# The Effects of the Euro-Conversion on Prices and Price Perceptions

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Despite the expectations of economists that the euro changeover would have no effect on prices, I show that European consumers perceive the contrary. The data indicate that consumers based their perceptions about inflation on goods that are frequently purchased. I 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 Spain, Italy and France show a stronger euro-effect on prices. The data also suggest that this price growth is correlated with consumers' ability to adapt to the new currency.

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# 1 Introduction

Despite economists' expectations that the introduction of the euro (€) currency in 1999 would have no effect on price levels, most citizens of the European Union believe that the transition to the euro triggered substantial price increases. In this paper I address the question of whether the introduction of the euro had an effect on prices, both perceived and real.

Given that the exchange rates were fixed long before the new currency was introduced, economic theory tells us that on January 1st, 2002 the euro changeover should have had almost no effect on consumer behavior. The euro was launched on January 1st, 1999 as an electronic currency in the eleven participating Member States[1]. At this stage of the European Monetary Union the exchange rates of the participating currencies were fixed, while on the first of January 2002 the euro became legal tender, and about 300 million EU citizens started using the new currency[2].

Prices might have adjusted slightly due to the disappearance of commission fees, but this adjustment should have caused a slight decrease in prices, not an increase. The introduction of the euro might also have caused a slight increase in prices due to menu costs, but this effect was thought to be low[3]. In short, there was no reason to observe a significant increase in actual and perceived inflation.

In reality, most of the citizens of the European Union think that the introduction of the euro has triggered a price increase. In Germany the euro is sometimes typically

[1]Greece joined the system on January 1st, 2001

[2]For a general overview of the euro and the literature related to the euro see Corsetti (n.d.)

[3]A survey among businesses organized by the National Bank of Belgium shows, that among the companies that had a price increase after the euro the impact of the menu costs of the euro were quite marginal. In fact, they represent the least important factor (*Survey on the Introduction of the Euro* (2002)).

called the Teuro. “Teuer” means costly. In fact the data in table 1 indicate that perceived inflation did grow more than actual inflation. As a consequence, the difference between perceived and actual inflation has increased in the euro countries significantly. Among the non-euro countries only Sweden had a a bigger difference after 2002, while for all other non-euro countries it actually became smaller.

These observations should be striking for economists. There are two important reasons for analyzing the changeover. First, other European countries remain outside the euro zone and no doubt will consider joining in the future. Understanding both perceived and actual price dynamics of those who did join is critical for the rational decisions of those considering entry. Second, the introduction of the euro provides a natural experiment which allows tests of more general models of economic behavior and price setting.

There have been few attempts to explain the observed patterns of inflation in the euro zone. One possible explanation for the increase in perceived inflation is the rounding effect. Consumers tend to round the exchange rate to compare current and past prices. In Italy 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%. This explanation, suggested by Biggeri (*Istat: L'inflazione percepita al 6%* (8 October 2003)), the head of the Italian Statistical Institute, is, however, rejected by the data. This theory implies that in some euro countries there should have been no increase in perceived inflation because the rounding worked in the opposite direction, which is not true. The twelve euro-countries in fact have different exchange rates with different approximation errors (table 2).[4] According to Biggeri's claim, only a negative approximation error would generate a positive gap between perceived

[4] The approximation errors are based on a study conducted by an Italian economic institute (*Le previsioni per l'economia italiana* (2003)).

and actual inflation. However, examples of Austria, the Netherlands and Belgium contradict this idea (table 1). They have a positive approximation error and should therefore have perceived inflation growing less then the actual one. However, this is not the case.

The main aim of this paper is to study the mechanism of the impact of the euro on prices and perceived inflation. This is done by putting some structure on the statistical analysis using a theoretical model. There are several questions I address:

1. Is there any effect of the euro on prices?
2. If there is an effect on prices, why is it the case? In particular, why did some goods have much higher inflation than others?
3. Why did perceived inflation grow so much?

In order to explain a changeover effect on inflation, actual and perceived, it is necessary to go beyond the perfect information and no-frictions economy framework. In such an economy nominal changes have no real effect.

The starting point of my analysis is a conjecture by the European Central Bank (*Recent developments in consumers' inflation perceptions* (2002)) that, after the introduction of the euro, consumers based their estimation of price increases on goods that are purchased more frequently[5]. Inflation patterns for different types of goods show that inflation was in fact higher for goods that are cheaper and are purchased by customers more often. As will be made clear later, this is consistent with a model of consumers with incomplete information.

I study the question of why a difference in inflation patterns for different goods may arise and conjecture that the reason for higher inflation among cheap goods is

[5]See also Guiso (25 February 2003)

the cost of obtaining information.

I build a theoretical model that assumes consumers have computational limitations in both, converting prices to their old and familiar currency and optimizing their utility under price uncertainty. To make optimal consumption choices they need to express everything in the old-currency units, as they remember their income and prices of other products in this medium. When seeing a price in euros they have only a vague idea of how much it is in their old currency. They may find this out by converting the price, however this is costly. It is also costly to perform the optimization under price uncertainty. For simplicity I assume that both costs are the same, then if the cost of conversion exceeds the expected loss of not adjusting the consumption optimally, consumers will not convert the price and buy an old bundle. The uncertainty about the old-currency-equivalent of the price in euros is higher the higher the price in euros is. Therefore the loss of utility is higher the higher the initial price of the product. That implies that consumers will convert prices more often for those goods, and adjust demand accordingly. This consumer behavior provides an incentive for rational firms to exploit this phenomenon by increasing prices for products for which the conversion is not optimal.

In other words, the changeover to a new currency reduces the information about prices available to the consumer. Such an interpretation of the problem closely relates this model to models of consumer behavior with incomplete information. The euro introduces a cost of conversion which closely resembles search costs faced by buyers that look for the seller with the lowest price.

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 of them. Diamond (1971), in a very influential paper, shows that even small search costs could result in non-competitive outcomes. In another theoretical paper, Salop & Stiglitz (1977) assume that consumers have heterogenous costs of gathering information. This assumption can generate an equilibrium with price dispersion, but Diamonds' 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.

Starting with the seminal paper by Pratt, Wise & Zeckhauser (1979), empirical work has mainly looked at price dispersion, not due to product differentiation, to test these models. Interesting studies in the food industry have shown that providing consumers with information can lower prices (among others Devine & Marion (1979)). 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 & Perloff (2002)).

The layout of the paper is as follows. In section 2 I shortly present the data about actual-perceived inflation discrepancy and outline the formal model. Section 3 deals with the empirical specification. Section 4 concludes.

# 2 The model

There is a wide consensus that perceived inflation grew much faster than actual inflation following the introduction of the euro. Indices of perceived inflation are usually based on differences between positive and negative opinions about the level of inflation. It is therefore impossible to interpret the crude difference between actual and perceived inflation. Nevertheless, changes of this difference over time should be less prone to comparability issues. The data are based on the European Union

Business and Consumer Surveys (Eur (2004)) and Eurostat's annual harmonized consumer price index.

Figures 1 and 2 represent a way to show this change over time. They plot perceived versus actual inflation in all EU countries. Different labels have been used to distinguish the pre-euro from the post-euro period in order to highlight the change after the changeover. In most countries that participated in the currency union the break is striking, and pre and post changeover scatters can be fairly easily distinguished. On the other side there is no effect in Sweden, United Kingdom and Denmark, countries that have not yet adopted the euro (figure 2). Table 1 shows the difference between the standardized perceived and the actual inflation in all 15 countries, both before and after the introduction of the new currency. The same table also shows the perceived inflation index. Again, it is important to note that while the simple difference between perceived (a qualitative index) and actual inflation (a quantitative index) cannot be easily interpreted the change over time should be meaningful. Looking at the change between the first and the second column it can be seen the difference between actual and perceived inflation grew, and this effect did not occur to such extent in non-euro European countries. The last two columns show the big increase in perceived inflation.

These patterns suggest that consumers based their perceptions on goods that were purchased more frequently, were cheaper and had higher price increases (*Recent developments in consumers' inflation perceptions* (2002)). I propose a model that may explain why cheaper goods may be more subject to price increases after a currency changeover. In the model consumers are rational but have a cost of processing information.

## 2.1 General model

Before the euro is introduced the consumer knows her income and prices expressed in old currency, say lire, and maximizes her utility. Once the euro is introduced, the consumer does not observe the price in lire ($p$) anymore. She observes the price in euros ($p_e$). Let $e$ be the exchange rate, therefore, the price expressed in lire is $p_e e = p^*$.

It is reasonable to assume that consumers do not calculate the prices in euros perfectly. Consumers observe the price in lire with an error. I assume that the higher the price of a good is the higher the mistake is, that is the error-ridden lire-price is

$$\widetilde{p} = p^*(1 + \epsilon)$$

I claim that this is a very reasonable assumption. First, consumers learn to convert small numbers faster as these are the numbers they deal with in every day life. If the bus ticket costs 2 euros, and its price in lire did not change, consumers can learn quickly how much 2 euros is. However, when asked how much 5000 euros are, they have very little information to base the answer upon; they are likely to make a higher mistake. The above assumption about the error term can also be interpreted as if the consumer was using an approximate conversion rate, $e^* = e(1 + \epsilon)$.

A difficult exchange rate will induce the consumer to make a higher mistake if she does not convert prices precisely. $\epsilon$ may depend on the consumer's familiarity with the euro, her abilities, etc. The worse memory and analytical skills are, the higher the variance of the error term should be. The effect of prices on the error term will be discussed later.

If consumers do not know the relative prices in euros, they can act in three ways. First, they can convert the price into their old currency, the one they used to remember prices. In this way they eliminate all the uncertainty related to the price and can optimize their consumption bundle. The other two options are either to optimize under price uncertainty, or to stick to their previous consumption bundle. I assume that both the conversion and the optimization under price uncertainty involve a computation that is costly. I further assume for simplicity this cost to be $k$. This cost can be interpreted as the opportunity cost of time spent on doing the computation or as the cost of mental activity. Later in the text I will call this cost, the cost of conversion. The assumptions of the model imply that the consumer prefers to convert the price into her old currency over performing the optimization under price uncertainty.

I will show that the price growth due to currency change will be a decreasing function of the initial price. Let us consider two goods that in equilibrium are consumed in the same quantity. The quantity consumed initially has to be fixed in order to isolate the effect on prices per transaction. It may be argued that cheaper goods are bought more frequently. However, converting the price once, does not mean that the consumer will remember it the next time she buys this good. She will have to incur the conversion cost every time she makes a purchase.

To avoid dealing with income effects and keep things simple I assume that, when making decision about how much of a given good to buy, the agent's utility is quasi-linear in this good. This situation can be interpreted as one in which two different consumers, with the same income, buy two different goods.

