# The Euro Changeover and Its Effects on Price Transparency, and Inflation. Mission Euro, Mission Accomplished!

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**Abstract**

Despite the expectations of economists that the euro changeover would have no effect on prices, we show that European consumers perceive the contrary. The data indicate that consumers based their perceptions about inflation on goods that are cheaper and more frequently purchased. We use this insight to develop and estimate a model of imperfect information that explains why these goods were subject to higher price growth after the changeover. The data indicate that some retailers, aware of the consumers' difficulties in adopting the new currency, used the changeover to increase profits by increasing prices. We also propose an explanation on why, contrary to common belief, this effect was smaller in more concentrated retail markets.

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# 1 Introduction

On January 1st, 2002, the euro was introduced as a legal tender in 12 countries of the European Union (EU). Given that the exchange rates between those countries had been fixed three years earlier, when the euro was launched as an electronic currency, many predicted that the cash changeover would have little effect on prices. In fact, the average inflation in the eurozone turned out not to be exceptionally high and the operation was considered a success.

In light of this, it is puzzling that most EU citizens think that the introduction of the euro had triggered a price increase. Around 70 percent believe that prices had been rounded up. Figure 1 shows that in the eurozone, perceived inflation significantly exceeds actual inflation in the post-euro period, while that is not true for the remaining EU countries for which the same data are available, namely, the United Kingdom, Denmark, and Sweden.

Are most Europeans wrong about inflation, or did the euro have some effect on prices? The main aim of this paper is to show that the changeover had contributed to inflation and to explain why this has not been observed in the aggregated data.

We propose a model in which consumers are rational, but have difficulty dealing with prices after a cash changeover. A new currency decreases the transparency of prices, hindering price comparisons. That weakens competition between retailers. Small differences in price levels are not perfectly observable. Imperfect observability generates incentives to increase prices and it decreases the incentive to undercut competitor's price. Therefore, the equilibrium price is higher after the changeover, even in competitive markets. Incentives to increase prices do not depend on the initial price level hence euro-related inflation is inversely proportional to the initial price. Cheap goods experience higher increase in prices. Given that the perception


Figure 1: Difference between perceived and actual inflation (in percent). Perceived inflation is based on differences between positive and negative opinions about the level of inflation. To make the two series comparable both indices have been standardized. Source: Authors' calculations based on the EU Business and Consumer Surveys and on Eurostat data.

of inflation is likely to be based on the prices of cheaper, more frequently bought goods[1], the currency changeover generates a divergence between perceived and actual inflation.

Within the model, we analyze how the effect of the euro introduction depends upon the market structure. We assume that retailers can improve consumers' price perception by investing in transparency-enhancing measures, such as advertising, dual pricing, explicit cross-shop comparisons, etc. If transparency increases, consumers are more likely to notice shops that lower their prices. Lowering the price may result in higher profit if enough consumers will perceive this price correctly. Transparency-enhancing investment is costly, therefore it will be undertaken only

[1]See also Guiso (2003) and Del Giovane and Sabbatini (2004).

by shops that benefit from it the most. In our model these are the shops that operate in a relatively concentrated market. Contrary to standard competitive models, we find that higher market concentration leads to lower euro-related inflation.

We found anecdotal evidence supporting our model. On their website, Carrefour, the leading retailer in 6 of the 12 euro countries, and the second largest retailer in the world, states "Mission Euro, Mission Accomplished!":

> "As a major retailer, Carrefour played a key role in the success of the historic changeover to the euro. The fact is that customers relied on the Group's banners to welcome them just as warmly as on any other day, make their task easier, assist them to find their way around the new system, and answer their queries."

Carrefour was also committed to "[...] 2. coach everyone in the euro by learning the new value of products together; 3. no price increases during the months of the changeover period (apart from normal seasonal variations)[2]; 4. rounding up [*sic!*] prices in a way that ensures no price increases for the customer; [...]; 6. putting exceptional measures in place to assist all its customers during the changeover to the euro; 7. continuing to clearly display prices in both currencies for a minimum of 6 months." Unless we believe that Carrefour was motivated by benevolent intensions, all these strategies were likely to be profit-maximizing.

We find strong support for our model in the data. First, we analyze self-reported attitudes toward the euro, using the Eurobarometer survey. We find that many EU citizens had problems dealing with the new currency. Among other things, when shopping they thought in terms of the old currency, felt a need for dual pricing, and had problems with remembering and comparing prices.

[2]Carrefour in Belgium, for example, froze prices from November 15, 2001, through March 15, 2002.

Second, we analyze the relationship between inflation and price levels. Using the data for individual products, we provide strong evidence that after the introduction of the euro, cheaper products experienced higher inflation. Using difference-in-difference estimation, we show that this is not true for EU countries that did not introduce the euro.

We regress the effect that we find using the parametric specification on country-specific measures of difficulties in dealing with new currency and on market concentration. For a given market concentration, countries whose citizens report more problems with new currency have higher inflation for cheap goods. Finally, consistent with our model, we find a very strong negative correlation between market concentration and inflation.

The layout of the paper is as follows: In Section 2 we present a short overview of the literature. In Section 3 we outline the formal model. Section 4 summarizes the evidence that consumers experienced difficulty dealing with new currency. In Section 5 we test the model. Section 6 concludes. The data are described in the Appendix.

# 2 Related literature

The introduction of the euro has attracted a fair amount of research. Much of the literature on this topic has focused on the restoration sector, which experienced a very high inflation in 2002. Hobijn, Ravenna and Tambalotti (2004) and Gaiotti and Lippi (2005) assume that prices are adjusted periodically due to menu cost. They argue that as a result of currency changeover restaurants were forced to incur those

costs at the same time, therefore they all adjusted prices at the same time[3]. This generated a spike in inflation. Additionally, menu costs were incorporated in prices at the time of the changeover, and that contributed further to inflation. While this assumption may hold for restaurants, a survey among businesses organized by the National Bank of Belgium shows that 83 percent of the cost related to the changeover was born and was loaded on prices before the changeover (NBB 2002). Even for retail trade, where one might expect less planning, 73 percent of the costs were transferred to consumers before January 2002. Although menu costs have certainly contributed to inflation, these papers do not seem to provide a complete description of the euro effect. In particular, they do not explain the relation between inflation and the euro-related difficulty consumers reported.

Adriani et al. (2003) propose a model, where consumers are either locals or tourists, and tourists lack any information about the quality of food served by restaurants. In their model, a simultaneous and coordinated increase in expected prices may generate a price jump to a higher equilibrium. The model seems to apply only to restaurants, while most Europeans perceived that after the changeover small retailers increased prices as much as restaurants (Table 1).

There also have been some attempts to explain the difference between perceived and actual inflation. It has been argued that one possible reason for the gap is that consumers may have simply used approximated exchange rates. In Italy, for example, the exchange rate is 1,936.27 lire for one euro. If consumers use an exchange rate of 2,000, this can bias perceived inflation by about 3 percent. If this explanation were true, some euro countries should have experienced a decrease in perceived inflation because the rounding worked in the opposite direction. Table 2 shows that

[3]Hobijn, Ravenna and Tambalotti use Eurostat's month-to-month inflation (HICP) for restaurants and cafes, while Gaiotti and Lippi use Italian data taken from a restaurant guide book

Austria, the Netherlands, and Belgium contradict this idea; they have a positive rounding error, and yet had a big, positive gap between perceived and actual price growth.

Apart from analyzing the currency changeover, our paper contributes to the literature on competition with imperfect information. There are many models of consumer behavior that attempt to capture the implications of costly information for price determination, but it has been difficult to provide convincing empirical tests for them. Diamond (1971), in a very influential paper, shows that even small search costs could result in noncompetitive outcomes. In another theoretical paper, Salop and Stiglitz (1977) assume that consumers have heterogenous costs of gathering information. This assumption can generate an equilibrium with price dispersion, but Diamond's unique monopoly-price equilibrium may still hold when there are high enough information costs. Braverman (1980) generalizes the former model, allowing for U-shaped cost functions and a continuous distribution of the cost of information.

In order to test these models, starting with the seminal paper by Pratt, Wise and Zeckhauser (1979), empirical work has mainly tried to measure the price dispersion that is not due to product differentiation. Many recent papers have tried to measure if the introduction of the internet, which considerably reduces search costs, reduces price dispersion (see, for example, Baylis and Perloff 2002).

# 3 Model of price competition under limited price transparency

## 3.1 Uniform market

There are $N$ shops selling an identical product at a constant marginal cost $c$. Shops compete in Bertrand fashion.

There is a continuum of consumers of measure one. Each consumer buys one unit of the good, and tries to minimize the price spent on it. If all shops charge the same price, consumers are uniformly distributed among them. Each consumer knows the distribution of the prices on the market, but does not know the location[4], i.e., she does not know which shop charges which price from the distribution. She can find out the location by searching, which is costless.

Initially, all prices are expressed in the old currency, call it lire. Clearly, in equilibrium $p = c$, and consumers are indifferent between shops.

