Does a common currency lead to (more) price equalization? The role of psychological pricing points

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Abstract

We analyze prices from 4 countries around the introduction of the euro. Prices of a good in two locations are more likely to be identical if prices are psychological and set in the same currency. These rounding effects are not important in explaining the size of price differences in the full sample however.

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Introduction

Are price differences between two locations lower if they share the same currency? It appears that the answer is yes and that a common currency has a much greater impact on price differences than a fixed, but adjustable, exchange rate does (Engel, 2002, Parsley and Wei, 2001, Friberg, 2003).[1] However, the reasons for this result are not well understood. Uncovering these mechanisms is important for predicting the impact of a monetary union and thus for the relative benefits of different exchange rate regimes. This paper examines one such mechanism using unique price data on a large number of well-specified products (such as

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[1] Arguably, it is not sharing the same currency per se that matters, but rather a perfectly credible fixed exchange rate fixed at 1:1. Several authors have reported smaller price differences between Belgium and Luxembourg than for other country pairs (e.g. Mathä, 2003), despite the fact that these two countries did *de jure* not share the same currency. However, their currencies were without interruption fixed at an exchange rate of 1:1 since 1944 and they constituted a *de facto* currency union.

Kellogg's Cornflakes, 500 gr. carton) from 5 closely located supermarkets in 4 different countries (Belgium, France, Germany, Luxembourg) at five occasions before and after the introduction of euro notes and coins (the data cover October 2001 through April 2003).

Let us briefly outline the mechanism that we focus on. It is well documented that a large share of retail prices are either psychological (for instance ending in .99 or .98) or fractional (ending in .50 for instance). Assume that prices are set such that the firm first decides on the optimal approximate price, say 20 euros, and in a second stage chooses a psychological price that is close to this, say 19.95 euros. Clearly, psychological prices set in different currencies will be equal to each other only by chance even if demand and cost conditions are otherwise identical. As an example, consider the cover prices of the magazine The Economist. In December 2001 it cost 9.50 Guilders in the Netherlands and 29 Francs in France. Thus, the price in France (equivalent to 4.42 euros) was 2.3 percent higher than the price in the Netherlands (4.32 euros). One month later, after the introduction of the Euro notes and coins among EMU members, the prices were identical at 4.35 euros. At first sight, it might seem farfetched that these rounding effects can be important for deviations from the law of one price. We argue that it is a question worthy of investigation however, since much of the evidence on price differences comes from relatively cheap goods, where such rounding effects may matter.[2] Indeed, the European discussion on price effects of EMU has focused on the rounding up of relatively cheap consumer products such as a can of soda for which the price effects often have been quite substantial. Why firms use psychological prices is an interesting area for research (see for instance Basu, 1997). Here we simply describe the pricing behavior in supermarkets around the natural experiment provided by the introduction of euro notes and coins in January 2002.

Data

Prices of about 100 goods were collected by one of the authors in different stores in October 2001, December 2001, February 2002, April 2002 and April 2003 (all stores were visited within the same week). The products are listed in the appendix. Not all goods and package sizes were available at each time yielding an unbalanced panel. The visited supermarkets are: *Auchan* (Luxembourg), *Auchan* (Metz, France), *Carrefour* (Arlon, Belgium), *Cora* (Messancy, Belgium) and *Extra* (Trier, Germany). We expect relatively small price

[2] For instance The Big Mac index collected by The Economist and used as a standard example in undergraduate textbooks or indeed the cover prices of The Economist (Goldberg and Knetter, 1997).

differences given that the prices are collected in neighboring regions with much cross-border interaction. The distances between the supermarkets range from 8.6 to 103.0 kilometers with an average distance of 63 kilometers. The whole region has been a part of the European Community since its founding and the locations are quite closely integrated in many ways. The one notable factor that may point to important price differences is that per capita income is substantially higher in Luxembourg than in the surrounding regions.[3] Until the introduction of the euro notes and coins in January 2002 all prices had to be paid for in local currency; French francs, German marks and Belgian/Luxembourg francs (Belgium and Luxembourg had a *de facto* currency union with an exchange rate of 1:1 since 1944). Converting these prices into euro entails dividing the local currency prices by 6.55957, 1.95583 and 40.3399, respectively. The data set is described in more detail in Mathä (2003) who shows that even in such a narrowly defined geographical area increasing transaction costs, proxied by distance and borders, lead to increased deviations from the law of one price.