The demand for good $x_1$ is the solution of the problem

$$max_{x_1,y_1} u(x_1) + y_1$$
$$\text{s.t. } p_1x_1 + y_1 = m \ ,$$

and the demand for good $x_2$ is the solution of

$$max_{x_2,y_2} \theta u(x_2) + y_2$$
$$\text{s.t. } p_2x_2 + y_2 = m \ .$$

Without loss of generality assume that $\theta > 1$. In order to have an equal demand $\hat{x}_1 = \hat{x}_2 = \hat{x}$, it can be shown that $p_2 = \theta p_1$.

In this limited information setup, after the changeover to the euro, the firm will increase its prices. As an extreme case, suppose that all consumers do the conversion. Then, by the profit maximization assumption, it is optimal for the firm to keep the price at pre-changeover level. On the other side, if consumers do not convert, and buy the same bundle they used to buy before the changeover, the firms optimal strategy is clearly to increase prices. In fact, the firm will set the price so that the consumer is indifferent between converting the price to lire and not converting. In terms of utilities the following equalities have to be satisfied:

$$u(\hat{x}) - \hat{x}p_1^* = EV(\widetilde{p}_1) - k \ \text{ and } \ \theta u(\hat{x}) - \hat{x}p_2^* = EV(\widetilde{p}_2) - k.$$

The terms on the left hand side represent the expected utilities when the consumer does not convert and sticks to her previous optimal consumption plan, while the utilities on the right hand side represent the expected indirect utility functions

$(EV(p) - k)$ when the conversion that costs $k$ is carried out and the consumption bundle gets updated. Solving this model I get the prediction about price growth due to the changeover.

**Theorem.** $0 \leq \pi_2^* < \pi_1^*$, *that is the more expensive good has a lower price growth.*

*Proof.* The first inequality follows from the previous discussion. First, let me show that $p_2^* < \theta p_1^*$ implies that $\pi_2^* < \pi_1^*$. $\pi_2^* = \frac{p_2^* - p_2}{p_2}$ and $p_2 = \theta p_1$, so $p_2^* < \theta p_1^*$ can be rewritten as $\pi_2^* = \frac{p_2^* - \theta p_1}{\theta p_1} < \frac{\theta p_1^* - \theta p_1}{\theta p_1} = \pi_1^*$ or $\pi_2^* < \pi_1^*$.

By contradiction. Assume that $p_2^* = \theta p_1^*$. Then $\theta u(x) - x\theta p_1^* = \theta EV(\widetilde{p}_1) - \theta k$ is equal to $\theta u(x) - x p_2^*$. But $\theta EV(\widetilde{p}_1) - \theta k < \theta EV(\widetilde{p}_1) - k$ and by the quasi-convexity of the indirect utility function $\theta EV(\widetilde{p}_1) - k \leq EV(\theta \widetilde{p}_1) - k = EV(\widetilde{p}_2) - k$. Therefore $\theta u(x) - x p_2^* < EV(\widetilde{p}_2) - k$. That means that for $p_2^* = \theta p_1^*$ the consumer prefers to convert the price, which is not optimal for the firm. Therefore the firm will decrease $p_2^*$. By similar reasoning I can show that $p_2^*$ cannot be greater than $\theta p_1^*$. □

## 2.2 Quadratic utility function

As a special case, assume the consumer has a quadratic utility function[6]:

$$U(x, y) = -.5(x - a)^2 + y$$

That implies a linear demand $\hat{x} = a - p$ and the following indirect utility function $V(p, m) = -.5p^2 + m - p(a - p)$. For simplicity I assume that $\epsilon \sim N(0, \sigma)$, so that $\widetilde{p} \sim N(p_e e, p_e e\sigma)$.

Recall, that firm will set the highest price possible while trying to keep consumer from converting. The expected utility loss from not converting is $\Delta(p_e e) =$

[6]The choice is mainly due to it's tractability when dealing with expected indirect utility functions.

$E[U(x(p_e e), y(p_e e)) - U(x(p_0), y(p_0))]$

For a quadratic function, $\Delta(\cdot)$ takes the form

$$\begin{aligned}\Delta(p_e e) = E(-.5\widetilde{p}^2 + m - \widetilde{p}(a - \widetilde{p}) + .5p_0^2 - m + \widetilde{p}(a - p_0))\\ = .5\int (p_0 - \widetilde{p})^2 d\Phi(\widetilde{p})\\ = .5(p_e e)^2\sigma^2 + .5(p_0 - p_e e)^2\end{aligned} \tag{1}$$

$\Delta(p_e e)$ is an average between the variance and the squared bias. It is higher the higher the precision of consumer perception ($\sigma$) is.

Consumers have a probability distribution over prices but they also have the choice of spending $k$ (in terms of utility) to observe prices without error. Assume that the cost differs across people, $k_i(\sigma)$, and is distributed $G(\cdot)$. I assume that the cost is a function of the variance of the consumer's error when she observes prices. It is reasonable to assume that when the variance goes to zero, the cost of conversion goes to zero as well. In other words, if the mistake is infinitesimal then the cost to get rid of the infinitesimal mistake should also be close to zero.

For each $i$ it is possible to find a threshold price in euros $\bar{p_e}$ above which the consumer will do the conversion. $\bar{p_e}$ equalizes the loss of utility $\Delta$ with cost of conversion $k_i$:

$$\bar{p_e}e(i) = \frac{1}{1+\sigma^2}\left(p_0 + \sqrt{2k_i(\sigma)(1+\sigma^2) - \sigma^2 p_0^2}\right).$$

Subtracting and dividing by $p_0$ I get the price growth

$$\pi_i(p_0) = \frac{\bar{p_e}e(i) - p_0}{p_0} = \frac{1}{1+\sigma^2}\left(-\sigma^2 + \sqrt{\frac{2k_i(\sigma)(1+\sigma^2)}{p_0^2} - \sigma^2}\right). \tag{2}$$

Notice that given the assumption that $\lim_{\sigma \to 0} k_i(\sigma) = 0$, when $\sigma = 0$ the threshold price is the initial price itself.

The firm maximizes profits. For homogenous consumers the firm would set prices according to equation 2. In this way it would face the same demand while charging higher prices. In equation (2) price growth is a decreasing function of the initial price, $p_0$. The reason for that is the following. When facing a high price in euros the consumer may incur a high cost if she does not convert the price. Given that the consumer is likely to perform the conversion, the firm, in order to avoid a lower demand than optimal, keeps the price at the pre-euro level.

While equation 2 represents the optimal price set by the firm when consumers bear the same cost of conversion it is interesting to analyze how the optimal price changes if I introduce heterogeneity in $k$. The firm's objective in the textbook model would be simply to maximize profits given the consumer demand. Assume for simplicity a constant marginal cost. The firm solves:

$$max_{p_e e}\Pi(p_e e) = (p_e e - c)\sum_i \hat{x}_i(p_e e) \tag{3}$$

The optimal price in lire is $p_e e^* = \frac{a+c}{2}$. Adding the conversion problem the firm cannot do worse. After the price is set, consumers fall into one of two groups: those who do conversion and those who do not. Therefore the problem of the firm is the following:

$$max_{p_e e}\Pi(p_e e) = (p_e e - c)\left[\sum_{p_e \geq \bar{p_e}(i)} \hat{x}(p_e e) + \sum_{p_e < \bar{p_e}(i)} \hat{x}_0\right]$$

**Theorem.** *Assuming that functions are smooth, after the introduction of the euro, it is optimal for the firm to set a price which is higher than the initial price.*

*Proof.* The firms problem is:

$$\begin{aligned} max_{p_e e}\Pi(p_e e) &= (p_e e - c)\left[\sum_{p_e \geq \bar{p_e}(i)} \hat{x}(p_e e) + \sum_{p_e < \bar{p_e}(i)} \hat{x}_0\right] \\ &= (p_e e - c)\left[\sum \hat{x}_0 + \sum_{p_e \geq \bar{p_e}(i)} (\hat{x}(p_e e) - \hat{x}_0)\right] \\ &= n(p_e e - c)(a - p_0 + G(\Delta(p_e e))(p_0 - p_e e)) \end{aligned} \tag{4}$$

The first order condition (FOC) with respect to $p_e e$ is

$$n\left[a - p_0 + G(\Delta(p_e e))(p_0 + c - 2p_e e) + (p_e e - c)(G'(\Delta(p_e e))\Delta'(p_e e)(p_0 - p_e e))\right] = 0$$

or, since $\Delta'(p_e e) = -(\frac{a+c}{2} - p_e e)$ and $p_0 = \frac{a+c}{2}$

$$\underbrace{\frac{a-c}{2}}_{I>0} + \underbrace{G(\Delta(p_e e))(\frac{a+3c}{2} - 2p_e e)}_{II<0} \underbrace{-(p_e e - c)(G'(\Delta(p_e e))(\frac{a+c}{2} - p_e e)^2}_{III<0} = 0 \tag{5}$$

It can be shown that there exists an equilibrium price and it is higher than $p_0$, the optimal price before the currency changeover. If I set $p_e e = p_0$, then $III = 0$ and the FOC simplifies to:

$$\frac{a-c}{2} - G(\Delta(p_0))\frac{a-c}{2} > 0 \Leftrightarrow G(\Delta(p_0)) < 1 \tag{6}$$

In other words, unless every consumer reoptimizes doing the conversion, $G(\Delta(p_0)) < 1$ and the firm can do better than putting $p = p_0$. On the other hand, as $p \to \infty$, $II$ and $III$ go to minus infinity, so it is optimal to decrease the price. Notice that these results do not depend on a particular distribution function $G(\cdot)$. □

A very simple but useful extension of the model is to assume that $k_i$ depends on some individual characteristics $z_i$. Since an increase in $G(\Delta(p_e e))$ increases profits, firms that deal with consumers who have a higher cost of conversion are better off.

# 3 Empirical Specification

In order to test the economic model it would be optimal to work with price levels based on microdata, i.e. on the original price information collected in the single retailers. An alternative is to work with the least aggregated data, Eurostat's monthly harmonized consumer price indices (HICP). In year 1995 an EU Council Regulation required Member States to compile monthly Consumer Price Indices on a harmonized basis from January 1997 onwards. The main purpose was to get comparable indices for the EU countries. 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, *Compendium of HICP reference documents* (2001)). These data contain information on 93 different aggregated items. The major drawback is that all the information about price levels is lost.