Introduction of a new currency affects the consumer's perception of prices. She knows the distribution of the prices in lire and does not know the location of prices. In every shop she visits, she observes the price in euro, but has difficulties converting it to lire in order to determine which price from the distribution she is facing. Additionally, she has a hard time remembering and comparing prices in euro. The problem with price perception is modeled in the following way. If there are two different prices on the market,[5] say $p$ and $\hat{p}$, the consumer enters the shop, observes the price in euro, and gets a noisy signal about the corresponding value in lire. The signal may be $H$ or $L$. Signal $H$ suggests that a given shop charges the higher of

[4]Like in Salop and Stiglitz (1977).

[5]For our analysis it is enough to model price perception for situations with only two distinct prices in the market.

$p$ and $\hat{p}$, and signal $L$ suggests that the price is the lower one. After observing the signal, the consumer decides whether to buy the good in the shop or not. If she does not buy the good, she goes to another shop, where she gets a new signal. Signals are independent across shops and consumers.

The signal's precision depends upon the difference between $p$ and $\hat{p}$. If $\hat{p}$ is very different from $p$, then price $\hat{p}$ expressed in euro will be rarely mistaken for price $p$. This is captured by the function $q(d)$, where $d$ is the distance between the two prices. Let $q(\hat{p}-p)$ be the probability of getting signal $L$ in a shop that charges the euro equivalent of price $p$, when some other shop charges $\hat{p}$. We set $q(0)=\frac{1}{2}$, which means that identical prices are indistinguishable. Also, $q(\cdot)\in[0,1]$, and $q(\hat{p}-p)=1-q(p-\hat{p})$, i.e., the probability of getting signal $L$ in shop charging $p$ is equal to the probability of getting signal $H$ in a shop charging $\hat{p}$. We assume $q'=\frac{dq(\hat{p}-p)}{d\hat{p}}=-\frac{dq(\hat{p}-p)}{dp}>0$, that is, increasing the distance between prices leads to a lower probability of mistake. $q'(0)$ measures how distinguishable prices are. If $q'(0)=\infty$, there is perfect price perception.[6]

The consumer observes only the signals, therefore she conditions her decision solely on them. Since the probability that a given shop charges a lower price is higher if $L$ is observed, she buys the good in the first shop in which she observes $L$. If she never observes $L$, she is indifferent between all shops, and we assume that she buys the good in the last visited shop.

Let $\hat{p}$ be the price on the market, once the new currency is introduced. For $\hat{p}$ to be an equilibrium, we need that no shop has an incentive to deviate by charging

[6]We believe that this a good approximation of a more complicated model in which perception of the price is $\tilde{p}=p+\varepsilon$, where $p$ price in Lire. Consumers get a noisy estimate of $p$, upon seeing $p^*=pe$ in euro. $e$ is the exchange rate. In such a model consumer chooses the shop with the smallest realization of $\tilde{p}$. Also, it suffices to specify the signal structure for two prices on the market, as we will use a Nash equilibrium concept and consider deviation by a single shop.

a different price. Consider a representative shop, call it shop 1. Shop 1 can raise its price, increasing its profit per customer but losing some of its initial customers who get signal $H$. Alternatively, it may decrease its price, decreasing its profit per customer but capturing new consumers. Charging $p \neq \hat{p}$, shop 1 will retain its customers who get signal $L$, will capture all consumers who get $H$ before reaching shop 1, and $L$ in shop 1 and will get all consumers, who reach shop 1 at the end. Therefore, the number of consumers served by shop 1 at price $p$ is[7]

$$\begin{aligned} x(p,\hat{p}) &= \frac{1}{N}\sum_{i=1}^{N-1}\left(q\left(\hat{p}-p\right)\right)^{i}+\frac{1}{N}\left(q\left(\hat{p}-p\right)\right)^{N-1} \\ &= \frac{1}{N}\frac{q\left(\hat{p}-p\right)+\left(q\left(\hat{p}-p\right)\right)^{N-1}-2\left(q\left(\hat{p}-p\right)\right)^{N}}{1-q\left(\hat{p}-p\right)}. \end{aligned} \tag{1}$$

Profits of shop 1 are

$$\Pi(p,\hat{p}) = x(p,\hat{p})(p-c).$$

The first order condition is

$$\frac{d\Pi}{dp} = x(p,\hat{p}) + \frac{dx(p,\hat{p})}{dp}(p-c) = 0. \tag{2}$$

As all firms are identical in equilibrium, the FOC must be satisfied for $p = \hat{p}$. Evaluating the FOC at $\hat{p}$, we get the formula for the equilibrium price

$$\hat{p} - c = \frac{1}{q'(0)\,4\left(1-\left(\frac{1}{2}\right)^{N-1}\right)}.$$

[7]We assume that consumers uniformly search all shops, that is, consumers who leave shop 1 go to each shop with equal probability.

Inflation is

$$\pi = \frac{p_1 - p_0}{p_0} = \frac{\hat{p} - c}{c} = \frac{1}{cq'(0)\,4\left(1 - \frac{1}{2}^{N-1}\right)}. \tag{3}$$

We can state the following proposition:

**Proposition 1.** *Inflation is inversely proportional to the initial price and to price transparency. It is decreasing with the degree of competition.*

After the introduction of a new currency, shops try to exploit the imperfect price perception and increase prices, as the increase in price per customer is not entirely offset by the loss of customers. If price perception is perfect, $q'(0) = \infty$, we have $p = c$ as before.

## 3.2 Market concentration

We introduce the possibility of investing in transparency-enhancing measures, such as advertising, explicit cross-price comparison, double pricing etc. Let $\alpha_i$ be the level of transparency-enhancing investment by shop $i$ and $\alpha = \frac{1}{N}\sum_i \alpha_i$ be the average level of investment in the market. Price transparency may vary across shops, and depends on the price difference, as before, but also on the average level of investment and on the relative investment of a given shop. Let $q(\alpha, \frac{\alpha_i}{\alpha}, \hat{p} - p)$ be the probability of receiving signal $L$ in a shop charging $p$ and investing $\alpha_i$, when the average investment is $\alpha$. We assume that the transparency of prices in every shop is higher, the higher the average investment is: $\frac{\partial}{\partial d \partial \alpha} q(\alpha, \frac{\alpha_i}{\alpha}, 0) = q_1'(\alpha, \frac{\alpha_i}{\alpha}, 0) > 0$. Also $q_1\left(\alpha, \frac{\alpha_i}{\alpha}, 0\right) = 0$, because if all shops make identical investment and charge identical price they should attract an identical number of consumers ($q(\alpha, 1, 0) = \frac{1}{2}$ for all $\alpha$). Additionally, other things equal, consumers in shops with higher investment relative to the market are more likely to receive signal $L$, that is, $q_2\left(\alpha, \frac{\alpha_i}{\alpha}, d\right) > 0$. The last assumption

means that consumers prefer shops with higher transparency even if $d = \hat{p} - p = 0$.

The cost of investment is $C(\alpha_i)$, where $C' > 0$ and $C'' > 0$. Every shop sets price and investment level taking the prices of other shops and the average investment level as given.

Let $\frac{1}{N}\psi\left(q\left(\alpha, \frac{\alpha_i}{\alpha}, d\right), q\left(\alpha, \frac{\alpha_j}{\alpha}, d\right), N\right)$ be the number of consumers captured by a shop with investment $\alpha_i$ and price $p$ when other shops invest $\alpha_j$, and charge price $\hat{p}$. We can show that

$$\frac{d\psi\left(q\left(\alpha,1,0\right), q\left(\alpha,1,0\right), N\right)}{dp} = -4q'\left(\alpha,1,0\right)\left(1 - \frac{1}{2}^{N-1}\right),$$

$$\frac{d\psi\left(q\left(\alpha,1,0\right), q\left(\alpha,1,0\right), N\right)}{d\alpha_i} = 2q_2\left(\alpha,1,0\right)\left(1 - \frac{1}{2}^{N-1}\right).$$

Maximizing the profit

$$\Pi\left(\alpha_i, p\right) = \frac{1}{N}\psi\left(q\left(\alpha, \frac{\alpha_i}{\alpha}, \hat{p} - p\right), q\left(\alpha, \frac{\alpha_j}{\alpha}, \hat{p} - p\right), N\right)(p - c) - C\left(\alpha_i\right).$$

with respect to $p$ and $\alpha_i$, we get the first order conditions

$$\frac{d\pi}{dp} = \frac{1}{N}\left(\frac{d\psi}{dp}(p - c) + \psi\right) = 0,$$

$$\frac{d\pi}{d\alpha_i} = \frac{1}{N}\frac{d\psi}{d\alpha_i}(p - c) - C'\left(\alpha_i\right) = 0.$$

In a symmetric equilibrium $\alpha = \alpha_i$ and $p = \hat{p}$, therefore

$$\frac{d\pi}{dp} = \frac{1}{N}\left(-4q'\left(\alpha,1,0\right)\left(1 - \frac{1}{2}^{N-1}\right)(\hat{p} - c) + 1\right) = 0, \tag{4}$$

$$\frac{d\pi}{d\alpha_i} = \frac{1}{N}2q_2\left(\alpha,1,0\right)\left(1 - \frac{1}{2}^{N-1}\right)(\hat{p} - c) - C'\left(\alpha_i\right) = 0. \tag{5}$$