We define a psychological price as one that ends in 9, 95 or 98. Fractional prices are defined as prices ending in 0 or 5. In April 2003, on average across supermarkets, 35 percent of prices were considered to be psychological and a further 25 percent were considered to be fractional. The focus of the paper is to understand price differentials across locations. We therefore describe these price differences in Table 1 (all prices are converted into euro for this purpose). We include only comparisons where the package size is identical in both locations. In the first row of Table 1, we present the values corresponding to various percentiles across all the periods. The median price difference is relatively modest at some 9.8 percent.

[Table 1 about here]

In the second and third rows we summarize deviations in the first and last period, noting that the price differences on the whole are somewhat lower in the last period. To capture the role of psychological and fractional prices we create a number of dummy variables. PSYCH_SAM is one if prices in both locations are psychological and set in the same currency (euro after January 2002 or in BEF/LUF before the introduction of the euro) and zero otherwise. PSYCH_DIF is the case where both prices are psychological but set in different currencies. FRACT_SAM and FRACT_DIF are defined analogously but refer to the case when both prices are fractional. The interaction between psychological prices and price deviations is salient. Prices are identical in more than 10 percent of the comparisons in which both prices

[3] In 2001, the monthly gross wage per employee was EUR 3816 in Luxembourg and EUR 3112 in the neighboring German region (Rhine-Palatinate) with the wages in the French and Belgian regions of Lorraine and Wallonia slightly lower yet.

are psychological and expressed in the same currency. Conversely, when the compared prices are psychological prices and expressed in different currencies, not a single observation is exactly zero. A similar pattern holds for FRACT_SAM and FRACT_DIF. Of course, important patterns may be hidden to the naked eye and appear only when we correctly account for other factors influencing price differences. Also, there is no obvious relationship between price differentials and pricing points for positive deviations. The overall importance of pricing points is therefore an open question. For that reason we proceed to an econometric investigation.

Price differences

In the first specification (1), we estimate the probability that a price deviation is zero. As explanatory variables in our Probit regression we use PSYCH_SAM, FRACT_DIF and FRACT_SAM.[4] In the specification (2), we also include a dummy if both supermarkets are located within the same country (SAME COUNTRY) and if one of the observations is in Luxembourg and the other in Belgium (BEL_LUX) as well as time period dummies. Specification (3) and (4) use a Random effects model, which is preferred to the simple pooling, as indicated by the Likelihood Ratio statistic. The used stratification variable aims to control for as much cross-sectional variation as possible. For each product supermarket-pair, we include a separate dummy variable. Specification (4) may be seen as an additional robustness check, as it only includes prices that were observed on all five occasions.

The results confirm our expectation insofar that psychological prices displayed in the same currency are more likely to be identical (PSYCH_SAM>0). A corresponding effect appears for FRACT_SAM in specification (1) but in contrast to the effect for PSYCH_SAM it is not robust across specifications. Being located in the SAME COUNTRY and in BEL_LUX significantly increases the probability of observing identical prices, although this last effect is not significant in specification (4). Thus, the results support the idea that psychological prices indeed have a role to play in understanding deviations from the law of one price.

We now turn to the wider question if psychological pricing influences the overall size of deviations, from the law of one price, in our sample. One could hypothesize that psychological pricing policies reduce price deviations, even if they do not lead to exactly equal prices. For instance some firms might round to 9.99 and others to 9.95 or 9.90. In

[4] There were no cases of equal prices where PSYCH_DIF was equal to one and thus it had to be dropped from the regression.

specification (5), (6) and (7), we examine if pricing points are significant for the *size* of deviations and use the absolute size of price differentials as dependent variable. In specification (5) we include dummy variables for individual supermarket pairs, goods and time periods and estimate the regressions with these fixed effects. Our reason for using this approach is that we are interested in the point estimates for several of the dummies - which supermarket pair and what types of goods have lower price differentials? The coefficients on pricing points are not significant except PSYCH_DIF, which enters in specification (5) with the opposite sign relative to our expectations. This result is, however, not robust across specifications and appears to be driven by outliers. Specifications (6) and (7) use the corresponding dummies and sample as specifications (3) and (4). The coefficients on the time periods (not reported) are negative in specification (5) and point to decreasing price differences. This also appeared to be present in the raw data in Table 1. The time effects are weak however and are not significant in specifications (6) and (7). In Table A1 in the appendix we list the store pair and product dummies of specification (5). The base store comparison is between *Auchan* in Metz and *Extra* in Trier, which are the furthest apart. It is therefore not surprising that all the pairs, which had a significantly different effect, had lower deviations from the law of one price. The smallest deviations are reported for the two closest stores (*Carrefour* and *Cora*) and the two belonging to the same chain (*Auchan* in Luxembourg and in Metz). Concerning the individual products we left Whiskas without a dummy. Since Whiskas had relatively small deviations from the law of one price most of the significant deviations are larger. One can try to relate these deviations to transportability, taste differences and other brand specific variables, but that remains outside the scope of this study.

