Promotional food retail sales: Frequency versus depth

by

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Abstract

Temporary price reductions (sales) as a means of promotional measures have become an increasingly important tool in the marketing mix of German food retailers. Various models have been proposed to explain the rationales behind such pricing strategies. Recently these models have been extended by Richards (2006) to capture the multiproduct nature of retail business. In this paper German retail food scanner data over two years are used to estimate a three step procedure to explain breadth and depth of sales, and their impact on category revenues.

Keywords: Food Retail Sales, Northern Germany

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1 Introduction

Food retailers use a great variety of marketing measures to increase their store traffic and sales volumes. Among those are flyers, advertisements, bonus packs, coupons, promotional prices, combined measures etc. Hosken and Reiffen (2001) define promotional prices or sales as "temporary price reductions that are not related to cost changes". This definition leaves considerable leeway in the measurement of sales. In many empirical applications in the field only price reductions of more than 5 % that last for a limited time such as no longer than 4 consecutive weeks are indicated as sales. In food German food retailing such sales are the most common measures in the marketing mix. For example in the sample under study in about 12 % of all weeks sales are offered. Most of the in store price variations are caused by sales and store traffic and sales volumes are much higher in periods with sales.

Only a few theoretical models have been proposed to explain the amount of sales observed in food retail stores as an outcome of a competitive equilibrium. Recently, RICHARDS (2006) has developed a multiproduct model based on the ideas of VARIAN (1980). Varian (1980) shows that firms with decreasing average costs tend to follow a mixed strategy even under free entry. Firms either set very high or very low prices to either exploit the loyal customers or to attract the shoppers. RICHARDS (2006) introduces multiple products to the model framework to analyze the relationship between the number of sales and the depth of sales (magnitude of discounts). He concludes that sales' breath and depth are complements rather than substitutes as expected intuitively. The idea compared to Varian is that a store in order to attract shoppers must off many sales with high price discounts. Employing data for fruits from the Los Angeles retail market RICHARDS (2006) provides first evidence for his hypotheses.

In this paper we adopt the empirical approach by RICHARDS and employ retail scanner data for various dairy products over the period from 2000 to 2001 in Northern Germany. We look at milk, butter, cheese and yoghurt prices and sales volumes to estimate the relationship between sales breath and depth and the impact of promotional prices on sales volumes. To our knowledge this is the first attempt to give evidence to RICHARDS' (2006) model using data from the European retail market. In this attempt we apply an enhanced modelling approach based on the panel estimation techniques.

The paper is structured as follows. First, we briefly define the term sales and its empirical conceptualisation. Second, essential parts of the theoretical models by Varian (1980) and RICHARDS (2006) are summarized and discussed. Third, we describe the data under study and develop model specifications and estimation techniques fitting the data under study. Fourth, estimation results for the three stage modelling approach are presented starting with the Tobit-model to analyze the determinants of sales' depth followed by the results for the negative binomial model to estimate the relationship between breadth and depth of sales. Finally a log-linear model is estimated to reveal the impact of breath and depth on sales volume. The last section summarizes and concludes the main findings.

2 Definition of sales

Bonus packs, coupons, special offers and promotional prices (sales) etc. all belong to the set of retailers' promotional activities. Sales or significant temporary price reductions are most common in the German food retail business. Hosken and Reiffen (2001) define promotional prices or sales as "temporary price reductions that are not related to cost changes". As cost changes are generally not known to researchers, the definition of sales empirically is often left to temporary price reductions. Even though a sale's indicator variable is available in some retail scanner data sets, it is generally added by the data collecting agency and is not provided by the retailers. Therefore, researchers and firms that collect retail scanner data have employed different conceptualizations using various thresholds for the depth (magnitude of discount) and the frequency (time length) of price changes to be identified as sales. LEVY ET AL., (2004), HEERDE ET AL., 2001 or GUPTA AND COOPER (1992) claim that to be recognized by consumers price reductions need to exceed a certain level. A minimum threshold of 5 % is often used in empirical studies. We follow this approach here.[*] But which reference price is to be used to measure the extent of a price reduction? In some studies the price of the last week (in the case of weekly data frequency) is used as reference price (Richards 2006). Thereby consecutive sales with the same promotional price would not be identified as sales except the first. Thus, sales would not last for more than one period. Alternatively, a regular price is defined as the price to which promotional prices return to after the promotional phase. This price should be the most frequent price in the sample. Thus, the regular price could be measured as the mode price, the most frequent price. This procedure identifies correctly consecutive sales but might cause some trouble shooting when regular prices for example due to cost changes alter in time or when retailers do not use regular price. To avoid such problems partly, we calculate the most frequent price for each calendar year

