

# PSYCHOLOGICAL PRICES AND PRICE RIGIDITY IN GROCERY RETAILING: ANALYSIS OF GERMAN SCANNER DATA\*

by

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- Selected Paper, American Agricultural Economics Association – 2005, Annual Meeting, July 24-27, 2005, Providence, Rhode Island -

- This is a preprint of an article accepted for publication in “Agribusiness: An International Journal” under the title “Do Psychological Prices Contribute to Price Rigidity? Evidence from German Scanner Data on Food Brands” -

\* Financial support provided by Deutsche Forschungsgemeinschaft in the project “Intertemporal Price Formation in the Grocery-retailing Sector: Theory and Empirical Tests” (He 1419/8-1) is gratefully acknowledged. This project made it possible to use the scanner dataset on which the empirical analysis is based. Thanks are due to seminar participants in the Institute of Agricultural Policy and Market Research, University of Giessen, and to two anonymous referees of this journal for very helpful comments on an earlier version and Simone THEUERKAUF for very helpful research assistance.

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# 1 Introduction

There is increasing evidence from scanner data that branded foods in the grocery retailing sector contain a substantial amount of price rigidity (HERRMANN/MÖSER 2003). One of the many alternative explanations for price rigidity is the existence of psychological pricing points. We define psychological pricing points as round numbers, which may be seen by decision-makers as price barriers: If those are exceeded, this may lead to a substantial reduction in consumption. Consequently, psychological pricing is defined here as just-below-the-round-figure pricing<sup>1)</sup>. There is evidence that such prices, e.g. 0.49 DM or 4.99 € have been used frequently (FENGLER/WINTER 2001; SCHINDLER/KIRBY 1996). The economic literature has been most hesitant against this theory and, in a survey, BLINDER et al. (1998) found no strong support based on the views of business managers. In that study, however, retail trade is underrepresented. The theory of psychological pricing points continues to be an important concept for pricing in firms which directly sell to consumers. Empirical findings in various studies, e.g. in the early work by FRIEDMAN (1967) for food retailing, suggest that psychological prices are widely used in the retailing sector. Hence, it is the objective of this paper to elaborate to which extent psychological pricing plays a role in grocery retailing and whether it contributes to price rigidity of branded foods in Germany. The empirical analysis will be based on scanner data of weekly prices for 20 branded foods in Germany in the period 1996-99.

The paper is organized as follows. The literature on the theory and evidence of psychological pricing will be surveyed in Section 2. Then, the scanner data base is sketched in Section 3 and an overview of price rigidity in food markets is given. In Section 4, an empirical analysis of the importance of psychological pricing for branded foods follows. It will then be discussed in Section 5 whether psychological pricing is a main cause of food price rigidity. Conclusions are drawn and major results are summarized in Section 6.

## 2 Theory and Evidence of Psychological Pricing Points in the Literature

We have to distinguish the industrial organization (IO) literature from the marketing literature on psychological pricing points. The treatment of the issue differs between the two branches of the literature. The increasing number of IO studies on price rigidity is partly driven by the major interest macroeconomists have in the microeconomic foundation of macroeconomic behaviour. More specifically, sticky prices are crucial in Keynesian macroeconomics (CARLTON 1986). Many studies have dealt with the question whether prices in the economy are actually sticky and why. Here, psychological pricing points come into play as they can cause price rigidity. There is also a natural interest of IO authors in the role of psychological prices for price rigidity as psychological prices are an outcome of imperfect markets. The marketing literature differs from the IO literature. Psychological prices are discussed there as to whether they are an adequate tool to realize firms' profit objectives. The question is addressed, too, which kind of psychological prices performs best in terms of the marketing objectives.

### 2.1 The IO literature

In the IO literature on price rigidity, the theory of psychological pricing points has received some attention in the important book by BLINDER et al. (1998). BLINDER et al. surveyed decision-makers in firms on how they set prices and which explanations of price stickiness are important for their decisions. Psychological pricing points has been one of twelve theories of price stickiness which was included: It is one of the few theories of **nominal rigidity**. According to the theory of psychological pricing points, nominal pricing points are psychologically so important to consumers that these react with a strong decrease in demand if prices go beyond the psychological pricing point. Firms following the theory of psychological prices would, thus, start from the presumption of a kinked demand curve – with several kinks at different pricing points – where demand is strongly elastic above the kinks.

At each kink, it is then optimal to leave the price unchanged for at least some variation in marginal costs. Hence, psychological pricing points are a cause of price rigidity if firms are profit maximizers.

BLINDER et al. (1998) came up with some very interesting empirical conclusions. In general, the theory of psychological pricing points is ranked eighth out of twelve theories – with a generally low score of agreement. However, the authors find a significantly stronger agreement for those firms selling directly to consumers. Psychological pricing points, as far as they are regarded as important, are also seen as a cause of price asymmetry. Pricing points are rather viewed as a wall against further price increases than as a general guideline where each price change implies a move from one psychological pricing point to the next. Moreover, BLINDER et al. detect that those who think that quality is judged by price and who assess demand as elastic, rate psychological pricing points high, too.

There are some other studies commenting on the role of psychological pricing for price stickiness. KASHYAP (1995), in his often-cited study on warehouse catalogue prices, found that “being near a price point in the low inflation period reduced the probability of a price change” (p. 268). He found some limited evidence for psychological pricing points. KÖHLER (1996), in a business-survey study, reached conclusions similar to BLINDER et al. for Germany. The theory of psychological pricing points was not supported by most participants of the study. However, there is a substantial amount of uncertainty regarding customers’ reactions to price changes which may cause price stickiness. The uncertainty about psychological pricing points seems to be part of this general uncertainty (KÖHLER 1996, pp. 172-174). In a further study with German data, FENGLER and WINTER (2001) strongly confirm the relevance of psychological pricing points for coffee retail prices. The authors explore information of the Gesellschaft für Konsumforschung (GfK) consumer panel and show that 86 % of more than 14,000 purchases in 1995 were subject to psychological focal pricing

(FENGLER/WINTER 2001, p. 100). Furthermore, it is elaborated that individual psychological prices matter for the dynamics of the general price adjustment.

