Breadth and depth of promotional sales in food retailing

Šířka a hloubka propagačních slev v potravinářském maloobchodě

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Abstract: Temporary price reductions (sales) as a means of promotion have become an increasingly important tool in the marketing mix of food retailers around the world. This paper investigates the retailers' pricing strategy by explicitly accounting for the multi-product nature of retailing. We find that retailers systematically adjust the breadth and depth of sales over time and they respond aggressively to their rivals' promotional activities. Finally, the breadth and depth of sales are found to be substitutes in the set of the available strategies to increase the store traffic.

Key words: multi-product food retail pricing, promotional sales, Germany, milk products

Abstrakt: Dočasná snížení cen (slevové prodeje) se jako způsob propagace stávají stále významnějším nástrojem marketingového mixu maloobchodních prodejců potravin na světové úrovni. Práce zkoumá cenovou strategii maloobchodních prodejců se specifickým důrazem na multiproduktový charakter maloobchodu. Výzkumem bylo zjištěno, že maloobchodní prodejci systematicky upravují šířku a hloubku slev v průběhu času a že agresivním způsobem reagují na propagační aktivity svých konkurentů. Bylo zjištěno, že šířka a hloubka prodejních slev jsou subsituty v systému dostupných strategií zvýšení obratu zásob.

Klíčová slova: multiprodukční oceňování v potravinářském maloobchodě, propagační slevy, Německo, mléčné výrobky

'Retail prices are frequently regarded as exceptions both to the law of costs and generally to every rational process of price formation, which is all the more remarkable since these prices are the only ones which are of direct interest to the consumer and which are directly influenced by consumption' (Wicksell, 1938, p. 86).

Retailers use a great variety of marketing measures to increase the store traffic and sales volumes. Traditionally, promotional sales are the dominant tool in the retailers' set of strategies (Simon 1992: 51). Although Wicksell's statement seems to suggest that classical economists have been rather sceptical with respect to the scope of economic reasoning to explain the rationale behind promotional sales in the retail sector, recent studies in the economics and management science have devoted a considerable attention towards this issue and substantially improved our understanding of retailer behavior (for a recent survey, see Berck et al. 2008).

Immanent to the retail business is its multiproduct nature. A typical retailer in Germany for example has between 1000 and 30 000 different products on stock and this number increased considerably over time. Richards (2006) observes that despite the importance of product variety within a store, the existing literature on sales still mainly focuses on single-product retailers and thus cannot explain why retailers typically offer many products on promotion at the same time. Using the theoretical framework introduced by Richards (2006), the present paper explicitly accounts for the multiproduct nature of retailing and aims at investigating the retailers' pricing strategies in terms of breadth and depth of sales. Do retailers offer deep discounts for a small number of products? Or do they use the breadth and depth of price promotions as complementary marketing tools, as Richards (2006) suggests?

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We use the modeling framework developed in Richards (2006) as the point of departure and assume that consumers purchase only one unit of each product in their shopping basket. The number of products in the shopping basket (n) is fixed and identical for all consumers. Each of the j = 1, 2, 3 ..., m retailers sells n products, where some products (s) are offered for sale and others ($n - s$) are not. There are two types of consumers: shoppers and loyal customers. Shoppers are assumed to be fully informed about the store prices at all times and purchase at the store which offers the lowest price for the shopping basket. Loyal consumers always purchase at the same store. All consumers practice one-stop-shopping (Warner and Barsky 1995). Retailer j chooses the depth (the discount price p_{ij} for product i = 1, 2, 3 ..., n) and breadth of sales (the number of products on sales s_j) to maximize the total store profits

$$\pi_j = \sum_{i \in s_j} \left(\alpha_j / m + 1 - \alpha_j\right)\left(p_{ij} - c_{ij}\right) + \sum_{k \in (n-s)_j} \left(\alpha_j / m + 1 - \alpha_j\right)\left(v_{kj} - c_{kj}\right) \quad (1)$$

where α_j is the share of loyal consumers (and $(1 - \alpha_j)$ is the share of shoppers), c_i is the wholesale price retailers have to pay, and v_i is the consumers' reservation price ($v_i > p_i$). If no sales are offered, profits are

$$\pi_j = \sum_{i \in n} \left(\alpha_j / m\right)\left(v_{ij} - c_{ij}\right) \quad (2)$$

