

# Assessing the Gap between Observed and Perceived Inflation in the Euro Area: Is the Credibility of the HICP at Stake?



## Working Paper Research

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April 2007    **No 112**

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ISSN: 1375-680X (print)

ISSN: (pending request) (online)

## **Abstract**

We find strong econometric support for a break in the relationship between perceived and HICP inflation in the euro area, triggered by the introduction of euro notes and coins in January 2002. The break is fairly homogeneous across individuals with different socio-economic characteristics. We found no support for the thesis according to which perceptions are systematically formed by frequently purchased products. A similar break is found when national CPIs instead of HICPs are used as benchmarks. The role of the non-inclusion of owner-occupied housing in the HICP was negligible. Therefore the credibility of the HICP *per se* is not at stake.

JEL-code : C22, C23, D12, E31.

Keywords: inflation, perceived inflation, panel unit roots tests.

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The views in this paper are those of the authors and do not necessarily reflect those of the National Bank of Belgium.

The authors would like to thank participants of the OECD conference "Inflation Measures: Too high - Too low - Internationally Comparable" held in June 2005 in Paris and participants in the 81st WEAI Annual Conference held in San Diego in July 2006. They are particularly grateful to their discussants Mark Wynne and Johannes Hoffmann and to Catherine Fuss for very useful comments. All remaining errors are the authors' responsibility.

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## 1. INTRODUCTION

While both the creation of the Economic and Monetary Union in 1999 and the introduction of euro banknotes and coins in January 2002 actually went remarkably smoothly, the introduction of euro notes and coins gave rise to a very lively debate regarding its impact on inflation. Indeed, the vast majority of consumers in every euro area country is under the impression that the new currency has led to pronounced price increases. This debate started in the period immediately before the euro cash changeover, as already at that time many consumers expressed their fear that the conversion would be taken as an opportunity to increase prices unduly. Immediately after the changeover in January 2002 this issue became a really hot topic. In Germany, for instance, the euro was labeled "*Teuro*", associating the new currency directly with the German word "*teuer*" - expensive. Rather than suggesting that the euro debate was a primarily German phenomenon, this metaphor illustrates the tone and intensity of the controversy at that time. Even now, 5 years after the changeover, this sentiment is still alive.

The impression of a substantial increase in the general price level contrasts sharply with all available estimates of the effect of the changeover on inflation. Already in 2001, attempts were made to quantify the possible effect on inflation. At that time the main focus was on possible rounding effects related to the need to find new attractive prices<sup>1</sup> and on the costs of the changeover. Using micro CPI databases, Folkertsma (2001) and Aucremanne and Cornille (2001) conducted *ex ante* simulations for the Netherlands and Belgium respectively. They found that even under a worst-case scenario, where all prices were rounded up, the inflationary impact would be mild and not exceed 0.7 percent. In both countries the central bank also conducted specific euro surveys. From these surveys it was learned that the costs related to the cash changeover were moderate<sup>2</sup>. Therefore the inflationary impact in 2002 was expected to be limited.

After the changeover, Eurostat (2003) came to the conclusion that the inflationary impact was in fact concentrated in the services sector and, at the aggregate level, most likely has ranged between 0.12 and 0.29 percent in 2002. Obviously such an estimate has to be interpreted cautiously, as it is difficult if not impossible to distinguish changeover effects unambiguously from other factors impacting on inflation. This is probably the reason why the ECB did not publish its own estimate, whereas such quantifications were available in several Eurosystem national central banks<sup>3</sup>. The largest effects were found in the Netherlands (0.6 percent - Folkertsma, 2002b) and in Italy (0.5 percent - Del Giovane, Lippi and Sabbattini, 2005). Even in these countries the order of

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<sup>1</sup> In practice, prices ending in 0, 5 or 9.

<sup>2</sup> Folkertsma (2002a) and National Bank of Belgium (2002a).

<sup>3</sup> See, for instance, Banco de España (2002), Banca d'Italia (2002), Banque de France (2002), Deutsche Bundesbank (2004), Folkertsma (2002b) and National Bank of Belgium (2002a).

magnitude is in no wise proportional to the heated character of the ongoing debate. An indirect test for price level effects is provided by Angelini and Lippi (2006): they find no evidence of a euro-related increase in the price level using data on cash withdrawals from ATMs in Italy. Probably the most convincing argument for claiming that the inflationary impact was mild can be found in the fact that aggregate inflation in the euro area continued to be relatively close to 2 percent during the period considered, despite the occurrence of some clearly identifiable inflationary shocks which were orthogonal to the changeover, such as increases in crude oil prices, BSE-related increases in food prices, increases in indirect taxes and administered prices and the lagged transmission of the depreciation of the euro in the period 1999-2000.

All this leaves us with the impression that the euro cash changeover has driven a wedge between actual and perceived inflation. The paper addresses this issue using the data of the monthly EU consumer survey conducted by the European Commission (EC), as this survey contains one question which provides information regarding inflation perceptions. The particular question asks participants how they think consumer prices have developed over the past year. Recently several publications stressed that a gap has arisen between the EC balance statistic on inflation perceptions and HICP inflation on the basis of simple graphs<sup>4</sup>. The aim of this paper is to address this question in a more formal econometric framework and to determine whether the inference drawn from a graphic analysis continues to hold. Mere reliance on graphic analysis has recently been challenged by Brachinger (2006).

