Interformat price competition of multi-product retailers:
Evidence for German grocery retailing

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1   Introduction

"From a practical point of view it is necessary to explicitly consider the fact that most interactions between consumers and supermarkets involve multiproduct purchases, incomplete knowledge of prices on the consumer's part before visiting a supermarket, and a choice among supermarkets"
(Rao and Syam, 2001: 62.).

The German grocery retail sector is characterized by fierce competition for consumers and an increase in retail concentration to only a few companies (Dobson et al., 2003; Weiss and Wittkopp, 2005). It features several formats which differ in the marketing policies such as pricing, promotional strategy, service level, variety, focus and convenience (Blattberg and Neslin, 1990). The main formats are discount stores, supermarkets and hypermarkets.

Much of the existing literature on competition in the grocery retail sector is based on the assumption that this competition is restricted to rivalry between stores of the same format (intraformat competition) (for an overview see González-Benito et al., 2005). Taking over the consumers' perspective it becomes evident that the decision to choose a certain store is not restricted to stores of only a particular format. In the recent past another stream of research emerged that considers and explores competition between stores of different formats (interformat competition). The central assumption of this stream is that different formats compete for business from most, if not all, consumers or at least the overlapping segments (González-Benito et al., 2005; Cleeren et al., 2010). We adopt this assumption and contribute to the existing research by examining the performance of interformat price competition and by analyzing retail scanner data.[1] We explicitly take into account the multi-product character of the grocery shopping situation by regarding price levels of typical shopping basket instead of single products (Lal and Matutes, 1994; Bell and Lattin, 1998; Loy and Weiss, 2009). According to Hosken and Reiffen (2004) and Richards (2006), we assume that retailers have to consider demand interdependencies when they set or change prices within their assortment. As a result, retail competition is conducted by so-called retailer's multi-product pricing decisions. From the consumers' perspective the multi-product character of grocery shopping is based on their preference for time-saving one-stop-shopping (e.g. Messinger and Narasimhan, 1997; Morschett et al., 2006).

Based on the theory of limited decision making and the three dimensions of retail competition (assortment, pricing and transaction costs) we propose a conception of interformat competition (see Messinger and Narasimhan, 1997). Price levels of different formats should only be independent if competition is restricted within formats (intraformat competition). Analyzing price level information that is based upon individual product price series from retail scanner data of 80 German grocery retail stores (2000/2001), we aim to investigate the formation of interformat price competition. In contrast to the majority of studies conducted on price competition we take into account the dynamic character of pricing (see Loy and Weaver, 2006; Bahadir-Lust et al., 2007). The dynamic approach gives us insight into the relationship of price levels at any point in time and into the intertemporal interactions and reactions of stores. For example, when we test for price leadership, we find little evidence for the presumption that discount stores dictate prices in the German grocery retail sector. Moreover, we investigate the outcomes of interformat price competition and find several promising positioning strategies of stores and formats that are involved in interformat price competition.

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[1] Most of the existing research relied on consumer (survey or panel) data (e.g. Solgaard and Hansen, 2003; Bhatnagar and Ratchford, 2004; González-Benito et al., 2005; Cleeren et al., 2010).

2   Store choice process and interformat competition

*"Phased" decision strategies have been suggested as characteristic of human decision-making
in a number of contexts where consumers have to cope with complexity"*
(SHOCKER ET AL., 1991: 185).

Grocery shopping can be considered to be a domain where the involvement of consumers in decision making is rather low. Product prices and thus the risk of decisions in grocery shopping are comparably low in contrast to other purchases. The same can be expected in the case of grocery retail store choice. In our work we apply the theory of limited decision making to the problem of store choice (KROEBER-RIEL AND WEINBERG, 2003). Limited decision making is proposed by consumer behavior theory to model low involvement decisions and can be characterized as a hierarchical process: First, consumers consider only a subset (evoked set or choice set) from the total number of alternatives (universal set) that satisfies certain needs on the basis of internal information, like experiences, images or predisposition (see HOWARD, 1969; SHOCKER ET AL., 1991). In the second step, consumers choose among the elements of the evoked set, using external information, too. From the marketing perspective, being in the evoked set of many consumers is essential to succeed in the competition.

Consumer behavior theory assumes that specific key attributes guide the decisions in any of the steps of limited decision making. This view is adopted by several authors who investigated in consumer (store) choice (e.g. SHOCKER ET AL., 1991; REUTTERER AND TELLER, 2009). We now discuss the main attributes for store choice in the retail sector (see MESSINGER AND NARASIMHAN, 1997).

Assuming consumers to have a preference for one-stop shopping, a wide (and possibly deep) assortment appears to be an important criterion. Investigations on the basis of consumer surveys found that the breadth and depth of a store's assortment is the criterion for constitution of the evoked set (first step decision) (BELL AND LATTIN, 1998; SOLGAARD AND HANSEN, 2003). However, we can also image that consumers only need a few (basic) products to satisfy their weekly needs. For this segment of consumers this "would indicate that there are other factors in addition to the absence or presence of product categories that determine [store choice]" (BHATNAGAR AND RATCHFORD, 2004: 39).

As German consumers are supposed to be extraordinarily price sensitive one might expect that price levels are an important attribute (decision criterion) in the grocery retailing sector (SOLGAARD AND HANSEN, 2003; MORSCHETT ET AL., 2006). Even if consumers may have relatively poor knowledge of individual product prices, they are supposed to make accurate distinctions about price levels in different stores or formats (DICKSON AND SAWYER, 1990; BELL AND LATTIN, 1998). Consequently, grocery price advertising and expectations of the non-advertised products are assumed to jointly determine the store choice (RAO AND SYAM, 2001). There is also reason to believe that German retailers themselves regard the price image as the key criterion for consumers' store choice. Most, if not all, formats provide a 'discount price range' and some explicitly communicate this (SCHMEDES, 2005).[2]

The category transaction costs comprises different efforts that have to be made by consumers in the context of grocery shopping like, i.e., searching for the best offer, traveling to the store and transportation of the goods (SLADE, 1999; CARLTON AND PERLOFF, 2000; GIJSBRECHTS ET AL., 2008). These efforts are calculated as costs by the amount and value of time they take.

