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Does money illusion matter? The impact of Euro on the vertical transmission of food price in Germany

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Abstract:

In this paper the impact of the introduction of the Euro on the vertical price transmission in German food markets is analyzed. It is hypothesized that the presence of money illusion might have lead to higher real prices as a result of the Euro, and if so it must be accompanied with a higher margin between the respective wholesale and retail price. While generally studies focus on the behavior of average prices, in this study the reactions of individual retailers are investigated. For lettuce and chicken the vertical price relationships between retail and wholesale prices are estimated by an error correction approach, which is extended to test for structural breaks with a flexible time frame. The results indicate no impact of the Euro for most of the retail stores. However, about every fifth grocery store did react to the new currency by generally increasing its mark up significantly. This leads to the conclusion that money illusion might have a significant impact on the real adjustment of prices.

Topic: Demand and Price Analysis

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Introduction

The introduction of the Euro in 2002 has received considerable attention in public and in academia. While people were more concerned about increasing marging, economists discussed the question whether Europe is an optimal currency area (De Grauwe 1994; Obstfeld & Peri 1998). Only few economic studies examined the impact of the Euro real prices (Aucremanne & Cornille 2001). Especially the publicly expected increase in retail margins has so far not been subject of detailed analysis. The theory behind such phenomenon is called money illusion.

Leontief (1936) defined money illusion as a violation of the 'homogeneity postulates', by which demand and supply functions are assumed to be homogenous of degree zero in all (nominal) prices. Shafir (1997) provides an interesting evidence for the potential significance of money illusion. According to his results consumer behaviour is affected by nominal prices. Fehr and Tyran (2001) run experiments to also show that money illusion is likely to affect the price adjustment process following a monetary shock, e.g. a deflationary shock leads to an increase the real prices. (see also Haitwanger and Waldman, 1989).

The introduction of the Euro provides a "natural" experiment to study the impact of money illusion. According to the theory, real prices (margins) are assumed to increase following the deflationary shock by the introduction of the Euro in Germany (1.95883 Deutsche Mark equals 1 Euro). This paper employs the natural experiment to analyze the impact of a monetary shock on the vertical price transmission in German food markets. We also discuss the timing as well as the duration of Euro-

induced food retail price adjustments. And unlike most studies, we use a unique data set containing of weekly food prices at the individual retail store level.

We choose two homogenous products, lettuce and frozen chicken, to run the analyses. An error correction model (ECM) approach is applied to quantify the vertical price transmission between retail and wholesale prices. A standard error correction model is expanded to capture potential structural break point triggered by the introduction of the Euro. Instead of using the date of the introduction of the Euro as a natural break point we endogenously determine the potential break points. Even though the average time series do not indicate a significant impact, the results for the individual stores' prices indicate significant reactions to the nominal shock. 20 percent of all stores show significant changes of the markup because of the Euro..

Potential impact of the Euro

The literature provides some theoretical basis for expecting a structural break in the retail price transmission following the introduction of the Euro.

"Attractive prices"

Converted to Euro, prices in national currency may not indicate psychologically attractive prices. Thus prices are rounded to a new "attractive" price level. Aucremanne and Cornille (2001) simulate price changes in the Belgian retail sector resulting from recalculations of all 'attractive' prices and psychological pricing points, respectively in national currency into Euro. They report slight positive effects on the consumer price index. However, the authors also mention factors such as competition on product markets, the prevailing demand conditions, and the commitments made by organisations representing the firm/retail sector that retrain

the possibility of rounding up. In addition, the authors emphasize the problem of isolating the Euro-induced rounding effects from 'regular' price changes. Similarly, Diller and Brambach (2002) analyse the extend of price adjustments towards a Euro-attractive price in the German retail sector around the year 2001/2002. They report that only 30% of the retail prices were converted into Euro-attractive prices, whereof less than 10 percent were rounded up. All in all, the authors did not find remarkable Euro-induced rounding effects and thus real price adjustments in the German retail sector due to the introduction of the Euro. Based on the results of the abovementioned studies we do not explicitly examine the argument of price increases due to adjustment to Euro-attractive prices since those results (show that rounding effects are rather small.