To test the model I match these data with information about price levels extracted from the Economist Intelligence Unit (EIU). The EIU collects, on a yearly basis, prices of several goods in several cities around the world. The Economist Intelligence Unit researchers collect information about prices twice a year (*How are prices gathered* (n.d.)). Survey prices are gathered and listed from three types of stores: supermarkets, medium-priced retailers, and more expensive speciality 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 to measure price level for different groups of products. In order to gain precision, prices have been averaged out every time multiple information was available. As a specification check, the models have been estimated using price averages over the entire time period available with almost no changes in the results. Splitting the post-euro period into more periods adds noise to the coefficients. Table 3 briefly depicts the main limits of the data.

The time frequency and the items covered match partially. I manage to combine 45 items from the Eurostat data (circa half of the data) with prices in levels from the EIU data. The match and all the items are listed in table 7, while table 8 shows the corresponding summary statistics. The information from the EIU is 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.

The empirical specification relies on equation 2, which can be fairly well approximated using

$$\pi(p_0) = \alpha + \beta \frac{1}{p_0} \ . \tag{7}$$

This can be seen by looking at figure 3 where both simulated inflation (based on equation 2) and fitted inflation are plotted against price. A fairly broad combination of $\sigma$ and $k$ allows the distance between the two functions to be small and the approximation to be good.

I use this particular equation for two main reasons. There is no closed form solution for the equilibrium price in equation (5), while equation (2) is simple and still represents the firms optimal price increase when consumers have homogenous costs of conversion.

In order to control for different pricing policies, price controls, different market structure and different exchange rates, I allow the costs of conversion to differ across countries. I estimate equation (7) separately for each country. I also estimate the model for three non-euro countries (United Kingdom, Sweden, and Denmark) in order to have estimates from a comparison group. The model predicts no effect of the changeover in these countries. It is implicitly assumed that international trade does not have a sizeable effect. No distinction is made and can be made with statistical precision given the data between tradable and non tradable goods.

Item specific ($j$) price growth will not depend only on the absolute price, but also on seasonal, cyclical and other exogenous factors, including demand and supply. I incorporate these factors in the model assuming additivity. The seasonal component $\pi_s$, the good specific fixed component $\alpha$ and the exogenous factors, observable $(1/p)$

and not ($e$), give rise to the model:

$$\pi_{j,t,c} = \pi_{j,s,c} + \alpha_{j,c} + \beta_{t,c}\frac{1}{p_{j,t,c}} + e_{j,t,c} \ , \tag{8}$$

$$\beta_{t,c} = g(t, X_c) \ . \tag{9}$$

I expect $\beta$ to decrease over time ($t$), and to depend on variables that are country specific ($X_c$). Most of these variables come from the 2002 Eurobarometer. This survey is based on approximately 1000 interviews per Member State[7]. The 2002 survey mostly covers issues related to the introduction of the euro. Information extracted from this source always uses the appropriate sample weights.

Given this model and the format of the data, the estimation is done in two steps. First, I estimate equation (8), then I compare the estimated coefficients with data that may be contained in $X_c$, like the fraction of consumers that do not think in euros and still convert the price from euros to the old currency.

The first step starts with dealing with seasonality and trends of prices. The assumption is that seasonal effects and trends are fairly constant over time, but different for different countries and different goods. This should not be too far from the truth, especially given that the data span not more than six years, therefore, I include 12 monthly dummy variables for each good (sub-index) in each country. Seasonally adjusting the data means being statistically conservative, since this is likely to capture only part of the euro effect.

A problem with the introduction of the euro is that the time pattern of its effect on inflation is not clear. The static model does not address this issue, while the empirical one does by allowing the effect $\beta$ to depend on time. On one side, firms

[7]Except Germany 2000, Luxembourg 600, United Kingdom 1300 including 300 in Northern Ireland

may need some time to learn that consumers observe prices with noise; on the other side, consumers learn and adapt to the new currency. Buyers first learn to convert more efficiently and finally switch completely to the new currency. They slowly memorize prices in euros and are able to judge how appropriate prices set by the sellers are, this time without the need of converting to the old currency.

Moreover, there was a dual circulation period of two months at the time of the changeover. A survey of 2,605 businesses in Belgium (*Survey on the Introduction of the Euro* (2002)) carried out in January 2002 shows in fact that about half of them used dual pricing. The number goes up to 95% for the retail trade. Unfortunately 60% of these retailers did not know (50%) or did not want to answer (10%) 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.

Once demeaned and deseasonalized, inflation depends on the inverse of price levels and on unobservables, such as demand and supply. Unfortunately monthly data on item-specific consumption is not available. Before the changeover it should be uncontroversial to assume that in general price levels and supply and demand factors are uncorrelated across different goods. If this is the case, even not controlling for them will yield unbiased estimates. Unfortunately this may not be true after the changeover. Demand for cheaper goods may be reduced by the fraction of consumers who do the exact conversion and notice a price increase.

Given this positive relationship between price and changes in consumption, the estimated effect of prices on inflation will be upward (downward) biased if changes in consumption and inflation are negatively (positively) correlated and I do not control for changes in consumption[8].

As proxy for consumption I use the weights used to calculate the overall inflation index. Each year these weights are based on the income shares spent in that sub-index the year before. Assuming that most of the variability comes from the change in consumption and not the change in prices and income, I can try to control for consumption using this proxy. When I do this, both using levels and changes, the results (not shown) remain basically unchanged, and the coefficient on weights is not significantly different from zero. If the proxy works, this would suggest that there is no bias of this sort in my estimates.

As an alternative solution all regressions have been estimated using lagged values of prices as an instrument. This could solve both, the aforementioned bias due to omitted variables and the measurement error problem due to the non-scientific design of the EIU data. Results, because of the very high correlation over time of prices, are almost unchanged and are therefore not reported. Reliability ratios vary between 89% and 98%. This may also depend on non-classical measurement errors since EIU analysts may be biased by the price reported in the previous period.

The estimated variance covariance matrix of the errors allows for heterogeneity over time and goods and dependence over goods by clustering the forty-six items into thirteen different groups. The groups are displayed in table 7. Once detrended there is no apparent autocorrelation. Moving away from the identically and independently distributed errors assumption slightly increases the standard errors, especially in the specifications that try to estimate more flexible time-varying coefficients.

Table 9 shows the estimated coefficients of the first regression model, while table 11 helps in interpreting the size of the effect of the seasonally adjusted model

[8]Assume the model: $\pi = \alpha \Delta c + \beta \frac{1}{p} + e$, then $plim \widehat{\beta} = \beta + \frac{cov(\epsilon, 1/p)}{var(1/p)} = \beta + \frac{\alpha cov(\Delta c, 1/p)}{var(1/P)} > \beta$ if $\alpha$ is negative

by expressing the estimated effect of the changeover in terms of yearly inflation. In this case the post-euro coefficient measures the effect after the introduction of the euro, while the pre-euro is expected to be close to zero[9].

Detrended seasonally-unadjusted (first two columns) and adjusted (last two columns) monthly price growth is regressed on the inverse of price and the inverse of price after the changeover. This model assumes a constant coefficient for the period after the introduction of the euro. The coefficient measures the additional effect of the inverse of price on monthly inflation after the changeover. A difference-in-difference estimator can be derived by simply comparing euro countries versus non-euro countries. This exercise is not performed, mainly because the control groups estimates would add unnecessary noise to estimates of the changeover effect.

There are some reasons to prefer this pooled effect over more flexible specifications. First, as already mentioned, consumers and firms may need some time to learn to deal with euros, with opposite effects on prices. Second, averaging the effect over the one-and-a-half years after the introduction represents a statistically conservative way of estimating the effect. Estimates are less susceptible to short term shocks like "hard winters" or mad cow disease. I already mentioned that consumers may switch mentally to the new currency only very slowly. Firms, as well, may not be immediately aware of the consumers difficulties. The effect could therefore persist over time.

As expected, the coefficients of the inverse of price over the entire period are not significantly different from zero. On the contrary, three of the twelve euro countries, Italy, France and Spain, have a positive and significant coefficient on the inverse of

[9]More formally $\beta_t = \beta_0 + \beta_1 1(\text{post } €)$, where $1(\text{post } €)$ is an indicator function equal to one after the euro was introduced and zero otherwise

price after the changeover. Table 11 shows the size of the effect in terms of yearly inflation. So, for example, goods that cost the equivalent of one dollar in Spain had on average a euro-related price increase of 2.66%. Germany and the Netherlands have a relatively big coefficient too, but with a t-statistic close to one.

There seems to be a relationship between the coefficients and the gap between perceived and real inflation. Not surprisingly big gaps lead to big coefficients and vice-versa. Countries without a gap do not show any significant effect of the inverse of price on price growth. What this means is that higher perceived inflation goes together with higher inflation of low-priced goods. Perceived inflation and its difference between the post and the pre-euro period are positively correlated with the coefficients too. This is coherent with the idea that consumers may base their predictions on cheaper and more frequently purchased goods.

Notice that the effects remain significant for two countries if I use seasonally adjusted data. As a comparison group I added three countries that did not participate in the currency union: Denmark, Sweden, and United Kingdom. All their coefficients are close to zero or even have the wrong sign. It seems that for some reason some euro countries do not show any effect. Ireland, Finland and Austria show a negative though small and insignificant effect.

Since averaging the effect over the one-and-a-half years after the changeover may downward bias the effect, the same model is 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". Table 10 shows that the 0-4 months effect (column 2) is generally bigger and that the second period has much lower coefficients, sometimes negative. Nevertheless, in a difference-in-difference setup, given the high negative coefficients for the non-euro countries, almost all euro countries show higher coefficients. In other words, it is true that prices of low priced goods decreased in May-August 2002, but in the euro zone some countries showed relatively strong price stickiness. Table 13 makes this comparison explicit by taking the difference between the euro-zone countries and the three euro-free countries. Except Finland and Belgium, all coefficients are positive and some are significant even if the control countries' estimates are very imprecise.

It is clear that positive effects in the first regressions are due to the fact that some countries seem to have systematically higher inflation rates for low-priced goods. Table 12 expresses the effect in the first 4 months period in terms of yearly inflation in order to facilitate the interpretation.

The other two specifications that have been used are non-linear ones: $\widehat{y} = be^{\gamma t}\frac{1}{p}$ and $\widehat{y} = (b_1 + b_2/t)\frac{1}{p}$. The first may have a more straightforward interpretation of $\gamma$, while the second has the advantage that it can be estimated using a linear model. The estimates are not reported, but the overall picture is unchanged. Coefficients drop over time. Figure 4 plots the estimated price growth versus time for $\widehat{y} = (b_1 + b_2/t)\frac{1}{p}$, and helps clarifying the timing effect. Figure 5 plots inflation on both price levels and time for one country, Spain. Other euro-zone countries have a similar shape.