In determining sales prices p_{ij}, Richards (2006) follows Varian's (1980) seminal analysis and assumes that retailers use a randomization strategy to compete for shoppers. They randomly draw the sales price for each product from a marginal probability density function. For a mixed strategy equilibrium to exist, the expected profit earned by using a price promotion strategy (expected profits from equation (1)) must be the same as that expected to be earned when no sales are offered (expected profits from equation (2)). Without going through the algebra of the Richards' model, the relationship between the depth and breadth of sales can be found by looking at the total differential of equation (1) with respect to p and s (assuming symmetry for products and retailers, we can suppress subscript j and i):

$$d\pi = \left(\alpha / m + 1 - \alpha\right)\left(p - v\right)ds + s\left(\alpha / m + 1 - \alpha\right)dp \quad (3)$$

from which we immediately find that $\frac{ds}{dp} = \frac{s}{v - p} > 0$. Thus, the number of sales decreases with the depth of the promotion (increases with p_j), the depth and breadth of sales are substitutes.[1]

The observation that the depth and breadth of sales are substitutes rests upon the assumption, that shoppers do not care whether a store has many sales with low discounts or few sales with a high discount. They only care about their expenditures for the whole shopping basket. The specific strategy a retailer chooses does not matter as long as the expenditures of the shoppers are cut by the same amount.

MATERIAL AND METHODS

To investigate (the relationship between) the breadth and depth of the retailers' sales, we employ the weekly retail scanner data provided by MaDaKom GmbH (2002) covering a two year period from 2000 to 2001 and focus on perishable dairy products. As demand for milk products is price sensitive and milk products are often used as loss leaders in the competitions between stores (Green and Park 1998; Kilic et al. 2009; Zentková and Hošková 2009), we choose a sample of milk products (milk, butter, yoghurt and cheese products) to study the interaction between the breadth and depth of sales.

The panel consists of 17 stores which belong to the six biggest retail chains in Northern Germany. Retail stores can be classified into the following categories: discounters (DC), supermarkets (SM) and consumer markets (CM). The available data are prices, volumes, and promotional activities for the 12 major brands of each product. The 12 brands were chosen to represent the most frequently bought brands of the respective product. Our dataset consist of 31 850 price observations.

Unfortunately, there is no unique definition of promotional sales. We follow Hosken and Reiffen (2001) and define sales as significant temporary price reductions which are unrelated to cost changes. More specifically, a product is considered to be on sale if its price is cut by at least five percent for no more than four consecutive weeks. The reference price is defined as the the modal price in the respective calendar year.[2] In Table 1, some descriptive statistics for the raw sample data are presented.

[1]A similar conclusion (that the depth and breadth of sales are substitutes) is also reached in Achabal et al. 1990; Raju 1992; Kurata and Liu 2007.

[2]We have carried out estimation experiments when using alternative definitions of sales, a number of additional results can be obtained by the others. With regard to the main hypothesis tested the results are similar.

Table 1. Descriptive statistics for the raw sample data

	Milk	Butter	Cheese	Yoghurt
Number of observations (max.= 17 × 12 × 104 = 21 216)	4 167	6 467	9 736	12 447
Average price	1.28	2.42	3.31	1.10
Maximum of average store price between stores	1.69	2.73	3.57	1.34
Minimum of average store price between stores	0.79	2.11	2.62	0.82
Standard deviation of all prices	0.35	0.36	0.60	0.55
Average share of weeks with sales	0.16	0.04	0.05	0.11
Average price in periods without sales (A)	1.30	2.45	3.33	1.10
Average price in periods with sales (B)	1.19	1.95	2.95	0.99
Average price reduction (1 – B/A) × 100	8.66	20.28	11.38	9.82

Source: Own calculations based on MaDaKom data (2002). For each product category, observations for 12 brands in 17 stores are used; all prices are in DM

Prices for milk, butter, cheese and yoghurt vary substantially between the stores and over time. The coefficients of variation over all prices range from 20 to 100%. The number of sales is the highest for milk (16% of all available observations) and the lowest for butter (4%). However, the magnitude of price decreases at sales is larger for butter and cheese (20% and 11% respectively) compared to milk and yoghurt (9 and 10% respectively), indicating that from a subcategory perspective, the sales' breadth and depth are substitutes rather than complements.