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[2] One remarkable example is the claim of one convenience store: "*Did you know that there is a discounter inside every famila store?*"

Consumers are assumed to rationally try to minimize the transaction costs of shopping, i.e., by visiting a shop close to their housing area and/or complete shopping trips by one-stop-shopping (MESSINGER AND NARASIMHAN, 1997).

The conception of interformat competition

From the perspective of demand, store formats might be defined as broad competing categories that provide benefits to match the needs of different types of consumers"
(GONZÁLEZ-BENITO ET AL., 2005: 59).

In the following, we take the retailers' perspective and try to explain the formation of interformat competition. The first central assumption is that (only) the above mentioned Before we introduce our conception of intra- and interformat competition we characterize the three criterions are meaningful for consumers' store choice when they plan their (next) shopping trip and thus for competition between stores (MESSINGER AND NARASIMHAN, 1997; HOSKEN AND REIFFEN, 2007). The second assumption is that consumers prefer to visit only one store per period (week) buying a regular shopping basket.[3]

Figure 1 illustrates our idea of interformat competition. The three circles represent the three major decision criterions: assortment, expected price level (price image) and transaction costs. The following typical characteristics of the major German retail formats show that the decision criterions of consumers can also be interpreted as the main dimensions of retail competition.

German supermarkets (SM) provide wide but flat assortments at low transaction (travel) costs. They have a high degree of spatial coverage and are often placed near housing areas. Low prices are originally not part of their marketing strategy, but many supermarkets do provide a narrow, typically private labeled, low priced product range (SCHMEDES, 2005). In contrast, the main characteristic of discount stores (DS) is a reliably low product price level as they grant EDLP (Every day low Price) (LEVY ET AL., 1998). By placing their stores near homesteads they also offer low transaction costs (search costs and travel costs). The assortment of genuine discount stores (so-called hard discount stores) is typically narrow and flat, so that they do not compete in this dimension. But the so-called soft discount stores provide national brands, too. This strategy of deepening their assortment can strengthen their competitive position relative to conventional formats (super- and hypermarkets) (DELEERSNYDER ET AL., 2007). So, hypermarkets (HM) provide deep and wide assortments at price levels somewhat between supermarkets and discount stores (SCHMEDES, 2005). Transaction costs, especially travel costs are generally rather high as hypermarkets are situated by Greenfield strategy, i.e. in trading estates. Thus, consumers have to bridge wide distances and hypermarkets originally do not compete with other formats in the dimension of transaction costs. However, a good transport connection and convenience leadership (one-stop shopping or fast and efficient transactions) can lower transaction costs, too (MORSCHETT ET AL., 2006).

On the whole, each format (discount stores, supermarkets and hypermarkets) is supposed to compete mainly in two dimensions illustrated by the position of the formats in the overlapping segment of two dimensions (darker grey). The area in the centre of the graphic represents the overlapping consumer segment for that all three formats potentially compete (dark grey). As can be seen from the graphical representation, each format involves in this center of interformat competition by meeting the third dimension that was originally not their core competence.

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[3] In fact, not every shopping trip is a regular shopping trip (KAHN AND SCHMITTLEIN, 1989; REUTTERER AND TELLER, 2009). We will come to this point later, defining the shopping basket and price levels for our empirical analysis.

Figure 1 The conception of intra- and interformat competition

DS: discount stores

SM: supermarkets

HM: hypermarkets
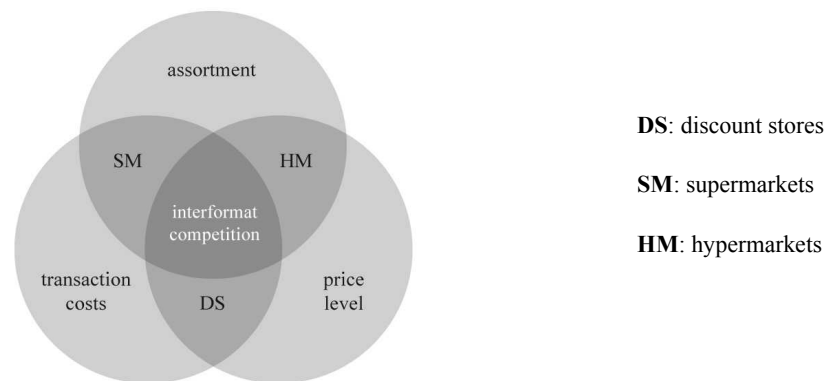
Recalling the supposed two-step process of store choice, interformat competition means that retail stores get into the evoked set of consumers who consider first the dimension that is originally not characteristic for their format. According to the literature, we assume the assortment to be an important or even the most important criterion for the first step decision for many consumers. Thus, super- and hypermarkets will be in their evoked set while (hard) discount stores will be excluded. Discount stores would have to widen and deepen their assortment if they attempt to involve in interformat competition and if assortment is the most meaningful decision criterion. If the price level is the second step criterion, we would observe fierce interformat price competition. Taking into account the high price sensitivity of German consumers and the high impact and fast growth of discount stores we could alternatively imagine a decision making progress that starts even with the attribute 'price level', followed by a trade-off of assortment against transaction costs in the second step. This trade-off leads to the choice of hypermarkets or discount stores, while supermarkets with a high price image would already be excluded in the first step. Supermarkets with a low price image would stay in the evoked set and can involve in interformat price competition for consumers regular shopping trips.