## **2.2 The marketing literature**

The marketing literature on psychological prices has a different focus compared to the IO literature. A major discussion exists on whether “psychological pricing”, “odd pricing” or “just-below-the-round-figure pricing” is justified from a marketing perspective or whether this pricing strategy leads to a major loss compared with even prices<sup>2)</sup>. Of course, it is crucial for the answer to this question whether and how strongly consumers react to odd as opposed to even prices. It is also important whether firms have full information on the behaviour of their customers or not.

In the German literature, KAAS and HAY (1984) showed that the firms’ decisions for odd rather than even prices may induce high aggregate losses, although, e.g., the difference between 2.99 and 3.00 DM seems negligible. Based on their finding and a survey of the related literature on psychological pricing, GEDENK/SATTLER (1999) argued that the firms’ decisions may be justified under uncertainty. They agree that high losses may occur if existing price thresholds are ignored. Additionally, they derive that the error is many hundred times more severe, if existing price thresholds are ignored than if non-existing price thresholds are considered with a general pricing strategy ending at digit 9. Thus, firms suffering from uncertainty about their customers’ behaviour are better advised if they follow an odd-pricing strategy.

Some recent contributions in the marketing literature are based on explanations of price endings based on cognitive psychology. Some major hypotheses are empirically tested and the sales effect of odd prices measured (STIVING/WINER 1997; SCHINDLER/KIBARIAN 1996; SCHINDLER/KIRBY 1997). A common result is that prices ending at digit 9 may raise sales. STIVING/WINER (1997) distinguish level and image effects for specific price endings. One

level effect, also stressed by SCHINDLER/KIBARIAN (1996) and SCHINDLER/KIRBY (1997), is due to rounding down. Consumers are expected to round down prices and, thus, an incentive exists for firms to utilize just-below prices ending at digits 9 or 99. Another explanation for a level effect is left-to-right comparison. This implies that consumers tend to compare prices by considering the digits from left to right. Image effects mean that consumers attach a low- or high-price image or a low- or high-quality image to certain price endings, e.g. digit 9. Based on empirical results for tuna and yoghurt, STIVING and WINTER find that level and image effects do exist and market shares are affected by price endings. SCHINDLER and KIBARIAN show with an experiment that prices ending in the digits 99 rather than 00 increase consumer purchasing at a direct-mail women's clothing retailer. SCHINDLER and KIRBY use a sample of retail price advertisements and find that 9-ending prices are overrepresented. They argue that the tendency of consumers to underestimate prices is responsible for this pattern and for a positive sales effect. ANDERSON/SIMESTER (2003) confirm in field experiments for sales of US retailers that the use of \$ 9 endings has a direct demand-increasing effect on dresses, in particular for new items in retailers' catalogues.

We can summarize that the IO as well as the marketing literature contain various theoretical arguments for the relevance of psychological pricing points to consumers. Despite this, economists often treat the rationale for psychological pricing points with caution. Given this background, the following empirical analysis is supposed to clarify whether psychological pricing is widespread in German grocery retailing and whether it actually contributes to price rigidity. If psychological pricing is important, the evidence will also be interpreted in the context of the IO and the marketing literature.

### **3 Data and Empirical Evidence on Price Rigidity**

In this section, the scanner dataset is described and empirical findings on price rigidity for the 20 selected food brands are summarized. The evidence on price rigidity is based on these scanner data as is the evidence on psychological pricing in Section 4.

#### **3.1 The Scanner Data**

The quantitative analysis is based on a commercially available scanner data set provided by MADAKOM GmbH (MADAKOM 1999a). It captures scanner data from the German food-retailing sector for 144 weeks, i.e. the period from September 30, 1996, to June 28, 1999. Four types of retailing firms were selected for this study: (i) large consumer markets (1,500 to 5,000 m<sup>2</sup> sales area); (ii) small consumer markets (800 to 1,499 m<sup>2</sup> area); (iii) supermarkets (400 to 799 m<sup>2</sup>) and (iv) discounters. A further selection criterion was that data were available for 100 consecutive weeks. 38 stores remained in the sample after applying this criterion as well as the rule that the regional distribution of stores should approximately picture the structure of the German food-retailing sector. Data for several retailing companies were included.

The selection of brands covers breakfast products in the broadest sense. The national food brands included are summarized in Appendix 1.

The individual articles could be identified with their EAN codes. EAN codes contain 13 or 8 numbers which are printed on the product and they contain an identification of the manufacturer and the details of the product. Comprehensive information was available on the items. This information includes the quantity sold, the product price, the name of the product and the package size. Information on different promotion activities at the point of sale were available as well as a variable accounting for price discounts. Those price actions are measured as those prices which remain for four weeks or less by at least five percent below

the normal price. After more than four weeks, such low prices are counted as normal price (MADAKOM 1999b).

It has to be stressed that this is a unique dataset at the individual retailers' level. Substantial work in recent years is based on consumer panel data (e.g., FENGLER/WINTER 2001; LOY/WEISS 2003) which might include the customers' switching from store to store and, thus, a different type of price rigidity<sup>3)</sup>. The utilized scanner dataset covers the retailers' pricing decisions irrespective of potential consumer switching between stores. However, as is in most comparable studies, the data do not include sociodemographic variables of consumers as these are typically not available in either retailer or consumer panels.

### **3.2 Empirical Evidence on Price Rigidity**

Table 1 summarizes price rigidity of the selected food brands. Price rigidity (*PRIG*) is measured as the mean duration of unchanged prices, following POWERS and POWERS (2001):

$$(1) \quad PRIG = w / w_{PCH} \cdot$$

$w$  stands for the number of weekly price observations,  $w_{PCH}$  is the number of weeks with price changes.

