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What drives inflation perceptions?

A dynamic panel data analysis¹

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Abstract

At the moment of the euro cash changeover, inflation perceptions in the euro area deviated from measured inflation, and in some euro-area Member States in a persistent way. In recent years, a growing body of literature has developed on the factors that might explain this deviation. This paper formally tests various explanations advanced in this literature. It adopts a cross-country perspective at the level of the euro area which is empirically implemented through a dynamic panel data model. Inflation perceptions are found to be highly persistent (the autoregressive term is large and statistically highly significant). In contrast to much of the – descriptive – literature, an index of "out-of-the-pocket expenditure" is found not to explain inflation perceptions better than does the all-items HICP index. As suggested by psychological experiments, inflation expectations seem to contribute to the formation of inflation perceptions, although to a limited extent. Prices of residential real estate contribute significantly to inflation perceptions, suggesting that households have a broader view of the cost of living when forming inflation perceptions. Our results have implications for policy, for the further research agenda and for the development of statistics. In particular, the persistence of inflation perceptions makes us think that communication efforts prior to euro introduction are essential to anchor perceptions. Once perceptions increase, it will be much harder to bring them back in line with measured inflation.

Key words: inflation, perceived inflation, dynamic panel data model

JEL classification: C23, D12, D84, E31

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1. Introduction

More than five years after the introduction of euro banknotes and coins - the euro cash changeover, polls reveal a widespread perception that the euro has led to higher inflation. In a Eurobarometer poll² of autumn 2006, more than 90% of respondents in the euro area considered that the euro had "*added to the increase of prices*" in the past 5 years.

This feeling of accelerated price increases persists despite the fact that inflation since the creation of the euro in 1999, or since the introduction of euro banknotes and coins in 2002, has clearly not been higher than before. The opposite is true in most euro-area Member States. The prices of some goods and services did increase more strongly around the date of the euro cash changeover. The impact on the overall HICP price index was, however, only small and temporary.

So, if measured inflation remained low after the introduction of the euro, why do people perceive much stronger price increases? A flourishing literature on the issue has put forward several explanations. Firstly, products which saw strong price increases at some point in time may be particularly important for the perception of price developments in general. Secondly, households whose consumption differs from the average HICP basket may have experienced a different pace and magnitude of price increases. Thirdly, the feeling that life has become more expensive might be influenced by the development of households' disposable income in the past few years. Fourthly, inflation perceptions may have been blurred by expectations of price increases, the complexity of the conversion rate from national currency to euro, extensive media coverage of price developments or by the way people compare current euro prices with prices of 2001 in national currency.

So far, much of this literature has been of a descriptive nature. Where explanations were tested formally, this has mostly – with few exceptions³ – been done at the level of an individual Member State. This paper therefore contributes to filling the empirical gap by testing, from a euro-area⁴ perspective, the joint validity of some of the hypotheses mentioned above within a single framework. Dynamic panel data analysis is employed to test whether inflation perceptions can be explained by different sub-indices of the harmonised index of consumer prices, e.g. frequently purchased goods (an index of "out-of-the-pocket" expenditure is constructed for the purpose), by residential property prices, house rents and other housing related costs, developments of household income or inflation expectations.

The results find mixed support for some of the hypotheses generally advanced in the literature and also bring in new findings. The price index of out-of-the-pocket expenditure has not more explanatory power than the all-items HICP itself. If the out-of-the-pocket index played a larger role than headline inflation itself closely before and after the euro cash introduction, this effect was transitory and did not last long enough to be identified by our regressions. In any event, the development in the out-of-the-pocket index has less explanatory power with regards to the persistence of a difference between perceived and measured inflation.

House price developments appear to play a significant role in explaining inflation perceptions, while the compensation per employee does not seem to have additional explanatory power. The results suggest that inflation expectations may explain inflation perceptions to a limited extent. Moreover, the introduction of the euro appears as a regime change.

² Flash Eurobarometer 193, available at: http://www.ec.europa.eu/public_opinion/flash/fl193_en.pdf

³ Aucremanne *et al.* (2007), for example.

⁴ The euro area is, for the purpose of this paper, defined as the 12 Member States that introduced the euro cash in 2002.

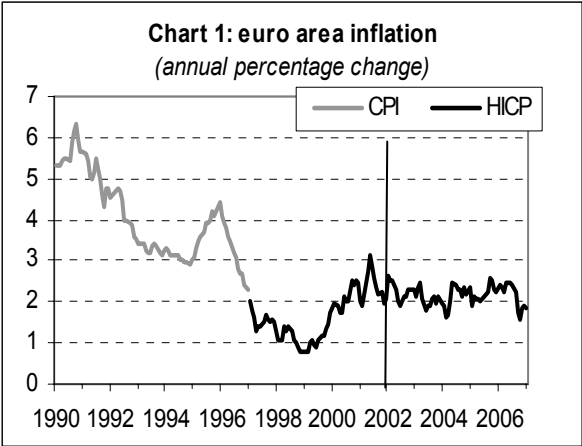
We find that inflation perceptions are highly persistent, which has important policy implications. In fact, the persistence of perceptions suggests that it is hard to dispel the perception of price increases once it has taken hold. Therefore, communication efforts should address inflation perceptions well before future cash changeover operations.

The remainder of this paper is organised as follows. Section 2 reviews developments in perceived and measured inflation, with an emphasis on HICP sub-categories which saw the most significant price changes around the cash changeover. A literature review is provided in Section 3, both on price-setting behaviour and market structure and on the suggested explanations for high inflation perceptions. The specific approach employed in this paper is discussed in Section 4, under three subsections: the model, the data, and the results. Section 5 concludes and discusses possibilities for further avenues of research.

2. Measured price developments at the euro cash changeover and perceived inflation

2.1. Headline inflation and some components

Annual consumer price increases in the euro area have averaged 2.0% since the creation of the euro and 2.2% since 2002. Inflation in most euro area Member States was higher, often significantly, in the first half of the 1990s than it has been since the adoption of the euro (chart 1). In the year following the euro cash changeover, annual inflation in the euro area was 2.3%, marginally down from 2.4% the year before. At the country level, average inflation in 2002 was lower than in 2001 in seven out of the twelve euro-area Member States (table 1). Mild inflation in 2002 is a first indication that the impact of the euro cash changeover on HICP inflation in 2002 was rather limited.



Source: Eurostat

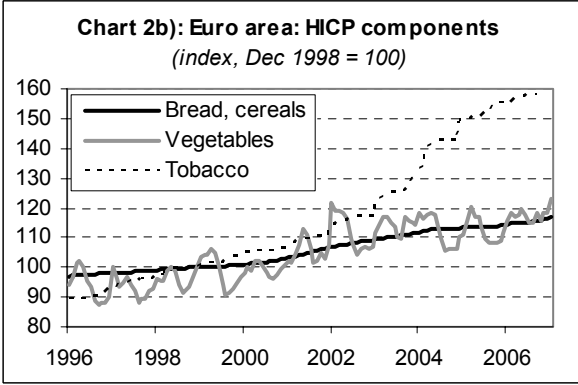
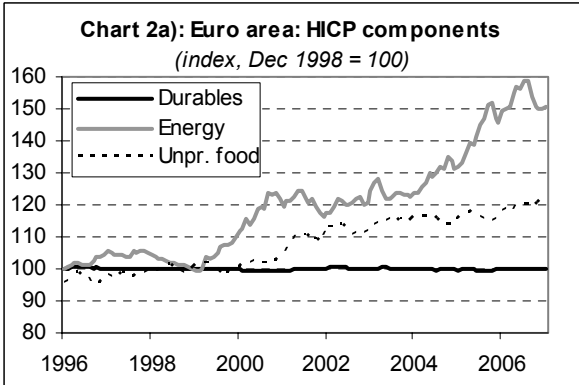
Table 1: Consumer price inflation (HICP) in the euro area and Member States
(annual average rate of change in %)

	euro area	BE	DE	IE	GR	ES	FR	IT	LU	NL	AT	PT	FI
1999	1.1	1.1	0.6	2.5	2.1	2.2	0.6	1.7	1.0	2.0	0.5	2.2	1.3
2000	2.1	2.7	1.4	5.3	2.9	3.5	1.8	2.6	3.8	2.3	2.0	2.8	2.9
2001	2.4	2.4	1.9	4.0	3.7	2.8	1.8	2.3	2.4	5.1	2.3	4.4	2.7
2002	2.3	1.6	1.4	4.7	3.9	3.6	1.9	2.6	2.1	3.9	1.7	3.7	2.0
2003	2.1	1.5	1.0	4.0	3.4	3.1	2.2	2.8	2.5	2.2	1.3	3.3	1.3
2004	2.1	1.9	1.8	2.3	3.0	3.1	2.3	2.3	3.2	1.4	2.0	2.5	0.1
2005	2.2	2.5	1.9	2.2	3.5	3.4	1.9	2.2	3.8	1.5	2.1	2.1	0.8
2006	2.2	2.3	1.8	2.7	3.3	3.6	1.9	2.2	3.0	1.7	1.7	3.0	1.3

Source: Eurostat.

