in the within group share of a brand and through its effect on the total category sales (the effect on the size of the outside option). Elasticities of wholesale prices with respect to variety can be derived from (11) by differentiating this equation with respect to variety [8]. Wholesale price elasticities with respect to variety are given in *Table 5* (values are multiplied by 100). It turns out that the effect of own variety on own wholesale price is positive but small. Nevertheless, these effects are statistically significant [9]. Variety has a positive effect on a brand's own wholesale price. This effect is strongest for Brand 2, the market leader. It is lowest for Brand 1 which also has the lowest market share across all 4 retail chains. Thus, brands that possess some market power (measured in terms of market share) seem to have a stronger ability to raise wholesale prices when they increase variety. The cross elasticities of wholesale prices with respect to variety are negative and show that competitor variety does affect the wholesale price of other competitors. If a competitor increases its variety, the other brands decrease their wholesale prices (at least in the short run). It is interesting to note that the cross-effects are strongest among brands 2, 3 and 4. Variety of Brand 1 does not have much of an impact on wholesale prices of the competitors, which is predominately caused by its relatively low market share compared to the other brands. Therefore the market leader, Brand 2, has the highest wholesale price elasticity with respect to variety. An interesting question that remains to be answered is why the market leader, Brand 2, offers a relatively small degree of variety. This question is difficult to answer in the absence of any cost information. Informal talks with brand managers in this category also revealed that the market leader offers the highest quality, probably at the highest costs, which may provide an explanation for its degree of variety. Brand 2 also offers vertically differentiated products, which may lead to its relatively small degree of variety.

Brand	Brand 1	Brand 2	Brand 3	Brand 4
Brand 1	0.775	-0.241	-0.153	-0.194
Brand 2	-0.260	1.674	-0.404	-0.514
Brand 3	-0.163	-0.399	1.194	-0.322
Brand 4	-0.215	-0.527	-0.335	1.488
Values multiplied by 100				

Table 5: Wholesale price elasticities with respect to variety

Next, we solve the market equilibrium in terms of prices with respect to various degrees of variety and investigate the effect of variety on wholesale prices. First, given the equilibrium prices of all brands, the impact of variety of each brand on its own wholesale price and the respective mark-up is studied. All competitors are assumed to offer 5 different variants of their brands. This study reveals whether manufacturers can increase their mark-ups if they engage in product proliferation when competitors do not follow. Second, we assume that all brands offer the same degree of variety and calculate the impact of this strategy on wholesale prices and the respective mark-ups given the equilibrium prices. In this case, the within group share of brands is only moderately affected by variety and changes in wholesale prices, and the mark-ups are primarily related to the power of the four brands, i.e. how they are able to attract new consumers to the product category and how they can take sales from the outside option.

Figure 1 provides the estimated mark-ups and wholesale prices given the equilibrium prices of all 4 brands across all 4 chains. We start our discussion where competitors do not respond to variety. The corresponding plots are the upper- and the lower-left plots in *Figure 1*. Again, competitors are assumed to offer 5 variants, and we study the impact of a brand's changes in variety on wholesale prices and mark-ups. It clearly can be seen that variety affects manufacturers' mark-ups and the respective wholesale prices. In the absence of any costs of introducing more variants, profits would increase in variety. If competitors do not respond, i.e. they keep the degree of offered variants constant, an increase in variety would lead to increasing mark-ups (see upper-left plot in *Figure 1*).

Brand 2 shows the strongest impact. Its mark-up would increase from 0.9554, if one variant is offered, to 1.0388, if 10 different variants are offered. Thus the mark-up would increase by roughly 8.7 percent, and the corresponding wholesale price would increase from 2.2927 (1 variant) to 2.3761 (10 variants), which is an increase of 3.6 percent. Results across brands are comparable. However, Brand 1 could increase its mark-up only 3.8 percent, which results in an increase in wholesale price by 1.8 percent. Respectively, Brand 3 could increase its mark-up by 4.5 percent and its wholesale price by 2.0 percent. Brand 4 could increase its mark-up by 6.6 percent and the wholesale price by 2.9 percent. Hence, if competitors are not responding to competitors' changes in variety, each brand is able to increase mark-ups as well as wholesale prices. In the absence of any costs of variety, it is hard to judge however, how many variants a brand should offer. But it seems that increasing variety appears to be a favorable strategy if competitors do not respond.