Our empirical strategy consists of testing whether the long-run relation between perceived and actual inflation has broken down as a result of the euro cash changeover. Unlike most studies on this issue, we opted for a universal approach, i.e. we considered all member states of the euro area. We first test whether the standardized EC balance statistic on perceptions tracks HICP inflation during the period prior to the euro cash changeover (January 1996 to December 2001). To do so, we conduct unit root tests on the difference between standardized perceptions and HICP inflation. Rejection of the null hypothesis of a unit root would imply that actual and perceived inflation indeed co-moved. However, as this reference period is rather short - perception data for all euro area countries were only available from 1996 onwards -, we expect these unit root tests to have low power, in the sense that they will (too) often fail to reject the null hypothesis. In other words, they will tend to find spuriously that perceptions did not track HICP inflation. To overcome this problem, we will conduct panel unit root tests which have more power. We then perform similar tests for longer samples which include data for the post-changeover period. In the event that the changeover effectively induced a break in the relationship between actual and perceived inflation, our test would

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<sup>4</sup> See, for instance, European Central Bank (2002, 2003 and 2005), European Commission (2004), National Bank of Belgium (2002b), Deutsche Bundesbank (2004) and Dziuda and Mastrobuoni (2006).

no longer find stationarity for the difference between both inflation measures when the longer samples are considered. To further sharpen the potential role of the introduction of the euro, we conduct identical tests for three non-euro area EU countries (Denmark, Sweden and the UK) for which similar perception data are available. For these countries, we expect that the EC balance statistic on inflation perceptions tracks HICP inflation both for the period before 2002 and for the longer periods. All the results obtained are as expected and therefore strongly point in the direction of a changeover-induced break in the relation between actual and perceived inflation in the euro area.

Then we use our econometric framework to test some more specific explanatory factors of the gap which have recently been put forward in the literature, such as its supposed dependence on certain socio-economic characteristics of consumers, or the thesis according to which inflation perceptions are based on frequently purchased goods and services. In both cases our econometric results are not supportive. Finally, we also assess whether the gap is related to the characteristics of HICP inflation measurement in the euro area, more particularly the fact that owner-occupied housing services (OOH) are not covered by the HICP at the current juncture. This allows us to assess whether there is a specific problem for the HICP or, alternatively, there is a more general, euro-induced perception problem in the euro area. It turns out that these measurement issues are not important for explaining the gap. Given the prominent role of the HICP in the monetary policy strategy of the Eurosystem, our finding that it is not the accuracy or the credibility of the HICP *per se* which is at stake, is an important result. The Governing Council of the ECB has indeed defined price stability as an annual increase of the HICP of the euro area which is below, but close to 2 percent in the medium term.

The remainder of the paper is organized as follows. Section 2 briefly reviews the explanations which have been proposed in the literature for the existence of a perception gap in the aftermath of the euro cash changeover. In section 3, we present our data set and the econometric framework used. In section 4, we discuss our results and interpret them against the background of some of the explanations for the gap between measured and perceived inflation. Section 5 tests the robustness of our results. Finally, section 6 concludes.

## **2. FACTORS POSSIBLY DRIVING THE GAP BETWEEN MEASURED AND PERCEIVED INFLATION: A REVIEW OF THE RELATED LITERATURE**

Several arguments have been put forward to explain why a gap between measured and perceived inflation may have occurred in the aftermath of the changeover. A first set of arguments has recently been formalized by Brachinger (2005 and 2006). Based on the Prospect Theory developed by Kahneman and Tversky<sup>5</sup>, Brachinger claims that loss aversion implies that consumers' inflation perceptions are more influenced by price increases than by price decreases. On top of that, he postulates that they are more influenced by the experience with frequently purchased products. Starting from these premises, Brachinger constructs his so-called IPI(2.0) index of perceived inflation for Germany which turns out to be substantially higher than measured inflation during the period January 2001 - June 2002<sup>6</sup>. At that time, large price increases for products which are frequently purchased have indeed been observed (e.g. for food products due to BSE and bad weather conditions, energy products as a result of crude oil price developments, changes in indirect taxation for some frequently purchased items, ...). As the above-mentioned price shocks were not specific to Germany, the argument can easily be extrapolated to the currency area as a whole. Indeed, Del Giovane and Sabbatini (2006) and Stix (2006) too found for Italy and Austria respectively that these price increases have played a role in shaping perceptions. Brachinger's argumentation is in principle not directly linked to the euro cash changeover. According to his theory, a gap between perceived and measured inflation can indeed arise at the time of the changeover just because of the timing of specific price shocks. However, below we argue that it is likely that the changeover itself has also contributed to the relevance of these arguments, at least temporarily.

First of all, some studies found that the euro cash changeover led to a menu cost-induced clustering of price changes which otherwise would have been spread over a longer time. Such evidence was found in Gaiotti and Lippi (2004) and Hobbijn, Ravenna and Tambalotti (2006) for restaurant prices. Angeloni, Aucremanne and Ciccarelli (2006) found for a broad set of consumer goods and services in the euro area as a whole that this clustering was clearly more pronounced and showed an asymmetric pattern in the less competitive services sector, where a very large spike in the number of price increases was seen at the time of the changeover, while the corresponding spike for the number of price decreases was far less pronounced. Dziuda and Mastrobuoni (2006) found evidence of changeover-induced price increases for lower priced items and in sectors where price transparency and market concentration are low. Ehrmann (2006) found for low-priced food and clothing products that changeover-induced price increases are larger when conversion rates are

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<sup>5</sup> See Kahneman and Tversky (1979) and Tversky and Kahneman (1991).

<sup>6</sup> In the IPI(2.0) index of perceived inflation, 2.0 is the value of the loss aversion parameter. Brachinger also constructs alternative indices of perceived inflation for parameter values 1.5 and 2.5 respectively.



more complex. While these findings are not at odds with the available estimates on the (limited) inflationary impact of the changeover, the finding that these price increases were mainly observed in low-priced and therefore frequently bought items or in outlets where consumers tend to buy a single good or service, such as in restaurants or in local shops, made them even more visible and may have strengthened the points made by Brachinger. Moreover, it has been argued that the introduction of the euro complicates information processing for consumers. In this perspective, it is quite plausible that the learning process is easier for frequently bought products and that the changeover therefore has strengthened the tendency of consumers to form their perception of inflation on a sub-set of frequently purchased items. Finally, the prominent media coverage of the euro cash changeover, in particular of the debate on its inflationary impact and the enhanced consumer resistance to price increases may have strengthened the asymmetry in weighing price increases relative to price decreases.