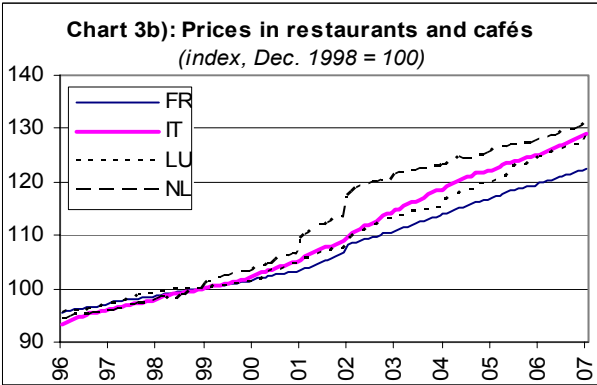
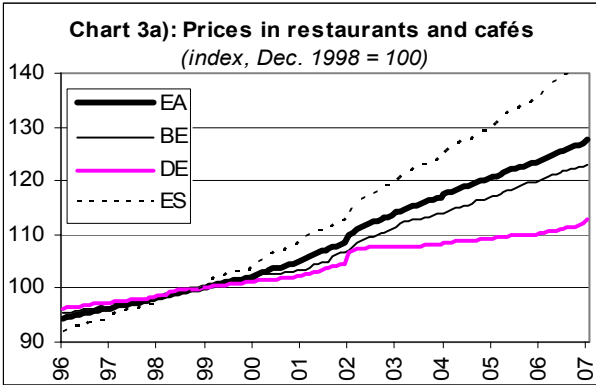
According to Eurostat (2003), the impact of changeover-related inflation on the HICP for the whole year 2002 is most likely to lie within a range of 0.12 and 0.29 percentage points of inflation. Angelini and Lippi (2006) use the evolution of cash withdrawals at ATMs in Italy as indirect evidence of price developments. Their argument is that since these data do not rely on official inflation statistics, they provide an independent check for the latter. They do not find evidence that consumer prices increased after the cash changeover in a way that would not be recorded in official statistics.

However, the euro cash changeover was accompanied by a much higher number of price adjustments than usual (cf. Chlumsky and Engelhard, 2002; Angeloni et al, 2006). And indeed, prices for some goods and services did increase at the time of the euro cash changeover (charts 2a and 2b). In the euro area as a whole, this was particularly the case for unprocessed food. Prices for fresh vegetables, that are usually quite volatile, increased sharply in early 2002. Prices for bread and cereals, which are generally far less volatile, experienced significant increases throughout 2001 and 2002. Energy prices also picked up in early 2002 across the euro area.



Source: Eurostat

An increase in prices of restaurants and cafés that seemed to be related to the euro cash changeover was widely noticed (charts 3a and 3b). In a number of Member States, a jump in these prices in January 2002 was clearly visible. In some countries, such as Germany and the Netherlands, an upward price adjustment in early 2002 was followed by a long period of more subdued price increases in restaurants and cafés, such that these price increases have reverted to their longer-term trend. In some others (including Belgium, France, Italy and Spain), however, a faster pace of price increases in the restaurant and café sector has been sustained after 2002. Restaurants and cafés exemplify similar developments in some other services, in particular recreational services (e.g. prices of cinema tickets), hairdressers and various repair and cleaning services.



Source: Eurostat

In its final report on the impact of the euro cash changeover on prices, Eurostat (2003) differentiates price increases in 2001/2002 into those which were due to the euro cash changeover and those that were due to other factors (cf. also Ercolani and Dutta, 2006). The main findings are as follows:

- The price increases for a number of items were unrelated to the euro cash changeover. Short-term variations in energy prices depend mainly on international energy market conditions. The energy price increase in the euro area in 2002 was similar to energy price developments outside the euro area and can thus not be ascribed to the euro cash changeover. Similarly, price increases for holiday packages and air travel were found to depend on energy prices and security measures rather than the euro cash changeover. Other increases, such as tobacco prices, were driven by tax increases.
- Price increases for fruit and vegetables were driven to a large extent by bad harvests in parts of Europe in 2001. Nonetheless, the typical pattern of their price developments changed around the euro cash changeover date. They might thus have been influenced by the changeover as well. The same is true for the prices for bread, beer and some services.
- Finally, a number of products show rather clear changeover-related price patterns. These include the above mentioned restaurants and cafés, hairdressers, repair and cleaning and recreational services.

Many of the prices most likely to have been affected by the euro cash changeover are thus indeed prices of products of everyday consumption: foodstuff and regularly purchased services. The prices of other items of regular consumption (fuel, tobacco) also increased, but independently of the euro cash changeover. By contrast to these "out-of-the-pocket" purchases, the prices for many "big-ticket" items consumed at lower frequency have remained stable or actually fallen.⁵

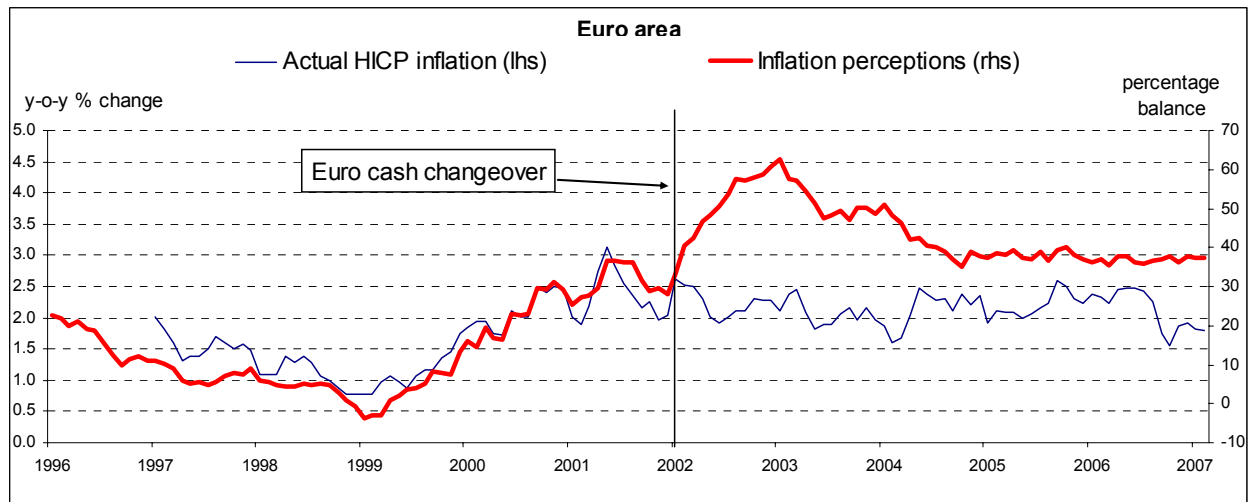
2.2. Inflation perceptions

Although the annual HICP inflation rate in 2002 was slightly below inflation in 2001, people's perceptions of inflation increased significantly with the euro cash changeover and, in a number of Member States, remained well above measured inflation thereafter.

The European Commission collects data on inflation perceptions within the framework of the Joint Harmonised EU Programme of Business and Consumer Surveys. The Commission indicator of perceived inflation corresponds to the difference between the weighted proportion of respondents stating that prices have risen over the past twelve months and the weighted proportion of respondents stating that prices have fallen or remained unchanged over the same period. This balance statistic used to track HICP inflation remarkably well in the period 1996-2001.

⁵ It is important to note in this context that the HICP measures price developments net of quality improvements.

Chart 4: Inflation perceptions and the HICP



Source: European Commission

However, in the course of 2002, inflation perceptions measured by the Consumer Survey moved significantly away from measured inflation. Thus, the prior close correlation between perceived and headline inflation broke as perceptions were moving to levels never registered before. The perception gap narrowed between early 2003 and the end of 2004. The narrowing of the gap came however to a halt in 2005, indicating either strong persistence in perceptions or a new relationship between perceptions and headline inflation induced by the regime change. If the latter explanation holds, one should not expect the gap to entirely close.

The break in the relationship between measured and perceived inflation occurred in all euro-area Member States (see detailed charts in the Annex 1). Developments at the level of Member States differed, however, with respect to the size of the perception gap, the precise moment when the gap widened and its persistence. For instance, the gap was large but temporary in countries such as Germany, Italy and the Netherlands, but large and persistent in France, Belgium, Greece and Finland.

3. A review of the literature

The literature has focused on two main themes. Firstly, the reasons for cash changeover-related price increases and, secondly, the reasons for higher inflation perceptions.