As worked out in the formats description above, supermarkets and discount stores really try to involve in the third dimension, too. One may doubt that this is a reasonable strategy for all formats and stores. Especially the wide and deep assortment of hypermarkets seems to be a promisingly successful strategy to differentiate from other formats as there exists a market basket size threshold beyond which consumers self-select hypermarkets (BHATNAGAR AND RATCHFORD, 2004).[4] Accordingly, interformat price competition should be relevant in product categories that are available in all store formats. Our empirical analysis includes an introducing part that describes the assortment and pricing strategies of formats and stores. The main part focuses on the price competition (relationship and reactions of price levels) and the last part points to the outcomes of interformat price competition. Thereby we try not only to test for the existence of interformat price competition but also to investigate its performance and to detect its potential profiteers.

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[4] The authors measure market basket size by how many different product categories are included and refer to supermarkets instead of hypermarkets, actually but from the context it can be seen that it also holds for hypermarkets (BHATNAGAR AND RATCHFORD, 2004).

3   Data and methodology

"we do find evidence to support a particular form of strategic pricing, namely intertemporal pricing"
(LOY AND WEAVER, 2006: 2).

The data under study are provided by Markt Daten Kommunikation GmbH, Köln, Germany (MADAKOM, 2002). They comprise retail scanner data from German grocery stores for 104 weeks from the first week in 2000 to the last week in 2001. To identify the product categories relevant for competition, we choose those categories that are sold in most, if not all, stores over the entire period. We assume that prices of frequently purchased products are more important for the store's price image and should, therefore, better reflect the expected price level of consumers that we focus. Thus, we restrict our analysis to the most meaningful brand (having the highest sales quantity) in each product category in each store being sold steadily over the whole period (at least in 90 out of the 104 weeks).Thereby, we attempt to capture the realized price level of each store that can be supposed to reflect their price image. Thus, we generate shop-specific product baskets consisting of one brand per product category in each store. Note that the store-baskets are equal with respect to the product categories included but may differ in the brands as the most meaningful brands can be different in each store (but consistent over time). We present three samples of stores: The first sample covers 14 stores where 60 food products and beverages are steadily bought by consumers (stores with a wide assortment) (see appendix 1). The second sample includes 22 stores where 46 product categories are steadily sold (stores with a medium sized assortment) and a third sample that incorporates 80 stores from all store formats where the relatively smallest assortment of 24 product categories are continuously sold. These 24 product categories (basic assortment) are frequently purchased by consumers and many of them are signpost items (i.e. butter, coffee).[5] They can also be described as the intersection of the formats' assortments or 'overlapping offerings' (CLEEREN ET AL., 2010). Before we concentrate on this so-called basic assortment, let us give a brief description of all three samples.

The stores under study belong to different retail companies and can be classified into three groups, which represent the store formats (discount stores, supermarkets, hypermarkets) (MADAKOM, 2002). Basically this classification rests upon the store size, but it is also strongly related to the above mentioned strategic dimensions of the formats (see tab.1). The sample of stores selling 60 product categories is composed of only hypermarkets, confirming the assumption that there can exist a market basket size threshold beyond which consumers self-select hypermarkets (BHATNAGAR AND RATCHFORD, 2004). In contrast, discount stores occur only in the third sample, as no more than the basic 24 product categories are bought here steadily.

By analyzing the weighted price levels of the so-called basic assortment of top-selling brands we confirm the formats' price level ranking by SCHMEDES (2005):[6] The weighted price levels are lowest in discount stores and highest in supermarkets (see tab. 1). But, as mentioned above, there is reason to believe that not the top-selling brands compete in prices as we

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[5] Research suggests that consumers use the prices of signpost items (loss leaders, key value items) to form an overall impression of a store's prices. That impression then guides their purchase of other items for which they have less price knowledge (ANDERSON AND SIMESTER, 2003).

[6] The weighted price levels are given by $p_{i,t} = \sum_{n=1}^{N} w_n P_{i,t}^n$, $\sum_{n=1}^{N} w_n P_{i,t}^n$, where n = 1,…,N (N is the number of product categories under study in the subsamples), for each store i = 1,…80 and each time t = 1,…,104. We weighted the individual prices of the top-selling (lowest priced) brand by their overall proportion of sales on the total sales in the assortment of the subsample to consider directly their purchase frequency. The weights are constant over time and identical for all stores (see appendix 1). Alternative weights were applied verifying the robustness of the results presented here.

potentially compare private brands with national brands. For that reason, we will have a closer look at the low price-level range (discount range) by choosing the brands with the lowest average price over the whole period in each of the 24 product categories constituting the basic assortment. As expected, the average weighted price level of the discount range is lower than the prices of the top-selling brands in each of the store formats. In fact, we found that hypermarkets offer an even less expensive discount range than discount stores, but the value of the variation coefficient of hypermarkets is more than twice as large as the one of discount stores. The great price level dispersion of hypermarkets indicates that some hypermarkets try to get into the price competition with discount stores while the remaining hypermarkets do not. At this point of the analysis, we cannot reject the hypothesis that some supermarkets try to get into the choice set of low-price shoppers, either. Indeed, the average price level is highest but the large variation can be a sign for price-competing supermarkets, too.