[*] RICHARDS (2006) uses different levels between the 5 and 15 % for the price discount to be considered as a sale. However, he did not find significant differences for the estimation results.

separately. The data provider (MaDaKom GmBH) changed the regular price whenever the same price is set in or more than 4 consecutive weeks.[†] With regard to the frequency of price changes we follow the MaDaKom GmbH approach. If a price reduction of 5 % compared to the mode price lasts for more than 4 weeks then it is not considered to be a sale but a low price strategy instead. To compare these two approaches, we present three store price series for fresh milk out of the sample under study for illustrative purposes.[‡]

Insert Figure 1 about here

We selected three stores for which the sale indicator variables differ to illustrate the deviations and potential advantages or disadvantages. In many cases all measures result in the same indicator, for example if stores set a regular price in most periods and offer sales from time to time for short periods (not more than 4 consecutive periods). For store one in Figure 1 the modal price is 1.59 German Marks (DM) per Liter in both calendar years. The circle dots indicate that MaDaKom GmbH identified a sale's period, the upper square dots indicate prices that are 5 % below the calendar mode and the lower square dots indicate sales when the price is 5 % below the mode and this holds for no more than 4 consecutive weeks. All indicator variables are the same except in the period from week 40 to week 55. In that period all prices are 5 % below the modal price; thus, those sales' indicators are deleted.

The second store shows a change in the calendar mode from 1.49 to 1.59 German Marks per Liter. There are only two deviations between MaDaKom and our measure used here. In week 6 and 8 though prices are 5 % below the regular price the MaDaKom indicates no sale. And in week 44 the MaDaKom indicates a sale which is deleted in our measure as the sale last for more than 4 consecutive weeks.[§] Store 3 shows the most significant differences. While our measure indicates no sales, the MadaKom reports 8 in total, which from our perspective are not

[†] We interviewed a former manager of the MaDaKom GmbH for their procedure of sales' identification. As sale's is 5% below the regular price. The regular price is the last price or the price that was set in 4 consecutive in former weeks. However, if one follows this rule, not the exact indicator results that is published by the MaDaKom GmbH.

[‡] To clarify the differences between the two sale's measures we calculate a third indicator variable that shows all prices 5 % below the calendar mode.

[§] The sale indicator generated by MaDaKom should indicate sales for the weeks 45 to 47 if their rule is applied. In could not be clarified whether such deviations are systematic or random mistakes.

conclusive. One either considers those periods with low prices as a low price strategy, which implies no sales, or all the low prices are sales.[**]

As there seems to be no objective rule to decide which measure of sales to use we will compare the results for both proposed indicators.[††] However, as the above discussion reveals, future research is needed to systematically analyze the impact of the concept to identify sales prices in scanner data samples.

3 Theory

VARIAN (1980) models a market for one product with a large number of retailer and free entry. All consumers buy one unit of the perishable product. Stockholding is not possible. Some consumers buy always at the same store (loyals), some under perfect information buy at the store which offers the lowest price (shoppers). Therefore, single price equilibriums do not exist as stores would always have an incentive to set a price just below that equilibrium to attract by which they would gain all shoppers. The Nash-equilibrium derived is a mixed strategy in which store either set very low or very high prices based on a random distribution. The low prices are then called sales, the high prices are called regular prices.

RICHARDS (2006) follows up on this idea and introduces similar assumptions for a multiproduct model which more realistic can capture the food retail business. Every customer buys a fixed basket of goods in every period instead of one unit of the one good in the VARIAN model. The number of customers that visit a store determine its revenues. As in VARIAN model there are two types of customers: Store loyal customers (α) and non-loyal customers ($1-\alpha$). Store loyal customers buy their products always at the same store. All customers have the same reservation price (v_h). Non-loyal customers (shopper) are assumed to switch between stores in order to find the one that provides the cheapest basket of goods. There are m stores and each (j) has the same share of loyal customers (α_j /m). The share of shoppers is ($1- \alpha$) is attracted by the store that offers the cheapest basket of goods. Because of significant switching costs all customers are assumed to practise one-stop-shopping (WARNER AND BARSKY, 1995). All products (n) can be offered either at sales (n_1) or regular prices (n_2). All retailers face the same wholesale prices. Total profits must

[**] Though the result is as expected, our procedure indicates some potential problems here. As the mode price for the second calendar year is lower than in the first year, the same and consecutive prices are 5 % below as well as not 5 % below the mode which could be inconclusive too.