Summarizing, there seems to be a relationship between the inverse of prices and inflation, especially in Spain, Italy and France. The effects are small in absolute terms, especially as prices go up, though they are big in relative terms. Remember that overall inflation in 2003 was quite low. This may explain why the effect is hard to be measured on a more aggregated level.

There also seems to be persistence. Countries that show a significant effect in the first four months after the changeover tend to have bigger coefficients later on too.

Cheaper goods could still have higher price growth for reasons that are unrelated to the euro. In order to show that the euro did matter, I link the coefficients for the euro zone countries to how hard consumers thought the adaptation to the new currency was. The model predicts the coefficients to be higher in countries where consumers are prone to think in terms of the old currency. If a consumer thinks in euros, my model collapses and there is no price growth, while if she bears a cost of conversion the firm will increase prices.

Also, it is clear from the discussion about the firms' problem with heterogeneity among consumers that prices will depend on the distribution of conversion costs and therefore on the distribution of consumers that convert. On the other side, I expect prices to depend on a series of market characteristics. In order to look into the relationship between market structure, distribution of conversion costs and inflation, I match the estimated coefficients with the Eurobarometer survey of April 2002, four months after the changeover and with Eurostat data about retailer concentration in the food industry (*Price differences for supermarket goods in Europe* (2002)).

Table 14 shows the correlation between the estimated coefficients and data extracted from the Eurobarometer[10]. Each column represents a different coefficient. Columns that refer to different models are separated by vertical lines. For some variables the model predicts a particular sign of the correlation. These variables are written in bold. In fact, all correlations have the right sign!

The harder it is to remember and to compare prices, the higher the coefficient and, therefore, the price growth of low-priced items. Also, a higher fraction of con-

[10]These data are expressed in fractions, and summary statics are shown in tables 4 to 6

sumers who always or often think in terms of the old currency and mentally convert the price is associated with a higher price growth. Notice that the correlations for the April-August 2002 period have, compared to all other periods, the opposite signs. The reason is simply that the during that period the estimated coefficients are negative and the opposite sign reflects that, in countries where a higher fraction of consumers had problems with euros, prices were stickier when going down.

Figure 6 plots the post-euro adjusted coefficient versus an index of conversion that tries to summarize the four different outcomes from the data (convert always, often, sometimes and never). The higher the index, the more consumers convert prices into the old currency. The picture makes it clear that Finland, Ireland and, to a lesser extent, Belgium are outliers. Notice that these are also the countries that showed almost no gap between perceived and actual inflation. Ireland shows an extremely fast learning pace. It has by far the lowest fractions of consumers who say they have difficulties with remembering and comparing prices (table 5). Moreover, only 7% of Irish consumer had great difficulties with euros (minimum) and only 21% did always convert when looking at a price in euros (another minimum, see table 4).

Finland leads to an interesting topic that is on the agenda. It has by far the highest level of concentration in the food retail market: the market share of the five leading groups in food retailing is around 90% in Finland while it is only 25% in Italy and about 40-60% in the remaining countries.

Table 14 shows that, in fact, retailer and producer concentration are negatively correlated with the coefficients. This means that prices of low-priced goods grew slower whenever the market was lead by few competing companies. This finding is in fact coherent with the data shown in table 6. Consumers had the impression that small shops were more likely to round up prices after the changeover. A possible explanation for this is that big retailers compete on "standardized" goods. This transparency increases the probability of finding a similar or even identical good at the competitors' shops. Also, the bigger and important the shop, the more likely it is that mass media get interested in their pricing policies. This may additionally discourage big chains from using the euro changeover to increase profits.

# 4 Conclusions

Some institutions, including Eurostat (*Euro-zone annual inflation down to 1.9%* (2003)), have found that the euro changeover had only a very limited effect on overall inflation, but inflation is an extremely synthetic measure of price growth and may not capture differentiated effects of the changeover on prices. To my knowledge, excluding anecdotal evidence and descriptive studies these possible differentiated effects have not been fully investigated.

I propose a model where consumers need some time to adapt to the new currency. Meanwhile, they observe the price in euros which is for them a noisy signal about the price in their old currency. The model predicts higher inflation for lower priced goods. It also predicts that the effect should vanish once the variance of the noise goes to zero.

The data I use support the model. I analyze the relationship between price levels and inflation in all twelve countries who introduced the new currency and in three countries that did not, Sweden, United Kingdom and Denmark, then I link this relationship to consumer behavior with respect to the euro.

In three countries, Spain, Italy and France the predicted relationship is stronger and more significant. These are also the countries that seem to have encountered the biggest problems with the new currency. They have higher percentages of consumers that tended to think and judge the price appropriateness using their old currency. They also have more consumers that had a hard time in remembering and in comparing prices expressed in euros.

Another interesting finding is that retailer concentration has a negative effect on the estimated coefficients of the changeover effect. This result seems to be confirmed by the fact that most consumers coming from countries that joined the euro perceive that prices grew more in small retailers than in big ones. The reason for this could be that big chains are more vulnerable to stigma effects due to discretionary price increases and that big chains compete on more standardized goods, for which the comparability issue is smaller.

This paper is a step towards understanding people's behavior when faced with nominal changes. I show that consumers have costs associated with dealing with the new currency, which in turn has an effect on prices and perceived inflation. Hopefully it will help some countries (especially future euro members) in better designing currency changes.

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Table 1: Mean difference between standardized perceived and actual inflation and perceived inflation before and after the euro changeover. Source: own calculations based on Eurostat and Consumer survey.

| | Perceived-actual inflation | | Perceived inflation | |
|---|---|---|---|---|
| | pre | post | pre | post |
| **Austria** | **-0.15** | **0.85** | **-5.77** | **33.11** |
| **Belgium** | **-0.09** | **0.62** | **22.42** | **40.94** |
| Denmark | 0.31 | -0.02 | -19.63 | -16.28 |
| **Finland** | **-0.09** | **1.12** | **-14.40** | **-2.17** |
| **France** | **-0.09** | **0.67** | **-0.38** | **43.61** |
| **Germany** | **-0.31** | **1.23** | **19.63** | **63.83** |
| **Greece** | **-0.43** | **0.89** | **23.70** | **43.94** |
| **Ireland** | **0.27** | **0.32** | **28.35** | **55.33** |
| **Italy** | **0.11** | **0.36** | **17.40** | **48.06** |
| **Luxembourg** | **.** | **-0.56** | **.** | **35.11** |
| **Netherlands** | **-0.29** | **1.18** | **23.07** | **74.44** |
| **Portugal** | **0.15** | **0.40** | **23.38** | **46.44** |
| **Spain** | **0.04** | **0.50** | **13.00** | **49.39** |
| Sweden | -0.16 | 0.75 | -28.05 | -15.33 |
| United Kingdom | 0.41 | -1.44 | 2.65 | -8.44 |

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% |
| 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% |

Table 3: Data sources

| Data | Eurostat | EIU | Cosumer Survey | Eurobarometer |
|---|---|---|---|---|
| Type | panel | panel | panel | cross-sec. |
| Frequency | monthly | yearly | monthly | - |
| Time spanned | 1/97-6/03 | 90-03 | 1/85-11/03 | 4/2002 |
| Countries | 17 | 15 | 17 | 12 |
| # of Items | 94 | 303 | - | - |
| # items matched | 45 | | - | - |

Table 4: Summary statistics from the Eurobarometer. Fractions

| | AT | BE | FI | FR | DE | GR | IE | IT | LU | NL | PT | ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hate Euro | 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 | 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 € | 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 price: don't look € | 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 price: 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 price: 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 |
| Dual price: Bias | *0.15* | 0.19 | **0.31** | 0.22 | 0.21 | **0.31** | *0.15* | 0.30 | 0.22 | 0.25 | 0.25 | 0.17 |
| Think always 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 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 |

Notes: Austria AT, Belgium BE, Germany DE, Greece GR, Spain ES, France FR, Ireland IE, Italy IT, Luxembourg LU, Netherlands NL, Portugal PT, Finland FI

Table 5: Summary statistics from the Eurobarometer. Fractions

| Problems with: | AT | BE | FI | FR | DE | GR | IE | IT | LU | NL | PT | ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 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 | 0.36 | 0.49 | 0.43 | *0.54* | 0.42 | 0.32 | **0.24** | 0.37 | 0.31 | 0.31 | 0.35 | 0.33 |
| nobs | 1,000 | 1,045 | 1,010 | 1,010 | 2,051 | 1,002 | 984 | 1,000 | 602 | 997 | 1,000 | 1,000 |
| Retailers concentr.[a] | 68 | 66 | **89** | 61 | 61 | 38 | 54 | *25* | - | 68 | 52 | 50 |

Notes: Austria AT, Belgium BE, Germany DE, Greece GR, Spain ES, France FR, Ireland IE, Italy IT, Luxembourg LU, Netherlands NL, Portugal PT, Finland FI

[a]Market share of five leading groups in food retailing

Table 6: Summary statistics from the Eurobarometer. Fractions

| | AT | BE | FI | FR | DE | GR | IE | IT | LU | NL | PT | ES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prices rounded up | 0.74 | 0.88 | 0.78 | 0.89 | 0.92 | 0.93 | 0.84 | 0.83 | 0.89 | 0.95 | 0.80 | 0.91 |
| nobs | 1,000 | 1,045 | 1,010 | 1,010 | 2,051 | 1,002 | 984 | 1,000 | 602 | 997 | 1,000 | 1,000 |
| 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 |
| Services | 0.92 | 0.82 | 0.87 | 0.85 | 0.94 | 0.91 | 0.97 | 0.86 | 0.83 | 0.89 | 0.86 | 0.81 |
| 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 |
| Leisure | 0.82 | 0.85 | 0.89 | 0.74 | 0.85 | 0.87 | 0.91 | 0.85 | 0.85 | 0.86 | 0.85 | 0.87 |
| 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 |
| Vending mach | 0.88 | 0.93 | 0.88 | 0.86 | 0.81 | 0.88 | 0.94 | 0.80 | 0.88 | 0.86 | 0.91 | 0.89 |
| nobs | 228 | 130 | 195 | 182 | 229 | 108 | 94 | 181 | 103 | 31 | 98 | 91 |

Notes: Austria AT, Belgium BE, Germany DE, Greece GR, Spain ES, France FR, Ireland IE, Italy IT, Luxembourg LU, Netherlands NL, Portugal PT, Finland FI