Table 1 Descriptive statistics on the three samples

Store format	Discount stores	Supermarkets	Hypermarkets	Total
1st sample: wide assortment: 60 product categories continuously sold				
Number of stores (retail companies)	0	0	14 (4)	14 (4)
Average price level (and variation [%]) of top-selling brands	n.a.[a]	n.a.	1.91 (11.49)	1.91 (11.49)
2nd sample: middle sized assortment: 46 product categories continuously sold				
Number of stores (retail companies)	0	2 (2)	19 (4)	21 (5)
Average price level (and variation [%]) of top-selling brands	n.a.	2.14 (8.84)	1.84 (18.06)	1.87 (17.68)
3rd sample: smallest assortment (basic shopping basket): 24 product categories continuously sold				
Number of stores (retail companies)	19 (2)	25 (5)	36 (4)	80 (5)
Average price level (and variation [%]) of top-selling brands	1.56 (10.37)	1.75 (14.31)	1.72 (19.84)	1.69 (16.96)
Average price level (and variation [%]) of discount range	1.22 (6.65)	1.36 (15.35)	1.19 (15.33)	1.25 (14.93)

Legend: [a] not available
Source: own calculation based on data from MADAKOM, 2002

The average price levels of the wider assortments approve that supermarkets price higher than hypermarkets, and the ranks of the stores' average price levels mainly persist over time (see tab. 1 and fig. 2).[7] Some hypermarkets change their position with a growing assortment. Whereas they are rather expensive in the basic assortment, they sell the almost cheapest wide assortment. This could be a cue for their location beyond the overlapping segment as well as for the important role of the price image as the final selection criteria for large basket shoppers, too.

For the analysis of interformat competition we concentrate on the price levels of the basic assortment and will have a closer look at the relationship of price levels in the third sample. This data set comprises 19 discount stores, 25 supermarkets, and 36 hypermarkets being under the management of five different companies (named A, B, C, D and E here). The number of stores within each company ranges from 9 (company D) to 24 (company A). Table 2 shows that company A is the only one that includes stores from all formats.

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[7] LOY AND WEAVER (2006) also came to that result.

Tabe 2   Descriptive statistics on the companies and formats (chains) in the third sample

Chain[a]	DS A	DS E	SM A	SM B	SM C	SM D	SM E	HM A	HM B	HM C	HM D
No. of stores	4	15	8	3	6	5	3	12	8	12	4
Market share [%][b]	8.1	20.7	11.0	3.4	6.6	4.9	3.0	19.1	8.0	12.9	2.3
Share of discount range's sales [%][c]	65.6	72.4	43.4	52.5	48.7	52.9	67.9	38.6	41.5	44.3	46.8

Legend: [a] stores of company format combination (so-called chains) SM B, SM E and HM B are not characterized by a common strategy within the same company and therefore shaded in grey (see also section 4)
[b] market shares are measured as the proportion of chain's average sales per m² on total sales per m²
[c] the share of discount range's sales is related to the volume sales of the top-selling brands
Source: own calculation based on data from MADAKOM, 2002

The more related price levels are across stores or the closer price levels' co-movements, the closer should be their rivalry. First, the averaged gap between the price levels MD^{ij} of each two stores (i and j) should reflect their similarity in costs and/or demand. Moreover, grocery retailing firms monitor their competitors' prices and tend to respond to (close) competitors' price changes either simultaneously or deferred. Thus, we choose an error correction specification of the following form, where the change in one price level $\Delta p_{i,t}$ is related to the change in another price level $\Delta p_{j,t}$ as well as the past equilibrium errors $ect_{t-1} = (p_{i,t-1} - \alpha_0 - \alpha_0 p_{j,t-1})$ and the past price level movements:[8]

$$\Delta p_{i,t} = \beta_0 + \beta_1 (p_{i,t-1} - \alpha_0 - \alpha_1 p_{j,t-1}) + \beta_2 \Delta p_{j,t} +$$
$$\sum_{k=1}^{K} \Gamma_i (Lk) \Delta p_{i,t-k} + \sum_{k=1}^{K} \Gamma_j (Lk) \Delta p_{j,t-k} + \varepsilon_t \qquad \text{, with } \varepsilon_t \sim N(0, \sigma_\varepsilon^2). \qquad (1)$$

Thereby, we conduct two additional indicators of the price competition (dynamic price relationship) of each two stores. Parameter β_2 reflects the contemporary adjustment or the degree of synchronization of both price levels as positive, and higher values of β_2 point to higher synchronization. Parameter β_1 reflects the speed of adjustment or how fast the two price levels return to their long-run equilibrium if and only if such a long-run equilibrium exists. Therefore, we start by testing for stationarity based on the Augmented-Dickey-Fuller test and SCHMIDT AND PHILLIPS (1992). We identify the optimal lag order of the price levels by means of different information criteria (AKAIKE, 1974; SCHWARZ, 1978).[9] Then we test for the cointegration rank choosing an appropriate trend specification and select the preferable Granger causality direction (HAMILTON, 1994; JOHANSEN, 1988; LÜTKEPOHL, 2005).

We do not restrict our analysis to the cointegrated price level series, as our aim is to reveal differences in the relationships of stores both from the same format (intraformat relationships) and from different formats (interformat relationships). Thus, the first outcome could be that price levels of intraformat competitors are cointegrated, while price levels of different store formats are not related. In fact, it is not that easy. The price levels neither of the top-selling brands nor of the discount range are cointegrated within formats and move independently across different formats over time. Therefore, we investigate which stores (formats and companies) aspire to compete in the interformat competition. First, we define the three proposed indicators of rivalry (the gap between both price levels MD^{ij}, the contemporary adjustment term β_2^{ij} and the estimated speed of adjustment β_1^{ij}) as endogenous variables. Then,

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[8] where $\Delta p_t \equiv p_t - p_{t-1}$ and i and j refer to one out of the 80 stores in the third sample (i = 1,…,80, j = 1,…,80, i ≠ j). The past price level movements are illustrated by the sum of lagged price level changes $\sum_{k=1}^{K} \Gamma (Lk) \Delta p_{t-k}$ where k is the lag order (k = 1,…,K) (see also footnote 14).
[9] The optimal maximum lag order is $k^* = 3$ for low-price levels $k^* = 5$ for top-selling brands. Accordingly, we specify K = 5 in the model for top-selling brands (main price level) and K = 3 for the low price levels.

we try to ascribe them to company and format effects controlling for regional and location characteristics using the following specification:[10]

$$r^{ij} = \gamma_0 + \sum \gamma_1 d_{format}^{ij} + \sum \gamma_2 d_{chain}^{ij} + \gamma_3 d_{sloc}^{ij} + \gamma_4 d_{sbor}^{ij} + \gamma_5 d_{coint}^{ij} + v^{ij}. \quad \text{, with } v^{ij} \sim N(0, \sigma_v^2). \quad (2)$$

4   Research results

"Whatever choice the retailer makes is important since it determines retailer's success in achieving its objectives in terms of [...], enhancing the store's image, and creating a price image"
(LEVY ET AL., 1998: 116).