However, the impact of variety on manufacturers' pricing heavily depends on competitors' strategies in variety and their impact on the equilibrium prices. Results change substantially if all competitors offer the same

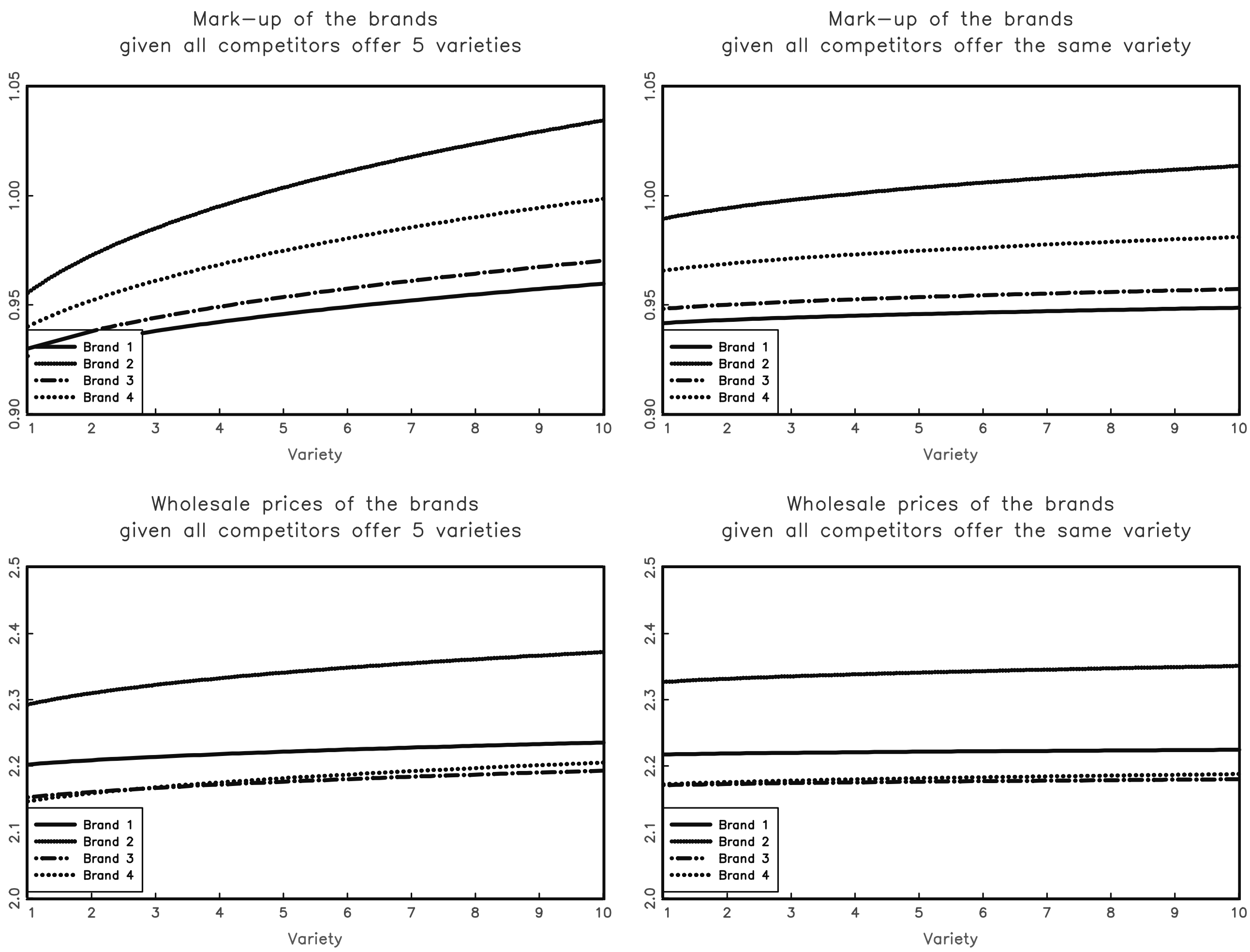

Figure 1: Impact of variety on wholesale prices and mark-ups

degree of variety. Now, changes in variety have a small impact on brands' within-group shares due to the fact that all brands simultaneously increase or decrease their variety. Increasing variety of all competitors draws primarily from the outside option. Hence, this strategy has only very small effects on mark-ups and wholesale prices (see upper-right and lower-right plot in *Figure 1*). For example, Brand 2 could increase its mark-up by only 2.6 percent, which would lead to an increase in its wholesale price of 1.1 percent if all competitors simultaneously increased their degree of variety from 1 to 10. Brand 1 for example could increase its mark-up by 0.8 percent and the respective wholesale price by only 0.3 percent, again if all competitors simultaneously increased their degree of variety from 1 to 10. Thus if all competitors offer more variants, its impact on mark-ups diminishes almost completely. However, out of the 4 brands, Brand 2 can increase its mark-up the most. This result also showed up when discussing wholesale price elasticities with respect to variety. Hence it seems that the market leader (i.e. Brand 2) could most benefit from increasing variety, irrespective of competitors' actions. However, an absolute answer to this issue can only be given on the basis of precise information about the cost of variety. An estimation of variety costs is beyond the scope of this paper. Notice that increasing the number of variants will increase the demand for the product category. When this increase is substantial, introducing more variety may benefit all firms in the industry.