3.1. Price-setting behaviour and market structure

The mechanisms behind changeover-related price increases are theoretically well understood and empirically fairly well documented. Market structure, dual pricing regulations, attractive pricing and menu costs are the main factors put forward to explain such increases. Angeloni et al. (2006) identify a sharp increase in the number of price adjustments – both upwards and downwards – in six euro-area countries in early 2002, in line with “menu costs” related to price adjustments. They find that after the initial adjustment, price setting behaviour returned to normal. Dziuda et al. (2005) build a model of imperfect competition among retailers in order to explain changeover-related price increases. In their model, the introduction of the new currency temporarily decreases price transparency and thereby weakens competitive pressure among retailers. The individual retailer can exploit that situation by increasing his prices, or he can invest in measures to increase price transparency in an effort to attract additional business from customers who find it difficult to deal with the new currency. The

authors show that the choice between the two possibilities depends on the market structure: the more concentrated the retail market, the stronger an investment in transparency is expected to pay off. (Efforts to increase transparency are more visible to the consumer in a market dominated by a small number of retail chains, and there are economies of scale to advertisement.) Indeed, their evidence from euro-area countries confirms that changeover-related inflation was weaker in countries with more concentrated retail markets.

Ehrmann (2006) finds that consumers use simple “rules of thumb” for the mental conversion of national currency to euro, in euro-area countries where conversion rates are complex. He shows that this approximative conversion has given retailers in the food and clothing sectors opportunities to increase prices by stealth.

Eife and Moschitz (2005) point to the role of changeover-related pricing regulations. They find that the obligation to use dual price tags in Austria for five months and a long "replacement" period for fading out prices in Schilling explain why the changeover produced less price increases in Austria than in Germany where there was no obligation for dual display of prices.

Some articles focus on menu costs and market structure in the restaurant sector, where price increases around the cash changeover were particularly strong. Hobijn et al (2006) argue that due to menu costs, restaurants adjust their prices only intermittently. At the moment of the cash changeover, where menus had to be re-written anyway, an unusually large number of restaurants in the euro area also adjusted their prices. Gaiotti and Lippi (2005) analyse price increases in a panel of restaurants in Italy. They acknowledge the concentration of price adjustments at the moment of the changeover, but find that the strong price increases in 2001 and 2002 can only partly be attributed to the changeover. Their empirical results show that cost factors (rising unit labour costs and food prices) as well as strong demand explain a great deal of the increases. Moreover, the authors find evidence that price increases were stronger where the geographical concentration of restaurants (a proxy for competition) is lower. In the model of Adriani et al. (2003) restaurants specialise on either local customers, who are well informed about the quality at offer, or tourists, for whom the offer is more intransparent. They collect data for six euro-area Member States and conclude that the cash changeover allows restaurants serving mostly tourists to coordinate on a new equilibrium with permanently higher prices and thus to extract rents from their customers.

Chlumsky and Engelhard (2002) analyse the inflationary impact of the movement from "attractive prices" in DEM to "attractive" euro prices (see also National Bank of Belgium, 2002 as well as Aucremanne and Corneille, 2001).⁶ They find strong sectoral variations in the timing and the inflationary impact of the move from prices converted at the official rate towards attractive euro prices. The services sector applied attractive euro prices mostly as of January 2002, and this was accompanied by significant price increases for items such as cinema tickets, hotel stays and car wash. For food and consumer durables the move towards attractive prices was more gradual and accompanied by price decreases for durables and price volatility for food (as mentioned above, the volatility of food prices was to a large extent unrelated to the euro cash changeover). Also for Germany, the Bundesbank (2004) reports that the prices of some items that saw the strongest increases in early 2002 later stagnated, thus reverting towards their longer-term trend.

⁶ An "attractive" price is understood as a price that ends on 0; 5; 8 or 9 (€2.99 and €3 are "attractive" prices for, say, a sandwich; €2.97 and €3.02 are not).

3.2. Explanations for high inflation perceptions

A growing literature deals with the factors that seem to influence the way consumers deal with price variations and could explain the divergence of measured and perceived inflation related to the euro cash changeover (Fluch and Stix, 2005, as well as ECB, 2007 are good overview articles). Most of the literature discusses one or more of the following classes of explanations: Individual prices or groups of prices within the HICP could influence perceptions more than headline inflation itself; price developments outside the scope of the HICP and household income developments could drive perceptions of a broad "cost of living"; technical factors (such as the complexity of the euro conversion rate) as well as psychological factors might have produced a bias of perceptions in the specific situation of the cash changeover.

The most prominent explanation for increased inflation perceptions is based on the observation, confirmed by the official price statistics, of substantial price increases for products purchased very frequently. Many authors argue that consumers' inflation perceptions are mainly formed on the basis of such "out-of-the-pocket" expenditure.⁷ The fact that TV sets are becoming cheaper will strike consumers only when they buy one. Consumers are also less frequently reminded of the price developments of items they pay for by standing bank order (e.g. rents). However, the ECB (2003 and 2005) and the European Commission (2004) argue that the price dynamics of out-of-the-pocket expenditure only partly explain the development of inflation perceptions.

Since the HICP is based on the consumption of an average household, the price developments faced by individual households will differ more or less strongly from the HICP, depending on their individual consumption patterns. For the individual household, the price for particular goods or services can play a role significantly higher or lower than the HICP weight. Del Giovane and Sabbatini (2005, 2006) look at different socioeconomic categories of consumers in Italy and show that dissimilar inflation perceptions across socioeconomic groups can arise from their different consumption patterns (e.g. the weight of basic foodstuff in the overall consumption of a particular group). When analysing the underlying factors of high perceptions in Italy, Giovane and Sabbatini (2006) suggest that "*a combination of ... factors contributed to the gap*". In addition to frequently purchased goods, they advance the hypothesis that the public is influenced more by upward (than downward) changes in prices. Differences between individual consumption baskets and the consumer price index basket are also found to play a role. In relation to this, the sharp rise in the price of items not included in the consumer price index basket, such as house prices, is identified as another factor. Extensive media coverage is equally found to be highly correlated with inflation perceptions. Finally, for rarely purchased durable goods, consumers may compare current prices with the prices when they last made such purchases -which can be well before December 2001.

Brachinger (2005, 2006) attempts to capture some of these elements more formally in his index of perceived inflation for Germany. It builds on the following hypotheses on human behaviour: First, people compare prices for any particular good with an internal, good-specific reference price, usually the memory of a price observed some time in the past. If the price for a good is lower than its reference price, this is perceived as a benefit; if it is higher, this is perceived as a loss. Second, people value such losses higher than benefits of equal size (i.e. they are more sensitive to price increases than to price reductions). Third, the perception of price variations is stronger the higher the frequency of concretely experiencing them. Brachinger formalises these hypotheses and combines them with official data on prices and

⁷ A different pace of price increases by frequency of purchase was, besides, also observed in the UK (O'Donogue, 2007).

approximate purchase frequencies⁸ to calculate his index of perceived inflation. However, in order to determine the concrete level of perceived inflation, an exogenous parameter of loss aversion is needed. In the author's preferred specification, this parameter is set at 2 (losses are felt twice as strongly as benefits), a level derived from experiments reported in related literature. By construction, the index so derived does not depend on any survey measure of inflation perceptions. The index of perceived inflation for Germany shows perceived inflation between 7% and 11% in most of 2001 and the first half of 2002 before converging back to the level of the HICP. If, in addition, one assumes that the adaptation of reference prices was slower than usual at the time of the cash changeover, because people continued for some time to use the latest DEM prices as reference, the index re-converges towards the level of HICP inflation much more gradually. Those who continue to use old DEM prices as a reference would even perceive a constant acceleration of inflation. Hoffmann *et al.* (2006) critically discuss the assumptions inherent to the index developed by Brachinger. In particular, they point out that households' inflation perceptions are likely to be influenced by the impact of large expenditure items on their budget. By assigning a high weight to frequently purchased items, Brachinger's index fails to take into account the impact of large, but less frequent expenditure items (such as rents) on households' budget. They also criticise the "*certain degree of arbitrariness*" that arises from the choice of the exogenous parameters.

Ehrmann (2006) shows that the complexity of euro conversion rates together with approximative "rules of thumb" for mental rounding may have contributed to the mismatch of perceived and actual inflation. The survey of cinema-goers by Cestari *et al.* (2007) demonstrates that consumers' memory of prices may be rather poor. The respondents to their survey recalled much lower pre-euro prices, but also lower euro prices of 2003, than the actual ones. Traut-Mattausch *et al.* (2004) demonstrate that expectations of changeover-related price increases are not dispelled by the presence of evidence to the contrary. In their experiments, test persons compared the old DEM prices and new euro prices on the menu of a fictitious restaurant. Three groups of respondents received menus where euro prices were higher, lower or unchanged from DEM prices. Asked to estimate by how much the restaurant had increased its prices, respondents in all groups delivered estimates that were biased upwards. When the average price had remained stable, significant price increases were perceived. Where the average price had increased (fallen), the prices were estimated to have increased by a larger than the actual rate (to have remained stable).