Based on the previous sections of the paper, our first objective is to find out whether the empirical data set confirms any interformat price competition. We cannot reject the hypothesis of entirely unrelated price level series across different formats (interformat price competition). As can be seen in table 3, low-level price levels are more frequently cointegrated between stores of different formats than price levels of the top-selling brands. This could indicate that interformat price competition is conducted by the discount range. Our second aim is to understand the formation of interformat price competition. We find that discounters are not the (only) price leaders in interformat price competition. On the one hand, price levels of discount stores are cointegrated to a lesser extent with stores of other formats than vice versa. If we cannot reject the hypothesis of cointegration, discounters' price levels are more often followed by their competitors than vice versa. Thus, the proportion of Granger causality is highest for discounters and price levels of top-selling brands (66.30 percent). On the other hand, the remaining third of discount stores seems to react on price levels of supermarkets or hypermarkets. Surprisingly, for the low price range, the empirical data makes us conclude that the proportion of discounters that affect other formats' price levels is smaller than for top-selling brands.

Table 3   The positioning of formats in interformat competition

	Discount stores	Supermarkets	Hypermarkets	Total
Number of observations	1159	1375	1584	2059
Price level of top-selling brands (basic assortment)				
Proportion of Cointegration [%]	56.82	60.95	61.83	60.42
Proportion of Granger causality [%]	66.30	47.73	40.88	-
Price level of low price range (basic assortment)				
Proportion of Cointegration [%]	51.82	67.71	62.63	61.63
Proportion of Granger causality [%]	59.84	40.82	49.90	-

Legend: Totally, we get 3160 equations where one price level is explained by another price level and 2059 equations include stores from different formats. From the 1159 equations which include one discount store, 56.82 percent are significantly cointegrated and in 66.30 percent of these 658 equations, the price levels of the discount store seems to cause the price levels of the other store format.

Source: own calculation based on data from MADAKOM, 2002

Altogether, these results confirm that all three formats are partly engaged in interformat price competition. For that reason, the stores' format tends to not be the only fundamental determinant of the engagement in interformat price competition. In order to identify the other important determinants and to examine the performance of interformat competition, we have a closer look at the estimation results of the dummy regression in table 4. As small gaps (mean absolute differences MD[ij]) between the price levels are supposed to point to closer

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[10] with r[ij] = [MD[ij] β_2^{ij} β_1^{ij}]. Further explanations of abbreviations and variables are given in appendix 2.

competition, price levels between stores from the same borough are significantly smaller. The smaller constant in the case of low level prices than of the most relevant price levels and the significantly negative parameters of the cointegration dummy are in line with our assumption. The estimation results signify interformat price competition and low level price levels tend to be more closely related than top-selling brands' price levels are.

Table 4 Dummy regression's results[a]

Price level	Mean absolute gap between price levels		Contemporary adjustment		Speed of adjustment	
	Main	Low	Main	Low	Main	Low
Constant	17.31***	15.50***	0.116***	0.0814***	-0.235***	-0.137***
	(0.341)[b]	(0.317)	(0.0110)	(0.00928)	(0.00471)	(0.00413)
Discount stores	-3.021*	-8.921***	0.0404	-0.00819	0.0760***	0.0589***
	(1.629)	(1.290)	(0.0558)	(0.0434)	(0.0240)	(0.0193)
Supermarkets	1.611*	0.713	0.166***	0.0520*	-0.0152	-0.0529***
	(0.846)	(0.670)	(0.0317)	(0.0293)	(0.0136)	(0.0130)
Hypermarkets	3.369***	-2.751***	-0.0526**	0.0371*	-0.0205*	-0.0327***
	(0.639)	(0.505)	(0.0244)	(0.0201)	(0.0105)	(0.00894)
DS A	-0.720	-0.709	0.0172	0.336**	0.0304	-0.0506
	(5.323)	(4.208)	(0.216)	(0.153)	(0.0927)	(0.0682)
DS E	2.596	1.019	0.367***	0.239***	-0.00629	-0.0267
	(2.013)	(1.591)	(0.0660)	(0.0526)	(0.0284)	(0.0234)
SM A	-6.135**	-1.693	-0.229***	0.180**	0.0198	-0.0131
	(2.484)	(1.963)	(0.0796)	(0.0863)	(0.0342)	(0.0384)
SM B	-13.39*	-13.68**	n.c.[c]	n.c.	n.c.	n.c.
	(7.224)	(5.712)				
SM C	-9.707***	-9.277***	0.217	0.339***	0.0560	-0.0821*
	(3.310)	(2.616)	(0.173)	(0.0973)	(0.0744)	(0.0433)
SM D	-13.44***	-3.333	0.185	0.402***	-0.0740	0.0159
	(4.014)	(3.173)	(0.124)	(0.135)	(0.0534)	(0.0600)
SM E	-9.840	3.937	n.c.	0.469***	n.c.	0.0796
	(7.223)	(5.712)		(0.172)		(0.0767)
HM A	-9.709***	-3.182**	0.0886	-0.00163	0.0431*	-0.00224
	(1.640)	(1.297)	(0.0575)	(0.0481)	(0.0247)	(0.0214)
HM B	9.169***	11.29***	0.218*	0.191**	0.00650	0.0220
	(2.420)	(1.913)	(0.114)	(0.0836)	(0.0492)	(0.0372)
HM C	-9.282***	-6.767***	0.666***	0.0681	-0.115	-0.0661***
	(1.644)	(1.294)	(0.210)	(0.0530)	(0.0902)	(0.0236)
HM D	-3.767	-5.233	0.290*	-0.113	0.0720	0.0384
	(5.108)	(4.041)	(0.149)	(0.295)	(0.0641)	(0.131)
Same location	0.904	-0.225	-0.0140	0.0275	-0.0134	-0.000749
	(0.635)	(0.502)	(0.0231)	(0.0199)	(0.00996)	(0.00887)
Same borough	-2.931**	-1.797*	0.0233	0.0660*	0.00216	-0.0101
	(1.244)	(0.983)	(0.0484)	(0.0395)	(0.0208)	(0.0176)
Coint. dummy	-1.170**	-3.375***				
	(0.458)	(0.363)				
No. of obs.	3,160	3,160	1,254	1,779	1,254	1,779
F statistics	8.20***	21.24***	12.42***	7.44***	3.31***	5.27***
Adj. R² [%]	3.73	9.82	11.31	5.15	2.52	3.48