Conclusions

Using the natural experiment of the euro introduction we show that the prices of a good in two locations are more likely to be the identical if prices are psychological and set in the same currency. We thus confirm the existence of one channel, that links price equalization to a common currency, which is not present when countries use different currency units. On the whole, however, this mechanism was not important for explaining price differentials in a large sample of supermarket goods. The results can thus be viewed as comforting for traditional economic analysis; while psychological prices are a common phenomenon and matter for some goods, the deviations from the law of one price in a large sample of goods are not systematically related to these rounding effects. Rather price differentials are likely to be

linked to the issues where textbooks tell us to look, cost and demand conditions, as well as the costs of arbitrage.

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Table 1. Descriptive statistics over absolute price differences* between locations, in percent

PERCENTILE	1	5	10	25	MEDIAN	75	90	95	99	#OBS
All OBS.	0	.56	1.57	4.17	9.86	18.57	27.69	33.97	61.41	2366
OCTOBER-01	0	1.00	1.78	4.63	10.48	20.20	27.93	34.13	61.41	430
APRIL-03	0	.32	1.01	4.00	9.67	17.31	26.34	34.36	52.42	444
PSYCH_SAM	0	0	0	5.06	11.81	21.31	28.97	33.66	35.07	112
PSYCH_DIF	.78	.98	1.54	4.00	9.71	16.70	27.78	31.23	44.90	71
FRACT_SAM	0	0	1.48	3.97	9.78	18.61	15.13	28.46	34.63	146
FRACT_DIF	0.15	1.16	2.66	5.41	10.23	19.70	26.73	28.97	44.59	168

* Absolute Price differences are defined as abs(ln(price of good j in location k at time t)-ln(price of good j in location m at time t))

Table 2. Deviations from the law of one price.

SPECIFICATION	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DEP. VARIABLE	PDIFF=0	PDIFF=0	PDIFF=0	PDIFF=0	|PDIFF|	|PDIFF|	|PDIFF|
ESTIMATION TECHNIQUE	PROBIT POOLED	PROBIT POOLED	PROBIT RE	PROBIT RE	OLS FE	OLS FE	OLS FE
SAMPLE	ALL	ALL	ALL	BAL	ALL	ALL	BAL
NO. OBS	2366	2366	2366	1435	2366	2366	1435
PSYCH_SAM	0.763 ***	0.959 ***	1.401 ***	1.716 ***	0.004	0.005	0.001
	0.156	0.176	0.290	0.417	0.009	0.007	0.008
FRACT_SAM	0.283 *	0.135	0.202	-0.003	-0.009	-0.010	-0.008
	0.163	0.222	0.302	0.366	0.009	0.007	0.008
PSYCH_DIF				0.008	-0.036 **	0.006	0.010
				0.654	0.014	0.008	0.015
FRACT_DIF	-0.594 *	0.203	0.121		0.003	-0.001	0.002
	0.357	0.408	0.600		0.008	0.006	0.007
SAME COUNTRY		1.306 ***	2.003 ***	2.030 ***			
		0.156	0.339	0.473			
BEL-LUX		0.846 ***	1.080 ***	0.580			
		0.155	0.291	0.436			
STRATIFICATION VARIABLES							
PERIODS	NO	YES (5)	YES (5)	YES (5)	YES (5)	YES (5)	YES (5)
PAIRS	NO	NO			YES (9)		
PRODUCTS	NO	NO			YES (92)		
PRODUCT PAIRS	NO	NO	YES (545)	YES (287)		YES (545)	YES (287)
R^2-ADJUSTED					0.42	0.79	0.77
PSEUDO R^2	0.045	0.183					
WALD χ^2	29.8***	110.3***	48.2***	26.7***			
LRTEST OF RHO=0			52.6***	31.3***			

Note: RE and FE denote Random and Fixed Effects estimation. Fixed effect estimation with robust standard errors. Sample BAL refers to the balanced sample, meaning that the product in the respective supermarket is observed all 5 times. This does, however, not induce balancing of the products across supermarkets. Standard errors in lower case letters below coefficients. ***,**, * denotes significance at the 1%, 5% and 10% level of confidence, respectively.