Table 7: Matched items and EIU identification code. Mean and standard deviation of prices over time and countries

| 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 |

Table 8: Means and SDs over time and countries. Inflation is expressed on yearly basis. Source: Eurostat and EIU

| Items | weight | SD | 1/p | SD | #nobs | $\pi_{1-4/2002}$ | SD |
|---|---|---|---|---|---|---|---|
| Bread and cereals | 27.67 | 5.91 | 0.50 | 0.13 | 1170 | 2.6% | 2.3% |
| Meat | 43.51 | 13.05 | 0.09 | 0.02 | 1170 | -0.8% | 2.6% |
| Fish and seafood | 11.95 | 11.35 | 0.10 | 0.03 | 1170 | 4.9% | 3.7% |
| Milk,cheese and eggs | 25.02 | 5.78 | 0.34 | 0.08 | 1170 | 2.0% | 3.0% |
| Oils and fats | 6.68 | 4.00 | 0.30 | 0.07 | 1170 | 5.6% | 8.6% |
| Fruit | 12.20 | 4.05 | 0.65 | 0.26 | 1170 | 25.9% | 21.8% |
| Vegetables | 17.12 | 4.71 | 0.56 | 0.15 | 1170 | 22.5% | 13.4% |
| Sugar,jam,... | 12.50 | 4.14 | 0.92 | 0.19 | 1170 | 1.9% | 3.2% |
| Coffee,tea and cocoa | 5.04 | 1.51 | 0.32 | 0.07 | 1170 | -1.8% | 3.1% |
| Mineral waters,soft drinks,... | 9.23 | 2.65 | 1.11 | 0.27 | 1170 | 1.4% | 3.5% |
| Spirits | 5.75 | 4.47 | 0.06 | 0.02 | 1170 | 3.5% | 3.9% |
| Wine | 9.33 | 3.77 | 0.08 | 0.03 | 1170 | 4.7% | 5.0% |
| Beer | 7.69 | 5.43 | 0.73 | 0.25 | 1170 | 4.8% | 6.8% |
| Tobacco | 28.63 | 16.44 | 0.30 | 0.10 | 1170 | 8.7% | 9.4% |
| Clothing materials | 0.83 | 0.72 | 0.10 | 0.03 | 1092 | 0.9% | 16.3% |
| Garments | 58.53 | 16.46 | 0.01 | 0.00 | 1170 | -2.4% | 12.3% |
| Cleaning,repair of clothing | 1.75 | 1.38 | 0.15 | 0.04 | 1170 | 5.6% | 3.8% |
| Footwear incl repair | 15.29 | 5.16 | 0.01 | 0.00 | 1170 | -0.8% | 10.4% |
| Actual rentals for housing | 57.81 | 31.53 | 0.00 | 0.00 | 1170 | 4.3% | 2.7% |
| Materials for maint. of dwelling | 8.92 | 6.06 | 0.26 | 0.06 | 1170 | 1.8% | 2.9% |
| Water supply | 5.83 | 3.54 | 0.03 | 0.01 | 1170 | 3.4% | 4.9% |
| Electricity | 24.25 | 8.43 | 0.01 | 0.01 | 1170 | 3.2% | 6.4% |
| Gas | 10.47 | 8.18 | 0.02 | 0.04 | 1170 | -3.3% | 12.2% |
| Heat energy | 11.55 | 7.00 | 0.02 | 0.01 | 468 | 2.5% | 5.0% |
| Major household appliances | 10.25 | 2.40 | 0.00 | 0.00 | 1170 | -0.3% | 2.4% |
| Non-durable household goods | 11.57 | 4.04 | 0.33 | 0.10 | 1170 | 0.8% | 1.7% |
| Domestic and household services | 7.91 | 4.87 | 0.13 | 0.05 | 1170 | 8.3% | 11.1% |
| Pharmaceutical products | 8.74 | 5.56 | 0.12 | 0.07 | 1170 | 0.4% | 11.5% |
| Medical & paramedical services | 7.00 | 6.24 | 0.02 | 0.02 | 1170 | 6.4% | 7.8% |
| Dental services | 5.37 | 4.97 | 0.01 | 0.00 | 1170 | 0.9% | 28.0% |
| Hospital services | 3.32 | 4.91 | 0.02 | 0.02 | 1170 | 8.9% | 9.6% |
| Motor cars | 51.70 | 15.05 | 0.00 | 0.00 | 1170 | 3.1% | 1.9% |
| Fuels and lubricants (transportation) | 41.31 | 10.92 | 1.05 | 0.19 | 1170 | 29.0% | 14.8% |
| Maintenance and repair (transportation) | 22.34 | 9.36 | 0.01 | 0.00 | 1170 | 8.0% | 4.2% |
| Passenger transport by road | 7.28 | 5.08 | 0.11 | 0.07 | 1170 | 3.6% | 7.5% |
| Telephone and telefax services | 19.81 | 5.91 | 0.08 | 0.03 | 780 | 0.1% | 3.3% |
| Recording media | 4.48 | 1.76 | 0.07 | 0.02 | 1170 | 0.7% | 3.4% |
| Cultural services | 15.48 | 6.11 | 0.01 | 0.00 | 1170 | 4.6% | 9.8% |
| Books | 6.46 | 1.75 | 0.09 | 0.02 | 1170 | -1.4% | 12.7% |
| Newspapers and periodicals | 10.95 | 3.87 | 1.18 | 0.34 | 1170 | 5.6% | 6.6% |
| Restaurants,cafs and the like | 79.81 | 34.69 | 0.02 | 0.00 | 1170 | 7.6% | 4.1% |
| Canteens | 7.17 | 4.00 | 0.12 | 0.05 | 1170 | 3.6% | 5.2% |
| Accommodation services | 13.98 | 10.97 | 0.01 | 0.00 | 1170 | 7.7% | 18.7% |
| Hairdressing salons | 10.29 | 2.97 | 0.03 | 0.01 | 1170 | 6.3% | 4.4% |
| Other personal effects | 4.23 | 2.66 | 0.16 | 0.02 | 1170 | -0.1% | 6.4% |
| Insurance (transportation) | 4.92 | 2.59 | 0.00 | 0.00 | 1092 | 8.4% | 9.8% |

Table 9: Estimated coefficients (in %) of the euro-effect, single effect model. Standard errors in parenthesis. "*" indicates a significance level of 10%, "**" one of 5%

| | Unadjusted model | | Seasonally adj. model | | |
|---|---|---|---|---|---|
| 1/p | pre € | post € | pre € | post € | # obs. |
| Austria | 0 | .02 | .01 | -.05 | 3332 |
| | (.1) | (.24) | (.07) | (.17) | . |
| Belgium | -.03 | .11 | 0 | 0 | 3299 |
| | (.11) | (.2) | (.08) | (.16) | . |
| Germany | -.04 | .19 | -.01 | .06 | 3411 |
| | (.08) | (.18) | (.06) | (.12) | . |
| Spain | -.05 | .26 ** | -.04 | .22 ** | 3139 |
| | (.04) | (.09) | (.04) | (.09) | . |
| Finland | -.02 | .09 | .03 | -.15 | 3392 |
| | (.11) | (.36) | (.09) | (.27) | . |
| France | -.06 | .29 * | -.04 | .18 | 3410 |
| | (.09) | (.17) | (.07) | (.13) | . |
| Greece | -.06 | .24 | -.02 | .07 | 3058 |
| | (.18) | (.28) | (.11) | (.23) | . |
| Ireland | .02 | -.07 | .04 | -.14 | 3191 |
| | (.09) | (.13) | (.08) | (.12) | . |
| Italy | -.04 | .17 ** | -.03 | .13 ** | 3309 |
| | (.03) | (.08) | (.03) | (.06) | . |
| Luxembourg | -.01 | .07 | 0 | .04 | 3309 |
| | (.07) | (.11) | (.07) | (.1) | . |
| Netherlands | -.05 | .22 | -.03 | .14 | 3266 |
| | (.07) | (.18) | (.06) | (.14) | . |
| Portugal | 0 | .07 | .01 | .01 | 3232 |
| | (.05) | (.08) | (.05) | (.07) | . |
| Denmark | -.02 | .08 | .03 | -.15 | 3122 |
| | (.11) | (.23) | (.09) | (.17) | . |
| Sweden | .02 | -.11 | .06 | -.27 | 3208 |
| | (.12) | (.23) | (.1) | (.2) | . |
| United Kingdom | 0 | -.02 | .02 | -.07 | 3191 |
| | (.08) | (.11) | (.06) | (.11) | . |

Table 10: Estimated coefficients (in %) of the euro-effect, seasonally adjusted time varying effect model. Standard errors in parenthesis. "*" indicates a significance level of 10%, "**" one of 5%

| 1/p | pre 2002 | 1/02-4/02 | 5/02-8/02 | 9/02-12/02 | post 2003 | #obs. |
|---|---|---|---|---|---|---|
| Austria | .01 | .02 | -.14 | .05 | -.11 | 3332 |
| | (.07) | (.5) | (.32) | (.3) | (.24) | . |
| Belgium | 0 | .2 | -.39 * | .07 | .11 | 3299 |
| | (.08) | (.47) | (.23) | (.21) | (.31) | . |
| Germany | -.01 | .44 | -.25 | -.05 | .08 | 3411 |
| | (.06) | (.34) | (.18) | (.15) | (.22) | . |
| Spain | -.04 | .64 ** | .15 | .09 | .04 | 3139 |
| | (.04) | (.2) | (.12) | (.14) | (.18) | . |
| Finland | .03 | .22 | -.69 * | .23 | -.31 | 3392 |
| | (.09) | (.83) | (.41) | (.36) | (.39) | . |
| France | -.04 | .4 | -.1 | .07 | .32 | 3410 |
| | (.07) | (.35) | (.15) | (.13) | (.3) | . |
| Greece | -.02 | .05 | .07 | -.06 | .22 | 3058 |
| | (.11) | (.47) | (.6) | (.3) | (.42) | . |
| Ireland | .04 | .09 | -.01 | .06 | -.58 ** | 3191 |
| | (.08) | (.21) | (.28) | (.19) | (.24) | . |
| Italy | -.03 | .37 ** | -.02 | .16 ** | .05 | 3309 |
| | (.03) | (.17) | (.08) | (.06) | (.13) | . |
| Luxembourg | 0 | .28 | -.04 | .02 | -.06 | 3309 |
| | (.07) | (.18) | (.12) | (.17) | (.25) | . |
| Netherlands | -.03 | .45 | -.03 | -.01 | .14 | 3266 |
| | (.06) | (.3) | (.22) | (.39) | (.21) | . |
| Portugal | .01 | -.07 | -.07 | .09 | .08 | 3232 |
| | (.05) | (.12) | (.17) | (.07) | (.13) | . |
| Denmark | .03 | .49 | -.25 | -.13 | -.59 | 3122 |
| | (.09) | (.39) | (.29) | (.24) | (.36) | . |
| Sweden | .06 | -.05 | -.39 | -.21 | -.4 | 3208 |
| | (.1) | (.57) | (.29) | (.3) | (.38) | . |
| United Kingdom | .02 | .11 | -.63 * | .09 | .06 | 3191 |
| | (.06) | (.16) | (.32) | (.15) | (.18) | . |

