Food Retail Sales (Pricing):

Theory and Empirical Evidence for German Grocery Stores

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Abstract

Retail pricing indicates many phenomena, such as sales or rigidities. A number of models have been proposed in particular to explain the occurrence of sales. Focussing on the market for fresh foods the model by Varian and the loss leader argument seem to be intuitively best fitting the conditions in the fresh food market. From these models we derive several hypotheses that are tested for a unique data set of the German fresh food retail market. The data set consists of weekly prices for ten food items in 131 grocery shops over the period from 1995 to 2000. The results support to some extent the Varian model and also indicate some dynamic loss leader pricing. However, rejections of some hypotheses provide some hints for successive models adjustments. Promising extensions of the theory might be based on the consideration of menu and switching costs.

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1. Introduction

All consumers are directly or indirectly through members of their households affected by the pricing strategies in the retail sector. Though decreasing, the share of food and beverages consumption expenditures today still accounts for 20 % of total private expenditures in Germany. However, theoretical and empirical research in this field is scarce. Even though our understanding of these markets is very limited, governmental actions are often regulating the pricing activities of stores. For instance, after the introduction of the EURO in Germany in 2002, a store chain (C&A) advertised 20 % rebates for customers on all purchased goods paid by electronic cash. The promotion was partly justified to reduce the waiting in line at the cashiers during the first phase of the currency adjustment. This promotion was classified as an anticompetitive strategy and stopped immediately by government forces without providing any convincing economic arguments.

Because of the improved access to detailed data, theoretical and empirical studies of retail pricing have recently increased and retail pricing seems to become a major topic in industrial economics in the near future. The complexity of the problem has so far prevented the development of a comprehensive theory of retail pricing. However, a few models have been proposed to explain some of the main features in retail pricing. Such main features are the occurrence of sales (promotion), the rigidity of prices, the use of discrete pricing points, the existence of multiple price equilibriums, or the low level of coordination of price adjustments between stores.

Between these phenomena, the occurrence of sales has been theoretically analyzed the most. Several models and arguments have been provided to rationalize sales. However, these theories have only been tested systematically a few times, in particular for US retail markets. Therefore, we employ a unique data set for German grocery stores to test hypotheses which we derive from those models that match the condition in the retail markets for fresh foods.

The paper is structured as follows. First, we summarize the theoretical models and arguments that explain the occurrence of sales in retailing. Second, we present the results of empirical studies on food retail pricing. In the third section the data basis is described and some descriptive statistics are provided. Fourth, we employ our data set of weekly German food retail prices for ten fresh food products in 131 grocery stores over the period from 1995 to 2000 to test the hypotheses derived in section 2. In the end we summarize our results and give an outlook for potential future directions of the theoretical research in food retail pricing.

2. *Review of the theory on retail sales*

Various models have been proposed in the last decades to explain some of the phenomena observed in retail pricing. A major part of the literature is directed to explain the occurrence of sales in the retail sector. Following Hosken and Reiffen (2001 p. 115), sales can be defined as “temporary (significant) reductions in the price of an item that are unrelated to cost changes”. In this section we briefly summarize the existing theories on sales or promotional retail pricing and extract from this the relevant ideas to model retail pricing for fresh foods. Different promotional strategies can be applied to organise sales, such as shelf price reductions, coupons (‘free standing inserts’ (FSI) or electronic), mail rebates, or price packs. However, we do not consider models to optimize to promotional portfolio (see Banks and Moorthy, 1999). Models of sales can be classified into static and dynamic models or as by Banks and Moorthy (1999) into models of changing demand and cost conditions, models of price discrimination, and models of strategic price competition.[2]

Models of changing or uncertain demand and cost conditions

Consalik et al. (1984) develop a monopoly model of intertemporal pricing. They distinguish between consumers with high and low reservation prices, all agents are fully informed and risk neutral. Under these conditions sales occur periodically. Sobel (1984) extends the model to multiple sellers and shows that in equilibrium sales occur periodically at the same time across sellers.

A second class of models are inventory based approaches, such as the models by Blinder (1982), Reagan (1982), or Blattberg et al. (1981). Here the authors assume that costs of inventory holding of goods vary between retailers and consumers. At least a significant share of consumers has lower inventory costs. Then retailers minimize their inventory costs by regularly putting the good on sale to give incentives to consumer for stocking up the product.

Lazear (1986) introduces uncertainty about the final demand, which can likely be assumed for fashion goods. He shows that retailers generally start with higher prices. In the end of the season they often put the good on sale.

Pesendorfer (2000) develops a dynamic model of demand accumulation. In every period low and high valuation consumers enter the market. In addition, low valuation consumers are

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[2] We do not consider entirely static approaches, such as the model by Bliss (1988), because we are primarily interested in the dynamic behaviour of prices, in particular sales or promotional prices. Static models can explain the occurrence of different or even negative markups (loss leader) for respective goods. However, an essential feature of sales in our definition is the temporary character of sales’ offers. For an overview of most of the models presented here see also Blattberg and Neslin (1990).

either store loyal or shoppers.[3] For this model setting Pesendorfer shows that the occurrence of sales is a function of the time since the last sales in the same store and in competing shops. The predicted price path consists of an extended period of high prices followed by a short period of low prices.[4]

Hosken and Reiffen (2001) extend the approach of Sobel by considering two goods, a durable and a perishable item. They show that prices changes for the durable goods exceed the changes in prices of the perishable good and the price changes are negatively correlated.[5]

Other motivations for sales are given when goods are newly introduced (Bass, 1980 or Kalish, 1983), when consumers need incentives to spread their buying across time (Gerstner, 1986), or when firms want to sell products forward (Salop and Stiglitz, 1982).

Models of price discrimination

Salop and Stiglitz (1977) analyze the impact of search costs on the price equilibrium. They differentiate between consumers with high and low search costs. Thus, there are informed and uniformed consumers. The uniformed select the retail shop at random, the informed always go to the lowest price store(s). For specific parameter restriction a two price equilibrium exists, in which some retailers charge low prices and others high prices.[6]

In the same fashion Narasimhan (1984) models price discrimination between consumers with higher and lower transaction costs by employing coupons as promotional instrument. To receive the sale's price consumers need amongst others time. If we assume different opportunity costs and demand elasticities for consumers, then it might be optimal to discriminate between these groups by using coupons.

[3] Shoppers are fully informed and purchase the good at the store that offers the good at the lowest price.

[4] Pesendorfer simplifies the Sobel model by letting his consumers not behave strategically, but he extends the model by letting some low valuation consumers to be store loyal (Hosken and Reiffen (2001).

[5] However, it seems to be hard to define which goods are to be considered perishable and which durable. Hosken and Reiffen (2001) consider peanut butter to be a durable good, while margarine is a perishable item.

[6] Varian (1980) criticises that consumers likely learn to know the low price stores in time and thereby become informed. Thus, the derived two price equilibrium ought to converge to a single price equilibrium in time.

Models of strategic price competition

For impulse goods Lal and Matutes (1994) or earlier Hess and Gerstner (1987) show that a loss leader pricing strategy might be a rational for retailers. The loss leader good is used to lure customers into the shop. Because of significant costs of store switching (costs of transaction), once in the shop the customer also buys other goods by which potential losses caused by the loss leader are compensated.