The empirical strategy closest to ours is the one employed by Aucremanne *et al.* (2007). The authors formally analyse the gap between measured inflation and inflation perceptions in view of some potential explanatory factors with a euro-area perspective. They first transform the balance statistic on inflation perceptions into a "quantitative" measure by standardising it on the means and standard deviation of observed inflation. They then use panel unit root tests in order to look at the relationship between standardised inflation perceptions and headline inflation over time. They test whether there is cointegration of perceived and measured inflation, and whether it is stable over time. Their main finding is that the gap between perceived and measured inflation is non-stationary after the euro cash changeover. While perceptions are found to track inflation prior to December 2001, this changes shortly after January 2002 - indicating that it is the euro that introduced the "wedge" between actual and perceived inflation. With regards to the contribution of socio-economic characteristics of consumers and a sub-index of frequently purchased goods to explaining inflation perceptions, no supportive evidence is found.

⁸ Purchasing frequencies are contained in the household surveys from which the weights of goods in the CPI are obtained, but they are not compiled as such by the statistical office. The author calculates the approximate purchasing frequency of a good from its weight in the CPI basket and its price.

4. Empirical analysis of inflation perceptions

The main innovation of this paper is to test the various potential explanatory variables of inflation perceptions in a dynamic panel data framework. The fact that the euro cash changeover is a major event common to all euro-area Member States motivates a joint longitudinal data analysis.

4.1. The model

Both from a theoretical (see Annex 2) and empirical point of view, a dynamic panel data model appears more suitable to our case than a static model. In specifying the model, we follow a “*general-to-specific*” strategy, as suggested by Mizon (1995).

We first estimate a static panel data model (the results are not reported here), but the residuals are found to display autocorrelation. We do not attempt to correct for this in a linear regression model, which would involve, as Spanos and McGuirk (2003) show, “*highly unrealistic restrictions and produce inconsistent estimates*”. We therefore read the autocorrelation in the residuals as a warning of an omitted autoregressive explanatory variable, or more generally a dynamic misspecification. De Grauwe and Skudenly (1999) mention that “*the lagged dependent variable catches up some of the effect of omitted variables varying over time, so that it helps to correct for autocorrelation.*”

Another argument in favour of a dynamic panel data setting is related to the interpretation of the coefficients. In a static panel data, one can capture either the short run or the long run effects, depending on the estimation method. It is often assumed that the “between” estimator measures long run effects, while the “within” estimator measures short run effects (Pirotte, 1999; Egger and Pfaffermayr, 2003). Moreover, Pirotte (1999) shows that “*when only individual dimension tends to infinity (i.e. the time dimension is fixed), long-run effects can be obtained by estimating a static relation whereas the true model is a dynamic one, as long as the coefficients are homogenous among individual units*”. Since the sample is limited in both dimensions, the “between” estimator proves inappropriate for calculating long run impacts in our case.

According to a related view, while the static panel framework is more suitable for long run relationships, the dynamic panel setting addresses better the short term influences (De Benedictis, De Santis and Vicarelli, 2005). Given the novelty of the event and the shortness of the sample, it appears more appropriate to focus the analysis on the short run effects⁹ when dealing with the impact of the euro cash changeover. The model we estimate can thus be formalised as:

$$Y_{it} = \beta_1 Y_{it-1} + \beta_2 X'_{it} + u_{it} ,$$

with $i = 1, \dots, N$ cross sections (countries) and $t = 1, \dots, T$ periods.

Y_{it} is the vector of the dependent variable inflation perceptions;

X_{it} is a matrix of explanatory variables;

u_{it} is the error term, $u_{it} = \mu_i + \varepsilon_{it}$, μ_i being the unobservable individual specific effects and ε_{it} the remaining disturbance.

⁹ While the model would also allow inferring the long run coefficients (see box 1), for the reasons discussed above, we limit our analysis to the short-run coefficients.

As dependent variable, we use qualitative inflation perceptions from the European Commission's Consumer Survey. Being qualitative, the Commission's indicator provides information on the perceived change in inflation, but not on its level. This has led Brachinger (2005) to reject the consumer survey indicator and to propose instead an "index of perceived inflation" based on a theory of inflation perceptions that is based on psychology. Nonetheless, we consider that the Commission's survey statistic, by reflecting respondents' actual perceptions (see also Hoffmann *et al.*, 2006), is better suited for our analysis than an entirely synthetic index.

The choice of explanatory variables (namely X_{it}) is as follows. Were measured inflation and inflation perceptions to correspond neatly, the indicator of perceived inflation should be entirely explained by the underlying consumer price inflation. The Harmonised Index of Consumer Prices (HICP) is therefore an obvious first explanatory variable.

However, the literature suggests that the prices of frequently purchased goods paid mainly in cash have an important impact on inflation perceptions. These prices are reflected in our index of out-of-the-pocket expenditure. Prices contained in this index increased more strongly than others around the time of the euro cash changeover, and might therefore explain the jump in perceived inflation.

Inspired by the work relating differing consumption patterns to inflation perceptions, we choose rents as a main suspect. In the euro area, 37% of households rent their apartment or house. The proportion varies substantially across Member States, from 11% in Spain to 57% in Germany. Rents also depend a lot on the region and type of housing. In some areas, they can easily amount to a third or more of a household's monthly expenditure, compared to an average HICP weight for the euro area of 6.3%. In the euro area as a whole, rents have increased by 1.5% per year on average since 1999 – well below average inflation. However, the differences across Member States were quite large. The average rent-paying household in Germany thus experienced lower inflation than measured by the HICP, while similar households in Ireland, Spain or Greece experienced stronger inflation.

The impact of house price developments on inflation perceptions is also examined. Residential property prices are not covered by the HICP, and also the cost for owner-occupied housing is currently not reflected in the HICP (as it is in the national consumer price indices of some Member States). However, most households in the euro area own their home, which is typically their biggest single asset. Others aspire to buying residential property. In both cases, households are likely to follow the development of house prices closely, and this may well influence their perception of inflation.

It has also been suggested (ECB, 2007) that inflation perceptions may be influenced by respondents' personal income situation or their assessment of the general economic situation. The euro-area economy experienced a cyclical downswing after the year 2000. The following upswing took time to gain strength. Only in 2006 was euro-area growth above potential again. These cyclical developments impacted on the labour market and wages with a delay. After 2001, employment in the euro area remained subdued for several years. From 2002 to 2005, the euro area registered annual employment growth of less than 1%. Accordingly, the growth of real wages and households' disposable income slowed down in the euro area and many Member States. The slowdown in income growth might have been mistakenly attributed to an acceleration of inflation rather than to the general economic slowdown. We use the compensation per employee as a proxy for disposable income. Although unrelated to expenditure and price developments, this is likely to have reinforced the perception that life has become more expensive after the euro cash changeover.

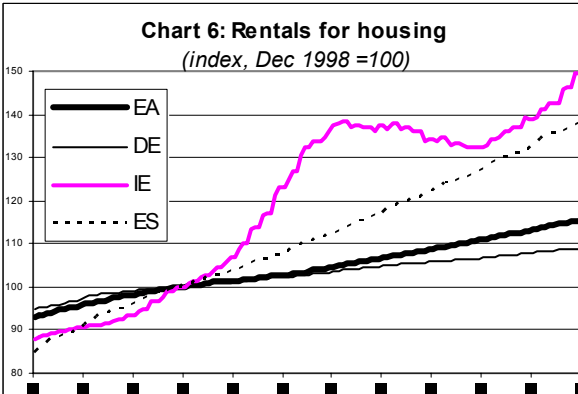
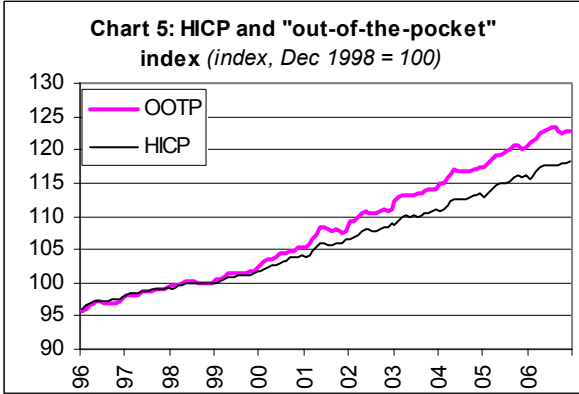
Finally, qualitative inflation expectations from the European Commission's Consumer Survey are used to test if inflation expectations drive perceptions, since expectations about price developments are thought to determine the way inflation is perceived. Expectations are often considered to have played a key role in the decoupling between inflation perceptions and HICP inflation.

4.2. The data

The available data allow us to construct two panels. The first panel includes all data available at monthly frequency and reaches from January 1997 to February 2007. This leads to up to 1320 observations included in the regressions. The second panel has a quarterly frequency, allowing us to include additional variables. At up to 393, the number of observations included in the regressions is still comfortable.