Legend: [a] variables' abbreviations and explanations are in appendix 2
[b] standard errors in parentheses *** $p<0.01$, ** $p<0.05$, * $p<0.1$
[c] no significant cointegration between price series within this group
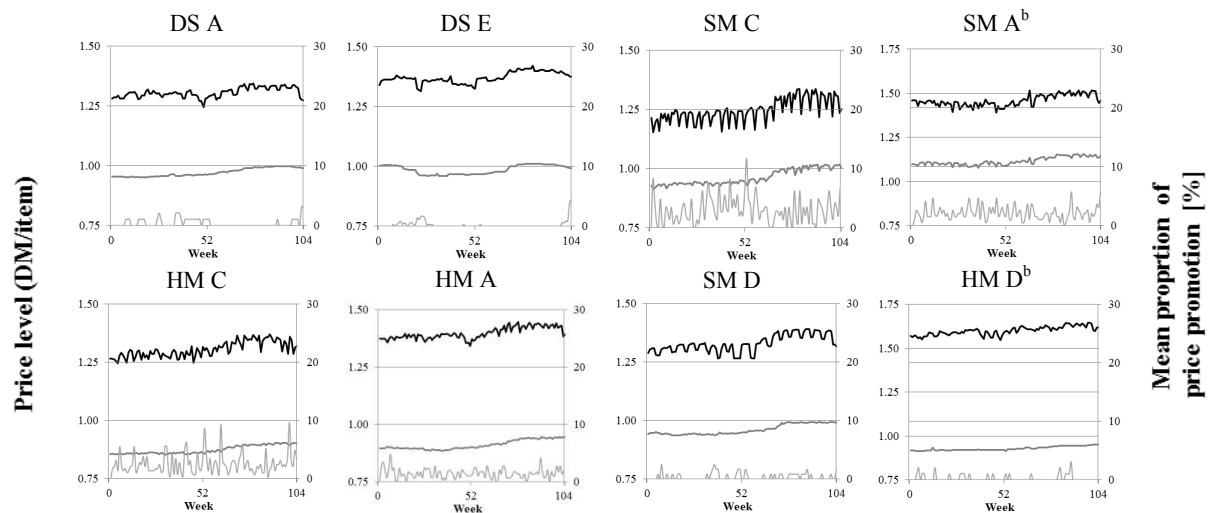Source: own calculation based on data from MADAKOM, 2002

The estimation results show some facts about the role of formats and companies and their interactive influence on the rivalry of stores (tab. 4). First and foremost, discount stores have significantly smaller price level gaps than the reference group (consisting of stores of different formats and companies). Supermarkets and hypermarkets, however, tend to have relatively large price level gaps between their basic assortments of top-selling brands but relatively small gaps between their low level price ranges. Company factors tend to exhibit very

individual effects on price level gaps. Whereas company factors have no significant effect on the resulting price gap in the discount segment (DS A, DS E), supermarkets of company C (SM C), as well as hypermarkets of company A and C (HM A, HM C) show relatively small price gaps. The analysis of the dynamic relationship of price levels reconfirm the relevance of company factors and the exceptional position of company C, whose super- and hypermarkets have significantly stronger related price levels (higher synchronized, returning faster to their long-rum equilibrium).[11] The estimated parameters denote that company C is likely to compete more strongly with discount stores than other companies do. DC E synchronizes price level changes above average. In contrast, SM B and SM E show independent price level movements and will be excluded from the next steps of the analysis.

We now compare intuitively the average price levels of company formats combinations (chains) and consequently rely on the assumption, that a common strategy of stores of the same chain is evident. Therefore, we also exclude HM B because its price level gap is significantly higher than those of all others. To show the retailer's efforts in interformat competition, figure 2 gives an insight into the chains' pricing behavior.