"Money Illusion"

The presence of money illusion might be an important source of Euro-induced retail price adjustments. Leontief (1936) defined money illusion as a violation of the 'homogeneity postulates', which stipulates that demand and supply functions are homogenous of degree zero in all (nominal) prices. Thus only relative price changes matter. Shafir et al. (1997) provided questionnaire evidence for the presence of money illusion. Their results suggest that preferences of people as well as their perceptions of constraints are affected by nominal and not only by real values. Moreover many people do also expect other peoples' behaviours to be affected by money illusion. Fehr and Tyran (2001) provided experimental evidence that money illusion affects the price adjustment process following a monetary shock. Brandstetter and Kehl (2002) empirically examine the Austrian beverage sector. Their results show different consumer demand responses to Euro prices when compared to

Schilling (national currency) prices.All these results indicate for a negative shock (smaller units) firms tend to increase real prices. This is particularly true, when firms believe that nominal prices of other firms are kept close to the pre-shock equilibrium (see also Haitwanger and Waldman, 1989). Similar, real price increases might be likely when consumers suffer from money illusion. This follows from a higher marginal willingness to pay in the case of a negative monetary shock (Brandstetter and Kehl, 2000). As in the case of menu costs, the presence of money illusion might lead to higher real food retail prices in Euro and thereby to increased retail margins.

In addition, because of the anticipated public debate on the impact of Euro, firms might have tried to veil their price reaction by anticipating or delaying it in time. It could also be possible that firms used the Euro introduction to generate or support their price image. Thereby it could be possible that the Euro introduction might have been accompanied by significant real price reductions at least for a limited period of time.[1]

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[1] Another argument is based on the impact of menu costs. Levy et al. (1997) and Dutta et al. (1999) provide a quantification of menu costs in US retail markets, demonstrating that they on average account for 27% to 35% of net profit margins. The introduction of the Euro might have affected such menu costs which in the following might have passed on to the consumer via retail price increases. The major part of these costs is attributable to the IT infrastructure, staff training and internal communication. Retailing differs from other branches in a larger proportion of costs incurred in modifying payment points, additional cash handling, special security measures and dual pricing. As these costs represent only 1% to 3% of the turnover (Müller-Hagedorn and Zielke, 1998) significant price impacts are not very likely. However, assuming retail stores act as price setter these adjustment costs lead to price increases in order to stabilize the profit margins at least in the short term. In addition supplementary charges, i.e. the difference between wholesale and retail prices, will increase ceteris paribus. Because of the share of menu costs (one to three percent of the price) is small and because food prices are adjusted regularly, no significant impact is expected.

Data

The data used for this study has been provided by the "Zentrale Markt- und Preisberichtstelle" (ZMP) in Bonn, Germany. To inform consumers and retailers about the developments in food retail prices, the ZMP has set up a price reporting system on a weekly basis. The ZMP maintains a network of roughly 450 so-called 'Melder' (melden = to report) who visit about 1,300 retail food stores in Germany and collect price data for a variety of standard fresh foods.[2] The sample is designed to represent the geographic regions and the type of stores with respect to their population values. Thus, the ZMP tries to reflect the relative weights of the region measured by its population and the number of store types for the underlying population in construction of the sample. Germany is divided into 8 geographic regions (see Appendix Figure A1) for this purpose, and retail stores are divided into 6 categories (small supermarkets (SSM: primarily food less than 400 square meter shopping area), big supermarkets (BSM: primarily food more than 400 but less than 800 square meter shopping area), combined supermarkets (CSM: food and other items more than 800 square meter shopping area), discounter (DC: primarily food with self service), butchers (BU), fruit and vegetable markets (FV)). In accordance to the relative weights given by the underlying populations with respect to regional, peoples', and store types' aspects the ZMP decides what kind of store from what region enters the sample.

To ensure the homogeneity of food products, the Melder are given detailed instructions on the quality of the product and the measure (price per piece or per kg).

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

The Melder decides on what day of the week she visits the stores to report on. Special offers are to be considered. The Melder fills out a standard sheet that is send back to the ZMP weekly. The ZMP does not publish individual store prices or any information on the price setting behaviour. Instead, on a weekly or monthly basis, average prices for regions and store types for all products are published. The data sent by the Melder are processed as follows by the ZMP prior to publishing[3]:

i) Removal of 'obvious outliers' (e.g. misplaced decimal points) by hand and removal of observations that deviate by more than 2.6 standard deviations from the mean. Roughly 1-2 % of the available observations are lost in this way.[4]

ii) Calculation of the unweighted average price for each store type within a region.

iii) Calculation of the regional average as a weighted average of the store type averages from ii), with weights equal to share of each store type in total purchases of the commodity in question.

iv) Calculation of the national average price for each store type as the weighted average of the store type averages from ii), with regional population shares as weights.