Varian (1980) develops a dynamic model of retail competition assuming consumers to be either informed of uniformed. The uniformed consumers randomly choose a shop, the informed always visit the lowest price store. Because of high fixed costs, average costs of retailers are decreasing. For these conditions Varian shows that an equilibrium strategy is to decide prices randomly based on a U-shaped distribution function. Thus, high as well as low (sales) prices are chosen most often.

Hypothesis relevant to fresh food retail pricing

Because of specific conditions in food retailing most models presented so far can *a priori* be excluded from further considerations. The products analyzed in this study are fresh foods (meats, vegetables, and fruits) which cannot be stored over longer time intervals (perishable goods). Thus, the inventory based models cannot explain the potential occurrence of sales for these products. Fresh foods are bought by consumers at a high frequency (e.g. weekly), and thereby, consumers will eventually learn about the low price stores. Following, the model by Salop and Stiglitz (1977) is likely also to be invalid in this case too. The same holds for the model of Lazear (1986) which is designed for fashion goods. The arguments concerning the introduction of new goods and incentives to spread demand across time are also not relevant in the market for fresh foods, at least for the products under study. Fresh meats, vegetables, and fruits are relatively (standardized) homogenous products.

The assumption about informed and uninformed consumers in the model of Varian (1980), however, is supported by questionnaire studies in this field. The results show that consumers know only to a limited extent the prices of foods in shops they just visited (see e.g. Gabor and Granger, 1961). Also, the loss leader argument cannot be rejected *a priori* as in particular fresh foods are often advertised in FIS. From the Varian model, the following hypothesis can be derived:[7]

[7] The loss leader model leads to the opposite hypothesis as the Varian model regarding the impact of sales on expenditures. If loss leaders are used to lure customers into the shop, total expenditures ought to be uncorrelated or positively with the number of sales.

- Prices stem from a continuous distribution,
- the distribution of prices is U-shaped,
- sales occur randomly in time,
- sales occur randomly between shops,
- sales lead to lower expenditures for foods.[8]

3. Review of empirical studies on food retail pricing

Villas-Boas (1995) tests the distribution of prices for the coffee and saltine cracker markets in the US (Kansas City) based on the hypotheses derived from the Varian model. The estimated distributions fit in about 50 % of the analyzed price series for saltine crackers and coffee to the functional predicted by the Varian model.

Pesendorfer (2000) analyzes the market for ketchup in Springfield Missouri (US). He finds the data to indicate the predicted path by the model. The duration variables are significant and indicate the predicted sign. Prices and sales exhibit only little correlation across chains, but are significant for the same chain between different brands.

Hosken and Reiffen (2001) find their main hypothesis to be supported by data for retail prices of peanut butter and margarine in Sioux Falls (Missouri) and Springfield (South Dakota) in various supermarket chains. Price changes for the perishable good (margarine) are significantly smaller than for the durable good (peanut butter) and price changes are negatively correlated.

4. Data

Data collection and sample reduction

The data used for this study have been provided by the "Zentrale Markt- und Preisberichtstelle" (ZMP) in Bonn, Germany. The ZMP is an independent organisation that has a mandate from the German Government to provide, among other things, representative consumer price data. The Government's mandate aims to inform all market participants on agricultural and food markets about the actual market developments. However, the Government has not outlined any directions to fulfil this mandate. Thus, the ZMP has developed its own rules and taken specific actions to achieve the goal. To inform consumers

[8] This could result in a negative correlation between the number of sales and total expenditure.

and retailers about the developments in food retail prices, the ZMP has set up a price reporting system on a weekly basis. The ZMP maintains a network of roughly 450 so-called 'Melder' (melden = to report) who visit about 1,300 retail food stores in Germany on a weekly basis and collect price data for a variety of standard fresh foods.[9] The sample is designed to represent the geographic regions and the type of stores with respect to their population values. Thus, the ZMP tries to reflect the relative weights of the region measured by its population and the number of store types for the underlying population in construction of the sample. For this purpose Germany is divided into 8 geographic regions, and retail stores are divided into 6 categories (small supermarkets (SSM: primarily food; less than 400 square meter shopping area), big supermarkets (BSM: primarily food; more than 400 but less than 800 square meter shopping area), combined supermarkets (CSM: food and other items; more than 800 square meter shopping area), discounter (DC: primarily food with self service), butchers (BU), fruit and vegetable markets (FV)). In accordance with the relative weights given by the underlying populations with respect to regional, peoples', and store types' aspects the ZMP decides what kind of store from what region enters the sample.

Price data are collected for 56 fresh food products. To ensure the comparability of reported prices, the Melder are given detailed instructions on the quality of the product and the measure (price per piece or per kg). The Melder decides on what day of the week he or she visits the stores that he or she is reporting on. Special offers are to be considered. The Melder fills out a standard sheet that is send back to the ZMP weekly. The ZMP does not publish individual store prices or any information on the price setting behaviour. Instead, on a weekly or monthly basis, average prices for regions and store types for all products are published. The data sent by the Melder are processed as follows by the ZMP prior to publishing:

- Removal of 'obvious outliers' (e.g. misplaced decimal points) by hand and removal of observations that deviate by more than 2.6 standard deviations from the mean. Roughly 1-2 % of the available observations are lost in this way.[10]
- Calculation of the unweighted average price for each store type within a region.
- Calculation of the regional average as a weighted average of the store type averages from ii), with weights equal to share of each store type in total purchases of the commodity in question.

[9] The list of products does only include some processed items, such as butter, yoghurt, or sausage.

[10] The automatic routine to remove outliers has not been applied to the raw data set that is used here; however, the data have been corrected for irregular observations by hand.

- Calculation of the national average price for each store type as the weighted average of the store type averages from ii), with regional population shares as weights.
- Calculation of the national average over all store types as the weighted average of the regional averages from iii), with regional population shares as weights.
- Average product prices are only published if at least 100 observations were available over all store types and regions.

The resulting regional, store type and national averages for each food product are published weekly and also provide the basis for a variety of monthly, quarterly, and annual publications produced by the ZMP (see ZMP internet page at http://www.zmp.de). Furthermore, this data is reproduced in many other publications, such as local farm journals and consumer affairs publications etc.

The ZMP-panel ought to be a random sample of the above mentioned types of food stores in Germany. However, reporters decide on the store they visit to report prices and neither the reporter nor the store he or she selects is chosen *a priori* randomly. As we do not have information about the group of reporters, such as age, education, income etc. we can only speculate towards which direction the actual sample might be biased. For instance, it is likely that low income pensioners are overrepresented in the sample of reporters; thus, it might well be that these people prefer to report on low price stores. In this case estimates of average prices would be biased downwards. By controlling the regional number of stores and the number of the various store types, potential biases of sample parameters due to these characteristics are limited.