As the above-mentioned arguments are closely linked to what happened in the period immediately surrounding the changeover, they can scarcely explain the apparently persistent nature of the wedge between actual and perceived inflation. It is in this respect indeed striking that Brachinger (2006) finds that his IPI(2.0) index of perceived inflation converges relatively quickly after the changeover (i.e. already in July 2002) to the official German inflation rate, while the graphic comparison of the EU balance statistic on perceptions and HICP inflation for Germany (and our econometric results below) suggests that this is only so in the course of 2004. For some other euro area countries the gap between inflation perceptions and HICP inflation appears to be even more persistent. Other factors more explicitly related to specific features of the euro cash changeover have therefore been put forward.

Traut-Mattausch et al. (2004) have highlighted the importance of psychological factors, and especially the role of *a priori* expectations. Based on an experiment, they show a bias towards a perception of price increases as a result of a previously held expectation, even when the latter was not confirmed by the evidence. This factor may have been relevant since prior to the changeover apprehensiveness of possible price increases was very widespread, as is evidenced by the EC's Eurobarometer surveys<sup>7</sup>. For instance, in November 2001 70 percent of the respondents feared – to varying degrees – abuses and price-gouging following the cash changeover.

Dziuda and Mastrobuoni (2006) emphasized the difficulties that consumers experience when adapting to the euro and they find that inflation perceptions are higher for consumers experiencing more such difficulties, in particular older and less educated people. Given the complexity of the conversion rates, the introduction of the euro was fundamentally different from most other historical

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<sup>7</sup> See EC (2001 and 2002).

examples of changes in the unit of account, as in many cases they merely implied that a number of zeros was dropped from inflated currencies. In this respect, the euro cash changeover was much closer to the 1971 decimalization of sterling in the UK, for which there is also narrative evidence that substantial price increases were perceived, while there was hardly any impact on actual inflation<sup>8</sup>. It is in this context also important to stress that Cornille (2003) and Hoffmann and Kurz-Kim (2006) showed that the changeover led to a substantial and persistent increase in price diversity, which further complicated information-processing in the new regime. One of the findings of Dziuda and Mastrobuoni (2006) is that consumers who still convert prices to their old currency have higher inflation perceptions. Interestingly, this factor leads *ceteris paribus* to persistence in the gap. Indeed, the reference point of these consumers is in the meantime already nearly 5 years old and this tends to lead to a persistent (and even increasing) overestimation of inflation as time passes, at least in an environment of positive inflation. Using alternative assumptions regarding the relevant reference price, Brachinger (2005 and 2006) constructs several indices of perceived inflation which display more persistence than his IPI(2.0) index. Stix (2006) shows that these factors are crucial for explaining the persistence of the gap in Austria.

Finally, a completely different factor relates to the fact that consumers may have incorrectly interpreted the loss of purchasing power incurred at the time of the changeover as being caused by higher inflation rather than by the general slowdown in economic activity at that time. Del Giovane and Sabbatini (2006) have found some evidence in favor of this argument in the case of Italy, but in principle this argument should also have led to inflation misperceptions in other periods characterized by an economic downturn.

Relative to this literature, the main contribution of our paper is that it formally tests for a discrepancy in perceptions having occurred in the aftermath of the euro cash changeover and that it allows us to quantify the magnitude and the evolution over time of the perception gap. Our proposed methodology is also capable of testing whether some of the above-mentioned drivers of the gap between observed and perceived inflation are indeed relevant in empirical terms.

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<sup>8</sup> See Moore (1973).

### 3. DATA AND ECONOMETRIC FRAMEWORK

#### 3.1. Data set

Our data set consists of HICP inflation, CPI inflation and the inflation perceptions in the EC survey of consumers. We have considered monthly data up to December 2005, while the starting date depends both on the series and the country considered. Data are available for the euro area, for individual euro area countries, and for Denmark, Sweden and the UK.

The HICP data are our benchmark statistic for observed inflation, given their important role in the monetary policy strategy of the Eurosystem. HICP inflation rates are available from January 1996 onwards. We have also considered CPI inflation for two reasons. First, as HICPs exist only since 1996, they are not always very well known to the general public, so perhaps inflation perceptions are based on the CPI. In that event, observing a gap between perceived and HICP inflation does not necessarily imply that a similar gap exists for CPI inflation. Second, only for CPIs we are able to test in section 5 whether our conclusions are robust to an extension of the sample period. Our CPI inflation series indeed start in June 1986.

We also use the qualitative data on inflation perceptions in the consumer survey of the EC. Each month, around 26,000 consumers in the euro area are asked about their perception of inflation. The specific question is: *"How do you think that consumer prices have developed over the last 12 months?"* Since reference is made to the last twelve months, we computed yearly inflation rates for HICP and CPI data. There are six possible answers to the question on inflation perceptions: A(1), "risen a lot"; A(2), "risen moderately"; A(3), "risen slightly"; A(4), "stayed about the same"; A(5), "fallen" and, finally, A(6), "do not know". These survey results for country  $i$  at time  $t$  are summarized as the balance statistic  $B_{it}$ , calculated as the difference between a weighted proportion of respondents stating that prices have risen and a weighted proportion of consumers stating that prices have fallen or stayed about the same. The weights of the different reply options are common for all countries. Note that the third option ("risen slightly") and the sixth option ("do not know") are not used actively, as the balance statistic is computed as follows:

$$B_{it} = A_{it}(1) + 0.5A_{it}(2) - 0.5A_{it}(4) - A_{it}(5) \quad (1)$$

The earliest common date for which these data are available for a large group of euro area countries (Belgium, France, Germany, Greece, Italy, the Netherlands, Portugal and Spain) is June 1986, while for Austria, Finland and Ireland they are only available from January 1996 onwards. Among non-euro area countries, data are available since January 1985 for Denmark and the UK and since January 1996 for Sweden. A breakdown of the balance statistic is available along

different dimensions of the socio-economic characteristics of the survey participants (income level, age, education level, profession and sex). Moreover, detailed data on the fraction of respondents for each of the six possible replies are available.