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[3] We use the unmanipulated data in our analysis.

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

v) Calculation of the national average over all store types as the weighted average of the regional averages from iii), with regional population shares as weights.

vi) Average product prices are only published if at least 100 observations were available over all store types and regions.

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

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

For our study we selected two out of the 56 food products available. As we focus on the price transmission behaviour during the introduction of the Euro we aim to get a

full panel data set. We first selected the food products by excluding the items that are only offered seasonally, such as cherries, by excluding the items that are only reported on a monthly basis, such as milk products. The remaining products can be classified into meat, fruits, and vegetables. We looked for food products that maximize the number of observations. Thereby we aimed to maximise the number of stores with a continuous reporting over time. We defined continuous price reporting by availability of price observations for each product in more than 94 % of all weeks in the sample. For the missing observations we set the price of the product in the week before. This entire selection process reduced the number of observations by about 80 percent. For the products under study we ended with retail price data for 142 stores in the case of chicken and retail price data for 169 stores in the case of lettuce. Prices are reported in German cent or pennies per kilogram, except for lattice and citrons for which prices are reported in cent or pennies per piece.

To study the vertical price transmission we secondly collected data for wholesale prices of lettuce and chicken. As prices at the wholesale level generally indicate a high level of market integration we use average wholesale prices in Germany to reflect buying in prices for retailers. These data are also available weekly and are also provided by the ZMP (2003). The average retail prices and the corresponding wholesale prices for the period from Jan. 2001 to April 2003 are shown in Figure 1.

Insert Figure 1 about here

Figure 1 shows no obvious structural break related to the introduction of the Euro occurs for the aggregate series. For the individual stores, information on the corresponding zip code (exact regional location), the type of the store (see above for

definition), the name of the store, and the company that owns the store are also available. The stores in our final sample belong to the following store type and companies. The real names of the companies have been suppressed and substituted for alphabetical letters by confidentiality reasons.[5]

Insert Table 1 about here

Modelling approach

As some of the data, e.g. the prices of chicken indicate non-stationary behaviour[6], we start with an error correction model (ECM) specification to analyze the price transmission process from wholesale to retail prices. In line with other studies, we assume that wholesale prices lead retail prices.[7] The general specification of the model we use is given in equation (1):

$$\Delta p_t^{R_i} = \alpha_0 + \gamma_1 p_{t-1}^{W} + \gamma_2 p_{t-1}^{R_i} + \sum_{n=0}^{K} \beta_n \Delta p_{t-n}^{W} + \sum_{n=1}^{L} \delta_n \Delta p_{t-n}^{R_i} + \varepsilon_t \qquad (1)$$

with t as a time index for each week and i as index for each individual retailer. The superscripts R_i and W indicate retail and wholesale prices, respectively. Allowing for individual price adjustment the lag-lengths K and L are determined by using the Akaike Information Criteria (AIC). The selected lags of contemporaneous price changes vary from 1 to 6 weeks in the case of the retailers selling chicken and from 1

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

[6] For reasons of brevity we do not present the results of the stationarity tests, but upon request we are pleased to provide them.

[7] See amongst others Kinnucan and Forker (1987), Boyd and Brorsen (1988), Pick et al. (1990), Griffith and Piggott (1994), Powers (1995), Brooker et al. (1997) and Worth (1999).

to 4 weeks in the case of those retailers that carry lettuce. In the case of chicken 142 price transmission processes between wholesale price and individual retail price are estimated and in the case of lettuce we estimate 169 of such relations.