For our study we selected ten out of the 56 food products. As we focus on the price setting behaviour we aimed to get a full panel data set, which means each store in our sample reports prices for all ten food items over the entire period of observation. For this reason, specialised fruit and vegetable as well as butcher shops have been excluded from the analysis. We first selected the food products by excluding the items that are only offered seasonally, such as cherries, by excluding the items that are only reported on a monthly basis, such as milk products. The remaining products can be classified into meat, fruits, and vegetables. We selected 4 meats, 3 fruits and 3 vegetables by choosing the product items with the maximum number of observations in the raw data set. Thereby we hoped to maximise the number of stores with a continuous reporting over time. For these 10 food products we selected only those stores that carry all items at all times. We defined continuous price reporting by availability of price observations for each product in more than 92 % of all weeks from May

1995 to December 2000 (n = 296). Missing observations are filled by values for the respective price of the product in the store in week before.[11] This entire selection process reduced the number of observations from around 250.000 for each product to 38.776, which corresponds to observations from 131 food stores over a period of 296 weeks. For the individual stores, information on the corresponding zip code (exact regional location), the type of the store (see above for definition), the name of the store, and the company that owns the store are also available. Our final sample of products consists of fresh beef (braised beef quality without bones), liver sausage (from calves, thin cut, packed in gold skin), fresh pork steak ("Schnitzel" without bones), fresh turkey breast steak (without skin and bones), apples (Golden Delicious, size 70 to 80 mm in cross section), pears (table pears of different sort), citrons (regular quality), lattice (ice salad), carrots (without foliage), onions (regular quality of typical sort). Prices are reported in German cent or pennies per kilogram, except for lattice and citrons for which prices are reported in cent or pennies per piece.

The stores in our final sample belong to the following store type and companies. The real names of the companies have been suppressed and substituted for alphabetical letters by confidentiality reasons.[12]

Insert Table 1 about here

Descriptive statistics

The data set consists of a complete panel of retail prices for ten basic food items in 131 retail stores that have been collected continuously on a weekly basis from 1995 to 2000. In Figure 1 average prices over all stores (m = 131) are shown for the entire period of observation to indicate the common price dynamics. Average prices do not show significant linear trends, except the prices of citrons which exhibit a slight upward shift in this period. For meat products some longer term cyclical behaviour can be observed which differs somewhat for the selected products. Because of the short period of observation this phenomenon cannot be analysed in more detail. Fruit and vegetable prices indicate significant seasonal patterns, which also vary between products and in time. Again, formal statistical testing is not possible because of the short time horizon covered by the sample.

[11] In case the first observation is missing, the price in the second week is taken to fill the gap.

[12] Because of the small number of observations in some cases we have to be cautious with some conclusions. For instance, with respect to DI and retail chains D and F.

Insert Figure 1 about here

Besides the deterministic time series components all series have an autocorrelated stationary residual component which is less significant for fruits and vegetables.[13] The average prices change from week to week and the magnitudes of changes are much bigger for meat products than for fruits and vegetables. The same holds for the volatility around the deterministic components.

To what extent are individual retail store prices represented by these average figures? In perfect markets, the law of one price ought to hold; thus, the average series should perfectly match all characteristic properties of individual prices. In Table 2 average prices over the entire period of observation and three measures of variation are calculated. The figures in the first row for each product in Table 2 show that average prices vary significantly between store types and between retailer chains.

Insert Table 2 about here

All product markets show significant differences in average prices for the respective groupings. Pork, for instance, is on average about 5 German Marks or 12 % cheaper at CSM or DC compared to SSM. Although the absolute differences decline for products of lower value, such as fruits and vegetables, relative deviations between store types occur to be at similar levels for most products. In sum, CSM and DC report the lowest price level compared to SSM and BSM. For meat products CSM and DC are the cheapest store types, fruits and vegetable prices are always the lowest at DC followed by CSM. SSM are most expensive for meat products, BSM report the highest average price level in fruits and vegetables.

Even though the stores within the clusters indicate a high level of variation in prices for the respective items, average price differences between clusters (store types and retailer companies) are mostly statistically significant.[14] In 80% of all cases the average price for the cluster is tested to be significantly different from the average price over all stores.

As for store types, we observe big differences in average price levels of the various retailer companies. In this case chain E and F are the cheapest supplier at almost all products. Chain D is (with the exception of citrons) always the most expensive chain. The result for the

[13] All series have been tested for stationarity using the ADF-test and the procedure by Phillips and Perron (1988). The Null-hypothesis is rejected at the 95 % significance level.

[14] Total variation is measured by the standard deviation of all observations in the respective cluster.

retailer companies E and F might partly be related to the fact that E and F include a high percentage of CSM; however, as almost half of the stores of chain D do also belong to CSM, the latter conclusion has to be interpreted with caution. In most cases these differences are statistically significant.

Though grouping of retail stores leads to significant differences in average prices, the variation within each group still is substantial (often at the same level as for the total sample). In the second row of Table 2 standard deviations of prices are reported. For instance, the standard deviation of beef prices for the store types is between 239 and 444 German cent per kg, the overall standard deviation is 299 German cent per kg. Thus, the clustering by store types does not substantially reduce the within group variation, meaning prices seem to vary as much within cluster as they do in the entire sample. The reduction in variation by clustering in the case of beef is 11%. For the other products the cluster effect is between 2 % and 11 %. The reduction is higher for meat products compared to fruits and vegetables. Interestingly, the clustering by retailer companies indicates an even lower reduction in the within group variation even though the number of clusters is increased by 4. In relative terms the standard deviations is between 20 to 30 % of the corresponding average price level for all products. Even though some variation in this relative measure can be observed, no systematic relationship with respect to either the type of the store, the retailer chain, or the product type occurred to us.

To analyse the variation of prices between individual stores, we develop the measure Var1 which is the ratio between the average of the variance between all stores of the respective group over time and the total variance (Var^2) in %:

$$\text{Var1}_{k,m} = \frac{\frac{1}{n \cdot m}\sum_{i=1}^{n}\sum_{j=1}^{m}\left(p_{i,j,k} - \overline{p}_{i,k}\right)^2}{\frac{1}{n \cdot m}\sum_{i=1}^{n}\sum_{j=1}^{m}\left(p_{i,j,k} - \overline{\overline{p}}_{k}\right)^2} \cdot 100$$

with: $$\frac{1}{n \cdot m}\sum_{i=1}^{n}\sum_{j=1}^{m}\left(p_{i,j,k} - \overline{\overline{p}}_{k}\right)^2 = \frac{1}{n \cdot m}\sum_{i=1}^{n}\sum_{j=1}^{m}\left(p_{i,j,k} - \overline{p}_{i,k}\right)^2 + \frac{1}{n}\sum_{i=1}^{n}\left(\overline{p}_{i,k} - \overline{\overline{p}}_{k}\right)^2$$

n = time index (1,..., 296)

m = index for stores (1, ..., 131 in case of first column in Table 2)

k = index for food items (1, ..., 10)

p = price (*p* bar is the average price in each period for the respective group, *p* double bar is the average price for the respective group over time)

Note that the total variance (in the denominator) can be separated into the variance at each point in time (first expression on the right hand side) and the variance of the means over time (second expression on the right hand side)[15]. Thus, Var1 describes to what extent the average price variation between shops of the respective group contributes to the total variation. Similarly, 100-Var1 indicates the share of variation caused by movements of average prices over time. A high value for Var1 implies that most of the variation comes from variation of prices between shops and only a little is contributed through changes in the average price level over time. The results in the respective third row of Table 2 indicate that in the case of meat products more than 90 % of the total variation comes from price differences between shops. Even though fruits and vegetables indicate stronger movements in average prices over time the measure is still above 75 %, except for citrons which besides the seasonal pattern also show a trend.