Table 11: Estimated yearly inflation (in %) due to the euro in the **post euro period** given the coefficients of the single effect model with seasonally adjusted data for different price levels

| | p=1 | p=2 | p=3 | p=4 | p=5 |
|---|---|---|---|---|---|
| Austria | -0.63 | -0.31 | -0.21 | -0.16 | -0.13 |
| Belgium | 0.06 | 0.03 | 0.02 | 0.01 | 0.01 |
| Germany | 0.69 | 0.35 | 0.23 | 0.17 | 0.14 |
| Spain | 2.66 | 1.32 | 0.88 | 0.66 | 0.53 |
| Finland | -1.76 | -0.88 | -0.59 | -0.44 | -0.35 |
| France | 2.21 | 1.10 | 0.73 | 0.55 | 0.44 |
| Greece | 0.90 | 0.45 | 0.30 | 0.22 | 0.18 |
| Ireland | -1.69 | -0.85 | -0.57 | -0.42 | -0.34 |
| Italy | 1.62 | 0.81 | 0.54 | 0.40 | 0.32 |
| Luxembourg | 0.50 | 0.25 | 0.17 | 0.12 | 0.10 |
| Netherlands | 1.64 | 0.82 | 0.54 | 0.41 | 0.33 |
| Portugal | 0.17 | 0.09 | 0.06 | 0.04 | 0.03 |
| Denmark | -1.78 | -0.89 | -0.60 | -0.45 | -0.36 |
| Sweden | -3.16 | -1.59 | -1.06 | -0.80 | -0.64 |
| United Kingdom | -0.88 | -0.44 | -0.29 | -0.22 | -0.18 |

Table 12: Estimated yearly inflation (in %) due to the euro in the first 4 months of 2002. The estimates are from the time varying effect model with seasonally adjusted data for different price levels in euro

| | p=1 | p=2 | p=3 | p=4 | p=5 |
|---|---|---|---|---|---|
| Austria | 0.30 | 0.15 | 0.10 | 0.07 | 0.06 |
| Belgium | 2.42 | 1.20 | 0.80 | 0.60 | 0.48 |
| Germany | 5.44 | 2.69 | 1.78 | 1.34 | 1.07 |
| Spain | 7.96 | 3.91 | 2.59 | 1.94 | 1.55 |
| Finland | 2.63 | 1.31 | 0.87 | 0.65 | 0.52 |
| France | 4.90 | 2.42 | 1.61 | 1.20 | 0.96 |
| Greece | 0.55 | 0.27 | 0.18 | 0.14 | 0.11 |
| Ireland | 1.08 | 0.54 | 0.36 | 0.27 | 0.22 |
| Italy | 4.55 | 2.25 | 1.50 | 1.12 | 0.90 |
| Luxembourg | 3.37 | 1.67 | 1.11 | 0.83 | 0.66 |
| Netherlands | 5.55 | 2.74 | 1.82 | 1.36 | 1.09 |
| Portugal | -0.86 | -0.43 | -0.29 | -0.22 | -0.17 |
| Denmark | 6.05 | 2.98 | 1.98 | 1.48 | 1.18 |
| Sweden | -0.55 | -0.28 | -0.18 | -0.14 | -0.11 |
| United Kingdom | 1.38 | 0.69 | 0.46 | 0.34 | 0.27 |

Table 13: Difference in difference estimators for the April-August 2002 period. Each column represents a different comparison country. Standard errors in parenthesis. "*" indicates a significance level of 10%, "**" one of 5%

| | - Denmark | - Sweden | - United Kingdom |
|---|---|---|---|
| Austria | .1 | .25 | .48 |
| | (.43) | (.43) | (.45) |
| Belgium | -.14 | 0 | .24 |
| | (.37) | (.37) | (.4) |
| Germany | 0 | .14 | .38 |
| | (.34) | (.34) | (.37) |
| Spain | .4 | .54 * | .78 ** |
| | (.31) | (.31) | (.35) |
| Finland | -.44 | -.3 | -.06 |
| | (.5) | (.5) | (.52) |
| France | .15 | .29 | .53 |
| | (.32) | (.33) | (.36) |
| Greece | .32 | .46 | .7 |
| | (.67) | (.67) | (.68) |
| Ireland | .24 | .38 | .62 |
| | (.4) | (.4) | (.43) |
| Italy | .23 | .37 | .61 * |
| | (.3) | (.3) | (.33) |
| Luxembourg | .2 | .35 | .58 * |
| | (.31) | (.31) | (.34) |
| Netherlands | .21 | .36 | .59 |
| | (.36) | (.36) | (.39) |
| Portugal | .17 | .32 | .56 |
| | (.33) | (.34) | (.37) |

Table 14: Correlation between the estimated coefficients of the euro-effect and consumer behavior towards the euro (fraction of sample responding:...). Source: Eurobarometer and Eurostat. The producer concentration is calculated by the Internal Market DG based on ACNielsen data.

| | post € | post €(adj.) | 1/02-4/02 | 5/02-8/02 | 9/02-12/02 |
|---|---|---|---|---|---|
| post € | 1.00 | | | | |
| post €(adj.) | 0.88 | 1.00 | | | |
| 1-4/02 | 0.68 | 0.68 | 1.00 | | |
| 5-8/02 | 0.27 | 0.59 | 0.16 | 1.00 | |
| 9-12/02 | -0.27 | -0.29 | 0.00 | -0.48 | 1.00 |
| **Hard to remember prices** | 0.34 | 0.28 | 0.29 | -0.41 | 0.30 |
| **Hard to compare prices** | 0.38 | 0.19 | 0.21 | -0.53 | 0.22 |
| **Always think in Lire** | 0.69 | 0.47 | 0.44 | -0.20 | 0.12 |
| **Often think in Lire** | 0.29 | 0.16 | 0.59 | -0.51 | 0.33 |
| **Sometimes think in Lire** | -0.73 | -0.53 | -0.65 | 0.28 | -0.21 |
| **Never think in Lire** | -0.48 | -0.21 | -0.56 | 0.63 | -0.33 |
| **Always convert** | 0.80 | 0.61 | 0.37 | -0.08 | 0.11 |
| **Often convert** | 0.31 | 0.09 | 0.51 | -0.66 | 0.36 |
| **Sometimes convert** | -0.68 | -0.44 | -0.40 | 0.33 | -0.19 |
| **Never convert** | -0.66 | -0.45 | -0.52 | 0.43 | -0.28 |
| Dual p:look at Euro only | -0.29 | -0.32 | -0.42 | 0.31 | -0.35 |
| Dual p:look at Lira only | 0.03 | 0.10 | 0.25 | -0.16 | -0.21 |
| Dual p:was essential | 0.29 | 0.29 | 0.18 | 0.13 | 0.08 |
| Dual p:was useless | 0.07 | 0.01 | -0.37 | 0.35 | -0.53 |
| Hard to use coins | -0.20 | -0.12 | 0.04 | -0.14 | -0.33 |
| Hard to use notes | -0.02 | 0.25 | -0.13 | 0.39 | -0.20 |
| Dislike Euro | 0.03 | -0.26 | 0.05 | -0.45 | -0.08 |
| Uncomfortable with Euro | 0.41 | 0.39 | 0.30 | 0.15 | -0.56 |
| Permanent diffic. with € | 0.30 | 0.35 | -0.07 | 0.02 | 0.25 |
| Overall no diffic. with € | -0.44 | -0.48 | -0.03 | -0.22 | -0.36 |
| Prices were rounded up | 0.70 | 0.62 | 0.59 | 0.40 | -0.65 |
| Retailer concentration | -0.23 | -0.48 | -0.03 | -0.75 | 0.22 |
| Producer concentration | -0.64 | -0.64 | -0.84 | -0.08 | 0.11 |

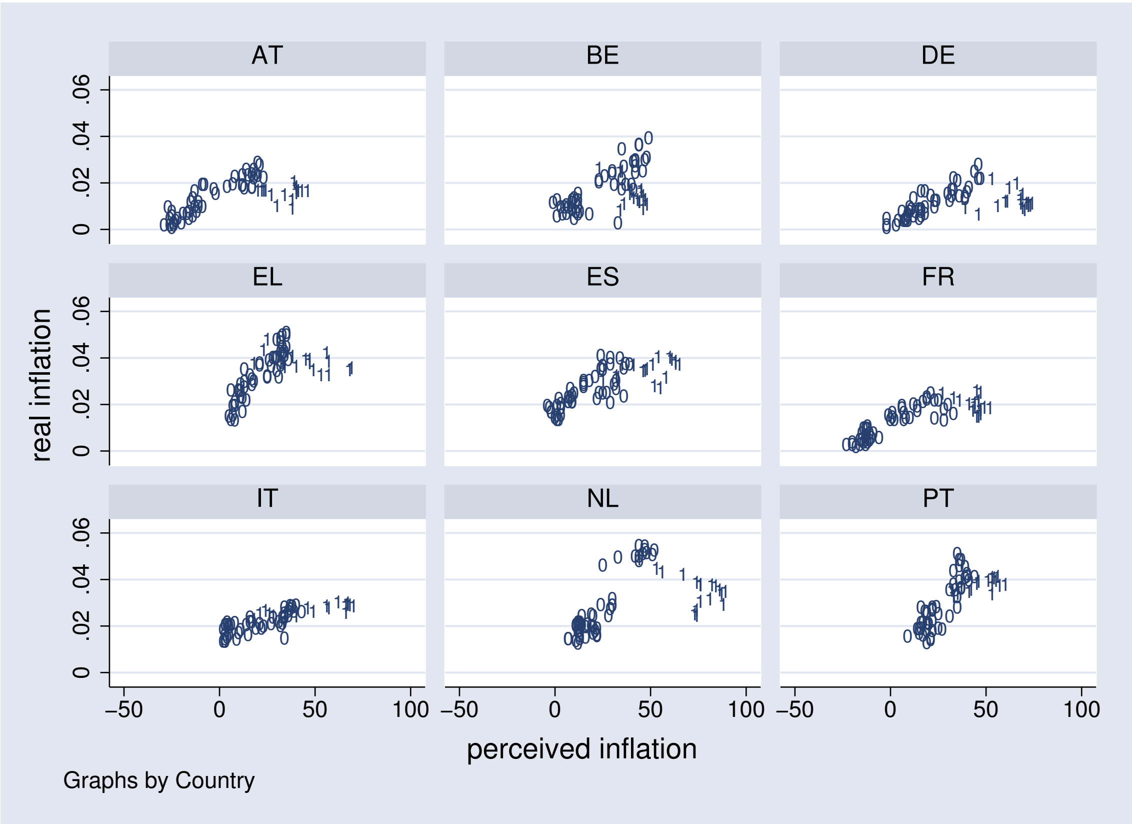


Figure 1: Perceived vs. real inflation before "0" and after the changeover "1" in countries where there is a clear change