[††] The results shown in detail here are calculated with our sales measure, the results for the MaDaKom sales measure can be obtained from the authors upon request. Significant deviations are reported in the test.

be positive in every period for all retailers. If a retailer offers no sales or if the retailer is not the cheapest store for the food basket, only loyal customers will visit the store. In the case of no sales the store's profits *(π_j)* follow from equation F1:

$$\pi_j = \sum_{i \in n} (\alpha_j \ / m)(v_{h,ij} - c_{ij}) \tag{F1}$$

If a retailer provides the cheapest basket of goods, profits can be calculated according to F2:

$$\pi_j = \sum_{i \in n2_j} (\alpha_j / m + (1 - \alpha_j))(v_{h,ij} - c_{ij}) + \sum_{i \in n1_j} (\alpha_j / m + (1 - \alpha_j))(p_{ij} - c_{ij}) \tag{F2}$$

To calculate expected profits, F2 has to be multiplied by the probability of being the cheapest provider of the product basket as shown in F3:

$$E\left[\pi_j\right] = \left(\sum_{i \in n_{2j}} (\alpha_j / m + (1 - \alpha_j))(v_{h,ij} - c_{ij}) + \sum_{i \in n1j} (\alpha_j / m + (1 - \alpha_j))(p_{ij} - c_{ij}) \right) * (1 - F_{-j}(p)) \tag{F3}$$

According to VARIAN (1980) there do not exist pure strategies. Otherwise it would always be favourable for a retailer to offer an arbitrarily small price discount on a product to attract all shoppers. Thus only mixed strategies exist in a Nash equilibrium. Consequently, expected profits for all cases (F1 and F3) must yield the same profits.

$$\sum_{i \in n} (\alpha_j / m)(v_{h,ij} - c_{ij}) = \left(\sum_{i \in n2j} (\alpha_j / m + (1 - \alpha_j))(v_{h,ij} - c_{ij}) + \sum_{i \in n1j} (\alpha_j / m + (1 - \alpha_j))(p_{ij} - c_{ij}) \right) * (1 - F_{-j}(p)) \tag{F4}$$

Solving F4 for n_1 (the breadth of sales) under the assumption that the probability of a store offering the cheapest basket of goods is zero, we obtain F5:

$$n_{1j} = \frac{(n_j(a_j / m) - n_2(a_j / m + (1 - a_j)))(v_{h,j} - c_j)}{(a_j / m + (1 - a_j))(p_j - c_j)} \tag{F5}$$

The first derivation of F5 with respect to the sale's price has a negative sign. That means, if the sale's price decreases the number of sales increases. Thus, between depth and breadth of sales a complementary relationship holds.

For the wholesale price a negative derivative is found. An increasing wholesale price increases the nominator more than the denominator so the number of sales is expected to rise. Consequently, a higher wholesale price leads to an increased number of sales.

Another issue is the impact of competitors' price setting behaviour. From RICHARDS' model an aggressive competition is derived. A price increase by a rival will cause a retailer to raise its own price and vice versa. In the empirical analysis he finds an accommodative strategy where aggressive behaviour of rivals elicits a passive response in reply. PESENDORFER (2002) results indicate that especially for products with low price levels the influence of competitors' prices on stores' demand is positive. Demand increases if prices in other stores are high.

WARNER AND BARSKY (1995) investigate the impact of seasonal demand variations. Such variations e.g. occur in weeks close to holidays.

The absolute mark-up a retailer requires in addition to the wholesale price is the difference between his price (*p*) and the wholesale price (*c*), e.g. (*p*-*c*) in the equilibrium situation. At the same time this is the relationship between transaction costs and the number of products purchased per consumer. Due to increasing economies of scale consumers are willing to pay the more transaction costs the more products they want to buy. If the relation between transaction costs and purchased product units decreases, consumers will accept absolutely higher transaction costs. Therefore the intensity of competition increases if consumers will have more time for shopping and need greater volumes. So increasing competition and a higher demand elasticity will lead to smaller mark-ups. This phenomenon occurs before holidays because the demand increases. Consumers accept higher transaction costs at these times. Therefore it is expected that depth and breadth of promotional sales increase before holidays.

Another hypothesis is that store type pricing strategy has an impact on the number and depth of sales (MÖSER (2002), KROLL (2000)). The authors find in their empirical research significant differences between store types in price setting in Germany. Due to "every day low price" strategies in Germany which are typical for discounters, we suppose that this store type will have less sales prices than supermarkets or consumer markets.