The following results can be summarized:

1. There is a substantial degree of price rigidity at the retail level which differs strongly across brands. There are brands where the mean duration of unchanged prices is as high as 53 weeks. If we compute the median of the medians for the 20 food brands, it is 18.9 weeks. Apparently, the median price rigidity indicates that prices of branded foods remain unchanged for 19 weeks.
2. Price rigidity varies strongly across grocery-retailing firms. It can be shown that the same holds true for the importance of price actions (see, HERRMANN/MOESER/WEBER 2004). Differences are so strong that no uniform pricing pattern for all retail chains



can be discovered. This is an indication of market power and the potential to set prices independently of the competitors' behaviour. On a competitive market, similar pricing patterns would not occur under ceteris-paribus conditions as input costs would affect all retailers similarly.

3. If price actions are additionally considered, it is striking that price rigidity is lower for those brands and in those firms which are characterized by a larger number of price actions. The correlation coefficient between price rigidity and price actions is negative and significantly different from zero (cf. Table 4).

**Table 1: Evidence on Price Rigidity in German Food Stores, 20 Brands, Weekly Prices, 1996-99<sup>a)</sup>**

Brands	Average Price Rigidity ( <i>PRIG</i> ) in Six Grocery-Retailing Firms <sup>b)</sup>						Median
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	
1	200.5	72.4	175.0	- <sup>d)</sup>	134.0	69.3	134.0
2	35.9	11.2	8.5	23.2	139.0	11.9	17.6
3	35.8	8.7	3.8	19.6	94.5	9.5	14.6
4	16.3	2.7	7.2	11.1	18.0	9.3	10.2
5	24.1	6.3	6.7	18.3	9.9	12.7	11.3
6	14.1	14.9	6.5	104.0	9.4	5.0	11.8
7	73.7	93.3	11.3	- <sup>c)</sup>	24.1	15.2	24.1
8	50.8	9.6	7.1	16.8	48.9	10.4	13.6
9	36.6	17.9	17.7	33.6	34.0	7.4	25.8
10	23.3	5.1	7.1	37.8	16.9	27.7	20.1
11	- <sup>d)</sup>	21.2	6.9	63.4	- <sup>d)</sup>	- <sup>c)</sup>	21.2
12	22.0	8.9	21.6	69.0	81.5	22.2	22.1
13	16.7	6.7	7.3	14.5	10.5	15.1	12.5
14	39.5	5.2	6.8	59.3	60.3	10.2	24.9
15	42.6	5.6	7.1	127.4	49.0	11.6	27.1
16	17.9	3.9	19.5	16.3	69.6	13.6	17.1
17	10.2	3.3	7.4	10.9	39.8	7.2	8.8
18	19.9	4.5	4.2	18.7	139.3	8.2	13.5
19	46.3	26.7	39.3	29.3	31.1	56.1	35.2
20	123.3	23.1	10.2	82.6	- <sup>c)</sup>	17.8	23.1
<b>Median</b>	<b>35.8</b>	<b>8.8</b>	<b>7.3</b>	<b>26.3</b>	<b>44.3</b>	<b>11.9</b>	<b>19.1<sup>e)</sup>/18.9<sup>f)</sup></b>

a) The sample period and the included stores are explained in the text. The number of observations differs across the grocery-retailing firms and products. - b) Price rigidity is measured as in equation (1) in the text. - c) Not computed as no price changes were observed. - d) Not distributed in this grocery retailing firm. - e) Median of the medians, computed across firms. - f) Median of the medians, computed across brands.

Source: Authors' computations.

#### **4 Empirical Analysis of Psychological Pricing in German Grocery Retailing**

We investigate in this section how important psychological pricing actually is in grocery retailing and whether the statistical evidence is consistent with the presented hypotheses from cognitive psychology on the level and image effects of price endings. Like in the analysis of price rigidity, psychological pricing is analyzed for the selected 20 food brands in six different

German grocery-retailing firms. As mentioned earlier, we define psychological prices as those prices which are slightly below psychological pricing points, e.g. 0.49 DM, 0.99 DM or 4.99 DM.

The most important psychological prices of all 20 brands have been analyzed in detail for all six grocery-retailing firms. We define those psychological prices as important ones which include 5% or more of all observed prices in the respective firms. Two brands are covered in Appendices 2 and 3 as examples; they provide an impression of the importance of psychological prices in individual firms' pricing decisions for two very different brands.

Brands 4 and 20 are selected in Appendices 2 and 3. Brand 4, the ground coffee, is very often utilized for price actions. Therefore, this is the brand where the two most important psychological prices reach the lowest share of all observed prices among the 20 brands. For brand 20, the crispbread with chocolate, on the other hand, the share of the two most important prices is the highest among all brands.

A common result for the two examples and, actually, for all 20 brands is that psychological pricing is most significant in German grocery retailing. A high share of all observed prices are psychological prices for the two examples in Appendices 2 and 3 and the other 18 brands, too. A further common result is that a relatively small number of psychological prices, e.g. five, accounts for a major share of all observed prices. This suggests that psychological pricing points along the lines of Sweezy's kinked demand function may well be relevant for retailers' pricing decisions. Stronger differences across brands occur, however, when the share of very few psychological prices – e.g. two or three – in all prices are measured. The differences between the two selected brands in Appendices 2 and 3 are cases in point. When psychological prices are important for a brand but the concentration on very few psychological prices does not exist, this indicates that no strong price barriers are involved.

Rather, pricing seems to be consistent with the arguments forwarded by cognitive psychology, e.g. rounding down or left-to-right comparisons.

In Tables 2 and 3, concentration ratios are presented for the five (two) most important psychological prices for all 20 products in the six firms. The *CR5* (*CR2*) values indicate the relative importance of these five (two) prices in pricing decisions across all brands.

The results in Tables 2 and 3 confirm that psychological prices for branded foods in Germany are extremely important. For eight out of 20 branded foods, Table 2 reveals that five or less of the important psychological prices covered more than 90 % of all observed prices in all six grocery-retailing firms. In additional eight cases, such a situation is given in five of the six grocery-retailing firms. And in all other cases, there are more than half of the grocery-retailing firms where five important psychological prices cover more than 90 % of all observed prices.

In all cases, the relative significance of the five most important psychological prices, i.e. *CR5*, is very high. In no case it is less than 70 %. The lowest share was 71.1 % (brand 4, firm B). In almost all cases it was higher than 80 % (114 of 117) and most often higher than 90 % (95 of 117 cases).