Notes: Austria AT, Belgium BE, Germany DE, Greece EL, Spain ES, France FR, Ireland IE, Italy IT, Netherlands NL, Portugal PT

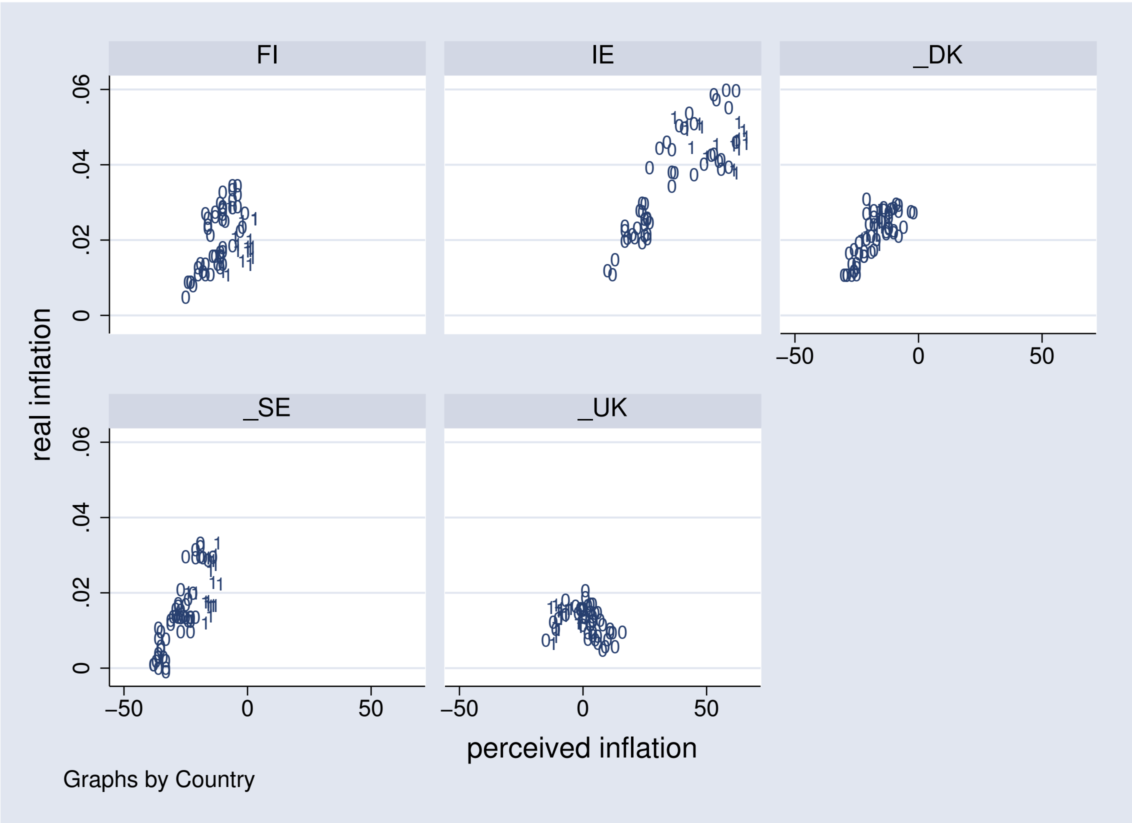


Figure 2: Perceived vs. real inflation before “0” and after “1” the changeover in euro and non-euro countries where no change is visible
Notes: Finland FI, Ireland IE, Sweden SW, Denmark DK, United Kingdom UK

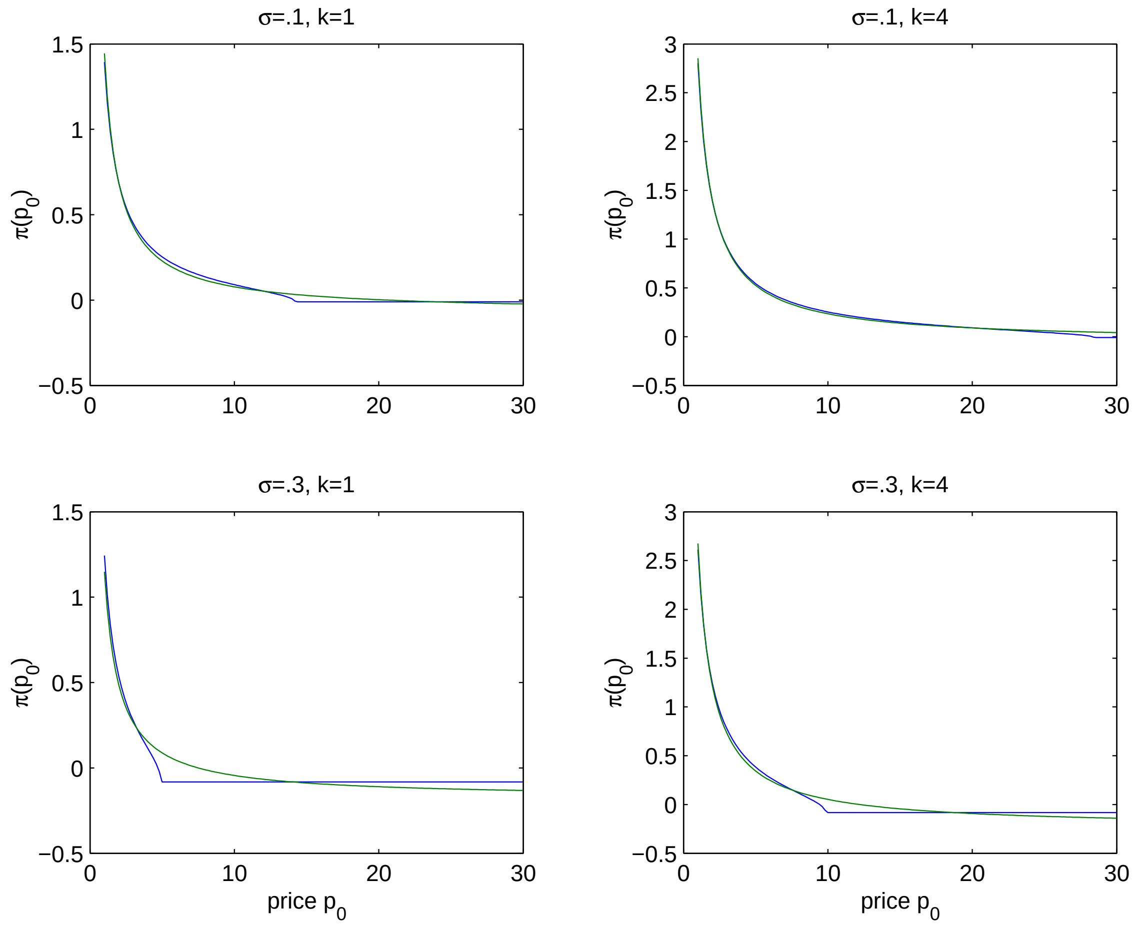


Figure 3: Simulations of equation (2) for different values of $\sigma$ and $k$ versus the OLS fit based on equation (7).

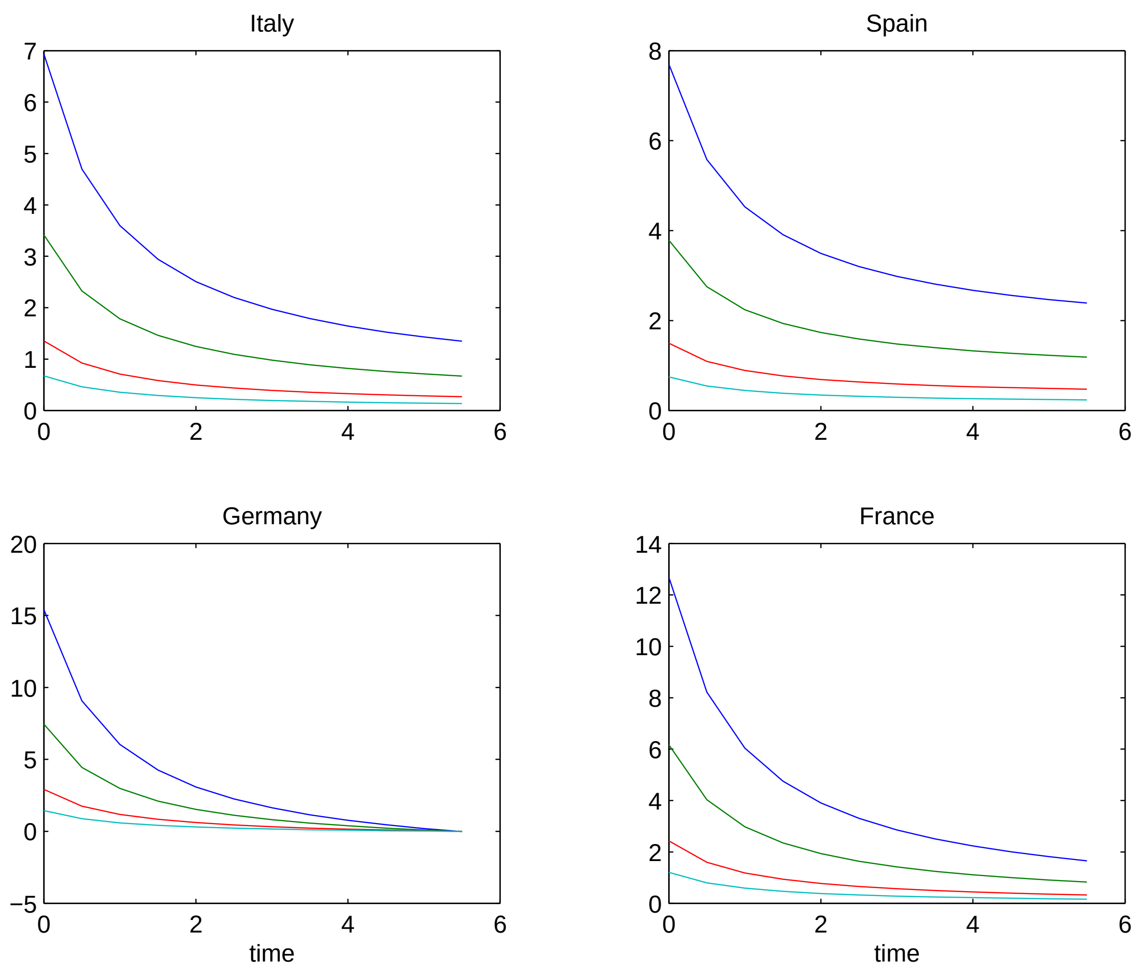


Figure 4: Predicted price growth (in %) for price equal to 1,2, 5 and 10 (decreasing) using the model $\widehat{y} = (\widehat{\alpha} + \frac{\widehat{\beta}}{t})\frac{1}{p}$.