From equation (4) we get that

$$\hat{p} - c = \frac{1}{4q'(\alpha, 1, 0)\left(1 - \frac{1}{2}^{N-1}\right)}, \tag{6}$$

which together with (5) gives us

$$\frac{q_2(\alpha, 1, 0)}{2q'(\alpha, 1, 0)} - NC'(\alpha) = 0.$$

Using the implicit function theorem, we get the formula for the derivative of investment level with respect to the number of shops

$$\frac{d\alpha}{dN} = \frac{-q'(\alpha, 1, 0) C'(\alpha)}{N\left(q_1'(\alpha, 1, 0) C'(\alpha) + q'(\alpha, 1, 0) C''(\alpha)\right)} < 0.$$

From equation (6) we get

$$\frac{d\hat{p}}{dN} = \frac{1}{4\left(q'(\alpha, 1, 0)\left(1 - \frac{1}{2}^{N-1}\right)\right)^2}\Phi,$$

where

$$\Phi = -\frac{d\alpha}{dN} q_1'(\alpha, 1, 0)\left(1 - \frac{1}{2}^{N-1}\right) + \frac{1}{2}^{N-1} \ln\frac{1}{2} q'(\alpha, 1, 0).$$

The sign of $\Phi$ is ambiguous but it is positive if

$$\frac{2C'(\alpha) q_1'(\alpha, 1, 0)}{2\left(q_1'(\alpha, 1, 0) C'(\alpha) + q'(\alpha, 1, 0) C''(\alpha)\right)} \frac{1}{N}\left(2^{N-1} - 1\right) > \ln 2.$$

In particular, for any set of parameters there exists $\bar{N}$ such that for all $N > \bar{N}$ $\Phi$ is positive.

For example, for $q = \frac{1}{2}\frac{\alpha_i}{\alpha}(\alpha d + 1)$ and $C(\alpha) = \alpha^2$, we have $\Phi = \frac{1}{2N}\left(2^{N-1} - 1\right) -$

$\ln 2 > 0$ for $N \geq 4$.

Define market concentration as the size of an average shop, $\eta = \frac{1}{N}$. It follows that if market concentration is not big enough, the post-changeover price is decreasing in market concentration. Investment in transparency-enhancing measures is more profitable if it results in much higher demand. A small investment, together with a small price decrease, results in higher demand in more concentrated markets.

# 4 Consumers' attitude toward the euro

To measure consumers' attitudes toward the euro we use the data from the Eurobarometer survey conducted in 2002. The data are summarized in Table 3.

A significant fraction of Europeans reported having problems dealing with the euro. When asked how difficult it is to remember or to compare prices in euro, around 40 percent said it was either fairly (30 percent) or very (10 percent) difficult. Around 20 percent said they were uncomfortable with the euro. Seven percent (Ireland) to 28 percent (France) were highly pessimistic, and believed these difficulties to be permanent. Four months after the introduction of the euro, the majority said they always, or often, thought in terms of their old currency and tried to convert the prices. We believe that thinking in terms of old currency and the need to convert suggest lower price transparency $q'$. Converting prices for every good leads to rounding mistakes, making some prices hardly distinguishable. Only around 10 percent of Europeans said that dual pricing had been useless, while a quarter said it was essential. This suggests that prices given in euro were not very transparent. Only from 6 percent (France) to 23 percent (Greece) of the consumers looked solely at the price in euro when both prices were available.

The attitude toward the euro differed across countries. It is interesting that

countries that used to have a strong currency and have strong national identities, such as Germany and France, had a higher fraction of people saying they were not pleased with the euro. On the other hand, the two "most European" countries, the ones that also host most of the European institutions, Belgium and Luxembourg, were the least hostile toward the new currency.

The differences in the distribution of age and education were another reason why the attitudes toward the euro varied across countries. Problems with the euro were mainly experienced by older, and less educated people. Among consumers older than 64 the numbers reported in Table 3 are approximately double as big. Notice that Ireland, which has, by far, the youngest population in Europe, had the lowest fraction of people admitting to having difficulties comparing and remembering prices in euro. High fractions of consumers also had a hard time dealing with the newly introduced coins, and again, the numbers are doubled if we restrict the sample to older consumers.[8]

In order to capture the relationship between years of education, age, and euro related variables, Table 4 shows the estimated coefficients of an ordinary least-square regression (OLS), when education and then age are used as the dependent variables. Difficulties dealing with the euro are good predictors for age and level of education. Older consumers and consumers with fewer years of education are more likely to feel uncomfortable with the euro. They have more problems when dealing with new coins, and it is more difficult for them to remember and to compare prices. They are more likely to say that dual pricing is essential. The need to convert is the only variable that shows a positive and strong relationship with respect to age, while not showing any relationship with respect to education.

[8]Many European countries did not have coins of reasonable value before the changeover.

The country fixed effects are included in Table 3 to remind us that countries such as Greece, Italy, Portugal and Spain tend to have lower levels of education, and that the average age is higher in Italy and Greece.

# 5 Econometric Framework

## 5.1 Specification

The main prediction of our model that we want to test is that the euro-related inflation was inversely proportional to prices.

Figure 2 provides a glimpse of what we find. It shows the difference between euro and non-euro countries in the difference between post-euro and pre-euro demeaned and deseasonalized annual inflation rates. This difference-in-difference is plotted against price quintiles. The difference for the first quintile is clearly the highest.

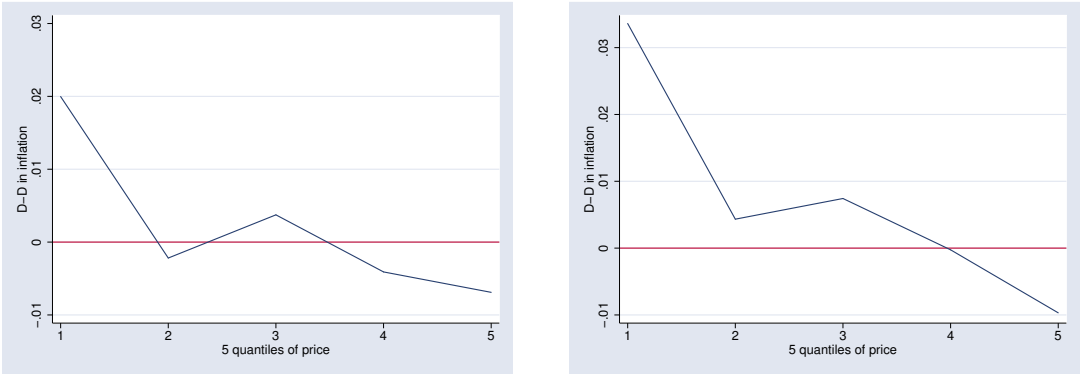


Figure 2: First panel: Difference-in-differences in annual inflation rates (demeaned and deseasonalized). The first difference is between euro-countries and non-euro countries (the United Kingdom, Denmark and Sweden), the second difference is between 1 year post-euro and 5 year pre-euro inflation. In the second panel the euro countries include only Italy, Spain and Greece. The quintile cutoffs are 3, 8, 19 and 100 euros. Source: Author's calculations using Economist Intelligence Unit and Eurostat data (Appendix A)

When we restrict the analysis to the three euro countries with the lowest degree of

retailer concentration, Italy, Spain, and Greece, the difference-in-difference for the first price quintile is almost twice as big.

First, we want to test the prediction of equation (3). We want to see how price levels affected inflation in the period before the introduction of the euro and after, and compare that to the relation between inflation and price levels in EU countries that did not introduced the euro. Equations (3) and (6) suggest the following specification:

$$\pi_{j,t}^{c} = \gamma_1^c 1\left(t \geq 2002\right) + \beta_0^c \frac{1}{p_{j,t}^{c}} + \beta_1^c \frac{1}{p_{j,t}^{c}} 1\left(t \geq 2002\right) + e_{j,t}^{c} \ , \tag{7}$$

$$\beta_1^c = a^c \frac{1}{q_c'} + b_c \frac{1}{q_c'} \eta_c + \varepsilon^c \ . \tag{8}$$

$c$ denotes a country, $j$ a product, and $t$ time. The indicator function $1\left(t \geq 2002\right)$ is 1 for observations after January 2002, and 0 otherwise. $\beta_0^c$ measures the average pre-euro impact of the inverse of price on inflation. $\beta_1^c$ is the equivalent of $\frac{1}{q'(0)4 \ \ 1-\frac{1}{2}^{N-1}}$ and measures how inflation was affected by the euro. A country-specific fixed effect $\gamma_1^c$ is added to measure any changeover effect that is unrelated to price levels. Equation (8) specifies that the impact of the inverse of price level on inflation depends upon the transparency of prices after the changeover, and on a product of this transparency and market concentration.

We estimate equation (7) by country to allow for differences due to exchange rates, institutions, market structures, etc. We use Eurostat item-specific inflation, and in order to recover information about price levels, we match these data with the Economist Intelligence Unit data (see Appendix A). Although inflation is measured as the annual percentage price change,[9] and therefore already captures seasonality,

[9]In a previous version of the paper the same analysis has been carried out using monthly price changes, yielding similar results (Mastrobuoni 2004).

for each country and each item we additionally control for any residual time-invariant seasonality by projecting inflation on 12 monthly dummies. We also detrend all item-specific price indices by demeaning their inflation rates over the observed six-year period (01/1997 - 12/2002).