### 3.2. Econometric framework

#### 3.2.1. Quantifying inflation perceptions

From the data discussion above it is clear that the balance statistic is of a fundamentally different nature than the two series on measured inflation, as its scale ranges from -100 to 100. Therefore, in its original form it provides information only on the directional change of perceived inflation. That is why we transform this balance statistic into a quantified measure of inflation perceptions by the following standardization:

$$\pi_{it}^P = \frac{(B_{it} - \bar{B}_i)}{s_{B_i}} s_{\pi_i} + \bar{\pi}_i \quad (2)$$

where  $\pi_{it}^P$  represents our proposed quantified measure of perceived inflation for country  $i$  at time  $t$ ,  $\bar{B}_i$  and  $s_{B_i}$  stand for respectively the mean and the standard deviation of the original balance statistic  $B_{it}$ , while  $\bar{\pi}_i$  and  $s_{\pi_i}$  stand for the corresponding statistics of officially measured inflation  $\pi_{it}$  (HICP or national CPI). These means and standard deviations are computed over the sample period for which it is thought that a stable relation between measured and perceived inflation exists, i.e. in our case the period 1996.01-2001.12. By construction, the result of the data transformation depends on both a reference index (HICP or national CPI) and on a reference period. Figure 1 shows the transformed data based on the HICP and actual HICP inflation.

(Insert Figure 1 here)

While the literature offers alternative approaches for quantifying survey data, such as the regression approach (Pesaran, 1984 and 1987), we have opted for our standardization of the balance statistic because of its simplicity and the fact that it is very similar to what is done implicitly in a graphic analysis. Therefore our approach can be seen as a very pragmatic one: we just test whether the inference made from a purely graphic analysis continues to hold in a formal econometric setting. We will consider Pesaran's regression approach in section 5 when it comes to test the robustness of our results.

Subsequently, we test for a unit root in the difference between  $\pi_{it}^P$  and  $\pi_{it}$ . In so doing, we verify explicitly whether perceived inflation tracks measured inflation. Rejection of the null hypothesis of a unit root implies that  $\pi_{it}^P$  tracked  $\pi_{it}$  over the test period. Finding cointegration during the reference

period is a prerequisite for addressing the issue of instability after the changeover. In the graphic analyses, the existence of a simple and stable relation between perceived and actual inflation for the period up to December 2001 is assumed implicitly and verified by visual inspection only. Our empirical strategy allows us to test this assumption formally. Such a formal test seemed justified to us, as from a visual inspection of Figure 1 it is not always clear whether perceived inflation tracks actual inflation at the level of the individual countries. In case of cointegration, the difference between both inflation measures can be seen as a meaningful - i.e. a (zero) mean-reverting - measure of the gap between perceived and actual inflation. This difference,  $GAP_{it}$ , is formally defined as:

$$GAP_{it} = \pi_{it}^P - \pi_{it} \quad (3)$$

### 3.2.2. Assessing the post-changeover gap between perceived and measured inflation

Having tested for stationarity of  $GAP_{it}$  during the reference period, we then perform an identical test for longer samples which comprise data for the post changeover period. Comparing the results of both tests allows us to check whether the inclusion of more recent observations has a significant impact on the behavior of the difference between perceived and measured inflation. In case a severe and persistent gap has occurred after the changeover,  $GAP_{it}$  would no longer be stationary over the longer samples. As we test for stability, it is clear that the data transformation for the longer samples must be identical to that applied to the shorter sample interval. This implies that the data transformation continues to be based on an identical reference period (i.e. 1996.01–2001.12). In contrast, using the longer samples to transform the data would accommodate to some extent any conjectural break and therefore induces a bias towards eventual stability. Obviously this implies that our quantification of perceptions and *a fortiori* of the perception gap is inevitably conditional on the regularities observed in the relationship between measured and perceived inflation during the reference period.

We also use our econometric framework to assess the relevance of some of the factors which are often suggested as possible explanations for the perception gap. Indeed, some (not all) of them can easily be translated in terms of our empirical test strategy. This is particularly true for the dependence of the gap on socio-economic characteristics and to some extent also for Brachinger's argument that perceptions are preponderantly shaped by frequently bought items. On top of that, our approach allows us to test whether the perception gap has to do with HICP measurement, or, alternatively, whether it is a more widespread phenomenon affecting also other inflation measures such as national CPIs.

### 3.2.3. Country specific and panel unit root tests

We perform unit root tests for the euro area as a whole and for the individual countries. In particular, the following augmented Dickey and Fuller (ADF) model (see Dickey and Fuller, 1981) is estimated:

$$GAP_{i,t} = c_i + \rho_i GAP_{i,t-1} + \sum_{j=1}^{p_i-1} \beta_{i,j} \Delta GAP_{i,t-j} + \varepsilon_{i,t} \quad (4)$$

where  $\rho_i$  is the sum of the autoregressive coefficients in an AR-model of order  $p_i$ , and  $\varepsilon_{it}$  is white noise. The optimal lag length of the AR-model is obtained on the basis of Akaike's information criterion (AIC) (Akaike, 1973). Under the null hypothesis,  $GAP_{it}$  is assumed to have a unit root.