To test whether the introduction of the Euro had an impact on the individual price spread between wholesale and retail prices, we introduced a dummy variable to estimate potential changes in the margin. For such purpose the ECM is estimated based on the following specification:

$$\Delta p_t^{R_i} = \alpha_0 + \alpha_1 D_t + \gamma_1 p_{t-1}^{W} + \gamma_2 p_{t-1}^{R_i} + \sum_{n=0}^{K} \beta_n \Delta p_{t-n}^{W} + \sum_{n=1}^{L} \delta_n \Delta p_{t-n}^{R_i} + \varepsilon_t \qquad (2)$$

D_t is a dummy variable with: $D_t = 1$ if $t_{start} \leq t \leq t_{end}$ and $D_t = 0$ otherwise. By means of this dummy variable, a structural change of the marketing margin between wholesale and individual retail prices can occur during the period $t_{start} \leq t \leq t_{end}$. Starting ($t_{start}$) and ending ($t_{end}$) points of the structural breaks are determined within a grid-search procedure. For each individual retailer a grid search is employed to result a specific period for structural change. The search procedure determines for each period, based on all possible starting and ending points, the critical F-values for significant structural breaks. Those periods are selected which maximise the F-value. The maximum F-value is selected for all potential combinations of starting and ending point of the structural break.

Empirical results

The final sample for the estimation of the structural break procedure explained in section 4 consists of prices of chicken (lettuce) for 142 (169) grocery stores and the two respective wholesale prices. The composition of the selected stores is shown in

Table 1. Most of the shops are combined supermarkets. The other groups are about equally distributed.

Because theoretically the impact of the Euro is supposed to vanish in time, the model allows the structural break to end sometimes. Thus, we estimate all combinations - besides some that have to be excluded due to reason of degrees of freedom - of starting and ending point over a symmetric sample around the Euro introduction in the first week of January 2002. Therefore the estimation procedure results a starting point (t_{start}), and ending point (t_{end}) and the estimator for the structural break dummy. From these estimations we obtain the results for the most likely structural break, which has now to be related to the introduction of the Euro. Instead of using the time of introduction of the Euro as a natural break point (starting point) we opt for a more flexible model as the market participants had full information about the currency introduction. To veil the direct impact of the Euro from the public and/or consumers, stores might have reacted to the new currency before or after its introduction. Therefore it has to be determined what time frame of a significant reaction is still indicating a relationship to the introduction of the Euro. We assume structural breaks related to the introduction of the Euro have to start in the period 4 months prior or post the official introduction of the Euro. Employing this rule, we obtain 25 Euro related structural breaks in the case of chicken and 39 in the case of lettuce. That is about 20 percent of the stores indicate a structural break which is related to the Euro. From the theory we expect in most cases that the margin between

retail and wholesale prices increase during this structural break[8]. Indeed the estimator for the dummy variable is positive in 84 (67) percent for chicken (lettuce). Also do these coefficients indicate economic significance as the margins increased by 15 to 130 Euro cents in the case of chicken and 36 to 188 Euro cents in the case of lettuce.[9] Figure 2 shows an example for an individual store price series which indicated a Euro related structural break. It is clearly seen that this store charges from 2001 up to spring 2002 often above normal prices compared to the other periods. These price increases are not related to cost changes as the wholesale prices do not show this behaviour (see Figure 1 compared to 2). Therefore, the margin between the two prices indicates almost the same pattern as the retail price in this case and thereby, the structural break was initiated by the departure of the retail prices. A similar picture can be drawn for a margin of an individual store for lettuce (see Figure 4).

Insert Figure 2 about here

In the case of chicken the Euro-related structural breaks show almost equally distributed starting points over the period from 4 month prior and 4 month post the Euro introduction[10]. For lettuce half of the structural breaks started closely (5 weeks prior and 5 weeks after January 1. of 2002) to the date of the official begin of the Euro

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[8] Except for theory that firms use the introduction of the Euro to reemphasize their low price strategy, we expect a raise in margin due to money illusion or menu costs.

[9] The upper end make between 50 and 100 percent of the average retail price.

[10] From the 25 stores that indicate an Euro related structural break 9 started more than 5 weeks before January 2002 and 6 more than 5 weeks after that date. The rest appeared in the remaining period 5 weeks prior to 5 weeks after January 1. of 2002.

currency. The average time span of the structural breaks is between 21 (lettuce) and 24 (chicken) weeks. Thus, we find that the potential impact of the Euro resulted in most cases in an increase in the margin that vanished on average after 6 month. The increase during the periods of the structural break was significant on average and varied significantly between stores too. The range in the case of chicken (lettuce) is 15 to 125 (18 to 90) Euro cent, which makes on average 40 to 60 % of the retail price level.