We use the estimates of $\beta_1^c$ from the first regression to estimate equation (8). The three non-euro countries (the United Kingdom, Sweden, and Denmark) serve as a comparison. In our model higher $q'$ means higher price transparency, therefore $\frac{1}{q'}$ will be approximated by measures of difficulties dealing with euro reported in the Eurobarometer survey. As a measure for $\eta$, we use the market share of the five leading retailers in the food industry (see Appendix A).

If we believe that all EU countries are subject to the same price shocks, then in order to identify the effect of the euro introduction we need to adjust $\beta_1^c$ for the euro countries by subtracting the corresponding $\beta_1^c$ of the non-euro countries. Below, we show a supporting evidence that the non-euro EU countries may be a good comparison group, as their inflation patterns by price levels are similar. We use a difference in difference (D-D) estimator. The euro countries represent a treatment group ($T$), while all non-euro EU countries represent the control group ($C$). Let $T = 1$ if a country belongs to the treatment group, and $T = 0$ otherwise. We estimate the following equation:[10]

$$\pi_{j,t}^c = \gamma_0^c + \gamma_1^c 1\left(t \geq 2002\right) + \gamma_2^c 1\left(t \geq 2002\right) T + \\ + \beta_0^c \frac{1}{p_{j,t}^c} + \beta_1^c \frac{1}{p_{j,t}^c} 1\left(t \geq 2002\right) + \beta_2^c \frac{1}{p_{j,t}^c} T + \beta_3^c \frac{1}{p_{j,t}^c} 1\left(t \geq 2002\right) T + \tilde{e}_{j,t}^c \quad . \tag{9}$$

In this specification, the effects of the changeover are assumed to be constant after

[10]Notice that the OLS and the D-D estimates should differ across countries by just a constant. The reason why this is not always the case is that the panel is not perfectly balanced.

the introduction of the euro. In reality, the results vary with time, and the first effects of the euro introduction might have occurred a few months after January 2002, if retailers needed some time to discover the consumers' difficulties, and might have decreased afterward, when consumers gradually overcame these difficulties.[11] We also estimate a version of equation (9) that allows for the euro effect to vary over time.

All regressions are estimated using ordinary least squares, and standard errors allow for heterogeneity over time and goods, and dependence over goods. This is done by clustering the 46 product-items into 13 different homogenous groups (see Appendix A).

## 5.2 Results

The estimates of equation (7) are reported in Table 5. The second column shows the estimates of $\beta_1$, $\widehat{\beta}_1$, when $\gamma_1$ is set to zero.

The non-euro countries have negative estimates for $\beta_1$. This means that in the United Kingdom, Sweden, and Denmark item-specific inflation was significantly lower for cheaper goods. When we include an after-euro constant term $\gamma_1$, these countries have $\widehat{\beta}_1$ close to -2.5 percent. For euro countries $\widehat{\beta}_1$ is always bigger than -2.5 percent. Moreover, it is positive and significant for Spain, Italy and Luxembourg. Assuming that all EU countries experienced similar exogenous shocks (and we have shown this seems to be true for Denmark, Sweden, and the United Kingdom), we can use the three non-euro countries as a comparison group, to identify the euro

[11] Moreover, there was a dual circulation period of two months at the time of the changeover. A survey of 2,605 businesses in Belgium (NBB 2002) shows that about half of them used dual pricing. The number goes up to 95 percent for the retail trade. Unfortunately, 60 percent of these retailers did not know (50 percent), or did not want to answer (10 percent), how long they would keep the dual pricing. Twenty percent said they would keep it for two months. This simply confirms that it is hard to fix a date for the changeover effect.

effect.

We estimate equation (9), and report the results in Table 6. The last column of this table shows the estimate of $\beta_3$. All coefficients are clearly positive, and all but one, Ireland, are significant at the 5 percent level. This strongly suggests that controlling for exogenous effects, the introduction of the euro had a bigger effect on prices of cheaper goods. This effect ranges from 0.95 for Ireland, to 4.43 for Luxembourg.[12] What this means, is that a good with a price of one euro had in Luxembourg, on average, an additional yearly inflation rate of 4.43 percent. Four other countries had effects above 3 percent, namely Italy, Spain, Greece, and Germany. Products priced at two euro would have an average gap in inflation that is just half of $\widehat{\beta}_3$, while products priced at 50 cents would have an average inflation rate that is twice as big as $\widehat{\beta}_3$.

As mentioned before, there is no reason to expect that the euro-effect has been constant for the entire post-euro period. While below we allow the post-euro effect to vary over time, there are some reasons to prefer the one-year "pooled" estimate over more flexible specifications. First, some shops might have reacted faster than others, and there is no reason to assume that all shops adjusted prices exactly at the time of the changeover. Second, averaging the effect over the whole year 2002 is statistically more conservative, since the estimates are less susceptible to short-term shocks. We estimated the same model, allowing the post-euro effect to last 6 additional months, until June 2003, and the results (not shown) were very similar, suggesting that the euro "confusion" lasted a long time.[13]

[12] Although Luxembourg "neutralizes" this effect with a big, negative post-euro constant term of -2.04, which is why for this country overall inflation was not very high.

[13] This fact has been confirmed by Eurobarometer surveys carried out in October 2002 and November 2003. In this last survey, two years after the changeover, 49 percent of consumers still seem to have difficulties using the new currency.

A more flexible model has been estimated using time-varying coefficients, by simply splitting the post-euro period in "0-4 months after changeover," "4-8 months after changeover," "8-12 months after changeover," and, finally, "12+ months after changeover." Tables 7 and 8 show the estimation results of the modified equation (7) and (9), respectively. All regressions control for the possibility of an additional effect on the constant term. The first three columns in both tables show the estimates of the constant term, while the last three columns show the estimates of $\beta_1$ and $\beta_3$ respectively. There is no clear time pattern. Looking at Table 8, we can notice that for majority of countries, the estimates for September-October period are smaller than are those for May-August, which would suggest a decrease in the effect.

Summarizing the first step, there seems to be a strong relationship between the inverse of prices and inflation during the post-euro period. The effects are not very big in absolute terms, although they are big in relative terms, since in 2002, overall inflation was around 2 percent. Also, in most countries the effect seems to be distributed over the entire year.

The second step of the estimation, based on equation (8), sheds some light on why the observed euro-related inflation for low-priced goods varies so much across the euro countries. Our theoretical model predicts the $\beta$s to be higher in countries where consumers have difficulties with the euro, and where the market concentration is lower.

In order to look at the relationship between market structure and our estimates of beta, in Figure 3 we plot the D-D estimate of $\beta_3$ from Table 6 against retailer concentration in the food industry.

As predicted by the model, there is a very strong negative relationship between market concentration and our estimate of $\beta_3$. Apart from Ireland, all countries

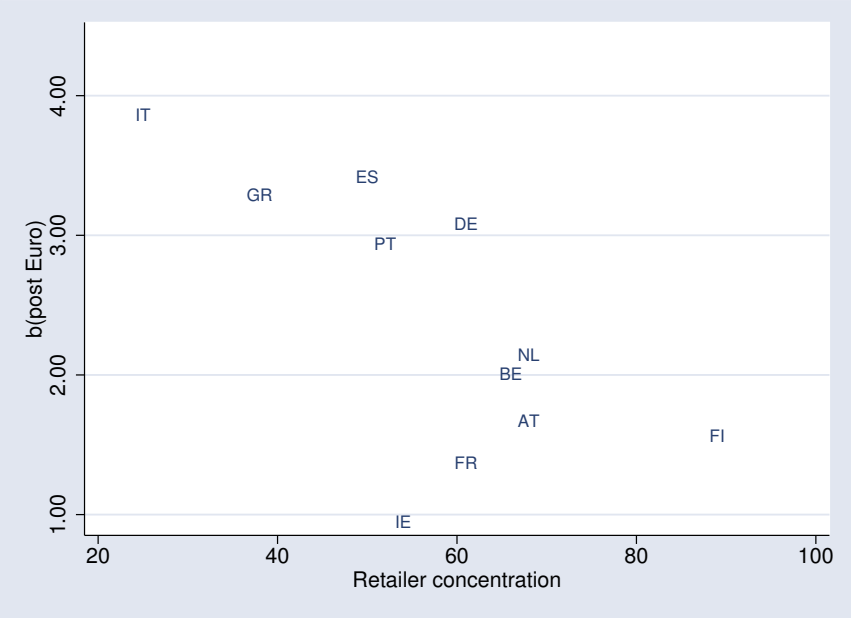


Figure 3: Retailers' concentration and the $\widehat{\beta}_3$s from Table 6. Notes: Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Netherlands (NL), Portugal (PT), Spain (ES).

seem to lie on a straight line. Ireland, though, shows an extremely fast learning pace. It has, by far, the lowest fractions of consumers who say they have difficulties remembering and comparing prices (Table 3). Moreover, only 7 percent of Irish consumers had great difficulties with the euro (the minimum), and only 21 percent always converted when looking at a price in euros.