Analyzing the individual countries seemed relevant for two reasons. First of all, from a conceptual point of view, the euro area is merely a statistical construction for the period prior to 1999. It therefore makes more sense to perform our test on the individual countries, since part of our sample is from before the start of EMU. Secondly, it is well known in the econometric literature that unit root tests have low power in short samples since in such cases they tend not to reject the null hypothesis, even if the latter is not true. This problem is potentially severe for our data, as our reference period covers only 6 years. Therefore, we use the individual countries to constitute balanced panels for which we performed panel unit root tests, which have more power. We have used the panel unit root tests of Levin, Lin, and Chu (2002) - LLC hereafter -, and Im, Pesaran and Shin (1997) - IPS hereafter. The LLC test assumes that the persistence parameter is common for all individuals in the cross-section. In contrast, the IPS test allows the persistence parameter to vary freely among individuals. Imposing a common persistence parameter can spuriously lead to the non-rejection of a unit root, in case of heterogeneity in the persistence parameter. As the IPS test is more general under the alternative hypothesis than the LLC test, it may be better suited for our analysis, particularly during the pre-EMU period. Based on robustness considerations, we nevertheless report the results of the two tests. Both tests are panel unit root tests of the first generation, which rely heavily on the hypothesis of no cross-sectional dependence. Based on the test of Breusch and Pagan (1980), independence in the error terms has been checked for each panel. In each case we are unable to reject the null hypothesis of no cross-sectional dependence. The first generation panel unit root tests are therefore appropriate in our case.

We defined four panels, essentially because they allow us to test some hypotheses formally, while the heterogeneous starting dates among the various series obliged us to consider a variant as well. We thus have defined:

- the "euro area panel", which includes all euro area members except Luxembourg<sup>9</sup>;
- the "restricted euro area panel", which includes fewer euro area countries, namely Belgium, France, Germany, Greece, Italy, the Netherlands, Portugal and Spain. This panel has been created, since the impact of an extension of the sample period (before 1996) can be tested only for this group;
- the "changeover control panel", which includes Denmark, Sweden and the UK. This panel was created for assessing the specific role of the changeover in driving perceptions;
- the "owner-occupied housing control panel", which includes Austria, Germany, Finland, Ireland and the Netherlands. The latter is created to assess the relevance of OOH as it is composed of countries where OOH is included in the national CPI.

## 4. RESULTS

### 4.1. Quantifying perceived inflation during the reference period

Table 1 presents the results of the unit root tests for  $GAP_{it}$  for the euro area as a whole, for the individual countries and for the different panels considered. The left column of the table presents results for the reference period, while the right column presents results for the entire sample (1996.01-2005.12). We first concentrate on the left column to check whether our data transformation yields an acceptable quantified measure of perceived inflation.

(Insert Table 1 here)

For the euro area as a whole, the estimated persistence parameter for  $GAP_{it}$  amounts to 0.82 for the reference period. Although this is a moderate value for monthly data, it is estimated imprecisely. Hence, we were unable to reject the unit root hypothesis. At the level of the individual countries, the results are more mixed. The unit root hypothesis is rejected for 4 countries (Belgium, Germany, the Netherlands and Portugal) at the 5 percent significance level and for Ireland at the 10 percent significance level. While for Austria the p-value hardly exceeds the 10 percent threshold, the null of a unit root is clearly not rejected for the other 5 countries (including large countries such as France, Italy and Spain). Based on this evidence, one would tend rather to reject than accept the existence of a clear relationship between perceived and actual inflation in the euro area, even for the period prior to the changeover.

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<sup>9</sup> No Luxembourg data on inflation perceptions were available before December 2001.

However, given the low power of unit root tests for short time series, we also conducted two panel unit root tests. The results for these panel unit root tests go unambiguously in the opposite direction. The unit root hypothesis is firmly rejected for the pre-euro period at the 5 percent significance level for both the euro area panel and the restricted euro area panel. This evidence suggests that, on average, euro area consumers quite accurately assessed the level of inflation before the cash changeover and that any differences between perceived and actual inflation tended to be short-lived. On the basis of the common persistence parameter provided by the LLC test, the half-life of a shock to  $GAP_{it}$  does not exceed 4 months for the euro area panel. Fairly similar results are obtained for the changeover control group, both at the level of the individual countries and at the level of the panel. The common persistence parameter in the LLC test is nearly of the same magnitude as for the two euro area panels.

We conclude from this that perceived inflation, as measured by the EC survey with consumers, tracked HICP inflation reasonably well during the period 1996.01-2001.12. This validates our proposed data transformation as a means for constructing a quantified measure of inflation perceptions. This also implies that the balance statistic of the EC can indeed be used as a basis for quantifying inflation perceptions and that in particular the use of the common weightings among countries of the different response options works relatively well<sup>10</sup>.

#### **4.2. Evidence of a euro-induced perception gap**

When considering the whole sample period, the null hypothesis of a unit root can never be rejected for the individual euro area countries. Indeed, the persistence parameters increased substantially relative to the period ending in December 2001 and are now close to unity for every country, including those for which stationarity was found during the reference period. On top of that, non-stationarity is now also found for each of the two panel unit root tests and this contrasts sharply with the results obtained for the pre-euro period. The common persistence parameter of the LLC test increased from 0.82 during the reference period to 0.96 for the whole sample period. This is strong evidence in favor of a break in the relation between perceived and measured inflation in the euro area. Our econometric analysis therefore tends to confirm the inference often made from purely graphic inspection of the time series.

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<sup>10</sup> Note however that verifying the relation between perceived and actual inflation was not easy because it was absolutely necessary to standardize the original balance statistic. Indeed, without this transformation the hypothesis of a unit root for the difference between perceived and actual inflation could never be rejected. Moreover, it was necessary to rely on the panel unit root tests, probably due to the relatively short time span of our exercise. This verifies our initial intuition that one can not take the existence of a strong link between measured and perceived inflation for granted, even for the period prior to 2002 and therefore motivates our econometric approach.



We use two different approaches to assess the particular role of the cash changeover. First we exploit the availability of similar data for three non-euro area EU countries. Secondly we perform recursive panel unit root tests for a set of windows for which the first date is fixed (1996.01) and one month is progressively added at the end of the sample. We let this exercise start with 2001.01 as first end of sample date, and then extend the estimation period month by month until 2005.12. This allows us to verify whether the break occurred at the time of the euro cash changeover. It should be noted, however, that we expect our test signaling the break in the course of 2002 and not precisely in January 2002, because even if the break actually occurred in January 2002 it is very likely that the method requires additional data before it is capable of giving a clear signal.