Because of the limitations in sample size, the differences in the occurrences of structural breaks (Euro-induced) between the different chains cannot be interpreted any further here. Table 2 indicates for chicken that Euro induced structural breaks appear most often (relatively) for small supermarkets (SSM) and combined supermarkets (CSM). Only one Discounter was found that showed a Euro induced break with a small positive value for the dummy variable estimate. The picture for lettuce is different as here the DC indicated the most Euro induced breaks. In the spatial dimension we find (see Table 3) the tendency that Euro induced structural breaks are found less often in Eastern Germany (Regions 6 to 8).

Insert Table 2 and 3 about here

Finally the cross correlations between the length of Euro induced structural breaks and the size of the estimator of the Dummy variable show some interesting features (Figure 5). While for chicken we observe a slight positive correlation, lettuce indicates a significant negative one. The latter means that increases in the margin for lettuce only endured for a short time interval. Thus the shops used the Euro introduction to

either exploit market power for a short time or reemphasised their low price strategy for a longer time period.

Insert Figure 3 about here

Conclusions

This study empirically examines the impact of the Euro changeover on wholesale-retail price transmission in the German food retail sector. It is hypothesized that money illusion can cause real price effects of a nominal shock, for example the introduction of the Euro in Germany in January 2002. Experimental studies have shown the potential significance of this effect in the real world. In this study we employed a panel of food retail price data from Germany grocery stores to investigate the impact of the nominal shock following the introduction of the Euro.

Though on average no significant impact is detected, the individual price series show significant reactions. In 20 percent of all stores the vertical price relationship between wholesale and retail prices did change around the date of the introduction of the Euro Germany. Most of the detected structural breaks indicate significant increases in the retail margins, which is consistent with the money illusion theory.

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Figures and Tables

Tab. 1: Number store types and retailer companies in the sample for chicken and lettuce

Chicken				Retailer chain				
	Total	A	B	C	D	E	F	Other
SSM	29	13	9	6	0	1	0	0
BSM	28	6	6	7	2	3	0	4
DC	24	1	1	6	8	0	7	1
CSM	61	13	4	10	3	18	3	10
Total	142	33	20	29	13	22	10	15

Lettuce				Retailer chain				
	Total	A	B	C	D	E	F	Other
SSM	24	8	9	5	1	0	0	1
BSM	44	8	6	9	4	7	0	10
DC	37	1	1	8	9	0	12	6
CSM	64	11	4	12	3	18	4	12
Total	169	28	20	34	17	25	16	29

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

Source: Data by ZMP, 2003.

Tab. 2: Number of Euro related structural breaks by store type and chain

Chicken	Retailer chain							
	Total	A	B	C	D	E	F	Other
SSM	7	3	3	1	0	0	0	0
BSM	5	3	0	2	0	0	0	0
DC	1	1	0	0	0	0	0	0
CSM	12	2	2	3	0	4	1	0
Total	25	9	5	6	0	4	1	0

Lettuce	Retailer chain							
	Total	A	B	C	D	E	F	Other
SSM	8	2	4	2	0	0	0	0
BSM	7	1	1	1	0	3	0	1
DC	12	0	0	2	4	0	4	2
CSM	12	2	2	1	1	4	0	2
Total	39	5	7	6	5	7	4	5

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

Source: Data by ZMP, 2003.