4 Data and methods

In this study we employ weekly retail scanner data provided by MaDaKom GmbH (2002) covering a two year period from 2000 to 2001. As RICHARDS we focus on one perishable product category which in this study is dairy products. Dairy products are represented by milk, butter, yoghurt and cheese products. The panel entails 17 stores which belong to the six biggest retail chains in Northern Germany. Available data are prices, volumes and promotional activities for the 12 major brands of each product. Retail stores can be classified into three categories: Three discounters (DC), eight supermarkets (SM) and six consumer markets (CM). The 12 brands were chosen to represent the most frequently bought brands of the respective product. Our dataset consist of 31850 price observations of which 2761 are sales prices. The share of sales prices is about 11 % over all products. In Table 1 some descriptive statistics for the raw sample data are presented.[‡‡]

The maximum number of observation per product is 21.216; however, as some stores do not carry all brands and due to missing observations we have to estimate an unbalanced panel with about 40 % of the maximum number of observation.

Insert Table 1 about here

The average prices for milk, butter, cheese and yoghurt in individual stores show significant deviations expressed by minimum and maximum average store prices which for milk differ by 100 %. The coefficients of variation over all prices range from 20 to 100 %. The number of sales is highest for milk (16 % of all available observations) and 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 product perspective sales breath and depth are substitutes rather than complements. Also except for milk sales volumes increase significantly during sales. In the case of milk sales volume even decline during sales. This result, however, has to be interpreted with care as the level of aggregation is rather high. It is likely that stores (products) that use only few sales indicate high sales volumes due to preferences of their customers or location advantages. This result does not necessarily mean that promotional prices do not increase sales volumes.

[‡‡] Table A1 in the appendix shows some descriptive statistics of all variables used in the three stage model.

Following RICHARDS we estimate a three step procedure to explain breadth and depth of sales, and their impact on category revenues. As assumed by most studies depth and breadth of sales are decided simultaneously by retailers (e.g. JEULAND AND NARASIMHAN, 1985; LAL AND VILLAS-BOAS, 1998). Therefore, we use a three-step-procedure with instrumented variables in the second and the third step. In addition our methodology accounts for the special nature of our data, i.e. zero observations for sales are considered in the first step. Overdispersion and a discrete distribution of the number of sales as dependent variable are considered in the second step. Suppressing all subscripts for ease of exposition, the reduced forms of the three equations that are to be estimated can be written as following:

Tobit: $$y_1{*} = \sum_k \beta_{1k} X_{1k} + \varepsilon_1, \cdots y_1 = max\left[y_1{*},0\right] \qquad \text{(F7)}$$

Count Data: $$y_2 = exp\left(\sum_l \beta_{2l} X_{2l} + \alpha\ y_1\right) + \varepsilon_2 \qquad \text{(F8)}$$

Loglinear regression: $$y_3 = \gamma_1 y_1 + \gamma_2 y_2 + \sum_m \beta_{3m} X_{3m} + \varepsilon_3 \qquad \text{(F9)}$$

for all i = 1, 2, 3…m stores and j = 1, 2, 3, …n products for weeks t = 1, 2, 3, …T, where y_1 is the observed discount offered on product by store j during week t. y_1^* is the discount when there is a sale. y_2 is the number of sales by the same store during the same week, and y_3 represents category revenues. To capture the information of both, the time-series and cross-sectional dimension, panel data estimation techniques are employed. We use a random effects model in all three steps in order to control for differences between store types.

In the first step we estimate a Tobit model to investigate promotional depth as the relative difference between the regular and the sale's price. This model is appropriate because retailers do not promote each product every week. The Tobit model estimates the probability of a promotional price (price) and the depth of sale. The influence of explanatory variables on the depth of price reduction can be forecasted with the help of a Likelihood-function. Promotional depth is hypothesized to depend on the number of products per store, the competitors' number of total products, and their products on sales, the retail store type, the wholesale price, and an index of retailers’ costs. Moreover there are dummy variables indicating the week prior to Christmas and Easter respectively.

In the second step a count data model is used to analyse the breadth of sales. We first test the specification to identify whether a Poisson Model or a negative binomial model fits best. Because of overdispersion and a negative binomial distributed dependent variable we apply a negative binomial model (CAMERON AND TRIVEDI, 1986, 1998). A negative binomial model is a generalized Poisson-model with less limiting restrictions. The sum of weekly sales over all brands is used as dependent variable. We control for endogeneity of promotional depth by including the fitted values of the magnitude of discounts from the Tobit-Model (depth of sales) as explanatory variable. Moreover, we control for wholesale prices, holidays (X-mas- and Easter-Dummies), different store types, number and sales of competitors’ products, a capital costs and insurances index and a marketing index of retailers’ costs.

To investigate the impact of promotional breadth and depth on category revenues a log-linear regression is estimated with the generalized-least square-method (GLS) in the third step. In addition to that, we consider the impact of holidays and store types, the log income per capita, the log price, the log rival price, and a weekly trend. We take account for heteroscedasticity by using robust standard errors.