Figure 2 The performance of interformat competition[a]

Legend: [a] stores of chain SM B, SM E and HM B are not characterized by a common strategy and therefore not presented
[b] the maximum value of the vertical price level axis is 1.75 DM instead of 1.50 DM
Source: own calculation based on data from MADAKOM, 2002

Figure 2 illustrates the price level movements both of the top-selling and the discount range brands as well as the mean proportion of price promotions over time. All three items of information could be crucial for the targeting consumer segment since they are part of the (pricing) strategy of each chain. Weighted price levels of the basic assortment seem to be hardly affected by any significant cost shock over the two years period, although inflation in the food sector reached up to 4.5 percent and single product prices, i.e. of milk products rose significantly from 2000 to 2001 in the data set (STATISTISCHES BUNDESAMT, 2011). In all chains, top-selling brands are priced significantly higher and affected more by price promotions than the low price brands. Consumers buy significantly fewer price promoted brands in discounters (especially in DS E) than in other formats. In company C, the proportion

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[11] The results of the dynamic analysis seem fairly confusing when we focus on the formats' behavior because the parameters' directions mainly oppose our expectation. Additionally, the price levels of the top-selling brands are partly higher synchronized and return faster to their long-run equilibrium than price levels of the low-price range do. We will try to explain this contradiction later concentrating on the company factors now.

of price promotions and their influence on the price level of the top-selling brands is highest. Moreover, company C sells the cheapest shopping baskets, no matter if we examine the top-selling brands or the low price range. Overall, chains we do not exclude according to our previous analysis show very close main and lowest price levels, indicating a fierce interformat price competition. Certainly, instead of a conspicuous price leader, we observe sophisticated interformat (low) price level competitors. Are the EDLP strategists the profiteers of interformat competition or do other chains win the interformat consumer segment?

To assess the performance of each chain we have a look at their market share of sales and the impact of their discount ranges on their sales (tab. 2). Comparing stores of different size and formats, we have to consider the size of the store and the width and depth of the assortment when we evaluate their success in interformat competition. For that reason, we weight the stores' sales volume of the basic assortment with the store size and relate it to the total sales per square meter over all stores. The impact of the discount range is measured by the sales volume of the low price range divided by the sales volume of the top-selling brands in each store.

The highest market shares of the overlapping consumer segment are gained by discount stores and hypermarkets (tab. 2). This might confirm the assumption that (low) price levels are the most important (first step) criterion for consumers who plan to buy their regular basic shopping basket. Correspondingly, only those supermarkets that we presume to be engaged in intraformat price competition reach appreciable market shares in the basic assortment. On the contrary, discount stores seem to realize higher market shares if they widen their assortment. For example, DS E is characterized through sizable gaps between the main and the low price levels because consumers tend to prefer manufacturer brands instead of private brands. Furthermore, we have to consider that the market shares of hypermarkets can be biased as they may include the outcomes of intraformat competition. For example, we assign a remarkable market share to HM B, although it seems to be hardly engaged in interformat price competition. In any case, those hypermarkets appearing to be interformat price competitors seem to be well positioned in the whole retail market. Their pricing strategies succeed in both, interformat and intraformat competition.

The impact of the low-price range (discount range) can be evidence of the idea of interformat competition presented above. Discount stores reach EDLP shoppers to a higher extent than super- and hypermarkets although consumers could realize an even lower price level if they visit stores of company C. Following our conception, supermarkets seem to be excluded from the evoked set of (only) price sensitive consumers in the first step if they do not involve in interformat competition and concentrate on their core competence. SM C can join the interformat competition as an appreciable number of price sensitive consumers buy there. But, unlike (hard) discounters, SM C sells low priced shopping baskets whose price levels are notably influenced by price promotion and reaches consumers who are equally interested in low price levels and a wide assortment (i.e., brand loyal consumers). From this perspective, discounters selling solely EDLP products would restrict their business to intraformat competition, but the success of DS E proves that discounters benefit from a widening of their assortment, too.

5   Conclusion

If rivalry in German grocery retailing sector was restricted to intraformat price competition one would expect significantly different price levels to be realized by discount stores (low), hypermarkets (medium) and supermarkets (high). The greatest similarities in price levels would be within the store formats. Assuming a two-step store choice process, we present a conception of intra- and interformat competition that combines the three meaningful

dimensions of retail competition (assortment, pricing and transaction costs). Based on this idea, we investigate the interformat price competition.

Given the multi-product character of retailers and assuming that consumers make their store choice on the basis of price images instead of searching for item-by-item price information, we analyze weighted price level series from up to 80 stores (5 companies) from retail scanner data from the German grocery retail sector (2000/2001). The empirical investigation can give us insights into the interformat price competition and the importance of the pricing dimension in retail competition that we sum up as follows.

Our results strongly confirm that all three formats are partly engaged in interformat competition and do not approve the exclusive price leadership of discount stores. Super- and hypermarkets generally are not following the pricing of discount stores; neither in the main assortment (top-selling brands) nor in the low-price range, although the low-price levels appear to be very similar in all formats. The last fact confirms that German retailers themselves regard their (low) price image to be essential for succeeding in competition. Our empirical investigation shows that this hypothesis holds only for supermarkets. We figure out an alternative understanding of the formation of interformat price competition. Contrary to the common belief that discounters are the price leaders and that the format itself does determine the success in interformat price competition, we identify the profiteers of interformat competition by their active efforts in the dimension being originally not part of their marketing strategy. Thus, those discount stores succeed that enlarge their assortment by manufacturer brands and offer price promotions; and so do supermarkets that have a low price image. Thereby HILO strategy (frequent price promotions) can be as effective as EDLP to communicate the 'right' price image – the price image that attracts consumers of the interformat competition segment. In contrast, stores that maintain their core competence and remain beyond interformat competition do not only fail in interformat competition but in intraformat competition as well. In particular, some supermarkets seem to fail in the whole market because they do not actively revise their strategy and their image. Again, we mention the image as it can be a link between a common (price) strategy and the chain's achievement in interformat price competition. It seems to be more likely to be in the consumers' evoked set of store choice when pricing strategies are consistent within the same chain. Also, most price levels seem to be relatively consistent over time. So price level information from the past last very long and consumers decide 'right' if they use internal price information (experience) planning the next shopping trip. Nevertheless, what happens if consumers notice a price rise in their chosen (favorite) store? By what means can they make a quick and check whether price levels in other stores have also risen? Frequently advertised product prices (i.e. like butter and coffee prices) are supposed to signal the overall price level of the store. Future research should investigate the existence and the attributes of signpost items.