We know from U.S. studies that other price endings than digit 9 have some importance, especially digits 0 and 5 (SCHINDLER/KIRBY 1997). The detailed analysis at the brand level indicates that it is clearly the digit 9 which dominates as price ending for the selected German food brands. Appendix 4 presents only a few prices with other endings than digit 9 that reached 5 % or more of all observed prices in individual retailing firms. Only digits 5, 7 and 8 are somewhat important, but they must be regarded as exceptions rather than the rule. Firm-specific patterns are evident here, too. The price endings at digit 7 occurred – with one exception – only in the grocery-retailing firm *F*. In three cases, prices ended at digit 8 in firm *C* gained some importance. In individual cases prices ending at digit 5 were important for four

different firms, but never for *B* and *F*. In two of these cases, a significant share of all observed prices were reached (28.4 % for the price 1.65 DM of brand 11 and 23.1 % for the price 2.85 DM of brand 18, both at firm *D*).

**Table 2: Concentration Ratios of the Five Most Important Psychological Prices for 20 Brands in Six German Grocery-Retailing Firms (CR5), 1996-99**

Brands	Grocery-Retailing Firms						Median
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>	
1	99.8 <sup>b)</sup>	99.7 <sup>d)</sup>	96.6 <sup>b)</sup>	n.d. <sup>e)</sup>	100 <sup>b)</sup>	99.2 <sup>c)</sup>	99.7
2	98.8 <sup>c)</sup>	94.2 <sup>d)</sup>	89.3 <sup>d)</sup>	99.2 <sup>d)</sup>	100 <sup>b)</sup>	97.9	98.4
3	98.7 <sup>c)</sup>	95.0 <sup>b)</sup>	89.8 <sup>b)</sup>	98.6 <sup>d)</sup>	100 <sup>b)</sup>	89.7	96.8
4	94.6 <sup>d)</sup>	70.9	83.1	86.5	93.7 <sup>d)</sup>	85.6	86.1
5	94.7 <sup>c)</sup>	93.5	88.1 <sup>c)</sup>	90.9	95.9 <sup>d)</sup>	85.2	92.2
6	97.5 <sup>d)</sup>	98.4	83.1 <sup>a)</sup>	99.0 <sup>b)</sup>	93.5 <sup>b)</sup>	86.9	95.5
7	99.6 <sup>c)</sup>	99.4 <sup>b)</sup>	97.5 <sup>c)</sup>	100 <sup>b)</sup>	97.1 <sup>a)</sup>	98.0	98.7
8	99.5 <sup>b)</sup>	91.3 <sup>d)</sup>	89.2 <sup>c)</sup>	95.8 <sup>d)</sup>	100 <sup>c)</sup>	95.7 <sup>c)</sup>	95.8
9	98.2 <sup>c)</sup>	94.9	91.6 <sup>c)</sup>	87.2	99.2 <sup>d)</sup>	90.6	93.3
10	98.3 <sup>b)</sup>	90.7 <sup>d)</sup>	92.9 <sup>c)</sup>	93.8 <sup>c)</sup>	97.0 <sup>b)</sup>	94.0	93.9
11	n.d. <sup>e)</sup>	96.6 <sup>a)</sup>	91.1 <sup>b)</sup>	n.d. <sup>e)</sup>	99.2 <sup>b)</sup>	100 <sup>b)</sup>	95.2
12	98.5 <sup>c)</sup>	95.1	98.1 <sup>c)</sup>	99.3 <sup>b)</sup>	99.4 <sup>a)</sup>	97.8	98.3
13	93.6 <sup>c)</sup>	85.0	89.1 <sup>d)</sup>	95.5 <sup>c)</sup>	95.0 <sup>b)</sup>	77.1	91.4
14	98.8 <sup>b)</sup>	98.0 <sup>d)</sup>	92.5 <sup>d)</sup>	97.6 <sup>d)</sup>	99.1 <sup>a)</sup>	87.8 <sup>b)</sup>	97.8
15	98.7 <sup>b)</sup>	96.3 <sup>d)</sup>	90.7 <sup>c)</sup>	95.7 <sup>b)</sup>	98.8 <sup>a)</sup>	88.8 <sup>b)</sup>	96.0
16	97.8 <sup>c)</sup>	82.1 <sup>d)</sup>	98.3 <sup>c)</sup>	92.6 <sup>d)</sup>	99.3 <sup>b)</sup>	91.2 <sup>c)</sup>	95.2
17	88.1	87.9	87.5 <sup>a)</sup>	92.7 <sup>c)</sup>	99.1 <sup>b)</sup>	89.6 <sup>d)</sup>	88.9
18	94.6 <sup>c)</sup>	80.4 <sup>c)</sup>	90.0 <sup>d)</sup>	92.4 <sup>c)</sup>	100 <sup>b)</sup>	90.2 <sup>c)</sup>	91.3
19	99.8 <sup>b)</sup>	90.9	95.8	96.1 <sup>d)</sup>	100 <sup>c)</sup>	98.9	97.5
20	99.6 <sup>b)</sup>	96.9 <sup>c)</sup>	93.8 <sup>c)</sup>	99.7 <sup>b)</sup>	100 <sup>a)</sup>	97.4 <sup>b)</sup>	98.5
<b>Median</b>	<b>98.5</b>	<b>94.6</b>	<b>90.9</b>	<b>96.0</b>	<b>99.2</b>	<b>90.9</b>	<b>95.7<sup>f)</sup>/95.3<sup>g)</sup></b>

a), b), c), d) Concentration ratios of the single, two, three, four most important psychological price(s). – e) Not distributed. – f) Median of the medians, computed across firms. – g) Median of the medians, computed across brands.

Source: Authors' computations.

The descriptive statistics on the role of psychological prices suggest as a general result that level and image effects posited by cognitive psychology do exist. With regard to the level effects, the dominant influence of prices ending at digit 9 indicate that rounding down prices and left-to-right comparisons are consistent with the data.