5 Estimation results

The parameter estimates of the Tobit model are reported in Table 1. The coefficient of total products is positive and highly significant. If a retailer offers more products promotional depth increases. The more products are offered the easier is a compensation of lower mark-ups by other products. Considering the competitors we find that the number of products offered by competitors has no significant impact on promotional depth opposed to their number of promotional sales. The coefficient of rival promotional sales products is 0.0016. If competitors offer one more brand on sale the promotional depth of the store in question will increase about 0.16 percentage points. This result matches with RICHARDS’ (2006) theoretical hypothesis of aggressive competition.[§§]

Insert Table 2 about here

[§§] The specification using the MaDaKom sales indicator revealed a negative but insignificant coefficient for the total number of rivals’ sales.

Also as expected the wholesale price has a significant negative coefficient, which implies that an increase in the wholesale price by 1 unit decreases promotional depth by 14 percentage points. The cost index, however, is positive but very small. The dummy for Christmas do not indicate significant impacts on promotional depth. The dummy for Easter is significant and negative. Likewise a previous study by HANSEN (2006) significant positive effects for butter in the weeks before Christmas on the 10%-level and before Easter occur. An explanation might be that milk, yoghurt and cheese are products of daily use. Their demand probably does not change on Christmas. Whereas butter is used more during Christmas and Easter because people bake and cook more than in other times of the year, the price discount is going to rise.

Both dummy variables for the discounter and the consumer markets have significant negative coefficients. Therefore in comparison to supermarkets, we find lower price reductions in the other two store types.

In Table 3 the results for the negative binomial model are documented. We find a significantly negative coefficient for promotional depth indicating that breadth and depth of sales are substitutes rather than complements as expected by RICHARDS (2006). This result is replicated when using the MaDaKom GmbH sales indicator; however the coefficient is insignificant.

Insert Table 3 about here

As for the Tobit model, store's sales increase with the number of brands offered. The impact of competitors is also significant. The number of sales in a store decreases if its competitors offer more brands. If competitors offer more sales, we observe vice versa an increased number of sales in the store. This supports that among competitors an aggressive price setting strategy is enforced as RICHARDS (2006) predicts from his theoretical model.

The wholesale price has a significant negative impact on the number of sales.[***] If the wholesale price increases, the prices rise and consequently the number of sales decreases. This result is reasonable. Increasing costs will lead to fewer sales. The index for capital costs and insurances has a negative impact on the number of promotional sales as well. The marketing cost index is significant positive. There could be inferences to promotional sales. Additional expenditures are necessary if there should be more products on promotional sale.

[***] For the MaDaKom sales indicator the wholesale price becomes insignificant in the negative binomial model as well as in the Tobit-Model.

The seasonal dummies for the weeks before holidays are significant for Christmas but not for Easter. The dummies for butter are again significant for Christmas and for Easter.

The dummies for the store types are significantly negative for discounters and consumer markets as also seen in the Tobit-Model. Thus, discounters and consumer markets offer fewer sales compared to supermarkets which is reasonable for discounters. Discounters often advertise their “every day low price” strategy.

Insert Table 4 about here

The results in Table 4 indicate that promotional depth has a positive impact on stores’ category revenues, whereas the coefficient for promotional breadth is not significant.

The coefficient for the log price is negative and significant. A price increase reduces stores’ category revenues. That finding points towards an elastic demand opposed to the assumption of an inelastic demand made in almost every theoretical model explaining the occurrence of sales.

Competitors’ prices have a positive impact on category revenues. If competitors increase their prices individual store revenues rise. This is in line with the results of PESENDORFER (2002) who finds higher demand if competitors raise their prices. The logarithmic income per capita has a significant negative impact on store category revenues. That means an increasing income lowers category revenues. Therefore dairy products seem to be inferior products.

In weeks before Christmas and Easter category revenues increase significantly. This supports the theory of WARNER AND BARSKY (1995) who also find an increased demand during these periods.

In discounters and consumer markets we find higher category revenues than in supermarkets. As expected category revenues are the highest in consumer markets due to the biggest stock of products. The variable logtrend indicates that there is no weekly trend in the data.

6 Conclusions

In this paper sales for dairy products in the Northern German food retail market are analyzed employing an enhanced three step estimation approach developed by Richards (2006). To our knowledge, this is the second paper testing Richard (2006) theory on sales. His main hypothesis claims a complementary relationship between promotional depth and breadth. Employing data for the retail market in Northern Germany the main hypothesis has to be rejected. Promotional depth and breadth seem to be substitutes rather than complements.