Table A1: Estimates for product and supermarket pairs: Specification (5) in Table 2

Supermarket Pairs				Supermarket Pairs			
Arlon_Carrefour	Messancy _Cora	-0.076	***	Messancy _Cora	Metz_Auchan	-0.038	***
Arlon_Carrefour	Lux_Auchan	-0.017	*	Messancy _Cora	Trier_Extra	0.004	
Arlon_Carrefour	Metz_Auchan	-0.027	***	Lux_Auchan	Metz_Auchan	-0.054	***
Arlon_Carrefour	Trier_Extra	0.009		Lux_Auchan	Trier_Extra	0.007	
Messancy_Cora	Lux_Auchan	-0.028	***	Metz_Auchan	Trier_Extra	Base	

Product Name		Product Name		
Calgon, Antikalk	-0.057 *	Tipp Ex Papid	0.025	
Uncle Ben's long grain, 500 gr	-0.051 *	Nivea Crème	0.026	
Bahlsen Schoko Leibnitz	-0.045	Toblerone	0.027	
Ariel Essentiel	-0.04	Mars Icecream	0.028	
Head & Shoulders	-0.038	Pritt Stick	0.03	
Gillette Razor Mach 3, 4 blades	-0.036	Nivea Crème soft	0.032	
Persil	-0.034	Coca Cola, 2 l	0.033	
LU Tuc	-0.033	Sugar	0.034	
Kinderschokolade	-0.032	Martini Bianco, regular bottle	0.036	
Melitta filter, 80 pieces	-0.032	Minute Maid	0.043	
Mr Proper citrus	-0.032	Colgate Total fresh stripe	0.049	
Ritter Sport	-0.032	Campari	0.05	
Tampax	-0.032	Schweppes	0.05	
Gillette Razor Mach 3, 8 blades	-0.028	Hoegaarden	0.052	
Mars	-0.026	Canderel 300	0.058 *	
Bailey's	-0.025	Hansaplast	0.059 *	
Granini	-0.025	Coca Cola, 1.5 l	0.066 **	
Bounty	-0.024	Heineken	0.066	
After Eight	-0.021	Leffe Blonde	0.07 **	
Martini Bianco, 1.5 l bottle	-0.02	Coca Cola, 1 l	0.071 *	
Cote d'Or	-0.015	Nivea Deo roll-on	0.074 **	
Cointreau	-0.014	Kellogg's Cornflakes, 375 gr	0.077 **	
Melitta filter, 100 pieces	-0.01	Canderel 100	0.081 **	
Milka	-0.009	Kellogg's Cornflakes, 750 gr	0.082 *	
OB Tampons	-0.008	UHU	0.088	
Johnny Walker	-0.004	Ajax	0.089 ***	
Snickers	-0.003	Barilla Spaghetti No. 5	0.091 **	
Uncle Ben's long grain, 1 kg	-0.003	LO Salt	0.094 ***	
Wc Ente	-0.003	Maggi Arome, 1 kg	0.094 ***	
Gordon's Dry Gin	-0.002	Dove	0.095	
Haribo	0.003	Canderel Powder 40	0.099 ***	
Kellogg's Smacks, 375 gr	0.004	Tempo	0.109 ***	
Gillette Gel	0.005	Coca Cola Can	0.117 ***	
Nestle Nesquik	0.005	Kellogg's Cornflakes, 500 gr	0.118 **	
Pampers	0.009	Labello	0.139 ***	
Magnum Classic	0.016	Rexona	0.148 ***	
Bacardi	0.019	Colgate Total	0.158 ***	
Barilla Spaghettini No. 3	0.019	Bahlsen Chips	0.166 ***	
Nutella	0.019	Vittel	0.175 ***	
Snickers Icecream	0.019	Maggi Arome, 250 gr	0.212 ***	
Pepsi Cola, 1.5 l	0.02	Kleenex	0.248 ***	
Barilla Spaghetti long	0.021	Pepsi Cola Can	0.287 ***	
Canderel Powder 75	0.021	Boss Stabilo	0.333 ***	
Pringles	0.023	Toffifee	0.433 ***	
Wheetabix	0.024	Post it	0.453 ***	
Bic Chrystal	0.025	Whiskas, Cat Food	Base	