Although psychological prices are significant in all grocery-retailing firms and for all brands, there are substantial differences in the psychological-pricing strategies across brands and firms. Table 3 summarizes to which extent pricing is concentrated on the two most important psychological prices, respectively.

**Table 3: Concentration Ratios of the Two Most Important Psychological Prices for 20 Brands in Six German Grocery-Retailing Firms (CR2), 1996-99**

Brands	Grocery-Retailing Firms						Median
	A	B	C	D	E	F	
1	99.8	86.7	96.8	n.d. <sup>b)</sup>	100	91.3	96.8
2	92.3	63.5	69.2	77.8	100	62.7	73.5
3	92.9	95.0	89.8	83.1	100	58.1	91.4
4	67.0	42.9	50.1	58.2	51.6	57.8	54.7
5	83.6	55.3	72.2	55.1	71.1	40.5	63.2
6	76.3	66.0	83.1 <sup>a)</sup>	99.0	93.5	58.9	79.7
7	83.5	99.4	92.3	100	97.1 <sup>a)</sup>	59.6	87.9
8	99.5	66.1	65.3	65.9	91.1	68.3	67.2
9	84.1	65.4	75.7	50.7	82.4	47.3	70.6
10	98.3	65.3	77.9	81.9	97.0	50.7	79.9
11	n.d. <sup>b)</sup>	96.6 <sup>a)</sup>	91.1	99.2	n.d. <sup>b)</sup>	100	97.9
12	87.7	55.6	88.7	99.3	99.4 <sup>a)</sup>	56.9	88.2
13	73.5	46.6	69.6	82.7	95.0	36.2	71.6
14	98.8	83.0	81.6	85.3	99.1 <sup>a)</sup>	87.8	86.6
15	98.7	81.7	83.5	95.7	98.9 <sup>a)</sup>	88.8	92.3
16	83.6	56.9	75.2	72.4	98.3	72.7	74.0
17	91.1	60.6	87.5 <sup>a)</sup>	83.4	99.1	58.4	85.5
18	71.9	66.4	63.7	74.1	100	84.1	73.0
19	99.8	66.3	68.4	83.3	74.7	64.8	71.6
20	99.6	84.5	88.3	99.7	100 <sup>a)</sup>	97.4	98.5
<b>Median</b>	<b>91.1</b>	<b>66.1</b>	<b>79.8</b>	<b>83.1</b>	<b>98.3</b>	<b>61.2</b>	<b>81.5<sup>c)</sup>/79.8<sup>d)</sup></b>

a) Concentration ratio of the single most important psychological price. – b) Not distributed. – c) Median of the medians, computed across firms. – d) Median of the medians, computed across brands.

Source: Authors' computations.

When we consider the median CR2 across brands for the individual grocery-retailing firms, the two most important psychological prices capture at least 61.2 % (firm F), but in four of the six firms 80 % or more. The highest median values are those for firms E (98.3 %) and A (91.1 %). These two firms do stick most to only a few psychological prices for a wide sample

of food brands. Interestingly, the grocery-retailing firms *A* and *E* are also characterized by the lowest number of price actions and the highest price rigidity.

The median *CR2* for the individual brands across the six firms differs strongly, too. However, it never falls below 50 %. The lowest median of *CR2* is 54.7 % (brand 4), followed by 63.2 % (brand 5) and 67.2 % (brand 8). Two of these three products with the lowest *CR2* are also among those three with the lowest price rigidity (brands 4 and 5). The median *CR2* is much higher for other products and is in three cases above 95 %: 98.5 % (brand 20), 97.9 % (brand 11) and 96.8 % (brand 1). One of these, brand 1, also ranks highest among all 20 brands in terms of price rigidity.

These individual cases suggest already that the concentration on a few psychological prices in food retailing, as measured by *CR2*, might be associated positively with price rigidity (*PRIG*) and negatively with price instability (*INST*) and the number of price actions (*ACTIONS*). It is a further interesting question whether psychological pricing is more concentrated on just a few prices when the unit price of a brand (*PRICE*) is higher.

These hypotheses are tested first within a correlation analysis. All variables are measured on the basis of the scanner dataset, and only the 18 brands which are distributed in all firms are included. *PRIG* and *CR2* are available from Tables 1 and 3 respectively. Data for the number of price actions (*ACTIONS*), on the average prices of the brands (*PRICE*) and on price instability (*INST*) are available from the authors upon request. The computation of price instability is based on the trend-corrected coefficient of variation as suggested by CUDDY and DELLA VALLE (1978).

Table 4 presents the correlation results for the pooled dataset of 18 brands and six firms<sup>4</sup>). The major results of Table 4 are as follows:

1. There is some correlation between psychological-pricing strategies and the other variables. The concentration on a few psychological prices in food retailing is

significantly stronger where price instability and the number of price actions are lower and where price rigidity is higher. It also seems that brands with a high per-unit price are associated with a lower *CR2*, but the correlation coefficient does not reach the 95 %-level of statistical significance.

2. Apart from psychological prices, the number of price actions is positively correlated with price instability and negatively with price rigidity.

The general pattern shown in Table 4 is not only valid in the comprehensive dataset for all firms, but holds true for the individual firms in most cases<sup>5)</sup>.

**Table 4: Correlation Coefficients Between the Concentration of Psychological Prices (*CR2*) and Other Variables, German Food Brands, All Firms<sup>a)</sup>**

<b>Variables</b>	<b><i>INST</i></b>	<b><i>ACTIONS</i></b>	<b><i>PRICE</i></b>	<b><i>PRIG</i></b>	<b><i>CR2</i></b>
<b><i>INST</i></b>	1.000				
<b><i>ACTIONS</i></b>	0.427***	1.000			
<b><i>PRICE</i></b>	0.222*	0.174	1.000		
<b><i>PRIG</i></b>	-0.492***	-0.459***	-0.071	1.000	
<b><i>CR2</i></b>	-0.530***	-0.562***	-0.175	0.525***	1.000

\*\*\*, \*\*, \* Statistically significant at the 99.9 %-, 99 %-, 95 %-level.

a) The variables are defined in the text. Data for *PRIG* and *CR2* are from Tables 1 and 2. Only those 18 brands are included which are distributed in all firms ( $n = 108$ ).