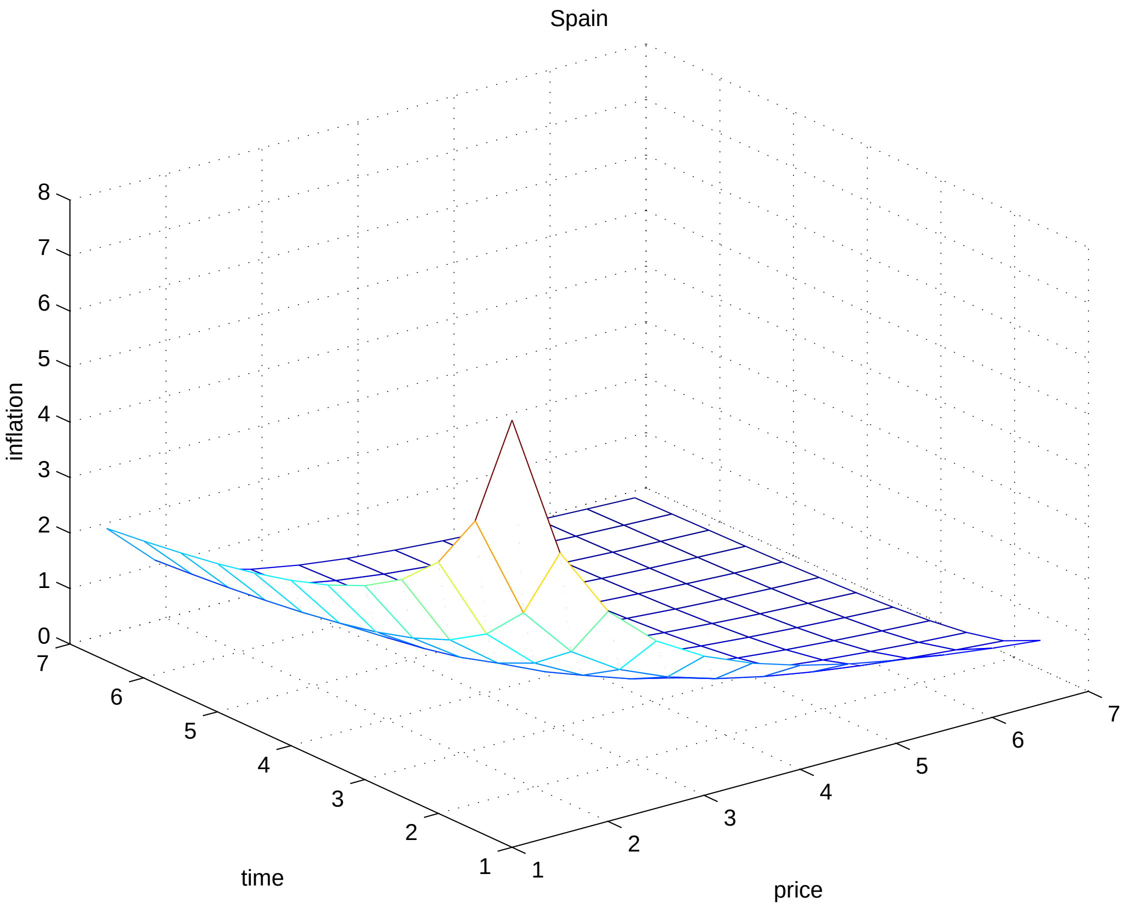


Figure 5: Predicted price growth (in %) versus price and time. Model: $\widehat{y} = (a + \frac{b}{t})\frac{1}{p}$.

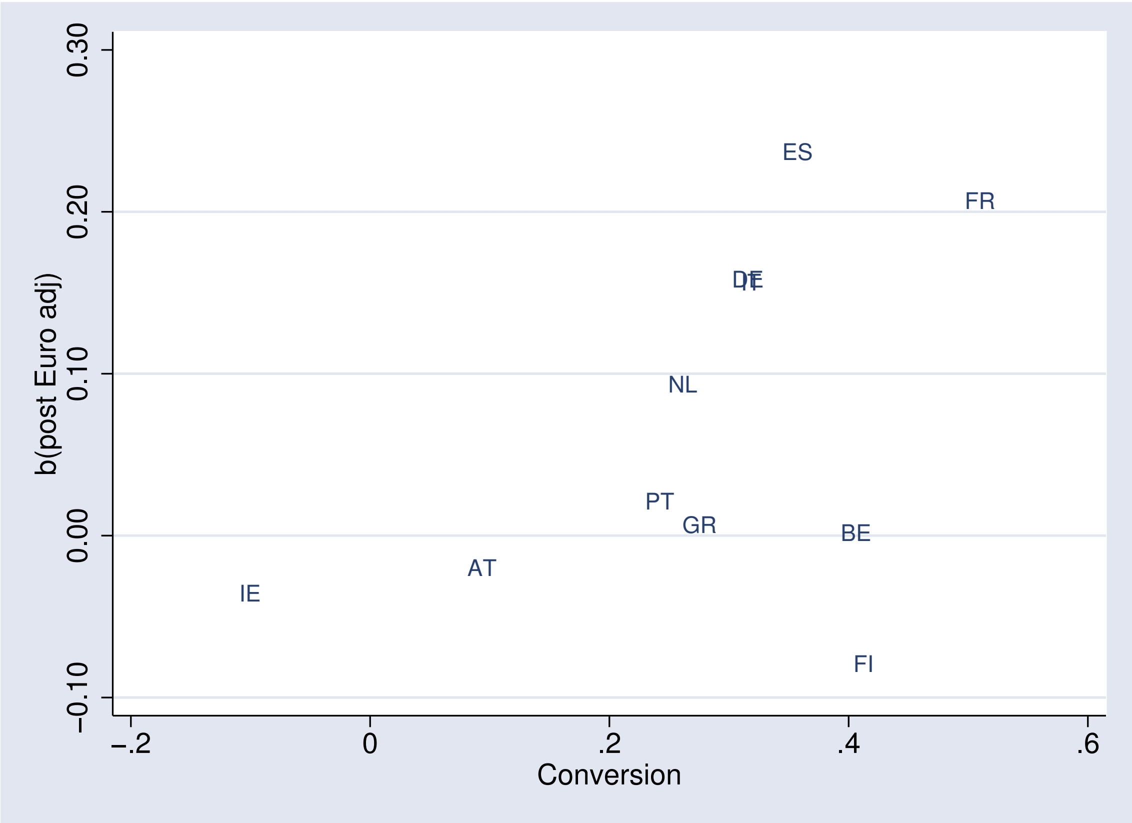


Figure 6: Index of conversion to the euro vs. the estimated seasonally adjusted coefficients
Notes: Austria AT, Belgium BE, Germany DE, Greece GR, Spain ES, France FR, Ireland IE, Italy IT, Luxembourg LU, Netherlands NL, Portugal PT, Finland FI, Sweden SW, Denmark DK, United Kingdom UK

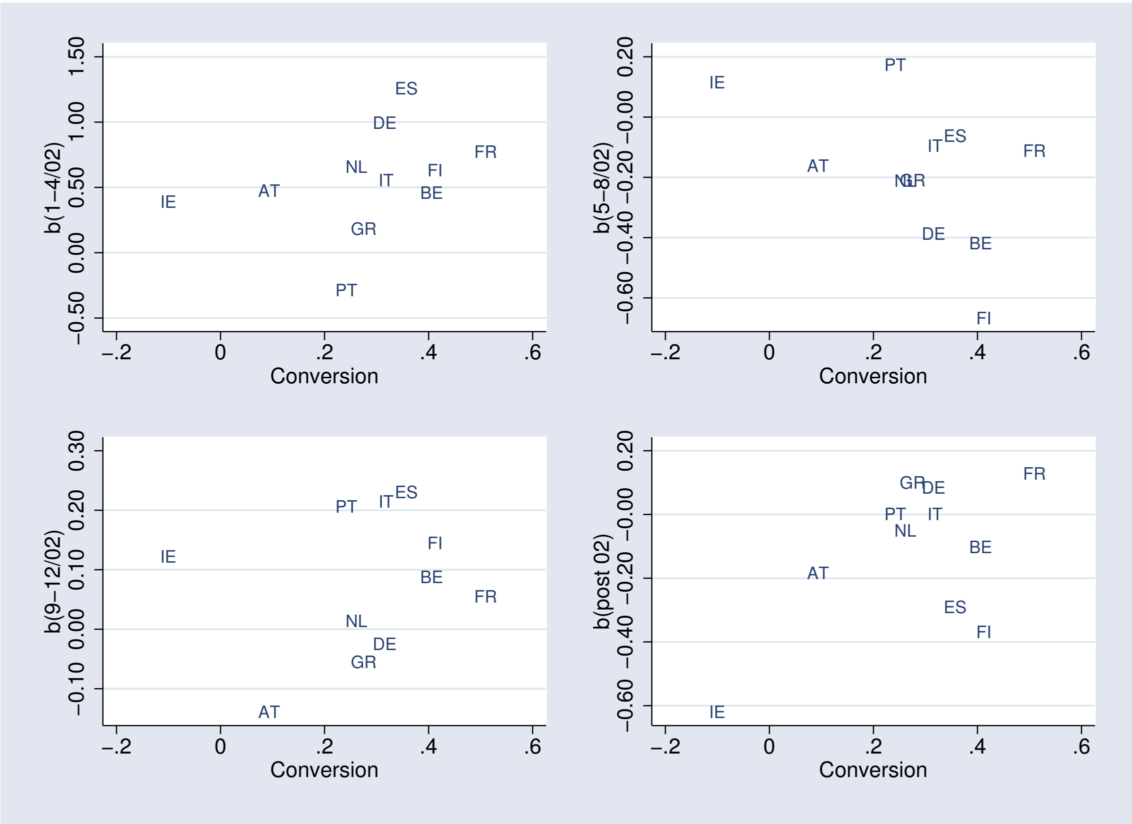


Figure 7: Index of conversion to the euro vs. the time varying estimated seasonally adjusted coefficients

Notes: Austria AT, Belgium BE, Germany DE, Greece GR, Spain ES, France FR, Ireland IE, Italy IT, Luxembourg LU, Netherlands NL, Portugal PT, Finland FI, Sweden SW, Denmark DK, United Kingdom UK