Significant determinants of sales are wholesale prices and the effects of competitors' price setting. Seasonal effects could only be observed for butter in the models of promotional depth and breadth. Christmas and Easter partly affect promotional breadth and depth. The number of sales and their magnitude rise prior to these holiday seasons. Category revenues also increase in these weeks. Furthermore, we find differences between the three main store types in Germany. Discounters and consumer markets offer fewer sales with smaller price reductions than supermarkets. Supermarkets in Germany seem to be the store type which typically employs sales to compete with their rival retailers. Supermarkets also show the highest average price level which indicates that they are using a hi-low pricing strategy.

References

Cameron, A. C. and Trivedi, P. K. (1986). "Econometric models based on count data: comparisons and applications of some estimators and tests." *Journal of Applied Econometrics*, 1(1), p. 29-53.

Cameron, A.C. and Trivedi, P.K. (1998). "*Regression analysis of count data*." Cambridge: Cambridge University Press.

Conlisk, J., Gerstner, E. and Sobel, J. (1984). "Cyclic Pricing by a Durable Goods Monopolist." *The Quarterly Journal of Economics*, 99(3), p. 489-505.

Gupta, S. and Cooper, L. (1992). "The Discounting of Discounts and Promotion Thresholds." *Journal of Consumer Research*, 19 p. 401-411.

Hansen, K. (2006). "Sonderangebote im Lebensmitteleinzelhandel." Göttingen: Cuvillier.

Heerde, H. J. van, Leeflang, P. S. H. and Wittink, Dick R. (2001). "Semiparametric Analysis to Estimate the Deal Effect Curve." *Journal of Marketing Research*, 38 p. 197-215.

Hosken, D. and Reiffen, D. (2001). "Multiproduct Retailers and the Sale Phenomenon." *Agribusiness*, 17(1), p. 115-137.

Jeuland, A.P. and Narasimhan, C. (1985). "Dealing - temporary price cuts by sellers as a buyer discrimination mechanism." *Journal of Business*, 58, p. 295-308.

Kroll, S. (2000). "*Der Einfluss von Verkaufsförderung auf den Absatz von Markenartikeln - eine empirische Analyse für den Cerealienmarkt*." Gießen: Inst. für Agrarpolitik und Marktforschung.

Lal, R. and Villas-Boas M., (1998). "Price promotions and trade deals with multiproduct retailers." *Management Science*, 15, p. 935-949.

Levy, D., Chen, A., Ray, S. and Bergen, M. (2004). "Asymmetric Price Adjustment in the Small: An Implication of Rational Inattention." *Working papers / Emory University, Department of Economics*.

Möser, A. (2002). "Intertemporale Preisbildung im Lebensmitteleinzelhandel: Theorie und empirische Tests." Frankfurt am Main: DLG-Verlag.

Pesendorfer, M. (2002). "Retail sales: a study of pricing behaviour in supermarkets." *The Journal of Business*, 75(1), p. 33-66.

Richards, T. J. (2006). “Sales by Multi-Product Retailers.” *Managerial and Decision Economics*, 27. p. 261-277.

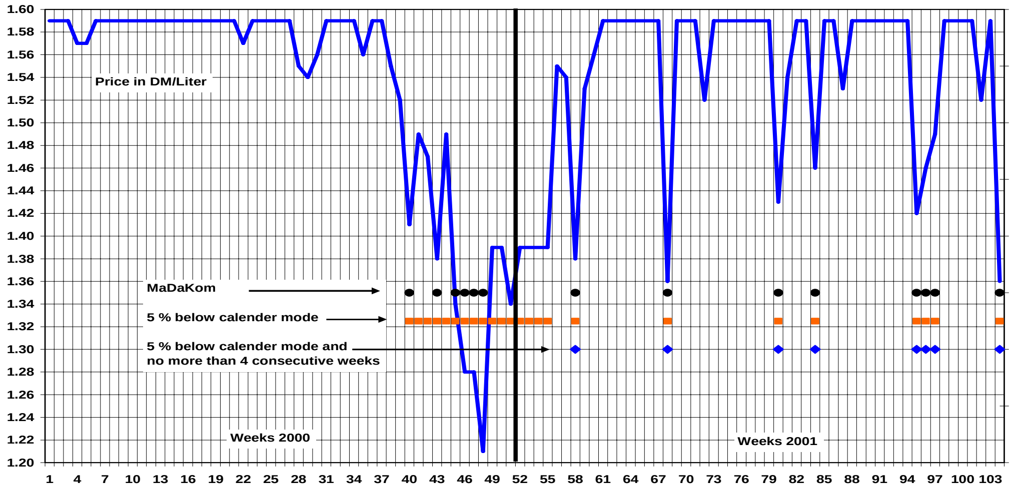
Sobel, J. (1984). “The Timing of Sales.” *Review of Economic Studies*, 51(3), p. 353-368.