RESULTS AND DISCUSSION

In our empirical model, we closely follow Richards' (2006) procedure to investigate the retailers pricing behaviour and in particular the relationship between the breadth and depth of sales. A Tobit model is estimated in the first step to investigate the promotional depth (d_{ijt}) which is defined as the relative difference between the regular and the sale's price. In the second step, a count data model is used to analyse the breadth of sales (number of products on sale). The total number of sales per week over all brands within a store (s_{jt}) is used as a dependent variable.[3]

$$d_{ijt}^{*} = \boldsymbol{\beta_l} \boldsymbol{X_l} + \varepsilon_{ijt} \text{ , with } d_{ijt} = \max[d_{ijt}^{*}, 0] \quad (4)$$

$$s_{jt} = \exp\left(\boldsymbol{\gamma_h} \boldsymbol{Z_h} + \alpha \hat{d}_{jt}\right) + \omega_{jt} \text{ , with } \hat{d}_{jt} = \sum_{i=1}^{n} \hat{d}_{ijt} \quad (5)$$

where $\boldsymbol{X_l}$ ($\boldsymbol{Z_h}$) are k (h) explanatory variables, $\boldsymbol{b_l}$ and $\boldsymbol{g_h}$ are vectors of parameters to be estimated and ε and ω are residuals. We investigate the interaction between the promotional depth and breadth by including the fitted values of the size of discounts ($\hat{d}_{ijt}$) from the Tobit model (equation (4)) as explanatory variable in equation (5). If the breadth and depth of sales are complements (substitutes), the parameter estimate for α in equation (5) should be positive (negative).

Table 2. Results for the Tobit-model

Variables	Coefficient	Std. Dev.	*t*-value
Total number of products	0.0073	0.0010	7.23**
Rivals' total number of products	0.0018	0.0123	1.43
Rivals' number of products on sale	0.0016	0.0001	12.72**
Wholesale price	–0.1362	0.0110	–12.39**
Index of wages in retailing	0.0091	0.0023	4.02**
Christmas	0.0149	0.0225	0.66
Easter	–0.0660	0.0268	–2.46*
Christmas_Butter	0.0930	0.0483	1.92
Easter_Butter	0.1741	0.0523	3.33**
DC	–0.4134	0.0359	–11.52**
CM	–0.0749	0.0126	–5.92**
Constant	–1.4444	0.2245	–6.43**

Note: The dependent variable is the percentage price reduction; the number of observations is 31 850. **, * indicates significance level of 1% and 5% respectively

Source: Own calculations based on MaDaKom data (2002)

[3]Richards (2006, p. 268) provides a detailed motivation for the recursive modeling structure chosen.

The parameter estimates for the random-effects Tobit model (equation (4)) are reported in Table 2.

We find the parameter estimate for σ, the Tobit 'normalizing parameter', to be significantly different from zero, thus rejecting the non-censored regression alternative. The coefficient of the total number of products in the respective store is positive and highly significant. If a retailer offers more products, the promotional depth increases. A reduction in profits due to the lower mark-ups for products on sale is easier to recover the larger the number of products on stock.

Table 2 also suggests that retailers respond to their rivals' behavior. While the average number of products offered by competitors has no significant impact on the promotional depth, the number of products on sale in a rival's store significantly influences the size of the discount. The parameter estimate reported in Table 1 implies that the promotional depth of the store in question will increase by 0.16 percentage points if the competitors offer one additional product on sale. In contrast to Richards (2006), we thus conclude that retailers respond aggressively to their rivals' promotional activities.[4]

The wholesale price of the products considered has a significant negative impact on the size of the discount. An increase in the wholesale price reduces the promotional depth by 14 percentage points. This corresponds to Richards (2006), who concludes that retailers use promotional activities to pass at least some upstream market price variation on to consumers. An increase in wages in the retail sector is associated with a significant increase of the promotional depth.