Another way of decomposing the total variance is by asking whether the variation between stores is short lived or inherent (Var2):

$$\mathrm{Var2}_{k,m} = \frac{\frac{1}{n\cdot m}\sum_{j=1}^{m}\sum_{i=1}^{n}\left(p_{i,j,k}-\overline{p}_{j,k}\right)^2}{\frac{1}{n\cdot m}\sum_{i=1}^{n}\sum_{j=1}^{m}\left(p_{i,j,k}-\overline{\overline{p}}_{k}\right)^2}\cdot 100$$

with: $$\frac{1}{n\cdot m}\sum_{i=1}^{n}\sum_{j=1}^{m}\left(p_{i,j,k}-\overline{\overline{p}}_{k}\right)^2 = \frac{1}{n\cdot m}\sum_{j=1}^{m}\sum_{i=1}^{n}\left(p_{i,j,k}-\overline{p}_{j,k}\right)^2 + \frac{1}{m}\sum_{i=1}^{m}\left(\overline{p}_{j,k}-\overline{\overline{p}}_{k}\right)^2$$

Now the first expression on the right hand side of the denominator is the average of the variance of prices for each individual store over the group *m* of stores, the second expression is the variance over the mean prices levels for each store. Thus, Var2 measures to what extent price changes in individual stores have contributed to the total variation of prices. If stores differ in the price level, but never change prices over time, then Var2 is 0. In that case all variation comes from differences in average prices between store. The results are shown in the respective fourth row of Table 2. For the total sample, Var2 for meat products ranges from 43 % to 58 %. Variations in prices at the store level over time are as important as variations in average prices between stores. Fruits and vegetables (with the exception of citrons) show

[15] We get the right hand side expression by calculing the variance of the average prices shown in Figure 1.

higher values that range from 72 % to 91 %; thus, most of the variation comes from movements in time at the store level.

Var1 and Var2 have also been calculated for the various store types and retailer chains; however, again we cannot identify any systematic differences compared to the values for the total sample that might be related to either the store type or the retailer company.

Even though the average price levels indicate big deviations between stores and price movements are only weakly correlated between shops, the use specific price levels seems to indicate some typical or common behaviour of stores in this sector. So called psychological pricing points or threshold prices occur most often for fruits and vegetables. In Table 3 the fifteen most frequent prices are listed for each product. For instance, 60 % of all carrot price observation equal either 99, 149, or 199 German cent per kg. For the fruit and vegetable products the fifteen most frequent prices account for about 90 % of all observations. For meats this measure ranges from 49 to 72 %, which is likely related to the bigger absolute range of prices between stores for meats.

Insert Table 3 about here

The magnitude of average absolute price changes is analyzed in Table 4. The upper part of Table 4 shows the average absolute price changes in the respective group, the lower part of Table 4 consists of the ratio between the average absolute price change and its respective mean price level. Then we can look at the absolute and relative importance of average absolute price changes across products and across the different aggregates of store type and store chains. The results indicate that in absolute terms the absolute average price changes are much bigger for high value goods, such as meats. However, only slight differences appear across either store types or store chains considering all products, except that the absolute average price changes for most food items are significantly higher in BSM compared to the other store types. In relative terms the same tendencies occurs, except differences across products are melting down considerably.

Insert Table 4 about here

4. Empirical results

The first step in the empirical analysis is to implement the definition of sales, respectively to construct such a variable. Our data set only consists of price series which are not accompanied by information which price is a sale's price and which is not. Based on the above definition sales are significant temporary reductions in prices that are unrelated to cost changes.[16] To identify a significant price reduction we search for downward price changes by at least 20 %.[17] To ensure that these changes are not induced by cost changes we only consider prices that deviate from the common price dynamics by more than 20 %. The procedure to identify sales prices works as following: First unweighted average prices are calculated for each food item (see Figure 1). These series indicate for most products a high correlation with the respective series of wholesale price which might picture cost developments.[18] Each food price time series is now compared with an adjusted average price series. The adjustment considers the deviation in means. Thus, the average series is corrected for the deviation in means between its own and the mean of the individual time series. Whenever the price of the individual time series is 20 % below the adjusted average series, then this price is to be considered as a sale's price. This procedure is used to separate between sales and inherent low price strategies. However, it might be problematic when, for instance, sales between shops are highly synchronized for food items.[19] An advantage of this procedure compared with procedures relying on shop announcements is that shops cannot falsely announce sales using prices that are not considered to be sales. For instance shops might have an incentive to advertise some food items via FIS saying that these are on sales, but charging and announcing a regular price.

Figure 2 shows the share of products that are put on sale in each week for all shops and for SSM and BSM only. On average over the entire period about 17 % of the 10 food items under study are put on sale, which roughly means 2 out of ten products. This share does not indicate a high variation in time. Thus, sales are not accumulated in single or particular weeks, but spread almost equally across time. Even though the series for all shops shows some slight temporal autocorrelation, it seems likely to be insignificant from an economic point of view.

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16 Hosken and Reiffen (2001) circumvent the problem by implicitly judging every downward price change as a sale and every upward price change as the return to the normal price.

17 We have also tested the robustness of results by varying this margin, for instance using also a 10 % and a 30 % threshold. The general conclusions are similar for these variations, detailed results can be obtained from the authors.

18 Another interpretation is that this measure indicates a sale when a shop offers the product for a price that is significantly lower than the price at competing shops. Store specific differences, for instance, in service or convenience are considered by adjusting the average prices to the store specific mean price.

The uniform distribution of sales across time also signalizes that at this level of aggregation we do not find any synchronisation of promotional measures between shops.[20] This feature also occurs when we limit the aggregation to shops of the same type (see the graphs for SSM and BSM in Figure 2). In addition, the series for the store types do not indicate significant correlation (synchronization between groups), only SSM and BSM as well as BSM and CSM indicate a slight positive correlation of about 0.15. When the share of sales is calculated for the different product categories, we also do not find any systematic differences. However, fruits and vegetables show a little higher degree of synchronization between store types. On average sales occur a little more frequent in BSM and CSM.

In conclusion, sales are not coordinate between shops and do not accumulate across time. However, a significant number of sales are held in each week. The number of sales does not differ between products and indicates only slight differences between store types.

Insert Figure 2 about here

To analyse the impact of sales on the expenditures of consumers we estimate the effect of the number of sales on the average per capita expenditures for the food items under study. Because price changes for high value goods are much bigger, we separate between the impact of the number of sales for meats and the number of sales for fruits and vegetables. Besides the number of sales, we expect buying in prices to have an effect on retail prices and thereby on expenditures.[21] First we construct the average per capita expenditures or the retail price index. We use the average human per capita consumption data for Germany of the products categories under study.[22] Then, for each shop the weighted price index is calculated as

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19 Considering the low correlation between prices, between price changes, and between sales, we do not see this to be a problem for the actual data set (see Loy and Weiss, 2003). This is confirmed by the results from the study by Pesendorfer (2000).