Monthly data on inflation perceptions in all euro-area Member States are collected within the framework of the Joint Harmonised EU Programme of Business and Consumer Surveys. This monthly survey is carried out on a EU-wide random sample of 21,000 consumers. It contains, among others, the following question: "How do you think that consumer prices have developed over the past 12 months?" Respondents have to choose among the possible answers: (1) risen a lot, (2) risen moderately, (3) risen slightly, (4) stayed about the same, (5) fallen, (6) don't know. The indicator of perceived inflation corresponds to the difference between the weighted proportion of respondents stating that prices have risen over the past twelve months and the weighted proportion of respondents stating that prices have fallen or remained unchanged over the same period Denoting S_i (for $i= 1, \dots, 5$) as the sample proportion opting for each of the five response categories, the balance statistic is calculated as $(S_1 + 0.5 S_2) - (0.5 S_4 + S_5)$.

Similar qualitative data on inflation expectations are available from the same survey. The question respondents have to answer this time is: "By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months?", and the possible answers are: "they will... (1) increase more rapidly, (2) increase at the same rate, (3) increase at a slower rate, (4) stay about the same, (5) fall, (6) don't know. The balance is calculated similarly as for perceptions.



Source: Eurostat

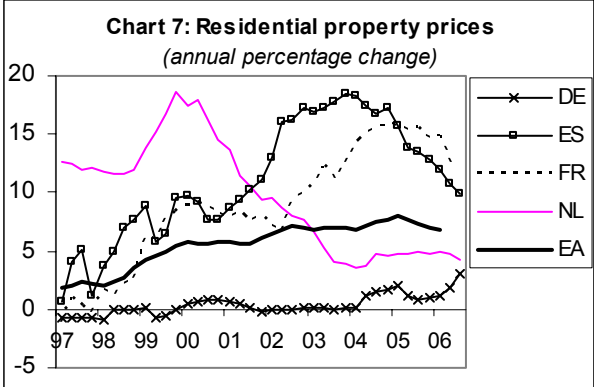
Consumer price developments in the euro area are measured by the Harmonised Index of Consumer Prices (HICP). The methodology for collecting and aggregating price data is

harmonised across the euro area¹⁰. The HICP indicates the development of prices for a large basket of typical goods and services of household consumption¹¹. The monthly price data in the all-items HICP and its components are from Eurostat. In order to ensure consistency with the survey data, percentage changes over the same month of the preceding year are used.

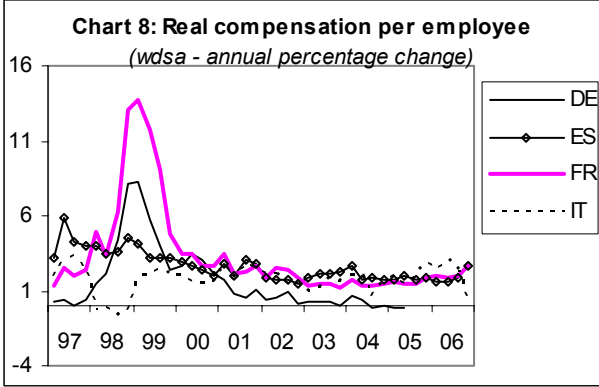
The index for out-of-the-pocket expenditure¹² comprises food, beverages, tobacco, newspapers, non-durable household goods and fuel. It also comprises personal, health care, transport and postal as well as recreational services (among the latter are hotels, restaurants and cafés). Prices for out-of-the-pocket expenditure increased by 2.5% in 2001 and 3% in 2002 (0.1 and 0.7 percentage point more, respectively, than average prices).

Data on house rents are collected within the framework of the HICP, and the broader index of housing-related prices¹³ is also built from HICP items.

Data on residential property prices are available from national sources for 11 Member States but Luxemburg. Quarterly data compiled by the ECB are used and expanded as follows. For Germany, quarterly series on newly built homes compiled by the Bundesbank are used. For Italy, semi-annual data calculated by the Banca d'Italia are used and the gaps filled by linear interpolation. With the exception of Germany, these data cover the price of new as well as old homes. However, severe limitations to their comparability across countries are acknowledged.



Source: National sources, ECB



Source: National accounts

In the euro area as a whole, the price for residential property increased by an average annual rate of 6.3% from 1999 to 2005 (7.2% p.a. from 2002-2005). This masks large differences across Member States. While property prices in Germany declined as a late consequence of the reunification boom, property prices in some other Member States increased strongly in recent years.

Quarterly national account data on net compensation per employee (working-day and seasonally adjusted) are available for eight Member States (unavailable for Greece, Ireland, Luxemburg and Portugal). Obtained by deflating the nominal compensation per employee with the HICP index, the real compensation per employee is used as a proxy for the development of household disposable income, as the latter is available only on an annual basis and for an even smaller subset of Member States.

¹⁰ HICP data, information on the prices of individual types of goods and services and additional information on the HICP methodology are available from Eurostat. <http://epp.eurostat.ec.europa.eu>

¹¹ Aucremanne *et al.* (2007) find that using the national Consumer Price Indices (CPI) instead of HICP does not influence the results.

¹² The list of components has been suggested by Eurostat (2005).

¹³ It includes actual rentals for housing (cp041), maintenance and repair of the dwelling (cp043), and water supply and miscellaneous services relating to the dwelling (cp044).

4.3. Estimations and results

The estimation of a dynamic panel data model is initially confronted with the fact that even after first-differencing aimed at eliminating the fixed effects, the lagged dependent variable as well as the predetermined explanatory variables, in differences, become endogenous¹⁴. Arellano and Bond (1991) propose a GMM estimator that instruments them with lags of their own levels. However, since lags are often weak instruments, especially for highly persistent variables, the original Arellano-Bond estimator is biased in finite samples. In our paper, this estimator, also called the difference estimator, is only used for sensitivity analysis.

To overcome the weak instruments limitation, Arellano and Bover (1995) propose the addition of level equations in which the predetermined and endogenous variables are instrumented with their first differences. We use this estimator, commonly known as the system estimator.

Both the difference and the system estimators can be computed in one or two steps. The one step estimator uses a weight matrix which does not depend on the estimated parameters. The two step estimator is computed based on an optimal weight matrix, often departing from the one step estimator and its weight matrix (Bond, 2002, p.9). The advantage of the two step estimator is that it ensures “*modest efficiency gains (...) even in the presence of heteroskedasticity*”, but the disadvantage is that it renders the asymptotic standard errors too small or the asymptotic t-ratios too big (Bond, 2002).¹⁵ Therefore, we iterate the procedure further until the parameter estimates and minimised objective function converge. This eliminates the dependence of the estimator on the initial weighting matrix and, according to Ferson and Foerster (1994), appears to improve the finite sample performance of GMM when the number of parameters is large.

A major issue for the empirical strategy is the way of dealing with the euro cash changeover which can be seen as a structural break in the series. One way of taking a regime change into account is by estimating the model separately for the pre-changeover and the post-changeover period (or, as appropriate, additional periods), allowing all parameters to vary between periods. Or, more commonly, if one believes that the relation remains unchanged apart from a mere change in levels, a dummy variable can be introduced to account for the regime change. For the model in monthly data, it is possible to apply both methods, and both are reported in the next section. However, in the quarterly data, there are not enough observations to split the sample in a pre- and post-changeover period. Therefore, for our quarterly model, only the estimations using a changeover dummy are reported.

As a preparatory step, to test for stationarity in the data on inflation perceptions, several types of unit root tests are carried out. At the country level, standard Augmented Dickey Fuller Tests are used. Over the entire sample (January 1997-February 2007) the hypothesis of a unit root can generally not be rejected in the country-level data (the exception being Finland, where it is rejected at the 5% level). Exploiting both the time and the cross-section structure of the data, panel unit root tests are also carried out. For the entire sample, the picture is mixed, as the Levin, Lin and Chu test rejects the hypothesis of a unit root at 10% level, while the test by Im, Pesaran and Shin fails to reject a unit root. When the sample is divided in a pre-changeover period (Jan 1997-Dec 2001) and a post-changeover period (Jan 2002- Feb

¹⁴ See Baltagi (2003) and Bond (2002) for an extensive chronological literature review on estimators for dynamic panel data models.

¹⁵ The two step system estimator is especially worth using after a finite sample correction, as it is more efficient than the one step, especially for system GMM. Note that Windmeijer (2000) rehabilitates the two-step estimator by proposing a finite-sample correction for its asymptotic variance, but the correction is not easily implemented in our econometric software.

2007), both tests fail to reject the hypothesis of a unit root in the first period, but strongly reject it for the period after the cash changeover. However, these findings have to be interpreted with caution, given the short sample constraints.¹⁶

The model is estimated with either headline inflation or the out-of-the-pocket price index (OOTP) as explanatory variables. As the correlation between both series is quite high, including both simultaneously would be inappropriate. Similarly, either house rents or the broader index of housing-related items within the HICP are included, because of the similarity of both concepts. Finally, inflation expectations or lags thereof are included.