Source: Authors' computations.

## **5 Psychological Pricing as One Determinant of Price Rigidity in German Grocery Retailing**

Table 4 has shown that psychological-pricing strategies are correlated with price rigidity and with the number of price actions. Correlation, however, is not causality. From an industrial-organization perspective, the question arises whether the kind of psychological pricing leads to additional price rigidity. This question will be analyzed in the following. It has been elaborated in the literature that price promotions are a major component of retailers' pricing strategies (HOSKEN/REIFFEN 2001) and a major determinant of food price variability



(HERRMANN/MOESER 2003). Moreover, differential firm strategies have also been identified in retailers' price policies. In particular, an "everyday low price" (EDLP) strategy is adopted by some retailers and Hi-Lo pricing with a promotion-oriented strategy by others (HOCH/DRÈZE/PURK 1994). Firm strategies as well as the number of price promotions should affect price rigidity.

We model price rigidity across brands and firms within a regression analysis where we consider *ACTIONS* and firm-specific variables as main determinants of price rigidity. Additionally, the psychological-pricing strategy is included as explanatory variable by *CR2*. Several alternative model specifications are presented in Appendix 5. Price rigidity is the endogenous variable in all these models, as we know that retail sales are an important strategic variable for intertemporal price discrimination by firms. Arguments have been provided above why psychological prices may be used as strategic variable, too. By definition, price rigidity will be affected by the extent to which these strategic variables are utilized. Thus, we can expect that *PRIG* is affected by *ACTIONS* and *CR2* and not vice versa<sup>6</sup>.

The major result of the empirical analysis is that – apart from price promotions and firm-specific characteristics as introduced by dummy variables – psychological pricing contributes significantly to the explanation of price rigidity. The coefficient for the impact of *CR2* on *PRIG* is positive in all model specifications. The change of the regression coefficients in Model 3 compared with Models 1 and 2 indicates the existence of some multicollinearity. However, both coefficients – for *ACTIONS* and *CR2* – are statistically significant in Model 3. The regression coefficients remain rather stable, too, when additional variables are included as in Models 4 and 5. Models 4 and 5 illustrate that the level of the unit price and intercept dummies for firms do not affect price rigidity when the number of sales and the psychological-pricing pattern are already taken into account. However, the introduction of

slope dummies shows that there are firm-specific effects of price actions on price rigidity for firms *A*, *B* and *E* which are at least significant at the 90 %-level.

If differential effects of sales on price rigidity are introduced in the regression model, the preferred specification is:

$$\begin{aligned}
 (2) \quad \text{EPRIG} = & -5.7996 - 0.5440^{***} \cdot \text{ACTIONS} - 0.7315^{[*]} \text{DUMMY A} \cdot \text{ACTIONS} \\
 & (-0.29) \quad (-3.85) \quad \quad \quad (-1.66) \\
 & + 0.3236^{**} \cdot \text{DUMMY B} \cdot \text{ACTIONS} - 1.3096^{[*]} \cdot \text{DUMMY E} \cdot \text{ACTIONS} \\
 & (2.67) \quad \quad \quad \quad \quad \quad \quad (-1.84) \\
 & + 0.7226^{**} \cdot \text{CR2} \\
 & (3.31)
 \end{aligned}$$

$$(\bar{R}^2 = 0.36; F = 13.01^{***}, n = 108)$$

*EPRIG* is the estimated value of price rigidity (*PRIG*); *DUMMY A* (*DUMMY B*, *DUMMY E*) are dummy variables for the grocery-retailing firms *A* (*B*, *E*) with 1 for the respective firm and 0 otherwise. Other variables are defined as before; \*\*\*, \*\*, \*, [\*] indicate the 99.9 %-, 99 %-, 95 %-, 90 %-levels of statistical significance.

Equation (2) indicates that

- (i) the marginal impact of one additional retail sale on price rigidity in the reference group, i.e. firms *C*, *D* and *F*, is a negative one with a decrease of 0.54 in the number of weeks with unchanged prices;
- (ii) this negative marginal impact of an additional retail sale is even stronger in firms *A* and *E*, by 0.73 and 1.31 weeks respectively, but weaker in firm *B*, by 0.32 weeks;
- (iii) an increase in *CR2*, i.e. the share of the two most important psychological prices in price-setting, by one percentage point raises the number of weeks with unchanged prices by 0.72.

We can conclude from the analysis of **the pooled data set** that, as expected, the number of price promotions is a significant determinant of the rigidity of food prices. An increasing number of promotions reduces price rigidity the most in retailing firms with a relatively low number of price actions (firms *A* and *E*). On the other hand, the effect is weakest in the firm with the highest number of price actions (firm *B*). Moreover, psychological pricing of retailers does affect food price rigidity, too.

When the importance of price actions and psychological pricing for price rigidity is tested for the individual grocery-retailing firms in separate regressions, some similarities and some differences compared with the pooled results are visible. Again, the influence of price actions on price rigidity is a negative one in all equations of Appendix 6. The coefficients are statistically different from zero in four of six firms. The psychological-pricing variable is only for firm *D* significantly positive as expected. This suggests that firms' individual strategies with regard to psychological pricing matter and might lead to a significant coefficient of *CR2* in equation (2) and, more generally, in the analysis of the pooled data set. Apparently, it is the differential use of psychological prices across firms which contribute to the explanation of the variation in price rigidity.

## **6 Summary and Conclusions**

It was the objective of this paper to elaborate in how far psychological pricing plays a role in grocery retailing and whether it contributes to price rigidity of branded foods in Germany. For this purpose, a large scanner dataset is exploited.