20 The standard deviation of the share of sales can be employed to measure the extent of synchronisation. An increase in the standard deviation indicates a higher synchronization. However, if the measure for different aggregates (e.g. groups of stores) are compared, the number of observations has to bo considered as also by the number of observations the measure has a tendency to decline.

21 As we assume the quantities to be fixed we expect a direct impact on the expenditures. In this view we could also define our measure of expenditures as a particular type of price index.

22 While for items such as lattice this measure might be very close to the actual purchase of the good, other products such as beef are consumed through many other items but by fresh beef of steak quality, to which the price used here refers to. For instance, we purchase fresh beef of other qualities, packed beef, etc.

following: $p_t^I = \sum_{i=1}^{9} p_t^i q^i$.[23] The same operation is employed to calculate a wholesale price index which is used to picture the development of costs or buying in prices. Because of seasonal variations in the prices of fruits we also consider monthly seasonal dummies in the model specification which equals in its static form the following equation:

$$p_t^{RTI} = a_0 + a_1 p_t^{WPI} + a_2 S_t^M + a_3 S_t^{F\&V} + \sum b_j D_t^j + e_t$$

The endogenous variable is the retail price index. The exogenous variables by ordering in the specification are the wholesale price index, the number of sales for meats, the number of sales for fruits and vegetables, and a set of seasonal monthly dummies. We estimate this model for the different store types separately (SSM, BSM, CSM, DC).[24] First we determine the time series properties. We find the price indices to be non-stationary of first order. The sales variables are stationary. Therefore, we test for cointegration and apply an error correction model (ECM) specification to test the impact of the number of sales. Alternatively we could use the Johansen procedure. As we are primarily interested in the impact of the number of sales, which are stationary, these parameters can also be tested in the ECM parameterisation of the model. The ECM specification is estimated as follows:

$$dp_t^{RTI} = a_0 + g_1 p_{t-1}^{RTI} + a_1 p_{t-1}^{WPI} + \sum g_{m+2} dp_{t-m-1}^{RTI} + a_{m+2} dp_{t-m}^{WPI} + \sum q_k S_{t-k}^M + y_k S_{t-k}^{F\&V} + \sum b_j D_t^j + e_t$$

This specification is estimated for each store type aggregate. Thus, average prices and average numbers of sales for these groups are used. The wholesale price index is the same for all groups. The dynamic specification (number of lags) is determined by the white noise property of the error term. We start with one lag and increase the number of lags symmetrically for all variables until autocorrelation is rejected at the 95 % significance level. Other specification

[23] Only 9 of the ten food items available are used here as for sausages neither an average per capita consumption measure could be found nor wholesale prices are quoted.

[24] At least for the level of the price index (expenditures) we expect differences between the store types, as DC are generally much cheaper than e.g. BSM. To test for these or other potential deviations in the parameters, a panel estimation would be preferable. Because of time series properties and the extended time component (296 weeks), the panel estimation and testing is not a standard routine. Thus, we start with an unrestricted dynamic single equation approach for each store type that considers the non-stationarity of the data.

tests, such as ARCH, heteroscedasticity, normality and functional form tests lead to rejection of the Null hypothesis. Thus, white noise error terms, might be assumed for the final estimations. Finally, we tested the short-run dynamic impact of sales by employing a Wald test. R-squares of the models range from 0.63 to 0.74. Though in all models the number of sales indicate the predicted significant negative impact on the per capita expenditures for all store types, the effects are, except in one case (number of meat sales in BSM), compensated through time (see test of SM=0 and SF&V=0, which stands for the sum of coefficients equals zero, see last two rows in Table 5).[25] This means that contemporaneously the expenditures are negatively affected by the number of sales (meats and fruits and vegetables) in all cases, but in the following periods this impact is set off by an increase in expenditures. Thus, the exploitation of consumers by charging higher markups on other than the sales products (loss leader argument) is not happening in the period the sales are offered, but in the weeks following. The argument for this strategy might be that consumers are lured into the shop by the sales offers and are expected to visit the shop again because they have even experienced even an significant expenditure saving. However, when they return the bargain is paid back.

Insert Table 5 about here

Though in the short term the transmission of the wholesale price index seems to be insignificant, the long-term impact is in all cases close to a complete transmission. This cannot be tested by a Wald test in the ECM specification, but we have run tests for the Johansen procedure. The hypothesis that an increase in the wholesale price by one unit is transmitted to the same extent to the retail price index could not be rejected.

5. Conclusions

Various models have been proposed in the literature to explain the use of promotional measures such as simple sales prices. However, most approaches do not fit the specific conditions in the market for fresh foods. The most promising concepts to match the conditions are the model by Varian (1980) and the loss leader argument. For these theories, we derive some essential hypotheses which we test employing a unique data set for the German food

[25] Using the procedure by Johansen, most results occur to be similar, except the test fort he overall impact of meat sales. While for the ECM, except in one case, the Nullhypothesis cannot be rejected, the test in the Johansen procedure rejects the Nullhypothesis. Thus, a negative impact can also in the dynamic setting not be rejected for beef sales.

retail market in the period from 1995 to 2000. The data consist of weekly retail prices for ten fresh food items (meats, fruits, and vegetables) in 131 grocery stores.

We find on the one hand that prices do not stem from a continuous distribution and sales prices in the medium-run do not lead to lower expenditures for foods. On the other hand sales occur randomly in time and across shops. The latter confirms the results by Varian, the former do not. The loss leader argument is supported from a dynamic sense; however, for the number of sales in meat the test procedures do not come to a unique conclusion.

The results that prices are not distributed continuously calls for an extension of the models by considering menu costs in price setting by shops and switching for the consumer. In the model of Varian shops set prices randomly based on a continuous distribution. If price changes are costly, a random draw which is close to the price in the last period would not lead to an adjustment in prices. If shops in addition use specific pricing points (psychological price barriers), then the distribution of prices might indicate mass points. Such mass point would interfere with n equilibrium in the Varian model. This could be solved by assuming that also consumers face switching costs when the change shops. Though intuitively appealing, these interactions of such assumption have to be formally analyzed, which might be a promising task for future research.