Results for the non-euro area EU countries are strikingly different from what we found for the euro area, as the estimated persistence parameters are barely affected by the inclusion of the post-2002 period. At the level of the individual countries, the unit root hypothesis continues to be rejected for Denmark and for Sweden, while we already failed to reject it for the UK during the reference period. As to the changeover control panel, the two tests continue to reject the null hypothesis of a unit root for the entire sample. In contrast to the euro area countries, we do not detect any asymmetry in the way consumers perceive inflation after 2002. The case of Denmark is in this respect particularly relevant. Indeed, the adoption of a fixed exchange rate relative to the euro implied that monetary policy decisions taken by the ECB were followed by the monetary authorities in Denmark and that exchange rate developments were very similar. As a result, measured inflation in Denmark was shaped to a large extent by determinants which were common to the euro area.

The upper level of Figure 2 displays p-values for the recursive IPS test described above. P-values for the euro area panel are below the 5 percent significance level for the period before January 2002. However, the relationship between perceived inflation and actual HICP inflation broke down right after the euro cash changeover, more precisely starting from the sample including data for May 2002. A similar analysis is also performed for the changeover control panel. Unlike for the euro area, the recursive p-values present a stable pattern over time and did not exceed the 5 percent significance level in the post-2002 period.

(Insert Figure 2 here)

Overall, we interpret these results as strong evidence that the euro cash changeover was the main driving factor behind the break between perceived and measured HICP inflation in the euro area. Strictly speaking, our empirical strategy allows us merely to detect a break in the relation between measured and perceived inflation. It gives us no formal clue as to which variable drives the break. In theory it might be due to perceptions, to measured inflation or to a combination of both. Therefore, it is worth mentioning that the evidence in favor of the euro as the main factor behind the gap is in

contrast with most studies mentioned in Section 2 and which have pointed out that the introduction of the euro had a relatively small impact on HICP inflation. Moreover, there is absolutely no reason to doubt that the HICP accurately captured the impact of the cash changeover. Several studies have indeed shown that, at the micro level, the transition is well reflected in the official price statistics<sup>11</sup>. Finally, it might well be the case that inflation measurement changes over time (as indeed it does in the case of the HICP) and that consumers do not adapt their inflation perceptions accordingly, at least not immediately. However, the process of upgrading the HICP methodology is a continuous one, which moreover slowed down somewhat in the most recent period relative to the reference period during which HICPs were introduced and this process also affects the countries in the changeover control panel. This implies that changes in HICP methodology cannot explain the occurrence of a sudden break in the relation between measured and perceived inflation in the euro area. We therefore argue that the observed gap is predominantly the result of misperceptions and not of inaccurate inflation measurement or sudden changes in measurement. Consequently it can be qualified as a euro-induced perception gap.

Given our methodology described in Section 3,  $GAP_{it}$  provides a straightforward quantified measure of the perception gap, in terms of percentage points of annual inflation. The graphs in Figure 1 are constructed accordingly and as a result the distance between the two curves measures the size of the perception gap. While gaps tended to be small and short-lived in the period prior to 2002, they increase sharply in a relatively synchronized fashion immediately after the cash changeover in January 2002. In most of the countries the gap continues to grow until early 2003 and thereafter remains steady or in some cases shrinks. Notwithstanding the overall movement towards smaller gaps in the period 2004-2005, in many cases a non-negligible gap persists even until the end of our sample. Germany is the only country where the gap closed completely, albeit only from the second quarter of 2004 onwards. When weighing the quantified perception gap for each country with its weight in the euro area HICP, our gap measure was close to or above 2 percent between June 2002 and August 2003 and reached a maximum of 2.7 percent in February 2003. In the second half of 2005 it still amounted to around 1.1 percent. As already pointed out, this quantification of the gap is conditional on the regularities in the relationship between measured HICP inflation and perceived inflation during the reference period. The corresponding gap measure barely exceeded 0.5 percent in absolute value for that period.

#### **4.3. No pronounced role played by socio-economic characteristics**

For each country a breakdown of the EC balance statistic is available along different dimensions of the socio-economic characteristics of the respondents, such as income, education, age, profession

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<sup>11</sup> See for instance Cornille (2003) for Belgium and Hoffmann and Kurz-Kim (2006) for Germany.

and sex<sup>12</sup>. Generally speaking, cohorts with different socio-economic characteristics have different perceptions. Figure 3 illustrates this in the case of the four available income categories. Individuals with low income are inclined to have a higher inflation perception. Analogue graphic analysis for the other socio-economic characteristics learns that lower educational levels, elder age cohorts and females tend to have higher inflation perceptions. As regards the different professional activities the image is less clear-cut. Nonetheless, the overall tendency that professions associated with lower income levels have somewhat higher inflation perceptions tends to be confirmed.

(Insert Figure 3 here)

These differences might result from the fact that inflation rates for cohort-specific baskets of goods and services diverge systematically from the average inflation rate. However, we do not possess the data necessary to test this hypothesis. Even in the absence of such differences, Brachinger's theory might imply that perceptions diverge. Indeed, as lower-income groups proportionally spend more on basic necessities its theory may imply that they have higher inflation perceptions. This could also be the case for the female population which presumably still is more in charge of daily purchases than men. Note, however, that the differences in perceptions tend to be of a permanent nature, and, at first sight, they are not strongly affected by the changeover in January 2002. Therefore, we assert that consumers' socio-economic characteristics were incapable of playing any important role in shaping the sudden perception gap at the time of the changeover. A similar point is made by Del Giovane and Sabbatini (2006). In contrast, both Stix (2006) and Dziuda and Mastrobuoni (2006) argue that household income, education level or age are factors determining changeover-induced inflation perceptions. Our econometric framework allows us to test this issue formally.