In the explanation of price stickiness, economists and many business managers do not rank the marketing argument of psychological pricing points very highly. Despite this, the analysis shows that psychological pricing points are extremely important in German food retailing. When prices of 20 food brands are investigated at the point of sale across 38 stores for 144

weeks in the period 1996-99, it is striking that prices ending at digit 9 are by far most important. Moreover, there is often a strong concentration in pricing on only a few psychological prices. This concentration is clearly higher for firms with an EDLP compared to a Hi-Lo strategy and it differs across brands. The *CR5* of the five most important psychological prices is in all cases remarkable: It never falls below 70 % of all prices and ranges above 90 % in roughly four out of five cases.

Moreover, psychological pricing seems to be one major determinant of price rigidity in German grocery retailing. Prices of branded foods are surprisingly sticky given the high variability of agricultural commodity prices in food retailing. Apparently, prices do not change much – apart from sales – and if they do, they tend to move from one psychological price to the next. Regression results show that price rigidity is higher for products where concentration on a few psychological prices is more important. It is lower for products with a high number of price discounts. Additionally, price rigidity as well as the *CR2* for the most important psychological prices differs widely across firms – i.e., grocery retailers do not follow one uniform pricing strategy.

There are interesting questions remaining for future research. It is not transparent why exactly psychological pricing points are viewed as important by grocery retailers. Survey results, similar to those by BLINDER et al. but within the retailing sector, could solve this puzzle.

Furthermore, it is most likely that there are other determinants of price rigidity in grocery retailing than the importance of sales, psychological prices, and firm-specific effects. It remains a challenge to collect additional data, e.g. on the competitive situation or on menu costs, in order to test for other theories of price rigidity, too.

## Notes

- 1) Of course, this is a restricted view of psychological pricing. Price-setting by decision-makers may be related, e.g., to consumers' perception of product quality. It may be the objective to send out quality signals via prices in order to affect the consumers' behaviour independent of the objective quality of the product. Such behaviour would have to be included in a wider definition of psychological pricing.
- 2) See, e.g., BLATTBERG/NESLIN (1990, pp. 349 et seq.) for a survey of the importance of psychological pricing in retailers' promotional activities.
- 3) Several U.S. studies are based on the so-called BLS data of the Bureau of Labor Statistics, e.g., BILS/KLENOW (2002). These data are the basis for the consumer price index and include prices on 70,000 to 80,000 non-housing goods and services per month, collected from around 22,000 outlets across 88 geographic areas. An information on "no price change" is also available that can be used as one indicator of price rigidity.
- 4) Here and in the following analysis in Section 5, the following assumption has been made. *PRIG* is set to 200 by assumption in those two cases where brands were distributed in all six firms but no price changes did occur in one of these firms: brand 7/firm *D*; brand 20/firm *E*. It would have been a distortion to leave the two cases with the highest price rigidity out. It would have been a distortion, too, to insert the value infinity which the equation (1) for *PRIG* yields in these two cases, if an infinitesimal value rather than zero is introduced for the number of price changes.
- 5) When we start from a statistical significance level of 95% or more, *CR2* is positively correlated with *PRIG* in firms *A*, *B*, and *D*. *CR2* is negatively correlated with *INST* and *ACTIONS* in firms *A*, *B*, *D*, and *E*. A high unit price is strongly negatively correlated with a low *CR2* and vice versa in firms *A* and *E*, i.e. in two firms with very different levels of price rigidity. In all six firms, *ACTIONS* is positively correlated with price instability and negatively with price rigidity.
- 6) There is some additional evidence in HERRMANN/MOESER/WEBER (2004) which deals with price rigidity within an equation system. The results support the view of *PRIG* being the endogenous and not an exogenous variable.

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## Appendix 1: Foods Brands Included in the Statistical Analysis

Brand	Description	Brand Name
1	170g-bottle of coffee cream with 12% fat	Baerenmarke "Feine 12", 170g
2	170g-bottle of evaporated milk with 8% fat	Baerenmarke Kaffeeraum 8%, 170g
3	Nine-piece-package of frozen rolls	Coppenrath & Wiese "Unsere Goldstuecke", 9 Stueck
4	500g-package of ground coffee	Dallmayr Prodomo, 500g
5	Package of four bottles at 100g of a probiotic drink	Danone Actimel Drink Classic, 4x100g
6	500g-package of butter toast	Golden Toast Butter Toast, 500g
7	Eight-piece-package of warm up rolls	Golden Toast Sonntagsbroetchen, 8 Stueck
8	200g-tin of cappuccino with 10g milk chocolate	Jacob's Café Zauber Cappuccino, 200g plus 10g Milkschokolade
9	375g-package of cornflakes	Kellogg's Cornflakes, 375 g
10	250g-piece of Irish butter	Kerrygold Original Irische Butter, 250g
11	1l-bottle of fresh milk with 3.8% fat	Landliebe Landmilch 3.8%, 1l
12	500g-package of full corn bread	Lieken Urkorn "Das Vollkorn-Saftige", 500g
13	500ml-beaker of chocolate drink	Muellermilch Schoko, 500ml
14	375g-package of breakfast cereals	Nestlé Cini Minis, 375g
15	375g-package of muesli-like breakfast cereals	Nestlé Nesquik fuer ein Knusperfruehstueck, 375g
16	400g-glass of nut-and-chocolate cream	Nutella, 400g
17	500g-beaker of margarine	Rama, 500g
18	450g-glass of strawberry jam	Schwartau Extra Erdbeerkonfituere Extra, 450g
19	Package of 25 tea bags	Teekanne Teefix, 43.75g, 25 Teebeutel
20	150g-package of crispbread with chocolate	Wasa Schoko Wikinger, 150g

Source: Own compilation.