Tab. 3: Number of Euro related structural breaks by region

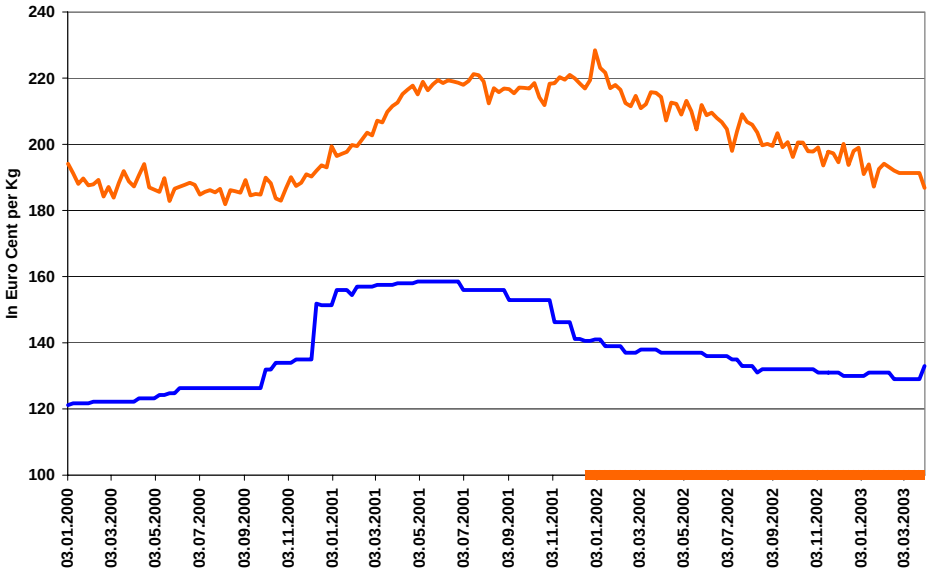
	Region							
Chicken	1	2	3	4	5	6	7	8
Number of stores	30	23	19	5	22	15	15	13
Structural breaks	4	6	5	1	5	2	1	1
Lettuce	1	2	3	4	5	6	7	8
Number of stores	42	30	21	7	25	13	14	17
Structural breaks	8	7	8	3	7	1	2	3

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

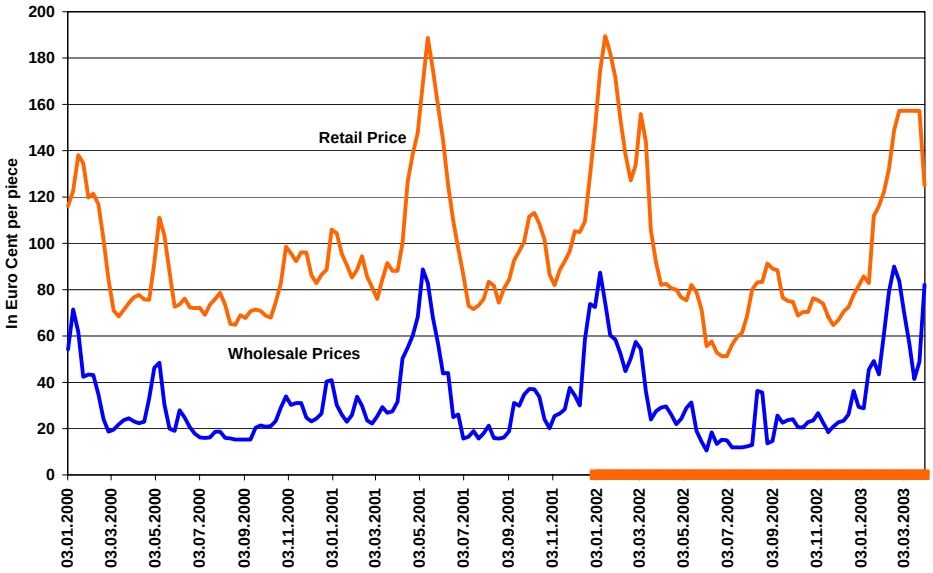
Source: Data by ZMP, 2003.