Table 2: dynamic model with monthly data

	I	II	III
Perceptions (-1)	0.38*	0.58**	0.91**
Ch'over dummy	21.6*	16.71*	2.96*
Headline HICP	3.90*	2.34°	
OOTP			1.17**
House rents	-1.62		
Expectations	0.35	0.28°	
Sargan-p	0.84	0.53	0.29

*Significance: ** at 1% level; *at 5% level; °at 10% level*

Reported specification: Orthogonal Deviations, AB n-step weighting

11 cross sections, 1320 observations (with expectations: 9 cross sections, 1080 observations)

Table 2 summarises the retained specifications for the model using a changeover dummy that is 0 for the period up to December 2001 and 1 thereafter. Specification I documents the starting point of the "general-to-specific" approach. As neither house rents nor the broader index of housing-related costs are found to contribute meaningfully to the explanation of inflation perceptions, they are eliminated. This yields a stable and significant specification (II). Specification III documents the inclusion of the out-of-the-pocket index instead of headline inflation.

The autoregressive term is highly significant, and its impact large, in all specifications.¹⁷ Inflation perceptions are thus quite persistent. This can be interpreted as a first indication that evidence of low inflation may not lead to a swift adjustment of high inflation perceptions (cf. also Traut-Mattausch *et al.*, 2004). The high coefficient of the lagged perceptions suggests that deviations of inflation perceptions from underlying inflation can prove quite long-lasting.

As expected, the changeover dummy is also significant in all specifications. This confirms the hypothesis advanced in the literature, according to which the regime change implied by the euro introduction marked a level shift in perceived inflation.

Both headline inflation and the OOTP index turn out with the correct sign and significance. With OOTP on the right hand side inflation expectations become statistically insignificant. However, OOTP does not explain inflation perceptions better than the HICP index itself.

¹⁶ It turns out, when we estimate the model, that the coefficient on the autoregressive term is not too close to one, as it would be if there was a unit root. This is also suggested by two important features of perceptions. First, the balance statistic is bounded to a range of +/- 100 by construction, in can therefore not be explosive. Second and more fundamentally, inflation perceptions are correlated with the underlying headline inflation, which is itself likely to tend towards the range defined by the ECB as price stability.

¹⁷ It is normal for the coefficient to vary as we move from the general specification (I) to the more robust specification (II). Some instability of the coefficient could also be due to omitted variable bias. As demonstrated below, house prices, for which we only have quarterly date, are a relevant driver of inflation perceptions that is missing in the monthly model.

While being highly significant, the coefficient on OOTP is smaller than the one on headline inflation, and more power is, in turn, picked up by the autoregressive term. This finding contradicts a part of the literature that focuses on OOTP as being a stronger driver of perceived inflation than headline inflation as measured by the all-items HICP.

The other explanatory variables prove weakly significant or insignificant. Inflation expectations contribute somewhat to the formation of inflation perceptions as suggested by the psychological experiments in Traut-Mattausch *et al.* (2004). Their significance is, however, weak, even in the preferred specification II. Rents and the broader index of housing-related costs do not contribute meaningfully to inflation perceptions. Thus, one cannot infer that perceptions were influenced by the development in either of the two.

Standard Sargan tests for over-identifying restrictions confirm the validity of the estimations. A sensitivity test is carried out by re-estimating the model with the Arellano and Bond difference estimator and different weightings for the instruments. This confirms the broad picture in terms of significance of the explanatory variables.

The second approach to the structural break induced by the euro changeover consists of comparing the parameters before (sub-sample Jan 1997-Dec 2001) and after (sub-sample Jan 2003 – Feb 2007) the euro cash changeover¹⁸. The findings are unsurprising. Before the euro cash changeover, perceptions were less resilient than after. As expected, perceived inflation followed headline inflation more closely before the euro changeover. The same is true for the OOTP index, the impact of which has also become weaker after the euro changeover. If OOTP played a more important role than headline inflation in shaping initial inflation perceptions at the euro changeover (possibly in conjunction with the extensive media coverage of price developments discussed in Del Giovane and Sabbatini (2006)), this role vanished fast enough not to be detected by our regressions. In any event, out-of-the-pocket expenditure is not a more powerful explanation of the perceptions gap than headline inflation after 2002.

Table 3: dynamic model with monthly data; sub-samples

	Ia) (Jan 1997- Dec 2001)	Ib) (Jan 2003- Feb 2007)	IIa) (Jan 1997 – Dec 2001)	IIb) (Jan 2003- Feb 2007)
Perceptions (-1)	0.76**	0.93**	0.76**	0.92**
Headline	3.08**	0.78**		
OOTP			2.73**	0.67**
Sargan-p	0.28	0.39	0.46	0.37

So which way of modelling the structural break due to the euro changeover is more appropriate? We suspect that the short samples reported in table 2 suffer from a well-known feature of dynamic panel data models with autoregressive terms, namely the tendency for the lagged variable to attract explanatory power to the detriment of other RHS variables. It is, e.g., counterintuitive for the persistence parameter in the pre-changeover period

¹⁸ 2002 is excluded in this specification, as the transition to a new equilibrium seems to have occurred gradually instead of instantly in January 2002. When the parameters are tested for a sub-sample Jan 2002-Dec 2003, the coefficients for perception persistence as well as headline inflation (OOTP) lie between the values reported in Ia (IIa) and Ib (IIb). At the same time, expectations in the 2002-2003 period are significant but negative, corroborating the impression of a transition.

(specifications 3(Ia) and 3(IIa)) to be higher than the one we find in our preferred specification over the entire sample 2(II).

We therefore take from the exercise with the sub-samples the general message that persistence was already present in the pre-changeover period and may have increased thereafter, while the influence of headline inflation decreased. But we do not attach too much importance to the parameter values, and otherwise continue to use a dummy in the next step.

As a next step, the panel is transformed to quarterly frequency, which allows adding residential property prices and compensation per employee, as a proxy for disposable income, as further explanatory variables. However, this comes at the price of a lower number of data points and the impossibility to split the sample into a pre-changeover and a post-changeover period. Therefore, only the specification with a changeover dummy is viable in the quarterly setup. Retained specifications are summarised in table 3. Again, the main results are robust to alternative specifications and estimation methods.

As before, the euro cash changeover dummy takes the value 0 for the period 1997Q1 to 2001Q4 and 1 thereafter. Specification I reports the results with headline inflation as explanatory variable, and specification II the same with OOTP.

The outcomes of the estimation with monthly data are confirmed as regards the autoregressive term and the weaker performance of the OOTP index as compared to headline inflation. Inflation perceptions are highly persistent, and otherwise depend mainly on inflation, whether measured by the overall HICP or the out-of-the-pocket expenditure index.

Table 4: dynamic model with quarterly data

	I	II
Perceptions (-1)	0.71**	0.69**
Ch'over dummy	6.28°	7.93
Headline	4.52**	
OOTP		3.60*
Resid.property	0.25*	0.18*
Sargan-p	0.21	0.26

*Significance: ** at 1% level; *at 5% level; °at 10% level*

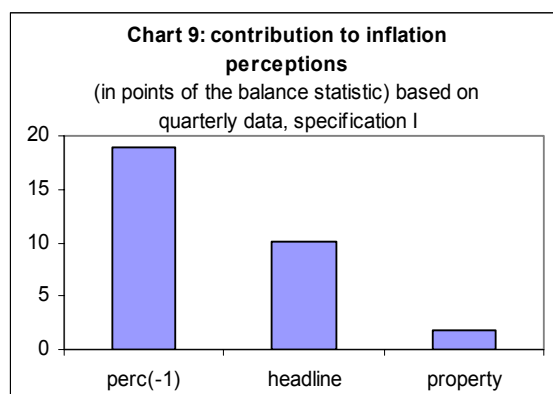
*Reported specification: Orthogonal Deviations, AB n-step weighting
11 cross sections, 393 observations*

Among the explanatory variables outside the HICP and its components, residential property prices are a relevant driver of inflation perceptions. Our results suggest that, on average, households perceive house prices as part of a broader index of "cost of living", which goes beyond consumer prices. This is not a priori obvious, as there is a potential opposite effect. For home-owning households, house price increases create a wealth effect. As this makes these households feel richer, house prices could as well enter inflation perceptions with a negative sign. We can only observe the aggregate of these two opposite effects. The relatively small size of the coefficient associated with house prices may be an indication that both are at work.

The compensation per employee (not reported here), either in nominal or in real terms, does not contribute to the explanation of inflation perceptions in a significant way. We can thus not confirm that reductions in households' disposable income are perceived as an increase in the cost of living. This does not exclude that income may be relevant. The non-detection of a contribution in our specification might also be due to the use of a proxy (compensation per employee) for disposable income and / or to the fact that also the proxy is not available for all Member States.

Expectations in this model no longer behave as suggested by the psychological literature and were also excluded from the reported specifications.