For each cohort the corresponding balance statistic is quantified using the standardization described in section 3. By construction, these standardizations are based on the cohort-specific means and standard deviations of the balance statistic during the reference period. In general this exercise confirms the existence of differences among different cohorts, in particular the existence of level differences which show up in the averages used and which are in some cases statistically significant. Identical cohort-specific standardizations are then also performed on the post-2002 data. In other words, we accommodated systematic differences during the reference period in either the average level of the balance statistic or in its sensitivity to changes in actual inflation. Doing so, we

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<sup>12</sup> In fact the survey population can be divided into four income groups: low (< € 1.000 net monthly income), medium low (€ 1.000 - € 2.500), medium high (€ 2.500 - € 4.000) and high income (> € 4.000); three educational levels: primary, secondary and higher; four age groups: 15-29, 30-49, 50-64 and 65+; ten professional categories: self-employed and professional workers, self-employed farmers, clerical and office employees, skilled manual workers, other manual workers, total workers, other occupations, full-time workers, part-time workers and the unemployed.

are able to concentrate on whether or not differences in socio-economic characteristics help to explain the appearance of the perception gap *after* the changeover.

The upper level of Table 2 reports - for the four income categories - the results of the panel unit root test for the difference of their quantified perceptions and measured inflation. For the euro area panel, all cohort-specific gap measures are stationary during the reference period. The common persistence parameters obtained by the LLC test are comparable across cohorts and are of similar magnitude as for the whole population (see Table 1). When the sample is extended with post-changeover data, the IPS test no longer rejects the null hypothesis of a unit root for each cohort. The LLC test reveals that for each cohort the persistence parameter increases substantially relative to the shorter sample, albeit it continues to reject the unit root hypothesis in case of the low and medium high income level. The evidence for the changeover control panel tends to go in the opposite direction. Indeed, in this case the null hypothesis of a unit root was less systematically rejected for the reference period, while for the longer sample interval the tests do so for each income level, except the LLC test for the high income level. Overall, these tests reveal a tendency to find, for each of the four cohorts considered, a changeover-induced break in the relation between measured and perceived inflation in the euro area, although there is some ambiguity in the case of the low and medium high income levels.

(Insert Table 2 here)

To investigate this issue further, the lower level of Table 2 also reports results of panel unit root tests for the differences in cohort-specific perceptions. In case the changeover would have had an asymmetric impact on the perceptions of the different cohorts, this should show up as a non-stationary behavior of these differences. However, the vast majority of the tests signal that these differences were stationary during the reference period and, importantly, remained stationary over the longer period, both for the euro area panel and for the changeover control panel. Moreover, for the longer period it was found that the average level of these differences is not significantly different from zero, while it is only for the reference period that this is automatically implied by the data transformation. In the specific case of the low income level there is still some doubt, since the LLC test does not reject the unit root hypothesis for the difference between quantified inflation perceptions for the low and high income levels. Note, however, that the LLC results for the low income category of both tests are precisely the opposite of what could be expected, as they could be interpreted as evidence in favor of not finding a break in the relation between perceived and measured inflation for individuals with a low income. Finally, it is worth mentioning that the (insignificant) changes in the average level of these differences relative to the reference period did not all go in the same direction. For instance, the difference between quantified perceptions for low and high income levels increased somewhat on average in Belgium, Finland, Germany, Italy,

Ireland and the Netherlands during the post-changeover period, but decreased somewhat in Austria, Greece, France, Portugal and Spain. Overall, there is no empirical support for the claim that inflation perceptions of individuals with a low income have been systematically more perturbed by the changeover than those for individuals with higher income levels.

For the other socio-economic characteristics (education, age, profession and sex) comparable results were obtained for similar panel unit root tests, confirming the image of a fairly homogeneous break in the relation between perceived and observed inflation<sup>13</sup>.

#### **4.4. Are perceptions based on frequently purchased goods and services?**

Our empirical strategy allows us also to test a variant of Brachinger's theory on inflation perceptions. We can in fact formally test whether perceptions are based on a so-called "out of pocket" index (see ECB, 2003) which comprises the HICP components food, beverages, tobacco, transport services, fuel, postal services, hotels, cafés and hairdressing. They represent around 40 percent of the total HICP basket. Obviously this index has its clear focus on frequently purchased goods and services in common with Brachinger's index. However, it differs from the latter on two points. First, when moving from the official HICP to the "out of pocket" index our transformation of the HICP weights is very simple, as the expenditure-based weights are either maintained (for items judged to be frequently purchased) or set at zero (for other items). In contrast, Brachinger's index uses explicit approximations of the relative purchasing frequencies. Second, the "out of pocket" index does not give a different weight to price increases and price decreases, while this is a crucial characteristic of Brachinger's index. As a consequence the "out of pocket" index is only a weaker variant of Brachinger's perceived inflation index, while the necessary data to conduct a formal test of his argumentation were not available.

(Insert Table 3 here)

The results of the panel unit root tests for the difference between the "out of pocket index" and accordingly rescaled inflation perceptions are summarized in the upper part of Table 3. One striking result is that for the euro area quantified inflation perceptions barely tracked the "out of pocket" inflation even during the reference period. At the level of individual countries the unit root hypothesis can indeed never be rejected for the pre-2002 period, with the exception<sup>14</sup> of Ireland and Finland. For the panel unit root tests the evidence is more mixed, but clearly less in favor of cointegration than when considering the whole HICP, as the unit root hypothesis is only rejected by the IPS test.

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<sup>13</sup> Results are not reported here, but can be obtained from the authors upon request.

<sup>14</sup> Table 3 reports only the results for the panel unit roots tests and not for the unit root tests for the individual countries. These can however be obtained from the authors upon request.

A second important result is that, even when one reads the panel unit root tests as being in favor of cointegration during the reference period, it is clear that the use of the "out of pocket index" did not induce a greater tendency to find cointegration when the period is extended after the changeover. The null hypothesis of a unit root is indeed never rejected for the whole sample - not for the individual countries and not for the panels. Finally, it is striking to see that also for the changeover control panel the unit root hypothesis is more difficult to reject for the whole sample, while Brachinger's argumentation should also apply for these countries, even after 2001.