Fig. 1: Average retail and wholesale prices for chicken and lettuce

Chicken



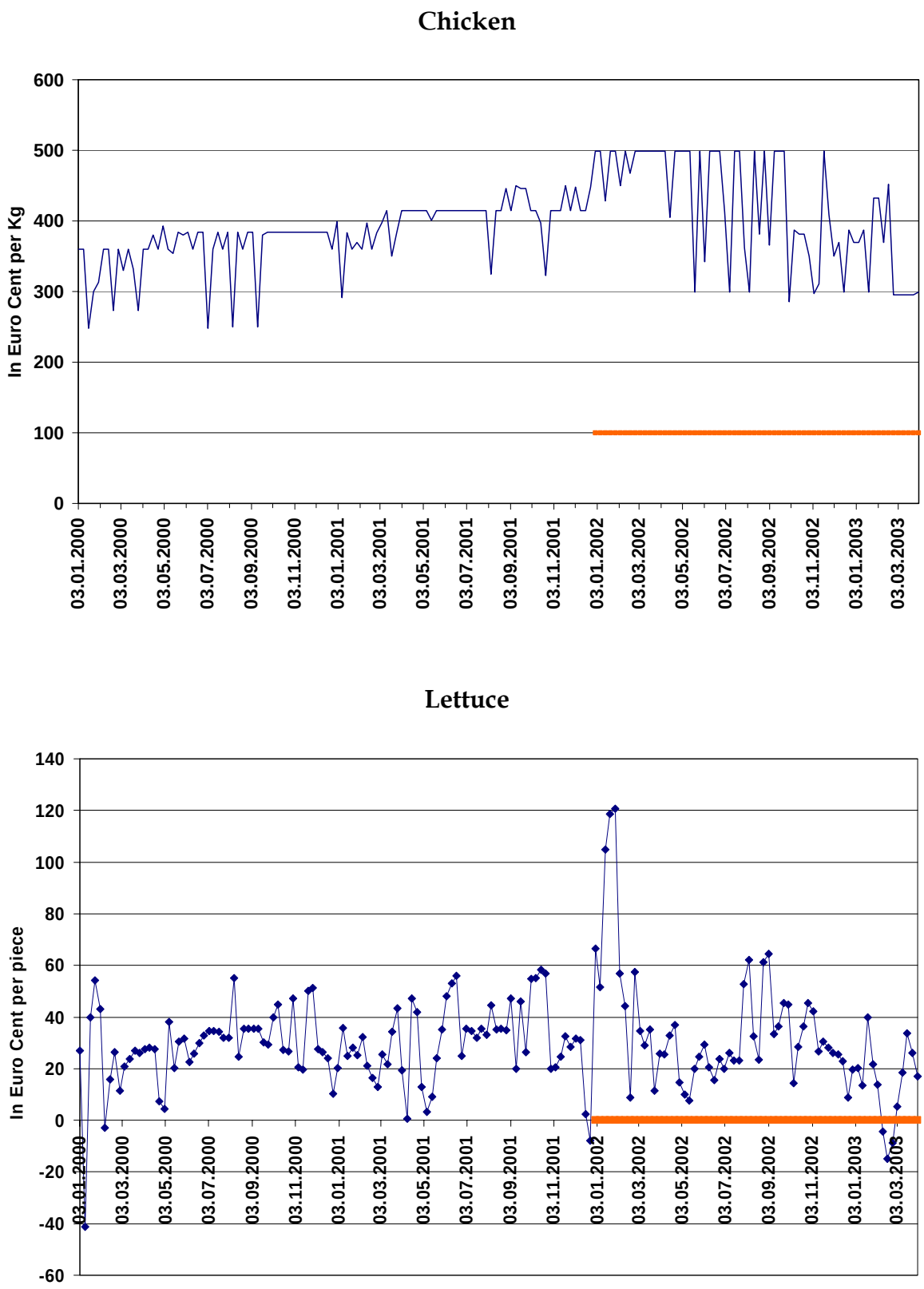
Lettuce



Notes: The thick line marks the official introduction of the Euro in January 2002

Source: Data by ZMP, 2003.