The estimated coefficients express how many points one additional unit of the underlying variable adds to inflation perceptions. The average contributions of the explanatory variables to inflation perceptions can be computed by multiplying each variable coefficient with the average value of the variable. The chart illustrates these contributions for specification I of the quarterly model, the dummy being excluded as it applies only to the second half of the sample.



5. Conclusion

The deviation of inflation perceptions from measured inflation at the moment of the euro cash changeover, which in some euro-area Member States has proved very persistent, is a well-known fact. In recent years, a growing body of literature has developed on the factors that might explain this deviation. However, so far, much of this literature has been of a descriptive nature. Where explanations were tested formally, this has mostly been done at the level of an individual Member State.

The contribution of this paper is to formally test various explanations advanced in the literature at the level of the euro area by exploiting the time-series and cross-section structure of the data on inflation perceptions and its potential explanatory factors. On empirical as well as theoretical grounds, we decide to carry out the analysis in the framework of a dynamic panel data model.

Monthly data are used to test the impact of measured HICP inflation, various HICP-items or sub-indices and inflation expectations on inflation perceptions. Inflation perceptions are found to be highly persistent (the autoregressive term is large and statistically highly significant in all specifications of this model). Both headline inflation and the index of out-of-the-pocket (OOTP) expenditure – which are used as alternatives in our specifications - are substantial drivers of inflation perceptions. However, in contrast to much of the – descriptive – literature, the OOTP index is found not to explain inflation perceptions better than does the all-items HICP index. As suggested by psychological experiments, inflation expectations seem to contribute to the formation of inflation perceptions, although to a limited extent. We fail to find an indication that house rents or a broader index of housing-related prices within the HICP drive inflation perceptions.

The exercise is then repeated with a set of quarterly data containing residential property prices and the compensation per employee in addition to the aforementioned variables. This confirms the findings of the exercise on monthly data with respect to strong persistence of inflation perceptions, and a weaker performance of the out-of-the-pocket index compared to headline inflation. The prices of residential real estate contribute significantly to inflation perceptions, suggesting that households have a broader view of the cost of living when forming inflation perceptions. Reductions in the compensation per employee are not found to lead to increasing inflation perceptions. The quarterly model no longer identifies inflation expectations as a factor influencing perceptions. It is well known that in dynamic panel data models the autoregressive term tends to attract most explanatory power. This might

overshadow the contribution of other factors. It is thus all the more remarkable that residential property prices are found to be relevant.

Our results have implications for policy, for the further research agenda and for the development of statistics. Deviations of inflation perceptions from measured inflation can be quite long-lasting. Cross-country differences could arise from different paces of consumer price inflation or house price increases. To address these deviations, specific communication strategies at the Member State level should focus on both the underlying factors of inflation perceptions and the sluggishness of perceptions' adjustment (e.g. by pointing out that changeover-related price increases were concentrated in the first months of 2002).

It is crucial for the acceptance of the euro to counter to a maximum extent all deviation of inflation perceptions from underlying inflation before it occurs. Our findings on the persistence on inflation perceptions suggest that intensified communication efforts on the part of national authorities of EU Member States aiming at joining the euro should be a key element of cash changeover strategies. Prevention is probably much easier and effective than reaction to already high perceptions. Given that, with property prices, a factor outside the HICP also plays a role, communication on the scope and purpose of the HICP would also seem advisable. This should in particular stress the differences between consumer prices and the broad "cost of living".

We call into question the popular explanation that inflation perceptions are mainly formed on the basis of an HICP-subset of out-of-the-pocket expenditure. Given that it is tempting to establish a link with these expenditure items that, indeed, have seen particular price increases at the moment of the cash changeover, further research is warranted. Further work could also examine the time dimension in more depth, e.g. how the respective relevance of perception persistence vs. underlying inflation changed with and after the euro cash changeover.

Finally, but crucially, the finding that house prices influence inflation perceptions suggests further work on the role of asset price inflation for the formation of inflation perceptions. At the same time, it confirms the usefulness of efforts to include the cost of owner-occupied housing in the HICP and also highlights the urgency of gathering more comprehensive data on residential property prices in the euro area.