We have estimated equation (8) using the estimates of $\beta_1$ from equation (7), and reported the results in Table 9. The correlation between $\widehat{\beta}_1$ and the retailer concentration is around -70 percent (minus the square root of $R^2$). The estimate is -4 percent, which means that increasing the market concentration from 0.2 to 0.9, that is moving from Italy to Finland, reduces $\widehat{\beta}_1$ by around 3 percentage points $(4 \times [0.9 - 0.2])$.

Finally, we regress $\widehat{\beta}_1$ on proxies of $\frac{1}{q'}$, and their interaction with $\eta$. The two proxies that are most significant are consumers' need to convert to the old currency

($R^2 = 0.7$), and the fraction of consumers saying that they are uncomfortable with the euro ($R^2 = 0.62$).[14] In both cases, higher $1/q'$, that is, higher need to convert and higher discomfort, are related to higher low-price inflation. It is interesting that when dual pricing is available, lower fractions of consumers who look at prices expressed in both currencies mean lower $\widehat{\beta}_1$s. It seems that if consumers look only at the euro price, it does not necessarily mean that they have perfectly learned to deal with the new currency. All other proxies have the right sign, although they are not significant.

We have established that the euro had a positive effect on low-priced goods and that this effect depends upon the market concentration and people's difficulty with dealing with the euro. It seems that people's perception of inflation depends upon the same factors. Table 1 shows the fraction of people in different countries who believes prices were rounded up after the introduction of the euro. These fractions are generally high, although there is still some variation across countries. Austria, Finland, and Portugal, for example, have fractions equal or below 80 percent, while more than 90 percent of consumers in the Netherlands, Greece, Germany, and Spain believe prices were rounded up after the changeover. The correlation between the fraction of people who believes prices were rounded up and and $\widehat{\beta}_1$ is 37 percent.

# 6 Conclusions

Some institutions, including Eurostat (EUROSTAT 2003), have found that the euro changeover had only a very limited effect on overall inflation. However, inflation is an extremely synthetic measure of price growth and does not capture differen-

[14]The index of conversion summarizes the four different outcomes: always, often, sometimes, and never convert to the old currency. The higher the index, the more consumers convert prices into the old currency.

tiated effects of the changeover on prices. To our knowledge, excluding anecdotal evidence and descriptive studies, these possible differentiated effects have not been fully investigated.

We propose a model in which consumers are fully rational, but after a cash changeover they remember and compare prices with some noise. The model predicts higher inflation for lower-priced goods. It also predicts that the effect is lower in less-concentrated markets, where some retailers gain from competing in "price transparency." We analyze the relationship between price levels and inflation in all 12 EU countries that introduced the new currency and in three EU countries that did not. We find that in the eurozone prices of cheap goods rose faster than prices of expensive goods, compared to other EU countries. We link this result to the level of retailer concentration, and to the difficulties euro consumers had due to the changeover.

The analysis sheds some light on what happened after January 2002. Hopefully, it also will help some countries (especially future euro members) with designing better currency changeovers and with predict their effects. Three countries that have been used as a comparison group, the United Kingdom, Denmark, and Sweden, have a retailer concentration of, respectively, 0.57, 0.76, and 0.95. Using our results, the predicted inflation rate due to changeover, would be inversely proportional to the level of prices by a factor of 1 percent for Sweden, 2 percent for Denmark, and 3 percent for United Kingdom. Enhancing price transparency, educating consumers, and some sort of "price watch," especially among smaller shops, are some of the measures that countries facing a currency change may want to adopt.

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# A Main data sources

**Eurostat's HICP:** The consumer price index is a measure of the general relative change of the prices of goods and services used by households for private consumption. In order to measure just the price change, weights are fixed over time (Laspeyres-type index, EUROSTAT (December 2001)). These data contain information on 93 different aggregated items. We use the monthly price indices from January 1997 to December 2002.

**Economist Intelligence Unit:** The EIU collects, on a yearly basis, the prices of several goods in several cities from around the world. The EIU researchers collect information about prices twice a year (EIU n.d.). Survey prices are gathered and listed from three types of stores: supermarkets, medium-priced retailers, and more expensive specialty shops. Only outlets, where items of internationally comparable quality are available for normal sale, are visited. The statistical design is weak, but the purpose of these data is just to classify products based on their approximate price level. The information from the EIU is then used by averaging over items and cities every time prices for multiple items and/or cities match one item from the Eurostat data. This procedure attenuates possible measurement errors. As a specification check, the models have been estimated using price averages over the entire time period available, and results were very similar.

**The match:** The time frequency and the items covered do not perfectly match. Table 10 briefly depicts these limits. We manage to combine 46 items from the Eurostat data (50 percent) with prices in levels from the EIU data. Table 11 shows these items with the corresponding average price.

**Eurobarometer:** This survey is based on approximately 1000 interviews per member state. The 2002 survey mostly covers issues related to the introduction of the euro. Information extracted from this source always uses the appropriate sample weights.

**Retailer concentration:** The data has been taken from an internal working paper of the European Commission's Internal Market DG (European Commission 2000).

Table 1: Perceived price increases (fraction of people who think that prices were rounded up after the changeover).

| | AT | BE | FI | FR | DE | GR | IE | IT | LU | NL | PT | ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Price increases | 0.74 | 0.88 | 0.78 | 0.89 | 0.92 | 0.93 | 0.84 | 0.83 | 0.89 | 0.95 | 0.80 | 0.91 |
| Supermarket | 0.47 | 0.64 | 0.85 | 0.75 | 0.74 | 0.90 | 0.68 | 0.63 | 0.76 | 0.60 | 0.90 | 0.77 |
| Small Food | 0.71 | 0.84 | 0.88 | 0.84 | 0.87 | 0.92 | 0.89 | 0.91 | 0.88 | 0.66 | 0.86 | 0.80 |
| Other Small | 0.79 | 0.81 | 0.88 | 0.81 | 0.87 | 0.88 | 0.91 | 0.90 | 0.87 | 0.76 | 0.87 | 0.78 |
| Cafes&Restaurants | 0.91 | 0.92 | 0.92 | 0.91 | 0.97 | 0.93 | 0.93 | 0.90 | 0.87 | 0.94 | 0.83 | 0.91 |
| Public transport | 0.69 | 0.75 | 0.86 | 0.71 | 0.74 | 0.78 | 0.41 | 0.67 | 0.52 | 0.71 | 0.92 | 0.81 |
| Bank | 0.77 | 0.78 | 0.82 | 0.78 | 0.62 | 0.78 | 0.73 | 0.71 | 0.63 | 0.63 | 0.94 | 0.71 |

Notes: Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Portugal (PT), Spain (ES). Source: Authors' calculations based on the Eurobarometer.

Table 2: Euro countries and their exchange rates with the euro.

| Country | Exchange Rate | approx. | error |
|---|---|---|---|
| Belgium | 40.34 | 40 | 0.8% |
| Germany | 1.96 | 2 | -2.2% |
| Greece | 340.75 | 350 | –2.6% |
| Spain | 166.39 | 166.67 | -0.2% |
| France | 6.56 | 6.67 | -1.7% |
| Ireland | 0.79 | 0.8 | -1.6% |
| Italy | 1936.27 | 2000 | -3.2% |
| Luxembourg | 40.34 | 40 | 0.8% |
| The Netherlands | 2.20 | 2.2 | 0.2% |
| Austria | 13.76 | 14 | -1.7% |
| Portugal | 200.48 | 200 | 0.2% |
| Finland | 5.95 | 6 | -0.9% |

The approximation errors are based on a study conducted by an Italian economic institute, ISAE (2003).