Varian, H. R. (1980). “A model of sales.” *The American Economic Review*, 70(4), p. 651-659.

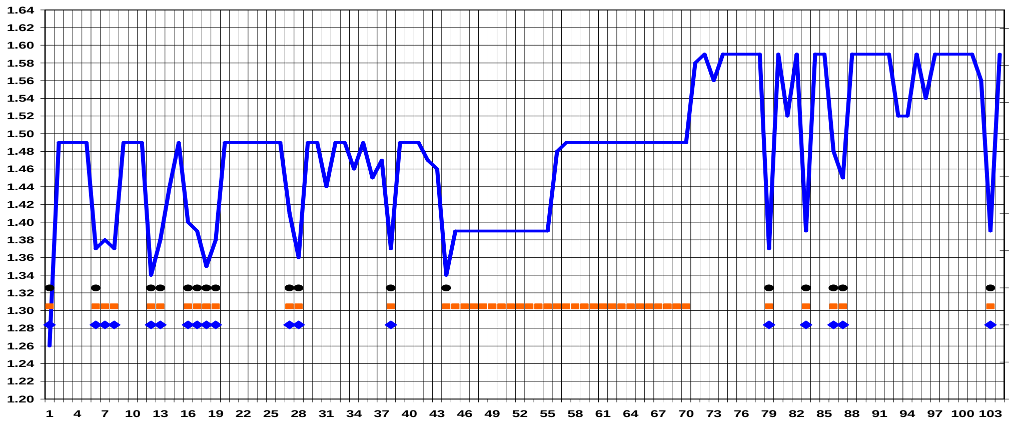
Warner, E.J. and Barsky, R.B. (1995). “The Timing and Magnitude of Retail Store Markdowns Evidence from Weekends and Holidays.” *The Quarterly Journal of Economics*, 110(2), p. 321-352.

Figure 1: Retail milk prices and respective sale indicator variables

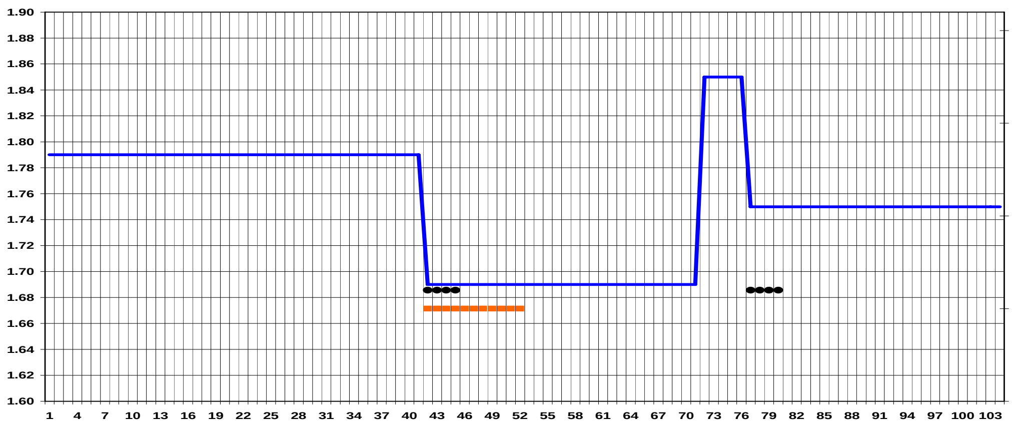
Store 1



Store 2



Store 3



Legend: Missing legends for store 2 and 3 can be found in the graph for store 1 for reasons of saving space.

Source: Data from MaDaKom GmbH, 2002.

Table 1: Descriptive statistics for the raw sample data

	Milk	Butter	Cheese	Yoghurt
Number of stores	17	17	17	17
Number of brands	12	12	12	12
Number of observations (max.= 17*12*104 = 21216)	4167	6467	9736	12447
Average prices	1.28	2.42	3.31	1.10
Maximum of average store price	1.69	2.73	3.57	1.34
Minimum of average store price	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 in %	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 in sales' periods (1-B/A) * 100	8.66	20.28	11.38	9.82
Average sales volume for periods with no promotional prices (sales) (C)	203.74	24.07	11.83	22.30
Average sales volume in periods with promotional prices (sales) (D)	162.47	417.99	18.83	52.33
Average increase in sales volumes in periods with promotional prices (sales) (1-D/C) * 100	-20.26	1636.30	59.12	134.64

Source: Own calculations with data from MaDaKom GmbH, 2002.