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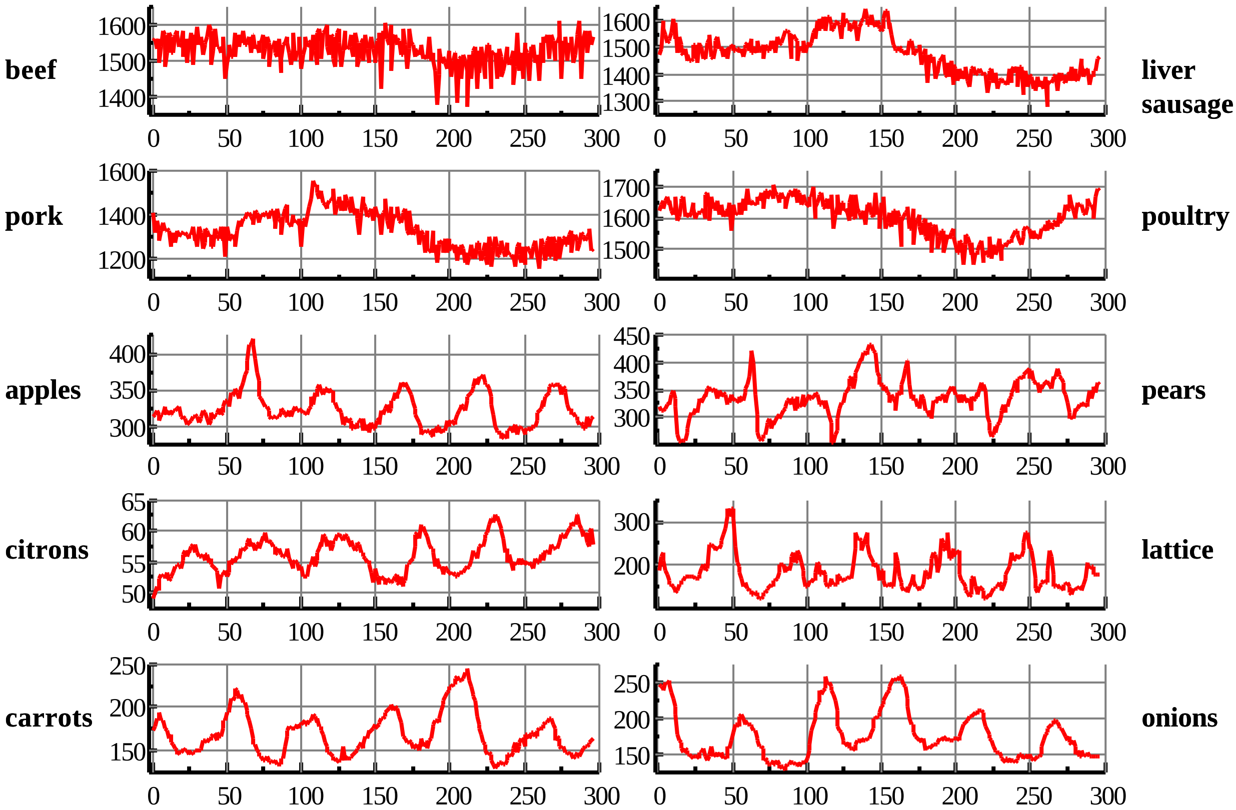
6. Figures and Tables

Tab. 1: Selection of store types and retailer companies in the sample

		Retailer company						
	Total	A	B	C	D	E	F	Other
SSM	16	5	7	2	1	0	0	1
BSM	43	12	5	11	3	4	0	8
CSM	68	7	4	12	5	20	6	14
DC	4	0	2	0	2	0	0	0
Total	131	24	18	25	11	24	6	23

Notes: SSM: Small supermarkets, BSM: Big supermarkets, CSM: Combined supermarkets, DC: Discounter. A to F: Different retailer companies, such as Edeka or Spar group.
Source: Data by ZMP, 2001.

Fig. 1: Weekly average food retail prices in Germany from 1995 to 2000 (sample of 131 stores over 296 weeks)



Legend: All prices in German cent per kg, except the prices of lattice and citrons which are quoted in German cent per piece.
Source: Data by ZMP, 2001.

Tab. 2: Average and variation of food retail prices in Germany

			Store type				Retailer company					
		All	**SSM**	**BSM**	**CSM**	**DC**	**A**	**B**	**C**	**D**	**E**	**F**
Beef	**Mean**	1531	1662	1634	1439	1482	1581	1582	1513	1726	1421	1333
	Var	299	239	285	277	444	276	317	238	289	291	206
	Var1	98	96	97	96	97	96	96	95	93	90	84
	Var2	54	64	70	61	13	66	49	78	41	62	76
Liver sausage	**Mean**	1477	1684	1564	1376	1428	1505	1584	1574	1443	1293	1212
	Var	456	427	416	458	480	484	426	411	467	428	393
	Var1	97	95	96	97	91	96	97	97	93	93	75
	Var2	43	46	56	41	30	40	43	49	42	54	77
Pork	**Mean**	1323	1529	1437	1211	1171	1366	1419	1303	1504	1150	950
	Var	387	372	358	365	399	401	370	349	421	321	230
	Var1	95	94	93	93	94	94	94	93	85	85	56
	Var2	55	67	72	58	19	58	56	70	66	71	91
Poultry	**Mean**	1602	1700	1679	1539	1435	1601	1644	1628	1710	1516	1441
	Var	306	305	281	298	364	320	307	302	292	284	238
	Var1	96	94	95	94	95	94	92	97	92	90	78
	Var2	58	61	67	63	20	60	62	50	68	65	90
Apples	**Mean**	322	309	341	315	297	305	326	333	347	315	299
	Var	67	66	68	64	56	68	71	63	69	57	44
	Var1	86	86	83	85	76	81	83	77	85	85	63
	Var2	72	64	78	76	76	74	69	84	75	74	98
Pears	**Mean**	335	329	351	327	309	326	341	331	354	329	322
	Var	74	71	77	73	58	75	70	72	77	71	68
	Var1	77	71	77	75	70	71	74	72	69	69	63
	Var2	85	85	85	89	82	82	91	92	81	91	97
Citrons	**Mean**	56	55	59	55	36	58	55	56	52	55	57
	Var	17	14	19	16	7	19	17	18	13	16	14
	Var1	97	95	98	96	81	98	96	95	93	93	88
	Var2	37	31	35	44	73	21	31	41	44	61	49
Lattice	**Mean**	183	181	194	179	162	183	186	179	194	181	167
	Var	59	54	61	58	46	60	57	56	62	56	57
	Var1	48	49	46	45	55	47	50	37	47	40	31
	Var2	91	93	94	92	78	92	90	97	87	94	98
Carrots	**Mean**	169	174	180	163	141	168	171	172	182	165	152
	Var	51	45	55	49	42	56	52	50	58	43	44
	Var1	76	75	75	72	75	76	72	78	76	66	58
	Var2	75	78	74	79	60	63	72	75	74	87	94
Onions	**Mean**	176	179	195	165	137	174	183	179	197	164	129
	Var	64	65	63	61	57	64	67	58	60	58	58
	Var1	73	72	70	69	78	66	79	72	71	66	47
	Var2	75	78	79	80	61	75	75	80	66	85	95

Legend: All prices in German cent per kg, except the prices of lattice and citrons which are quoted in German cent per piece. For definition of Var, Var1 and Var2 see text.
Source: Data by ZMP, 2001.