Table 2 suggests that retailers use sales on butter as an instrument to increase the store traffic in the periods of a high seasonal demand. Whereas the size of the sales discount appears to be smaller for milk, yoghurt and cheese prior to the Easter holydays, the size of the discount increases by 17 percentage points for butter. The increase in the depth of sales for butter prior to the Christmas season is significantly different from zero at the 10%-age level only.

Finally, we find significant differences in price setting (the size of discounts) between different types of retailers. Ceteris paribus, discounters (DC) and consumer markets (CM) use significantly larger price discounts to compete for consumers than supermarkets (SM), which are the left out category.

On the basis of these estimation results, the predicted values of the average size of discounts ($\hat{d}_{jt}$) in store j at time t are calculated. The predicted values are used as an explanatory variable in the count-data model. The results of a negative binomial model are reported in Table 3.[5]

Table 3. Results for the Negative-Binomial-Model

Variables	Coefficient	Std. Dev.	t-value
Discount (Tobit)	–17.2029	1.4521	–11.85**
Total number of products	0.0916	0.0028	33.13**
Rivals' total number of products	–0.0138	0.0033	–4.25**
Rivals' number of products on sale	0.0241	0.0003	70.68**
Wholesale price	–0.3567	0.0446	–8.00**
Index of wages in retailing	0.1420	0.0137	10.38**
Index of capital costs	–0.0728	0.0110	–6.60**
Christmas	0.1627	0.0283	5.74**
Easter	–0.0023	0.0298	–0.08
Christmas_Butter	0.1570	0.0609	2.58**
Easter_Butter	0.3399	0.0623	5.46**
DC	–2.1311	0.0940	–10.10**
CM	–0.5329	0.0517	–14.80**
Constant	–6.5327	0.4212	–15.51**

Note: The dependent variable is the number of sales. The number of observations is 31 850; ** indicates significance level of 1%

Source: Own calculations based on MaDaKom data (2002)

Table 3 reports a negative coefficient, which is significantly different from zero, for the instrumented sale's depth variable indicating that the breadth and depth of sales are substitutes rather than complements. The larger the discount offered on a particular product, the smaller is the number of products the retailer is offering on sale. Note that this result, in contrast to Richards (2006), corresponds well with the theoretical arguments outlined in Section 1.

We also find that the sales breadth increases with the number of products offered within a store. For every ten additional products on stock, retailers will

[4]A more detailed analysis of the strategic interdependency between retailers would have to take the geographical dimension (distance between retailers) into account. Due to the limited mobility of consumers, the competition between retailers is local and the strategic interdependence between retailers is likely to decline with the geographical distance between them.

[5]The specification test of Cameron and Trivedi (1986) rejects a Poisson model.

put one additional product on sale. The impact of competitors is also significant. The sales breadth (the number of products on sale) decreases with the rivals' average number of products on stock but increases with the rivals' average number of products on sale. Again, we conclude that the retailers respond aggressively to their rivals' promotional activities.

The wholesale price as well as our measure of capital costs has a significant negative impact on the number of products on sale. An increase in the wage-costs of marketing activities leads, however, to a significant increase in the retailers' breadth of sales. Since a large share of these costs will be fixed (independent of the number of products on sale), the retailers tend to use sales promotions more intensively to split costs among a larger number of products.

The number of products on sale is also significantly larger in the periods of a higher seasonal demand. A dummy variable, which is set equal to 1 in the week before the Christmas holidays, is found to exert a significant impact on the sales breadth. Butter turns out to be a product of the particular importance for the retailers' sales promotion activities. The sales breadth within this product category increases significantly during the Easter holidays.

Dummy variables for the store types are significantly negative for discounters (DC) and consumer markets (CM) suggesting that these two store types offer fewer products on sale than supermarkets (which are the left-out category).

The results of our empirical analysis suggest that the sales of multi-product retailers are systematically related to the product as well as the store characteristics. A more detailed analysis of the strategic interaction between rivals, which would also have to consider the location of retailers in space, would contribute to a better understanding of the retailers' pricing strategies and (hopefully) further reduce the discomfort economists must have with the Wicksell's statement about the rationality of the retailer pricing behaviour.

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