Table 2: Results for the Tobit-Model

Variables	Coefficient	Std. Dev.	t-value	
Total products	0.0073	0.0010	7.23	**
Rival total products	0.0018	0.0123	1.43	
Rival sale products	0.0016	0.0001	12.72	**
Wholesale price	-0.1362	0.0110	-12.39	**
Retail index	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	**

Remarks: The dependent variable is the percentage price reduction. The number of observations is 31850. **, * indicates significance level of 1% and 5% respectively.

Source: Own calculations with data from MaDaKom GmbH, 2002.

Table 3: Results for the Negative-Binomial-Model

Variables	Coefficient	Std. Dev.	t-value	
Discount (Tobit)	-17.2029	1.4521	-11.85	**
Total products	0.0916	0.0028	33.13	**
Rival total products	-0.0138	0.0033	-4.25	**
Rival sale products	0.0241	0.0003	70.68	**
wholesale price	-0.3567	0.0446	-8.00	**
marketing index	0.1420	0.0137	10.38	**
capital cost index	-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	**

Remarks: The dependent variable is the number of sales. The number of observations is 31850.
**, * indicates significance level of 1% and 5% respectively.

Source: Own calculations with data from MaDaKom GmbH, 2002.

Table 4: Results for the Log-Linear-Model

Variables	Coefficient	Robust Std. Dev.	t-value	
Log Tob	0.1873	0.0115	16.22	**
Log Negbin	-0.0166	0.0109	-1.53	
Log Price	-0.2894	0.0295	-9.81	**
Log Rival Price	0.1724	0.0440	3.92	**
Log Income	0.3546	0.0895	3.96	**
Christmas	0.2935	0.0159	18.47	**
Easter	0.3471	0.0169	20.56	**
DC	0.1403	0.1319	1.06	
CM	1.2235	0.0610	20.06	**
Log Trend	-0.0413	0.0040	-10.28	**
Constant	5.4534	0.5755	9.48	**

Remarks: The dependent variable is the logarithmic category revenue. The number of observations is 31850. **, * indicates significance level of 1% and 5% respectively. The R^2 is 0.54.

Source: Own calculations with data from MaDaKom GmbH, 2002.

Appendix

Table A1: Descriptive statistics for the variables in the three stage model

Variables	*defined as*	*Mean*	*Std. Dev.*	*Min*	*Max.*
dependant					
Discount	percentage price reduction	0.0145	0.0588	-0.75	0.59
Sale products	number of sales	3.0626	3.9595	0.00	22.00
Log category revenue	logarithmic purchases of the whole category	6.6876	1.0468	1.03	9.97
independent					
Total products	total number of products in the observed store in the observed category	20.1477	7.7720	0	33
Rival total products	total number of products in the rival stores in the observed category	7.7946	4.6869	0	17
Rival sale products	number of sales in the rival stores in the observed category	31.9589	22.6753	0.00	118.00
Wholesale price	selling price at dairy on monthly level	0.8148	0.5302	0.22	1.77
Retail index	index for wages in the retail sector	101.3688	1.5256	99.10	103.60
Marketing index	index for wages in the marketing sector	101.1723	1.4577	98.80	103.30
capital index	index for capital and insurances	101.3200	1.6471	99.10	104.00
Discounter (DC)	Dummy variable is equal to 1 if store type is discounter and 0 otherwise	0.0967	0.2959	0	1
Supermarket (SM)	Dummy variable is equal to 1 if store type is super market and 0 otherwise	0.4745	0.4994	0	1
Consumer market (CM)	Dummy variable is equal to 1 if store type is consumer market and 0 otherwise	0.4286	0.4949	0	1
Christmas	Dummy variable is equal to 1 if week is the week before Christmas and 0 otherwise	0.019	0.1367	0	1
Easter	Dummy variable is equal to 1 if week is the week before Eastern and 0 otherwise	0.019	0.1365	0	1
Christmas_ Butter	Dummy variable is equal to 1 if week is the week before Christmas and the product is butter and 0 otherwise	0.0060	0.0773	0	1
Easter _Butter	Dummy variable is equal to 1 if week is the week before Eastern and the product is butter and 0 otherwise	0.0060	0.0773	0	1
Discount (Tobit)	fitted values from the Tobit model	0.0140	0.0093	0.00	0.06
log discount	fitted values from the first equation	-4.7292	1.3269	-10.23	-2.83
log sale products	fitted values from the second equation	0.7851	0.4829	-6.05	1.51
log price	the logarithmic price of the product	0.8814	0.4197	-0.60	1.61
log rival price	the logarithmic average price of the product of rivals	0.6033	0.5613	-0.63	1.55
log income	the logarithmic income per capita on quarterly level	6.6748	0.0315	6.63	6.73
log trend	logarithmic weekly trend	3.6710	0.9212	0.00	4.64

Source: Own calculations with data from MaDaKom GmbH, 2002.