Tab. 3: The fifteen most frequent prices over all stores

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Sum %
beef	**1699**	**1399**	**1799**	**1499**	**1299**	**1690**	**1498**	**1899**	**1599**	**1598**	**1798**	**1290**	**999**	**1698**	**1199**	
%	*8*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*56*
liver sausage	**1990**	**1690**	**1290**	**1490**	**990**	**1790**	**1590**	**1390**	**790**	**1090**	**1890**	**1190**	**890**	**2190**	**2290**	
%	*10*	*9*	*8*	*8*	*8*	*6*	*4*	*3*	*3*	*3*	*3*	*2*	*2*	*2*	*2*	*72*
pork	**1499**	**1299**	**1399**	**1590**	**999**	**1490**	**1599**	**799**	**899**	**1699**	**1790**	**1799**	**1690**	**1290**	**990**	
%	*5*	*4*	*4*	*4*	*4*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	*2*	*2*	*49*
poultry	**1799**	**1899**	**1999**	**1599**	**1690**	**1699**	**1499**	**1790**	**1290**	**1490**	**1990**	**1590**	**1890**	**1798**	**1399**	
%	*7*	*6*	*5*	*5*	*5*	*5*	*4*	*4*	*4*	*4*	*4*	*4*	*3*	*3*	*3*	*63*
apples	**299**	**399**	**349**	**199**	**249**	**298**	**499**	**279**	**333**	**259**	**398**	**277**	**379**	**239**	**295**	
%	*39*	*25*	*5*	*5*	*4*	*3*	*2*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*90*
pears	**299**	**399**	**349**	**199**	**499**	**249**	**298**	**279**	**379**	**398**	**277**	**297**	**259**	**359**	**198**	
%	*31*	*28*	*6*	*5*	*4*	*4*	*3*	*2*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*89*
citrons	**79**	**50**	**69**	**59**	**49**	**40**	**45**	**39**	**35**	**30**	**99**	**25**	**55**	**89**	**33**	
%	*12*	*12*	*12*	*11*	*10*	*5*	*5*	*3*	*3*	*3*	*2*	*2*	*2*	*2*	*1*	*86*
lattice	**199**	**149**	**179**	**249**	**99**	**299**	**139**	**129**	**159**	**169**	**111**	**198**	**229**	**119**	**279**	
%	*22*	*14*	*8*	*7*	*7*	*6*	*5*	*5*	*5*	*2*	*1*	*1*	*1*	*1*	*1*	*87*
carrots	**199**	**149**	**99**	**179**	**129**	**249**	**159**	**139**	**169**	**299**	**119**	**198**	**98**	**79**	**189**	
%	*25*	*15*	*10*	*8*	*6*	*5*	*4*	*3*	*3*	*3*	*2*	*2*	*1*	*1*	*1*	*88*
onions	**199**	**149**	**99**	**299**	**129**	**249**	**179**	**159**	**139**	**79**	**198**	**98**	**169**	**119**	**89**	
%	*27*	*12*	*10*	*7*	*6*	*5*	*5*	*3*	*2*	*2*	*2*	*2*	*1*	*1*	*1*	*87*

Legend: All prices in German cent per kg, except the prices of lattice and citrons which are quoted in German cent per piece.
Source: Data by ZMP, 2001.

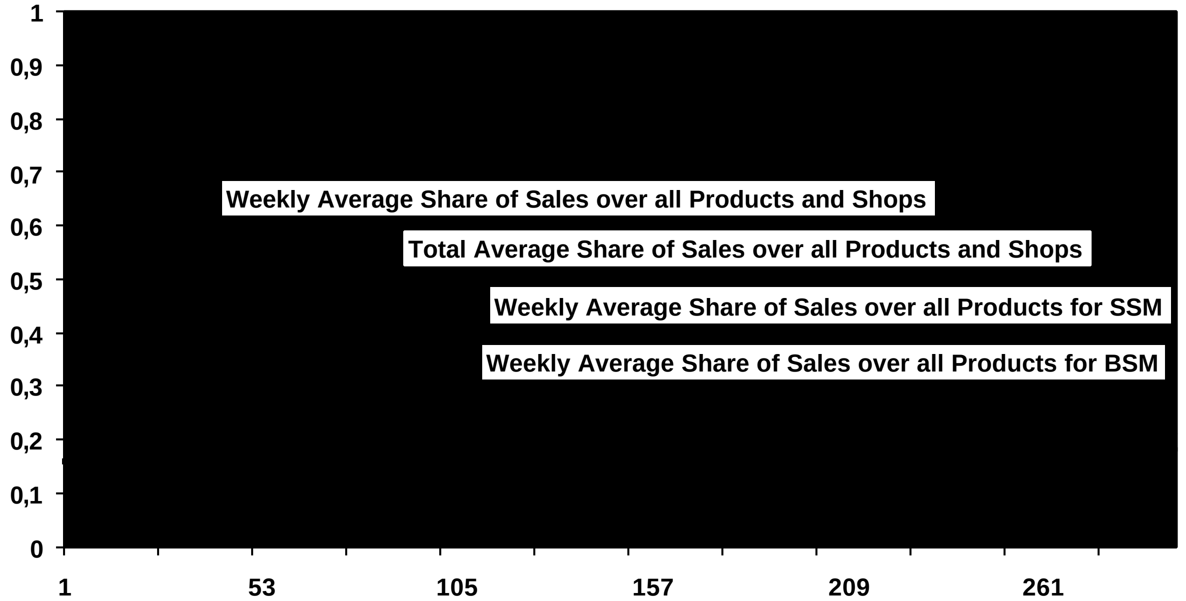
Tab. 4: Mean absolute price change and standard deviation in absolute (upper part) and relative terms (lower part)

	Type of store					Retailer company					
	All	SSM	BSM	CSM	DC	A	B	C	D	E	F
Beef	**309**	**257**	**365**	**295**	**248**	**329**	**286**	**288**	**292**	**335**	**232**
	229	*225*	*254*	*213*	*173*	*234*	*244*	*217*	*192*	*220*	*190*
Liver sausage	**338**	**311**	**378**	**332**	**262**	**415**	**292**	**333**	**342**	**369**	**214**
	311	*310*	*328*	*302*	*283*	*330*	*281*	*305*	*339*	*325*	*254*
Pork	**377**	**422**	**421**	**352**	**222**	**425**	**340**	**374**	**494**	**371**	**233**
	303	*365*	*322*	*276*	*194*	*313*	*320*	*312*	*363*	*248*	*190*
Poultry	**310**	**316**	**315**	**310**	**223**	**348**	**310**	**296**	**336**	**302**	**268**
	234	*261*	*240*	*226*	*193*	*241*	*260*	*230*	*254*	*208*	*207*
Apples	**77**	**65**	**92**	**73**	**66**	**82**	**74**	**79**	**97**	**65**	**64**
	52	*49*	*50*	*52*	*44*	*50*	*51*	*52*	*53*	*48*	*42*
Pears	**82**	**74**	**94**	**79**	**76**	**88**	**82**	**83**	**91**	**78**	**79**
	52	*51*	*50*	*52*	*46*	*53*	*49*	*53*	*48*	*52*	*49*
Citrons	**11**	**9**	**13**	**11**	**8**	**11**	**10**	**11**	**12**	**12**	**10**
	9	*7*	*10*	*9*	*7*	*9*	*9*	*9*	*10*	*10*	*8*
Lattice	**48**	**45**	**55**	**45**	**36**	**51**	**48**	**46**	**56**	**44**	**43**
	34	*34*	*35*	*33*	*23*	*35*	*36*	*33*	*36*	*31*	*32*
Carrots	**44**	**37**	**50**	**42**	**37**	**42**	**39**	**47**	**55**	**41**	**41**
	37	*31*	*39*	*36*	*27*	*35*	*37*	*35*	*39*	*36*	*34*
Onions	**49**	**47**	**59**	**46**	**38**	**49**	**46**	**49**	**53**	**47**	**43**
	60	*63*	*62*	*58*	*66*	*63*	*68*	*50*	*43*	*60*	*65*