**Appendix 2: The Distribution of Psychological Prices for the Ground Coffee Brand in the German Scanner Data (Brand 4: Dallmayr Prodomo, 500g)<sup>a)</sup>**

Most Important Psychological Prices (DM)	Percentage Shares of Psychological Prices in Various Grocery-retailing Firms					
	A (n = 525)	B (n = 1264)	C (n = 707)	D (n = 1115)	E (n = 561)	F (n = 974)
7.99		11.4				
8.49						6.3
8.79				6.9		
8.97						7.2
8.99		24.4	26.6	14.9	20.7	15.5
9.49	21.1	6.3	10.9	6.5	21.4	
9.98		6.8	10.5			
9.99	39.0	18.5	23.5	35.5		42.3
10.49		10.0	11.6	22.7	25.8	14.3
10.79	28.0				25.8	
10.99	6.5					
<b>Sum of the Psychological Prices (%)</b>	<b>94.6</b>	<b>77.4</b>	<b>83.1</b>	<b>86.5</b>	<b>93.7</b>	<b>85.6</b>
<b>Number of Different Prices</b>	<b>17</b>	<b>104</b>	<b>30</b>	<b>37</b>	<b>13</b>	<b>24</b>

a) All prices are included which account for 5% or more of all prices in the six grocery-retailing firms.

Source: Authors' computations with MADAKOM data.

**Appendix 3: The Distribution of Psychological Prices for the Crispbread with Chocolate in the German Scanner Data (Brand 20: Wasa Schoko Wikinger, 150g)<sup>a)</sup>**

Most Important Psychological Prices (DM)	Percentage Shares of Psychological Prices in Various Grocery-retailing Firms					
	A (n = 497)	B (n = 1141)	C (n = 598)	D (n = 586)	E (n = 455)	F (n = 664)
2.69		12.4				
2.79	83.1	53.0		54.3	100	67.0
2.85			13.4			
2.98			5.5			
2.99	16.5	31.5	74.9	45.4		30.4
<b>Sum of the Psychological Prices (%)</b>	<b>99.6</b>	<b>96.9</b>	<b>93.8</b>	<b>99.7</b>	<b>100</b>	<b>97.4</b>
<b>Number of Different Prices</b>	<b>4</b>	<b>14</b>	<b>9</b>	<b>4</b>	<b>1</b>	<b>4</b>

a) See footnote a), Appendix 2.

Source: See Appendix 2.

**Appendix 4: Important Prices with other Endings than Digit 9, 20 German Food Brands, 1996-99<sup>a)</sup>**

<b>Price (DM)</b>	<b>Brand</b>	<b>Firm</b>	<b>Share of All Observed Prices for the Brand in the Respective Firm (%)</b>
1.15	13	<i>E</i>	16.4
1.65	11	<i>D</i>	28.4
2.25	17	<i>A</i>	8.1
2.85	20	<i>C</i>	13.4
2.85	18	<i>D</i>	23.1
0.97	13	<i>D</i>	12.8
1.37	13	<i>F</i>	9.3
1.87	17	<i>F</i>	15.4
1.97	17	<i>F</i>	15.8
2.47	3	<i>F</i>	8.5
3.47	9	<i>F</i>	6.9
3.77	19	<i>F</i>	6.5
3.77	9	<i>F</i>	18.9
8.97	4	<i>F</i>	7.2
1.98	17	<i>E</i>	18.5
2.88	18	<i>C</i>	6.8
2.98	20	<i>C</i>	5.5
9.98	4	<i>B and C</i>	6.8 and 10.5

a) All prices are included that do not end at digit 9 and have a share of all observed prices for the brand in the respective firm of 5% or more.

Source: Authors' Computations.

**Appendix 5: Determinants of Price Rigidity, German Food Brands, Alternative Models<sup>a)</sup>**

Explanatory Variables	Estimated Coefficients				
	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	46.4257*** (10.64)	-61.0614*** (-412)	-29.3988 (-1.52)	-33.0158 (-1.60)	-26.0260 (-1.33)
<i>ACTIONS</i>	-0.3891*** (-5.32)		-0.2030* (-2.45)	-0.2069* (-2.48)	-0.2292* (-2.34)
<i>CR2</i>		1.1789*** (6.36)	0.8766*** (4.00)	0.8894*** (4.02)	0.8217** (3.56)
<i>PRICE</i>				0.8200 (0.54)	
<i>DUMMY A</i>					-7.2165 (-0.79)
<i>DUMMY B</i>					-6.6416 (0.67)
<i>DUMMY E</i>					12.2927 (1.30)
$\bar{R}^2$	0.20	0.27	0.30	0.30	0.31
<i>F</i>	28.32***	40.39***	24.16***	16.09***	10.54***

\*\*\*, \*\*, \*, [\*] Statistically significant at the 99.9 %-, 99 %-, 95 %-, 90 %-level.

a) The variables are defined in the text. For the data sources, see the text, too. Only those 18 products are included which are distributed in all firms ( $n = 18$ ). Values in parentheses are  $t$  values.

Source: Authors' computations.

**Appendix 6: Marginal Changes in Price Rigidity Due to a Change in the Number of Price Actions and a Change in Psychological Pricing<sup>a)</sup>**

Grocery-retailing Firms	Marginal Changes in PRIG Due to a Change in ...			
	ACTIONS	CR2	$\bar{R}^2$	$F$
<i>A</i>	-0.7275 (-1.28)	0.8097 (1.27)	0.22	3.40 <sup>[*]</sup>
<i>B</i>	-0.0872 (-1.18)	0.5312 (1.57)	0.29	4.49 <sup>*</sup>
<i>C</i>	-0.2654 <sup>***</sup> (-4.48)	-0.1119 (-0.84)	0.52	10.04 <sup>**</sup>
<i>D</i>	-0.9005 <sup>[*]</sup> (-2.09)	1.4356 <sup>*</sup> (2.17)	0.52	10.07 <sup>**</sup>
<i>E</i>	-4.4875 <sup>*</sup> (-2.43)	-0.046 (-0.00)	0.36	5.72 <sup>*</sup>
<i>F</i>	-0.2443 <sup>*</sup> (-2.58)	-0.1481 (-0.94)	0.22	3.35 <sup>[*]</sup>

\*\*\*, \*\*, \*, [\*] Statistically significant at the 99.9 %-, 99 %-, 95 %-, 90 %-level.

a) The variables are defined in the text. For the data sources, see the text, too. Only those 18 products are included which are distributed in all firms ( $n = 18$ ). Values in parentheses are  $t$  values. The regression equations for which the corrected coefficient of determination and  $F$ -values are presented contain a constant additionally.

Source: Authors' computations.