Fig. 2: Example for a store with an Euro related structural break in prices

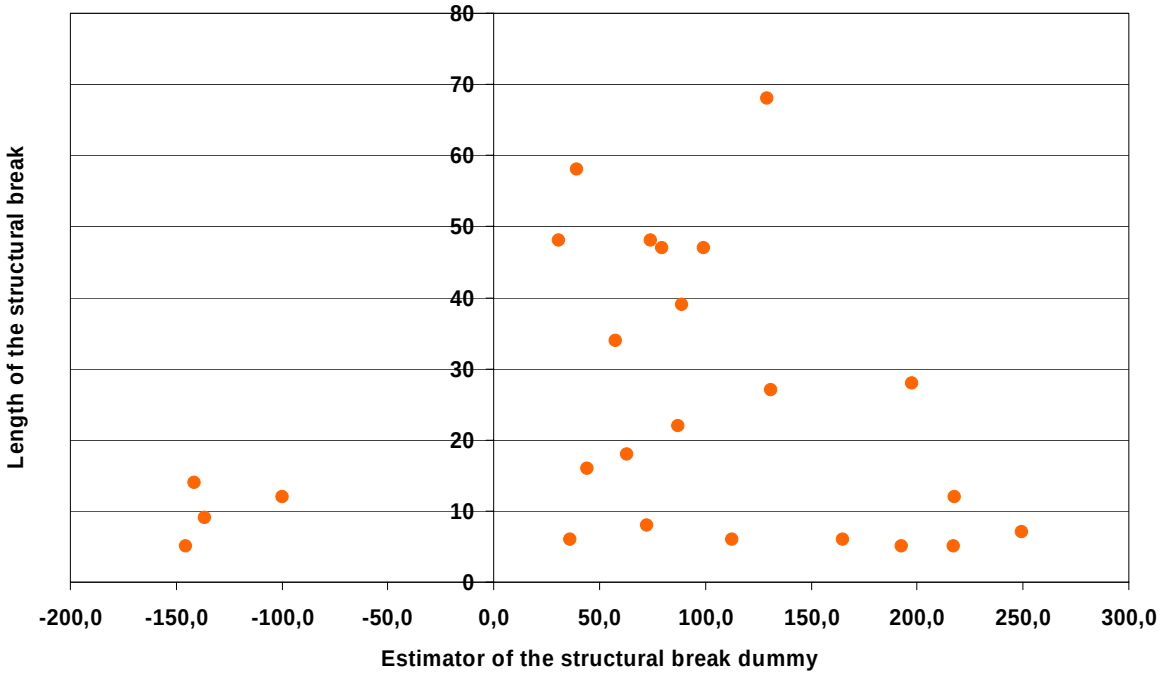


Notes: The thick line marks the official introduction of the Euro in January 2002

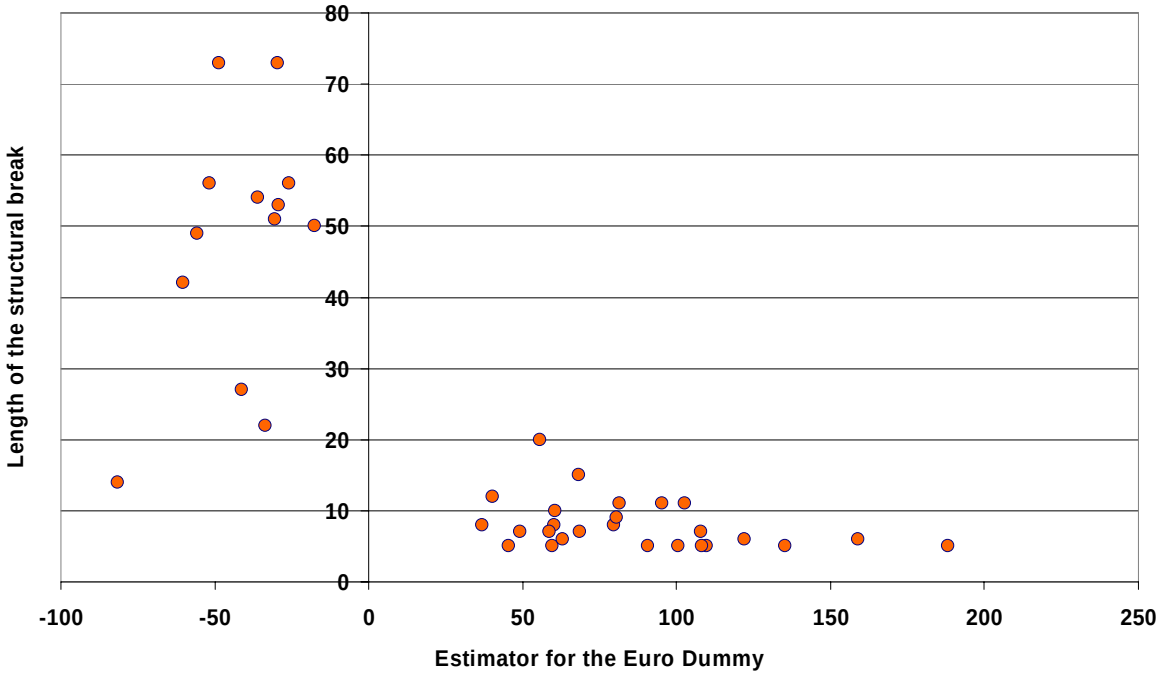
Source: Data by ZMP, 2003.

Fig. 4: Relationship between the length of the Euro related structural break in prices and the magnitude of the estimated break dummy

Chicken



Lettuce



Source: Data by ZMP, 2003.