Table 3: Attitude toward the euro. Fractions of the whole population. Numbers in **boldface** show the countries with the lowest and in *italics* show the countries with the highest difficulty. Retailer concentration measures the market share of five leading groups in food retailing

| | AT | BE | FI | FR | DE | GR | IE | IT | LU | NL | PT | ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Problems with: | | | | | | | | | | | | |
| Using €coins | 0.36 | 0.36 | 0.15 | *0.40* | *0.40* | **0.11** | 0.36 | 0.16 | 0.29 | 0.31 | 0.20 | 0.14 |
| Using €notes | 0.10 | 0.07 | 0.05 | 0.10 | 0.09 | 0.06 | 0.07 | 0.06 | **0.03** | 0.08 | *0.14* | 0.10 |
| Remembering prices in € | 0.42 | 0.48 | 0.41 | *0.53* | 0.40 | 0.30 | **0.29** | 0.41 | 0.41 | 0.37 | 0.37 | 0.38 |
| Comparing prices in € | 0.36 | 0.49 | 0.43 | *0.54* | 0.42 | 0.32 | **0.24** | 0.37 | 0.31 | 0.31 | 0.35 | 0.33 |
| Not pleased with € | 0.16 | 0.09 | 0.28 | 0.26 | *0.29* | 0.16 | 0.19 | 0.09 | **0.06** | 0.21 | 0.18 | 0.10 |
| Uncomfortable with € | 0.27 | 0.16 | 0.14 | 0.26 | *0.39* | 0.21 | 0.11 | 0.11 | **0.09** | 0.22 | 0.23 | 0.27 |
| Overall, no difficulties w. € | 0.45 | 0.36 | 0.40 | *0.21* | *0.53* | 0.31 | 0.50 | 0.26 | 0.42 | 0.51 | 0.29 | 0.30 |
| Permanent difficulties w. € | 0.14 | 0.15 | 0.12 | *0.28* | 0.09 | 0.11 | **0.07** | 0.14 | 0.09 | 0.10 | 0.22 | 0.14 |
| Dual price: look only at € | 0.10 | 0.07 | 0.12 | *0.06* | 0.14 | **0.22** | 0.20 | 0.12 | 0.14 | 0.12 | 0.15 | 0.11 |
| Dual p.: do not look at € | 0.18 | 0.19 | 0.12 | *0.21* | 0.19 | **0.08** | 0.15 | 0.10 | 0.12 | 0.18 | 0.14 | 0.14 |
| Dual p.: is essential | 0.17 | 0.26 | 0.20 | *0.43* | 0.17 | 0.22 | 0.26 | **0.16** | 0.37 | 0.17 | 0.21 | 0.28 |
| Dual p.: is useless | 0.08 | 0.06 | 0.08 | *0.04* | 0.16 | **0.26** | 0.12 | 0.13 | 0.16 | 0.13 | 0.17 | 0.08 |
| Think always in old currency | **0.24** | 0.40 | 0.36 | *0.46* | 0.34 | 0.35 | 0.25 | 0.31 | 0.38 | 0.29 | 0.29 | 0.37 |
| Think often in old currency | 0.34 | 0.36 | 0.40 | 0.31 | 0.37 | 0.25 | 0.24 | 0.37 | 0.31 | 0.38 | 0.27 | 0.35 |
| Convert always | 0.25 | 0.41 | 0.38 | *0.51* | 0.35 | 0.42 | **0.21** | 0.39 | 0.40 | 0.34 | 0.36 | 0.39 |
| Convert often | 0.27 | 0.32 | 0.35 | 0.27 | 0.32 | 0.21 | 0.19 | 0.27 | 0.30 | 0.29 | 0.25 | 0.31 |
| nobs | 1,000 | 1,045 | 1,010 | 1,010 | 2,051 | 1,002 | 984 | 1,000 | 602 | 997 | 1,000 | 1,000 |
| Retailer concentration | 0.68 | 0.66 | **0.89** | 0.61 | 0.61 | 0.38 | 0.54 | *0.25* | - | 0.68 | 0.52 | 0.50 |

Notes: Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Portugal (PT), Spain (ES). Source: Authors' calculations based on the Eurobarometer.

Table 4: Weighted OLS regressions of age and education.

| | (1) Education | (2) Education | (3) Age | (4) Age |
|---|---|---|---|---|
| Only look at euro | -0.408 | -0.415 | -0.121 | -0.653 |
| | (0.121)** | (0.117)** | (0.566) | (0.546) |
| Only look at old currency | -0.171 | -0.250 | -1.229 | -1.452 |
| | (0.114) | (0.107)* | (0.557)* | (0.524)** |
| Need to convert | -0.055 | 0.002 | 0.884 | 0.812 |
| | (0.046) | (0.043) | (0.218)** | (0.207)** |
| Uncomfortable with euro | -1.326 | -1.009 | 4.924 | 3.194 |
| | (0.100)** | (0.094)** | (0.495)** | (0.473)** |
| Dual pricing is essential | -0.604 | -0.445 | 2.476 | 1.688 |
| | (0.103)** | (0.097)** | (0.499)** | (0.470)** |
| Difficult to remember prices | -0.252 | -0.106 | 2.266 | 1.937 |
| | (0.108)* | (0.102) | (0.507)** | (0.479)** |
| Difficult to compare prices | -0.365 | -0.243 | 1.883 | 1.407 |
| | (0.109)** | (0.103)* | (0.508)** | (0.481)** |
| Diffcult to use coins | -0.425 | -0.016 | 6.345 | 5.790 |
| | (0.098)** | (0.094) | (0.473)** | (0.450)** |
| Belgium | -0.025 | 0.041 | 1.016 | 0.984 |
| | (0.159) | (0.156) | (0.862) | (0.837) |
| Finland | 1.783 | 1.897 | 1.773 | 4.098 |
| | (0.203)** | (0.200)** | (0.874)* | (0.867)** |
| France | 0.540 | 0.350 | -2.951 | -2.247 |
| | (0.164)** | (0.162)* | (0.864)** | (0.845)** |
| Germany | 0.127 | 0.183 | 0.873 | 1.039 |
| | (0.152) | (0.152) | (0.746) | (0.739) |
| Greece | -1.167 | -1.007 | 2.476 | 0.954 |
| | (0.192)** | (0.181)** | (0.857)** | (0.811) |
| Ireland | -0.618 | -0.636 | -0.272 | -1.079 |
| | (0.155)** | (0.153)** | (0.906) | (0.882) |
| Italy | -0.400 | -0.246 | 2.385 | 1.863 |
| | (0.197)* | (0.191) | (0.855)** | (0.832)* |
| Luxembourg | 0.957 | 1.092 | 2.090 | 3.338 |
| | (0.252)** | (0.233)** | (1.062)* | (0.973)** |
| The Netherlands | 0.978 | 0.968 | -0.159 | 1.117 |
| | (0.197)** | (0.187)** | (0.994) | (0.951) |
| Portugal | -3.751 | -3.745 | 0.088 | -4.803 |
| | (0.194)** | (0.182)** | (0.854) | (0.816)** |
| Spain | -1.713 | -1.714 | -0.019 | -2.253 |
| | (0.187)** | (0.178)** | (0.852) | (0.810)** |
| Age | | -0.064 | | |
| | | (0.002)** | | |
| Education | | | | -1.304 |
| | | | | (0.044)** |
| Constant | 12.118 | 14.445 | 36.099 | 51.902 |
| | (0.170)** | (0.180)** | (0.828)** | (0.969)** |
| Observations | 10704 | 10704 | 10704 | 10704 |
| R-squared | 0.15 | 0.22 | 0.10 | 0.17 |

Notes: Robust standard errors in parenthesis. "*" indicates a significance level of 10 percent, "**" one of 5 percent. Source: Authors' calculations based on the Eurobarometer

Table 5: OLS estimates of annual price growth ($100 \times [p_t/p_{t-12} - 1]$) on $1/p$, using one year after the changeover (01/97-12/02).

| | | Without constant | With constant | | |
|---|---|---|---|---|---|
| | $\beta_0$ | $\gamma_1 = 0$, $\beta_1$ | $\gamma_1$ | $\beta_1$ | Obs. |
| Euro countries: | | | | | |
| Austria | 0.14 | -0.99 | -0.11 | -0.81 | 2556 |
| | (0.26) | (0.48)** | (0.12) | (0.49) * | |
| Belgium | -0.03 | -0.09 | 0.19 | -0.37 | 2534 |
| | (0.33) | (0.63) | (0.18) | (0.64) | |
| Germany | -0.04 | 0.31 | -0.13 | 0.51 | 2629 |
| | (0.26) | (0.47) | (0.17) | (0.49) | |
| Spain | -0.36 | 1.98 | 0.67 | 1.18 | 2400 |
| | (0.21) * | (0.48)** | (0.11)** | (0.42)** | |
| Finland | 0.05 | -0.50 | 0.17 | -0.82 | 2616 |
| | (0.37) | (0.91) | (0.17) | (0.97) | |
| France | -0.07 | 0.60 | 0.82 | -0.71 | 2628 |
| | (0.29) | (0.53) | (0.10)** | (0.51) | |
| Greece | -0.33 | 1.37 | 0.37 | 0.93 | 2339 |
| | (0.37) | (0.84) | (0.53) | (1.07) | |
| Ireland | 0.05 | -0.58 | 0.45 | -1.32 | 2460 |
| | (0.36) | (0.47) | (0.16)** | (0.55)** | |
| Italy | -0.38 | 1.98 | 0.31 | 1.54 | 2544 |
| | (0.15)** | (0.39)** | (0.15)** | (0.47)** | |
| Luxembourg | -0.02 | 0.05 | -1.20 | 1.57 | 2544 |
| | (0.30) | (0.57) | (0.28)** | (0.51)** | |
| The Netherlands | -0.23 | 1.24 | 0.85 | 0.02 | 2518 |
| | (0.27) | (0.49)** | (0.15)** | (0.52) | |
| Portugal | -0.14 | 0.94 | 0.29 | 0.61 | 2484 |
| | (0.25) | (0.43)** | (0.14)** | (0.44) | |
| Non-euro countries: | | | | | |
| Denmark | 0.21 | -1.42 | 0.55 | -2.53 | 2340 |
| | (0.38) | (0.72)** | (0.19)** | (0.86)** | |
| Sweden | 0.27 | -1.20 | 0.94 | -2.86 | 2460 |
| | (0.38) | (0.86) | (0.22)** | (0.79)** | |
| The United Kingdom | 0.35 | -1.99 | 0.00 | -2.00 | 2460 |
| | (0.26) | (0.52)** | (0.14) | (0.55)** | |

Notes: Standard errors (in parentheses) allow for heterogeneity over time and goods, and dependence over goods, by clustering the 46 items into 13 different homogenous groups (Appendix A). "*" indicates a significance level of 10 percent, "**" one of 5 percent.