	Type of store					Retailer company					
	Alle	SSM	BSM	CSM	DC	A	B	C	D	E	F
Beef	**20**	**15**	**22**	**21**	**17**	**21**	**18**	**19**	**17**	**24**	**17**
	15	*14*	*16*	*15*	*12*	*15*	*15*	*14*	*11*	*15*	*14*
Liver sausage	**23**	**18**	**24**	**24**	**18**	**28**	**18**	**21**	**24**	**29**	**18**
	21	*18*	*21*	*22*	*20*	*22*	*18*	*19*	*24*	*25*	*21*
Pork	**28**	**28**	**29**	**29**	**19**	**31**	**24**	**29**	**33**	**32**	**25**
	23	*24*	*22*	*23*	*17*	*23*	*23*	*24*	*24*	*22*	*20*
Poultry	**19**	**19**	**19**	**20**	**16**	**22**	**19**	**18**	**20**	**20**	**19**
	15	*15*	*14*	*15*	*13*	*15*	*16*	*14*	*15*	*14*	*14*
Apples	**24**	**21**	**27**	**23**	**22**	**27**	**23**	**24**	**28**	**21**	**21**
	16	*16*	*15*	*16*	*15*	*16*	*16*	*15*	*15*	*15*	*14*
Pears	**25**	**23**	**27**	**24**	**25**	**27**	**24**	**25**	**26**	**24**	**25**
	15	*15*	*14*	*16*	*15*	*16*	*14*	*16*	*14*	*16*	*15*
Citrons	**20**	**16**	**21**	**20**	**23**	**19**	**18**	**20**	**24**	**23**	**18**
	17	*14*	*17*	*17*	*19*	*15*	*16*	*17*	*20*	*19*	*13*
Lattice	**26**	**25**	**29**	**25**	**22**	**28**	**26**	**26**	**29**	**24**	**25**
	19	*19*	*18*	*19*	*14*	*19*	*19*	*18*	*18*	*17*	*19*
Carrots	**26**	**21**	**28**	**26**	**26**	**25**	**23**	**27**	**30**	**25**	**27**
	22	*18*	*22*	*22*	*19*	*21*	*22*	*20*	*21*	*22*	*23*
Onions	**28**	**26**	**30**	**28**	**28**	**28**	**25**	**27**	**27**	**29**	**33**
	34	*35*	*32*	*35*	*48*	*36*	*37*	*28*	*22*	*37*	*50*

Legend: All prices in German cent per kg, except the prices of lattice and citrons which are quoted in German cent per piece.
Source: Data by ZMP, 2001.

Fig. 2: Total and weekly share of sales over all products (sample of 131 stores over 296 weeks from 1995 to 2000)



Legend: Share of products (total of 10 food items) that are on sale based on the definition in the text.
Source: Data by ZMP, 2001.

Tab. 5: Estimation results for the relationship between the number of sales and the retail price index (per capita expenditures)

Endogenous	Price Index SSM		Price Index BSM		Price Index CSM		Price Index DC	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
dPRT_1	-0,37	*-5,55*	-0,40	*-5,80*	-0,53	*-8,73*	-0,55	*-6,97*
dPRT_2	-0,24	*-4,13*	-0,40	*-6,24*	-0,43	*-6,94*	-0,35	*-4,43*
dPRT_3	-	-	-0,24	*-4,24*	-0,34	*-6,22*	-0,28	*-3,68*
Constant	1447,03	*4,49*	1357,38	*3,64*	616,82	*2,98*	1050,80	*3,28*
PRT_1	-0,29	*-4,98*	-0,24	*-4,19*	-0,15	*-3,72*	-0,23	*-3,49*
PWS_1	0,35	*4,10*	0,26	*3,75*	0,25	*2,80*	0,21	*1,88*
dPWS	0,37	*1,08*	-0,10	*-0,36*	0,07	*0,27*	-0,19	*-0,36*
dPWS_1	-0,23	*-0,63*	-0,15	*-0,51*	-0,01	*-0,03*	0,37	*0,66*
dPWS_2	0,13	*0,38*	0,16	*0,56*	0,29	*1,00*	-0,15	*-0,27*
dPWS_3	-	-	-0,14	*-0,51*	-0,22	*-0,81*	-0,02	*-0,03*
SM	-420,62	*-13,20*	-614,87	*-16,80*	-531,78	*-13,80*	-321,35	*-12,30*
SM_1	208,36	*5,14*	245,22	*4,65*	144,03	*2,96*	57,95	*1,75*
SM_2	77,52	*1,86*	-24,32	*-0,45*	40,30	*0,83*	44,63	*1,37*
SM_3	112,88	*2,81*	71,59	*1,31*	77,71	*1,61*	11,51	*0,35*
SM_4	-	-	117,59	*2,22*	165,45	*3,47*	80,31	*2,45*
SF&V	-83,43	*-3,75*	-91,18	*-3,20*	-72,71	*-2,21*	-37,27	*-2,05*
SF&V_1	82,73	*3,47*	-6,09	*-0,20*	-13,35	*-0,37*	7,88	*0,41*
SF&V_2	-16,23	*-0,66*	17,61	*0,58*	50,83	*1,41*	-2,48	*-0,13*
SF&V_3	28,92	*1,23*	-20,76	*-0,68*	-48,40	*-1,35*	23,67	*1,25*
SF&V_4	-	-	63,52	*2,21*	88,42	*2,69*	-17,20	*-0,91*
R^2	0,71	-	0,74	-	0,70	-	0,64	-
DW	2,06	-	2,02	-	2,12	-	2,02	-
AR2: F(2,263)=	2,35	*[0,10]*	0,55	*[0,58]*	2,49	*[0,08]*	0,71	*[0,49]*
ARCH1: F(1,258)=	1,84	*[0,18]*	0,00	*[0,98]*	1,75	*[0,19]*	0,12	*[0,73]*
Normality: Chi^2(2)=	0,11	*[0,95]*	3,08	*[0,21]*	4,46	*[0,11]*	6,33	*[0,04]**
Heterosk.: F(41,223)=	0,77	*[0,84]*	1,29	*[0,12]*	1,21	*[0,19]*	0,88	*[0,69]*
Reset: F(1,264)=	0,45	*[0,50]*	2,85	*[0,09]*	0,11	*[0,74]*	0,07	*[0,80]*
SM=0: Chi^2(1)=	0,11	*[0,75]*	6,63	*[0,01]***	2,10	*[0,15]*	3,03	*[0,08]*
SF&V=0: Chi^2(1)=	0,15	*[0,70]*	0,92	*[0,34]*	0,02	*[0,89]*	0,46	*[0,50]*

Legend: Calculations are run with Ox 3.0 and PcGive 10.0 (Hendry and Doornik, 2001, Doornik and Hendry, 2001).
Source: Data by ZMP, 2001.