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Appendix 1   Product categories under study and their weights

Product category	Weights	Product category	Weights
Basic assortment (included in all samples)		**Product categories that are in the middle sized and widest assortment (1st and 2nd sample)**	
Butter	0.0467		
Cheese	0.0318	Asparagus (tinned)	0.0018
Coffee	0.0387	Cake (fresh)	0.0047
Condensed milk	0.0371	Convenience foods (meat)	0.0025
Desserts	0.0127	Eggs	0.0198
Edible oil	0.0124	Frensh fries (deep-frozen)	0.0066
Fresh milk	0.0498	Green beans (tinned)	0.0032
Instant cacaos	0.0038	Mushrooms (tinned)	0.0085
Pizzas and quiches (deep-frozen)	0.0203	Rice	0.0028
Sauerkraut	0.0072	Sweets	0.0023
Vegetables (deep-frozen)	0.0062	Ananas (tinned)	0.0030
Yogurt	0.1591	Fish (tinned)	0.0095
Apple juice	0.0176	Flour	0.0140
Backing ingredients	0.0023	Honey	0.0038
Blancmange powder	0.0055	Ice cream	0.0063
Chips	0.0214	Instant soups	0.0259
Chocolate	0.0475	Pickles	0.0149
Cold cuts	0.0128	Rye mix bread	0.0039
Mineral water	0.1474	Salad with sausages and mayonnaise dressing	0.0078
Peas (tinned)	0.0042		
Shortbreads	0.0060	Starch, porridge and pulses (dry)	0.0091
Soft drinks	0.0606	Sugar	0.0142
Tea	0.0091	Tinned meat	0.0046
Vinegar	0.0062	Toast	0.0231
Product categories that are in the widest assortment (1st sample)			
Baby food	0.0015	Marinades	0.0024
Cakes (deep-frozen)	0.0036	Nuts and snacks	0.0013
Candies	0.0014	Poultry (refined)	0.0013
Cereals	0.0033	Ravioli (tinned)	0.0025
Fast food	0.0013	Sausages	0.0083
Ketchup and dressing	0.0012	Studentenfutter	0.0009
Lollies	0.0015	Whole-wheat bread	0.0042

Source: own calculation based on data from MADAKOM, 2002

Appendix 2   Explanations and comments on the dummy regression

Variable in formula 2	Abbreviations in table 4	Explanation
r^{ij}		Endogenous variable of the dummy regression, where i and j stand for different stores in the third sample ($i = 1,…,80, j = 1,…80, i \neq j$)
MD^{ij}	Mean absolute gab between price levels	Mean absolute gab between the price level of store i and the price level of store j
β_2^{ij}	Contemporary adjustment	Estimated parameter from the first part of the analysis (see formula 1). Perfect synchronization of price levels is shown by values of β_2^{ij} near 1, while values near 0 indicate that a price level change of store j leads to no simultaneous price level change in store i or vice versa.
β_1^{ij}	Speed of adjustment	Estimated parameter from the first part of the analysis (see formula 1). The existence of a long-run equilibrium is supposed to be accompanied by a negative value of β_1^{ij}. The higher its absolute value, the faster the price levels adjust to their long-run equilibrium.
	Main	Estimation results for the price levels of top-selling brands in the basic assortment.
	Low	Estimation results for the price levels of low price range in the basic assortment.

Exogenous variables		
γ_0	Constant	
d_{format}^{ij}	Dummy variable for formats: Discount stores Supermarkets Hypermarkets	1 if store i and j are both discount stores, 0 otherwise 1 if store i and j are both supermarkets, 0 otherwise 1 if store i and j are both hypermarkets, 0 otherwise
$\gamma_1{}^a$	Matrices of estimated parameters for dummy variables for formats	
d_{chain}^{ij}	Dummy variable for chains (company format combinations): DS A DS E SM A SM B SM C SM D SM E HM A HM B HM C HM D	1 if store i and j are both discount stores from company A, 0 otherwise 1 if store i and j are both discount stores from company E, 0 otherwise 1 if store i and j are both supermarkets from company A, 0 otherwise 1 if store i and j are both supermarkets from company B, 0 otherwise 1 if store i and j are both supermarkets from company C, 0 otherwise 1 if store i and j are both supermarkets from company D, 0 otherwise 1 if store i and j are both supermarkets from company E, 0 otherwise 1 if store i and j are both hypermarkets from company A, 0 otherwise 1 if store i and j are both hypermarkets from company B, 0 otherwise 1 if store i and j are both hypermarkets from company C, 0 otherwise 1 if store i and j are both hypermarkets from company D, 0 otherwise
γ_2	Matrices of estimated parameters for dummy variables for chaina	
d_{sloc}^{ij}	Same location	Dummy variable: 1 if store i and store j have the same location (i.e., city, green field, residential area). The location information comes from MADAKOM (2002).
d_{sbor}^{ij}	Same borough	Dummy variable: 1 if store i and store j are in the same borough, 0 otherwise. The borough information comes from MADAKOM (2002). Totally, 34 different boroughs in Germany are given.
d_{coint}^{ij}	Coint. dummy	Dummy variable: 1 if price levels of store i and j are cointegrated according to pretests (see for further information section 3 and tab. 3)
$\gamma_3, \gamma_4, \gamma_5$	Vectors of estimated parameters for dummy variable for same location, same borough and coint. dummy	

Legend: [a] the reference group consists of stores i and j from different formats. If only chains had an impact on interformat price competition all estimated parameters in γ_1 would not be significantly different from zero, while elements of γ_2 would be significantly different from zero.

Source: MADAKOM, 2002