Table 6: Difference-in-difference estimates (one but last column) of deseasonalized and detrended annual price growth ($100 \times [p_t/p_{t-12} - 1]$) on $1/p$.

| | Constant term | | | Inverse of price $1/p$ | | | |
|---|---|---|---|---|---|---|---|
| | $\gamma_0$ | $\gamma_1$ | $\gamma_2$ | $\beta_0$ | $\beta_2$ | $\beta_1$ | $\beta_3$ |
| Austria | 0.04 | 0.50 | -0.65 | 0.28 | -0.20 | -2.42 | 1.67 |
| | (0.08) | (0.11)** | (0.17)** | (0.26) | (0.28) | (0.55)** | (0.46)** |
| Belgium | -0.03 | 0.50 | -0.27 | 0.28 | -0.26 | -2.42 | 2.01 |
| | (0.11) | (0.11)** | (0.20) | (0.26) | (0.26) | (0.55)** | (0.49)** |
| Germany | 0.11 | 0.50 | -0.74 | 0.28 | -0.47 | -2.42 | 3.08 |
| | (0.12) | (0.11)** | (0.21)** | (0.26) | (0.26) * | (0.55)** | (0.51)** |
| Spain | -0.18 | 0.50 | 0.36 | 0.28 | -0.45 | -2.42 | 3.42 |
| | (0.08)** | (0.11)** | (0.15)** | (0.26) | (0.22)** | (0.55)** | (0.39)** |
| Finland | -0.02 | 0.50 | -0.30 | 0.28 | -0.19 | -2.42 | 1.56 |
| | (0.08) | (0.11)** | (0.19) | (0.26) | (0.26) | (0.55)** | (0.64)** |
| France | -0.22 | 0.50 | 0.55 | 0.28 | -0.01 | -2.42 | 1.37 |
| | (0.08)** | (0.11)** | (0.15)** | (0.26) | (0.23) | (0.55)** | (0.43)** |
| Greece | -0.06 | 0.50 | -0.06 | 0.28 | -0.54 | -2.42 | 3.29 |
| | (0.59) | (0.11)** | (0.80) | (0.26) | (0.81) | (0.55)** | (1.19)** |
| Ireland | -0.10 | 0.50 | 0.06 | 0.28 | -0.07 | -2.42 | 0.95 |
| | (0.10) | (0.11)** | (0.19) | (0.26) | (0.37) | (0.55)** | (0.67) |
| Italy | -0.08 | 0.50 | -0.10 | 0.28 | -0.55 | -2.42 | 3.86 |
| | (0.08) | (0.11)** | (0.20) | (0.26) | (0.21)** | (0.55)** | (0.47)** |
| Luxembourg | 0.34 | 0.50 | -2.04 | 0.28 | -0.73 | -2.42 | 4.43 |
| | (0.19) * | (0.11)** | (0.35)** | (0.26) | (0.36)** | (0.55)** | (0.55)** |
| The Netherlands | -0.23 | 0.50 | 0.59 | 0.28 | -0.22 | -2.42 | 2.15 |
| | (0.13) * | (0.11)** | (0.20)** | (0.26) | (0.23) | (0.55)** | (0.39)** |
| Portugal | -0.10 | 0.50 | -0.10 | 0.28 | -0.32 | -2.42 | 2.93 |
| | (0.10) | (0.11)** | (0.19) | (0.26) | (0.25) | (0.55)** | (0.53)** |

Notes: Standard errors (in parentheses) allow for heterogeneity over time and goods, and dependence over goods, by clustering the 46 items into 13 different homogenous groups (Appendix A). "*" indicates a significance level of 10 percent, "**" one of 5 percent.

Table 7: OLS estimates of deseasonalized and detrended annual price growth ($100 \times [p_t/p_{t-12} - 1]$) on $1/p$, over the whole period (01/97-6/03) and after the euro was introduced, using time-varying coefficients.

| | Constant term 2002 | | | Inverse of price $1/p$ 2002 | | |
|---|---|---|---|---|---|---|
| | Jan-Apr | May-Aug | Sep-Oct | Jan-Apr | May-Aug | Sep-Oct |
| Euro countries: | | | | | | |
| Austria | 0.23 | -0.30 | -0.26 | -0.61 | -1.59 | -0.24 |
| | (0.17) | (0.21) | (0.18) | (0.94) | (0.76)** | (0.45) |
| Belgium | 0.87 | 0.27 | -0.57 | 0.57 | -1.60 | -0.07 |
| | (0.22)** | (0.30) | (0.29)** | (1.14) | (0.88) * | (0.62) |
| Germany | 0.56 | -0.25 | -0.71 | 0.58 | -0.48 | 1.43 |
| | (0.26)** | (0.27) | (0.26)** | (0.77) | (0.78) | (0.53)** |
| Spain | 0.83 | 0.66 | 0.53 | 0.41 | 0.99 | 2.15 |
| | (0.22)** | (0.19)** | (0.14)** | (0.78) | (0.69) | (0.44)** |
| Finland | 0.51 | 0.33 | -0.32 | 0.48 | -2.10 | -0.84 |
| | (0.28) * | (0.33) | (0.24) | (2.00) | (1.52) | (0.72) |
| France | 1.15 | 0.74 | 0.57 | -0.17 | -1.86 | -0.09 |
| | (0.16)** | (0.14)** | (0.18)** | (0.84) | (0.93)** | (0.44) |
| Greece | -1.08 | 1.34 | 0.85 | 3.87 | -1.43 | 0.37 |
| | (1.57) | (0.28)** | (0.16)** | (2.82) | (1.00) | (0.65) |
| Ireland | 1.37 | 0.54 | -0.54 | -2.83 | -1.99 | 0.85 |
| | (0.22)** | (0.25)** | (0.21)** | (0.65)** | (0.69)** | (0.73) |
| Italy | 0.32 | 0.20 | 0.41 | 1.98 | 1.28 | 1.37 |
| | (0.32) | (0.25) | (0.19)** | (0.95)** | (0.86) | (0.43)** |
| Luxembourg | -0.79 | -1.15 | -1.68 | 1.09 | 1.07 | 2.56 |
| | (0.41) * | (0.42)** | (0.57)** | (0.67) | (0.81) | (0.67)** |
| The Netherlands | 1.40 | 0.90 | 0.26 | 0.00 | -0.65 | 0.71 |
| | (0.26)** | (0.26)** | (0.22) | (1.02) | (0.73) | (0.45) |
| Portugal | 0.20 | 0.07 | 0.60 | 1.73 | 0.48 | -0.37 |
| | (0.19) | (0.27) | (0.23)** | (0.69)** | (0.58) | (0.58) |
| Non-euro countries: | | | | | | |
| Denmark | 0.49 | 0.62 | 0.54 | -2.41 | -4.02 | -1.14 |
| | (0.26) * | (0.33) * | (0.36) | (1.60) | (1.37)** | (0.97) |
| Sweden | 1.36 | 0.94 | 0.54 | -2.26 | -3.95 | -2.36 |
| | (0.44)** | (0.33)** | (0.30) * | (1.48) | (1.21)** | (0.79)** |
| The United Kingdom | 0.30 | -0.18 | -0.10 | -1.12 | -3.11 | -1.77 |
| | (0.25) | (0.25) | (0.21) | (1.04) | (0.79)** | (0.54)** |

Notes: Standard errors (in parentheses) allow for heterogeneity over time and goods, and dependence over goods, by clustering the 46 items into 13 different homogenous groups (Appendix A). "*" indicates a significance level of 10 percent, "**" one of 5 percent.