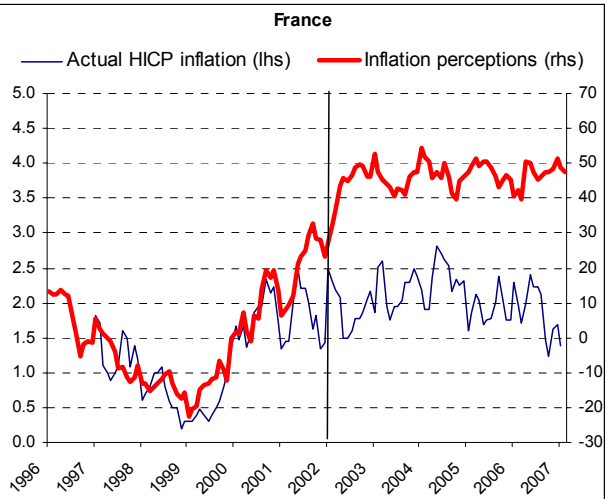
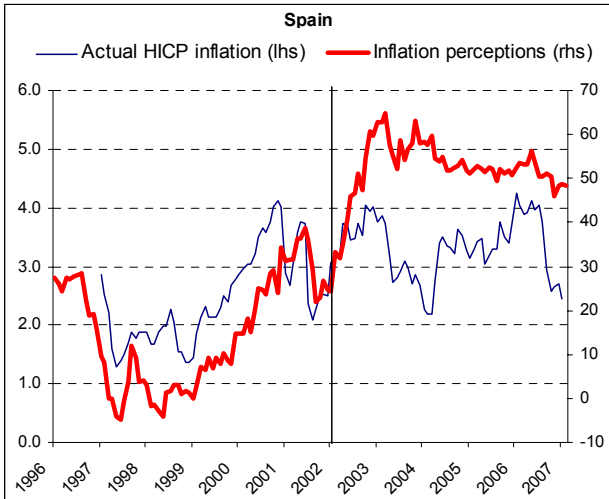
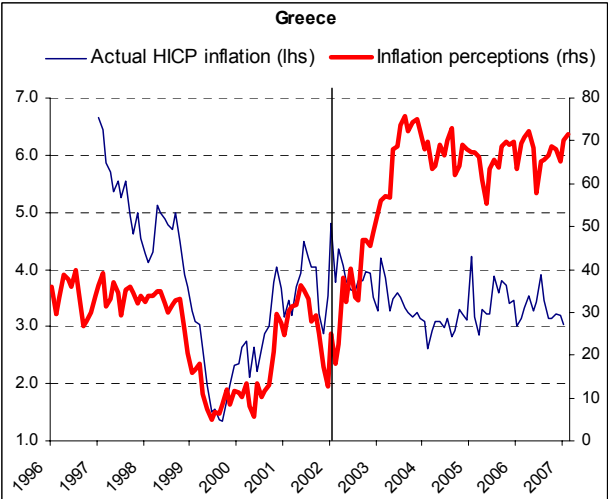
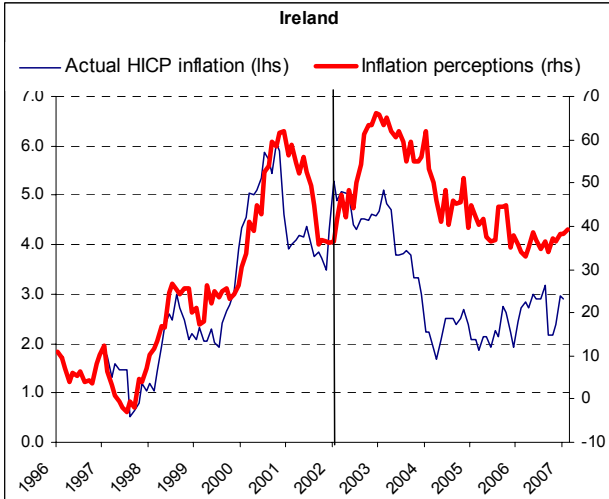
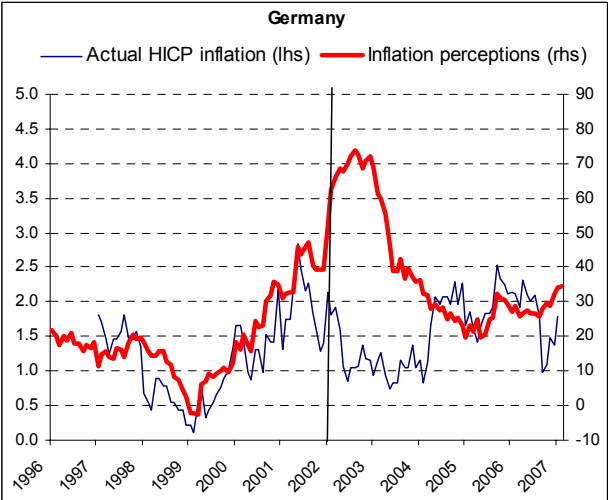
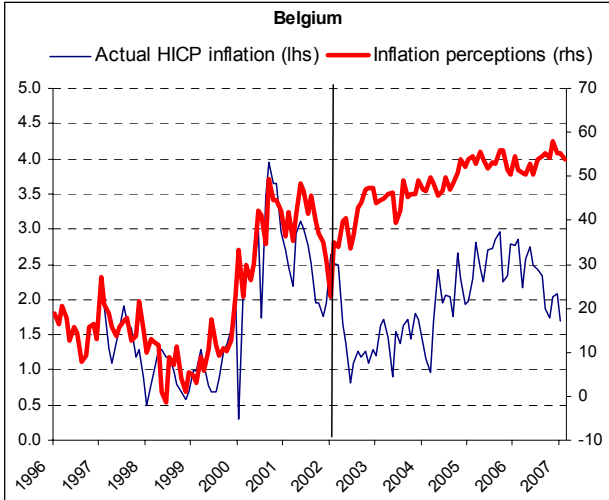
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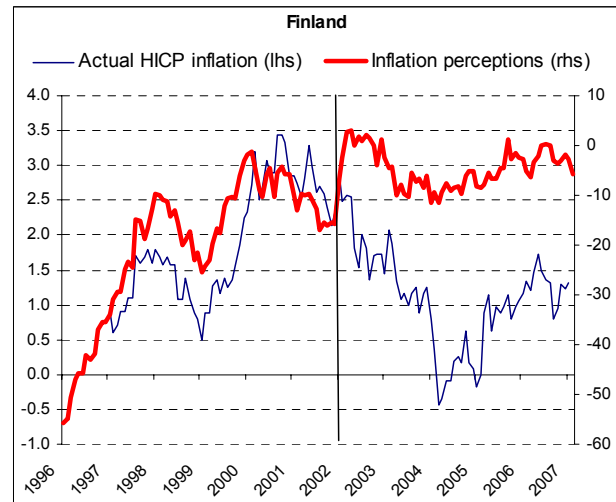
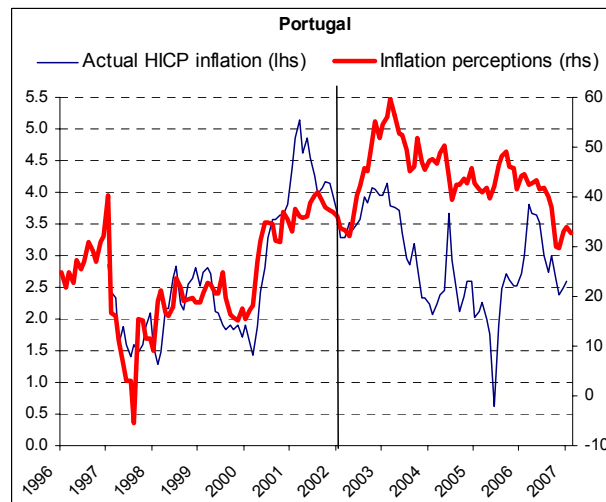
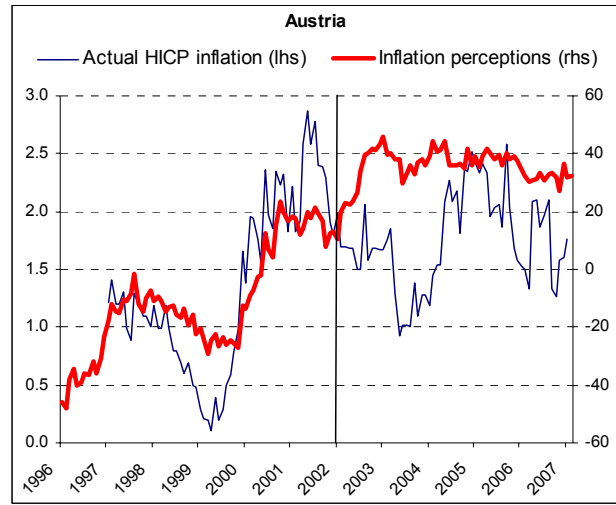
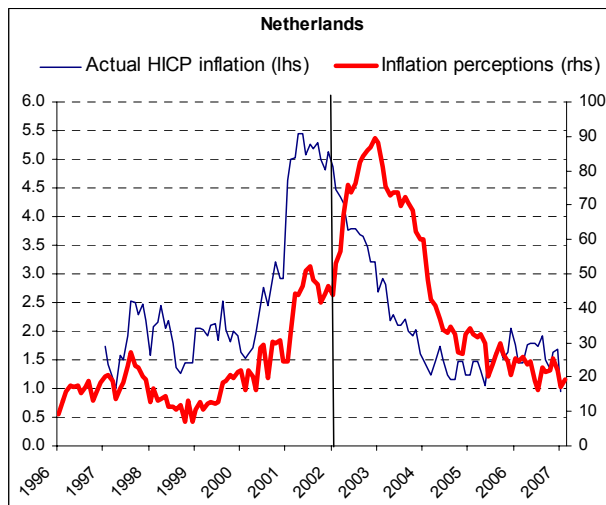
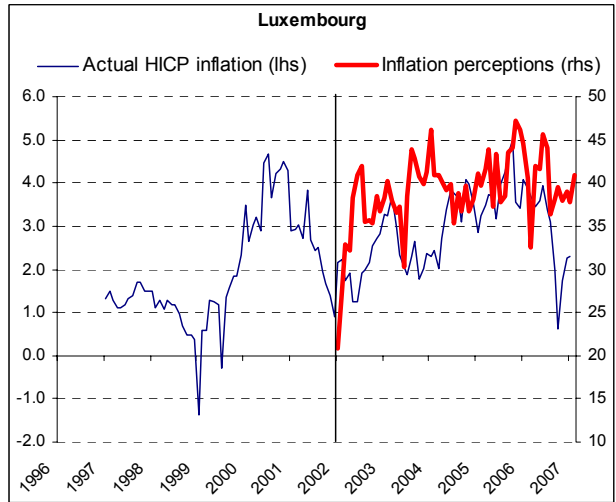
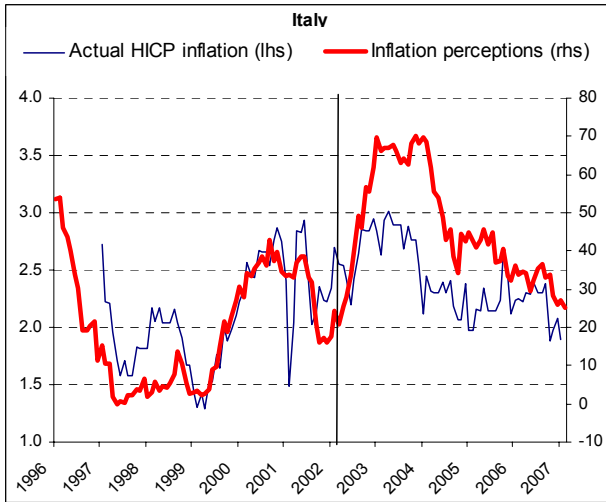
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Annex 1: HICP and perceived inflation





Annex 2: A partial adjustment model

From a theoretical point of view, the dynamic panel data model can be interpreted as a Partial Adjustment Model (PAM). A PAM is a simple dynamic process, which assumes the equilibrium or target value of the dependent variable Y_t^* to be related to one or more explanatory variables. If inflation perceptions tend to an equilibrium value¹⁹, the dynamic panel data model can be interpreted as a PAM

$$Y_t^* = \beta_1 + \beta_2 X'_t + u_t \quad (\text{A1})$$

The intuition behind is that the actual value of the dependent variable deviates from the equilibrium value. At any time period, its increase is proportional with the divergence of the actual value in the previous time period from the equilibrium value.

$$Y_t - Y_{t-1} = \lambda(Y_t^* - Y_{t-1}) \quad (\text{A2})$$

The actual value of the dependent variable can then be written as a weighted average of the equilibrium value and the previous actual value. λ measures the speed of the adjustment, and should be between 0 and 1. 1 implies full adjustment in the first period, whereas 0 means no adjustment at all.

$$Y_t = \lambda Y_t^* + (1 - \lambda)Y_{t-1} \quad (\text{A3})$$

Plugging (A1) into (A3), the result is a specification with observable variables only, which can then be estimated.

$$Y_t = \beta_1 \lambda + \beta_2 \lambda X'_t + (1 - \lambda)Y_{t-1} + \lambda u_t \quad (\text{A4})$$

¹⁹There are several reasons to believe that inflation perceptions do tend towards equilibrium. Technically, the balance statistic is bounded to a range of +/- 100 by construction, it can therefore not be explosive. More substantially, inflation perceptions are correlated with the underlying headline inflation, which is itself likely to tend towards the range defined by the ECB as price stability.