5. Summary

Overall this study has shown the impact of variety on brands' sales. We identified a positive effect of variety on market shares. This effect is related to elasticities in variety around 0.6. Thus a doubling of variety would increase sales by 60 percent, and a halving of variety would cut sales by 30 percent. Given different choices in variety, equilibrium prices were calculated. This enables us to investigate the impact of variety on manufacturers' pricing. It clearly turns out that manufacturers can raise prices and increase their profits through higher mark-ups if they increase variety and if competitors do not follow. In that case, each manufacturer could benefit from the introduction of new variants. However, in the more realistic scenario in which manufacturers respond to each other and where they follow competitors, the clear and positive effect of variety on profits almost diminishes. In this case, variety affects only consumers who have opted for the outside good. Nevertheless, if this increase in demand is substantial, introducing new variants can be an effective strategy to increase profits.

The optimal degree of variety depends on the costs of variety. In the absence of any realistic assumptions about these costs, it is hard to make any plausible predictions. Any analysis that focuses on firms' costs of variety must account for the fact that in this particular case variety must be treated as a discrete variable. Further research could also study the impact of the uniqueness of an attribute on demand and supply.

Notes

[1] Alternatively, one could resort to an ad hoc methodology by assuming that variety is a continuous variable and the strategic interaction between the firms yields a unique equilibrium to estimate costs of introducing new variants, as in *Draganska* and *Jain* (2005).

[2] This argument assumes the variants of a brand are priced equally and are subject to the same promotional efforts. In the market where we perform our empirical analysis, these assumptions are satisfied.

[3] See also *Boatwright* and *Nunes* (2001) or *Broniarczyk*, *Hoyer* and *McAlister* (1998).

[4] Prices at retailer r do not affect the outcome at another retailer.

[5] In our empirical study, we have more than one retailer, but since the markets of the retailers are assumed to be independent, the same formulas apply at each retailer.

[6] A joint estimation can add efficiency to the parameter estimation if we are sure about the vertical competition between manufacturers and retailers. If there are uncertainties or if we make wrong assumptions about the vertical interaction, a joint estimation will probably bias the demand parameters. This in turn would seriously damage our wholesale price and cost estimates. Our implied effects of variety on the mark-ups of retailers and manufactures would then be wrong. For that reason, the sequential estimation is chosen. First, the demand parameters are estimated before, in the second step, the parameters of the pricing equation are estimated, given the demand estimates.

[7] Private label sales in the German market are low in some product categories, especially in those categories in which strong brands are sold at moderate prices. Many private label sales are also generated in so-called discount stores, which offer a small assortment with little assortment depth. Aldi is a prominent representative of such a discounter which does not sell national brands in most categories. These discounters generally do not provide data about their retail sales.

[8] Own wholesale price elasticity with respect to variety:

$$\eta_{jj}^{v} = \frac{1}{w_{jt}} \left(\frac{s_{j|g}(1-(1-\sigma)(1-Z)^2)(1-s_{j|g})\mu + (1-\sigma)^2 s_{j|g}{}^2 (1-Z)^2 Z\mu}{\beta(1-s_{j|g}(1-(1-\sigma)(1-Z)^2))^2} \right)$$

Cross wholesale price elasticity with respect to variety:

$$\eta_{ji}^{v} = \frac{1}{w_{jt}} \left(\frac{s_{j|g}(1-(1-\sigma)(1-Z)^2 s_{j|g}\mu + 2(1-\sigma)^2 s_{j|g} s_{i|g} (1-Z)^2 Z\mu}{\beta(1-s_{j|g}(1-(1-\sigma)(1-Z)^2))^2} \right)$$

[9] The standard errors for the elasticity of own wholesale price to own variety are 0.157, 0.339, 0.242 and 0.302 for brand A, B, C and D, respectively.

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Keywords

Product variety, competition, manufacturers' pricing behavior