Table 8: Difference-in-difference estimates of deseasonalized and detrended annual price growth ($100 \times [p_t/p_{t-12} - 1]$) on $1/p$, using time varying coefficients.

| | Constant term 2002 | | | Inverse of price $1/p$ 2002 | | |
|---|---|---|---|---|---|---|
| | Jan-Apr | May-Aug | Sep-Oct | Jan-Apr | May-Aug | Sep-Oct |
| Austria | -0.50 | -0.80 | -0.64 | 1.24 | 2.11 | 1.66 |
| | (0.30) * | (0.26)** | (0.26)** | (0.72) * | (0.78)** | (0.52)** |
| Belgium | 0.22 | -0.15 | -0.88 | 2.31 | 1.99 | 1.73 |
| | (0.21) | (0.35) | (0.35)** | (0.59)** | (0.79)** | (0.70)** |
| Germany | -0.24 | -0.82 | -1.16 | 2.52 | 3.31 | 3.42 |
| | (0.33) | (0.32)** | (0.32)** | (0.81)** | (0.90)** | (0.64)** |
| Spain | 0.32 | 0.38 | 0.37 | 2.01 | 4.44 | 3.80 |
| | (0.20) | (0.25) | (0.23) | (0.62)** | (0.53)** | (0.52)** |
| Finland | -0.16 | -0.10 | -0.64 | 2.23 | 1.49 | 0.96 |
| | (0.24) | (0.35) | (0.33)** | (1.09)** | (1.10) | (0.77) |
| France | 0.68 | 0.50 | 0.45 | 1.27 | 1.43 | 1.41 |
| | (0.24)** | (0.22)** | (0.26) * | (0.58)** | (0.91) | (0.51)** |
| Greece | -1.71 | 0.95 | 0.57 | 5.59 | 2.14 | 2.14 |
| | (1.69) | (0.67) | (0.63) | (2.61)** | (1.28) * | (1.02)** |
| Ireland | 0.78 | 0.18 | -0.79 | -1.19 | 1.50 | 2.54 |
| | (0.28)** | (0.30) | (0.29)** | (1.11) | (1.00) | (0.83)** |
| Italy | -0.29 | -0.18 | 0.15 | 3.66 | 4.81 | 3.11 |
| | (0.39) | (0.30) | (0.29) | (0.79)** | (0.77)** | (0.61)** |
| Luxembourg | -1.81 | -1.94 | -2.36 | 3.31 | 5.14 | 4.83 |
| | (0.52)** | (0.50)** | (0.60)** | (0.87)** | (0.68)** | (0.72)** |
| The Netherlands | 0.94 | 0.67 | 0.14 | 1.49 | 2.69 | 2.25 |
| | (0.33)** | (0.29)** | (0.28) | (0.68)** | (0.61)** | (0.50)** |
| Portugal | -0.39 | -0.28 | 0.36 | 3.42 | 4.02 | 1.37 |
| | (0.29) | (0.31) | (0.28) | (0.70)** | (1.01)** | (0.73) * |

Notes: Standard errors (in parentheses) allow for heterogeneity over time and goods, and dependence over goods, by clustering the 46 items into 13 different homogenous groups (Appendix A). "*" indicates a significance level of 10 percent, "**" one of 5 percent.

Table 9: OLS regression of the estimated changeover effect, ($\widehat{\beta}_1$ with constant from table 5, although all estimates give similar results) on consumer's difficulties and its interactions with retailers concentration. We do not have information on Luxembourg's retailer concentration, so the sample size is 11. Source: Authors' calculations, based on Eurostat and the Eurobarometer.

| | Mean | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Retailer concentration (in %) | 61 | -0.04 | | | | | | | | |
| | | (0.01)** | | | | | | | | |
| Interacted with: | | | -0.30 | -0.29 | -0.13 | -0.15 | -0.21 | -0.27 | -0.10 | -0.11 |
| | | | (0.12)** | (0.14)* | (0.03)*** | (0.08) | (0.07)** | (0.08)*** | (0.04)** | (0.04)** |
| Dual p: look at old curr. only | 0.15 | | | 11.47 | | | | | | |
| | | | | (12.52) | | | | | | |
| Dual p: look at euro only | 0.13 | | 14.54 | | | | | | | |
| | | | (6.71)* | | | | | | | |
| Need to convert (index) | 0.29 | | | | 9.91 | | | | | |
| | | | | | (2.34)*** | | | | | |
| Difficult to use coins | 0.27 | | | | | 5.48 | | | | |
| | | | | | | (6.04) | | | | |
| Dual pricing is essential | 0.24 | | | | | | 8.96 | | | |
| | | | | | | | (4.97) | | | |
| Uncomfortable with euro | 0.21 | | | | | | | 19.04 | | |
| | | | | | | | | (5.45)*** | | |
| Difficult to remember prices | 0.40 | | | | | | | | 6.59 | |
| | | | | | | | | | (4.53) | |
| Difficult to compare prices | 0.37 | | | | | | | | | 7.62 |
| | | | | | | | | | | (4.16) |
| R-squared | | 0.51 | 0.46 | 0.53 | 0.70 | 0.56 | 0.58 | 0.62 | 0.52 | 0.52 |

Table 10: Data sources

| Data | Eurostat | EIU | Consumer Survey | Eurobarometer |
|---|---|---|---|---|
| Type | panel | panel | panel | cross-sec. |
| Frequency | monthly | yearly | monthly | - |
| Time spanned | 1/97-12/02 | 90-03 | 1/85-11/03 | 4/2002 |
| Countries | 17 | 15 | 17 | 12 |
| # of items | 94 | 303 | - | - |
| # items matched | 46 | | - | - |

Table 11: Matched HICP-items and EIU identification code. Mean and standard deviation of prices in euro.

| Eurostat | EIU | mean | sd | #obs | group |
|---|---|---|---|---|---|
| Bread and cereals | fwbs fwbm fcfs fcfm | 2.4 | 0.76 | 210 | 1 |
| Meat | ffms-fcwm | 12.5 | 2.94 | 210 | 1 |
| Fish and seafood | fffs-ffim | 12.1 | 3.56 | 210 | 1 |
| Milk,cheese and eggs | fmks fmkm fchs fchm fegs fegm | 3.4 | 0.88 | 210 | 1 |
| Oils and fats | fbus-fmgm foos-fpcm | 3.9 | 1.23 | 210 | 1 |
| Fruit | fors-fbnm | 1.9 | 0.51 | 210 | 1 |
| Vegetables | fpts-fcrm flts fltm | 1.9 | 0.6 | 210 | 1 |
| Sugar,jam,honey,chocolate and conf. | fsus fsum | 1.2 | 0.26 | 210 | 1 |
| Coffee,tea and cocoa | fics-fdcm | 3.4 | 0.62 | 210 | 2 |
| Mineral waters,soft drinks, juices | fcos-fojm | 1 | 0.25 | 210 | 2 |
| Spirits | asws-alcm | 19.7 | 8.06 | 210 | 2 |
| Wine | awcs-awfm | 15.1 | 6.75 | 210 | 2 |
| Beer | abls-abtm | 1.6 | 0.67 | 210 | 2 |
| Tobacco | tcms-tpto | 3.6 | 1.24 | 210 | 2 |
| Clothing materials | csws cswm | 10.9 | 2.8 | 210 | 3 |
| Garments | cbsc-cmtm cddc cddm cwcc-ccjm cgdc-cbtm | 81.6 | 16.07 | 210 | 3 |
| Cleaning,repair and hire of clothing | hlas-hdtm | 7.7 | 2.48 | 210 | 3 |
| Footwear incl repair | cmsc cmsm cwsc cwsm | 130.3 | 27.68 | 210 | 3 |
| Actual rentals for housing | rf1m-ru3h rf3m-ruh3 | 1,484 | 424 | 210 | 3 |
| Maintenance and repair of dwelling | hlds-hdlm hlbs hlbm | 4.3 | 0.96 | 210 | 3 |
| Water supply | uwmb | 39.5 | 14.92 | 197 | 3 |
| Electricity | uemb | 118 | 61.24 | 210 | 3 |
| Gas | ugmb | 89 | 42.18 | 183 | 3 |
| Heat energy | uhto | 45.2 | 18.67 | 178 | 3 |
| Major household appliances | rctv rnfp hfps-hetm | 291.7 | 94.36 | 210 | 3 |
| Non-durable household goods | hsps-hspm hiks hikm hbts hbtm | 3.4 | 1.16 | 210 | 4 |
| Domestic services and household services | dhdc dhbr | 9.8 | 5.5 | 210 | 5 |
| Pharmaceutical products | pcas pcam | 10.2 | 4.34 | 210 | 6 |
| Medical services; paramedical services | icgp | 64.6 | 48.51 | 150 | 6 |
| Dental services | icdt | 98.7 | 42.94 | 150 | 6 |
| Hospital services | ixgp | 64.5 | 27.23 | 150 | 6 |
| Motor cars | tcll-tcfh | 23,531 | 6124 | 210 | 6 |
| Fuels and lubricants for transport | trup | 1 | 0.16 | 210 | 6 |
| Maintenance and repair of transport equip. | ttul ttuh | 217.5 | 62.56 | 210 | 6 |
| Passenger transport by road | ttrk ttim ttac | 12 | 5.14 | 210 | 6 |
| Telephone and telefax services | utlr | 14.5 | 4.92 | 202 | 7 |
| Recording media | rdcp | 19.1 | 6.99 | 209 | 8 |
| Cultural services | rtfp rcfp | 131.7 | 57.55 | 210 | 9 |
| Books | rpbn | 11.5 | 2.59 | 209 | 10 |
| Newspapers and periodicals | rdln | 0.9 | 0.31 | 210 | 10 |
| Restaurants,cafs and the like | bmtp bffs | 84.5 | 32.4 | 210 | 1 |
| Canteens | bdrb | 9.9 | 3.33 | 210 | 1 |
| Accommodation services | bhth bmht | 208 | 52.74 | 210 | 1 |
| Hairdressing salons | pcmh pcwh | 36.3 | 11.93 | 210 | 12 |
| Other personal effects | pcts-pclm pcrs pcrm | 6.3 | 0.87 | 210 | 14 |
| Insurance connected with transport | tcil tcih | 1,618 | 553 | 210 | 14 |