Overall, these results suggest that the presumed focus on price developments for frequently purchased goods and services is not very important in explaining the perception gap in the euro area. Given that our "out of pocket" index is only a weak variant of Brachinger's perceived inflation index, we can however not formally reject his argumentation. Nevertheless, it is in this respect important to stress that the gap between Brachinger's index of perceived inflation and actual inflation differs in several respects from the perception gap for Germany obtained on the basis of the EU consumer survey and shown in Figure 1. First of all, there are important differences in timing. Using Brachinger's IPI(2.0) index, the German perception gap already widens substantially in the beginning of 2001 and diminishes suddenly at the end of the second quarter of 2002, while the EU consumer survey shows that in reality the perception gap appears more suddenly at the beginning of 2002 and then lasts until the first quarter of 2004. Second, the size of the perception gap is also different. In Brachinger (2006), the average size during the euro-introduction period was between 2.6 percent and 5.7 percent, depending on the degree of loss aversion assumed, with a point estimate of 4.2 percent based on IPI(2.0). However, the corresponding point estimate was close to 7.5 percent when Brachinger's gap reached its maximum in January 2002. According to the EU consumer survey (and our quantification), the German gap never exceeded 2.8 percent of annual inflation. In other words, even if we were able to reconstruct Brachinger's index for every euro area country, it is very unlikely that it would track the quantified measure of inflation perceptions of German households. In this respect we share the skepticism of Hoffmann, Liefer and Lorenz (2006) relative to Brachinger's approach. Note also that our empirical strategy enables us only to check the systematic relevance of frequent purchases for the whole period considered and is not suited for checking whether consumers' focus has recently made a sudden shift towards this type of purchases, for instance because of the complexity of information processing after the changeover. However, in that case the ultimate triggering factor for the perception gap would still be the introduction of the euro and not the price evolution of frequently purchased goods and services *per se*.

#### 4.5. How important are the specific characteristics of HICP inflation measurement?

In this section we use our empirical framework to assess the role of the specific characteristics of HICP inflation measurement in shaping the perception gap in the euro. Given the crucial role of the HICP in the monetary policy strategy of the ECB, it is particularly relevant to assess whether the perception gap challenges the accuracy and the credibility of the HICP *per se*.

##### 4.5.1. A general assessment

It has often been argued that national CPIs are still the primary reference indices at the national level and that the HICPs are ranked as secondary indicators. This can be due to the fact that the National Statistical Institutes (NSIs) tend to favor them in their external communication. In addition, in some countries the national CPIs are still used as the reference for indexation mechanisms. Finally, it should be noted that the EC survey does not make reference to a particular consumer price index when asking respondents to assess the evolution of prices. As a result, it is possible that consumers in general, and survey participants in particular, form their inflation perceptions on the basis of their experience with the national CPIs, rather than the HICPs.

The lower part of Table 3 summarizes the results for the panel unit root tests for the  $GAP_{it}$  variable based on the national CPI. They are completely in line with those based on the HICP. First, at the level of the individual countries, the unit root hypothesis can never be rejected for the whole sample, with the exception of Belgium, while for the pre-euro sample the evidence is less clear-cut, as for 4 countries the null hypothesis of a unit root can be rejected at the 5 percent significance level. For the remaining 7 countries, p-values barely exceed the 10 percent significance level in 3 of them, while for 4 countries the null of a unit root clearly could not be rejected<sup>15</sup>. Second, the panel unit root tests do provide convincing evidence of a break in 2002. Indeed, the unit root hypothesis is always rejected for the pre-2002 period, while we are never able to reject it for the whole sample. The common persistence parameters obtained for the LLC test are moreover comparable to those for the HICP based gap, both before and after the changeover. Third, for the changeover control panel we do not observe any significant difference between the pre-2002 and post-2002 periods. The IPS test rejects the null of a unit root in both cases. The LLC test shows fairly low common persistence parameters which are comparable for both sample periods, although the unit root hypothesis is never rejected. Moreover, similar conclusions are drawn from the recursive panel unit root tests (see upper level of Figure 2 for the results). For the euro area panel, the relationship between official and perceived inflation broke down in June 2002, shortly after the euro cash changeover, which is fairly similar to the results obtained on the basis of the HICPs (May 2002). As to the

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<sup>15</sup> Results for the unit root tests for individual countries can be obtained from the authors upon request.

changeover control panel, p-values remained continuously below the 5 percent significance level. Finally, both the size and the persistence of the gap associated with the national CPI are comparable to what was found on the basis of the HICP. In sum, our findings on the perception gap in terms of the HICP are also valid for the national CPIs.

#### 4.5.2. The non-inclusion of owner-occupied housing

One of the particular methodological features of the HICP is that OOH is not included in the basket, at least not at the current juncture<sup>16</sup>. However, the purchase of houses constitutes by far the most important transaction of households. In recent years, house prices have moreover increased faster than HICP inflation in many euro area countries. In the euro area as a whole, residential property prices have increased during the period 2002-2005 by approximately triple the HICP inflation rate. Furthermore, these developments have received extensive media coverage and, as a result, households may have been particularly sensitive to this. On top of that, it is reasonable to think that consumers in general, and survey participants in particular, are unaware of the fact that house prices are not included in the HICP. House price developments may therefore have contributed to the perception gap. To test for this we have opted for two approaches.

First of all, we formed the OOH control panel with the euro area countries where OOH is included in the national CPI<sup>17</sup> and performed panel unit root tests for both the pre and post-2002 samples. In case the non-inclusion of OOH in the HICP is responsible for the perception gap, we expect that in this panel the tests will reject the unit root hypothesis for the times both before and after the introduction of the euro. However, results do not support this argument, since they are similar to those obtained for the more complete euro area panels. Indeed, also for this control panel, the unit root hypothesis can not be rejected for the whole sample (Table 3, panel B).

(Insert Figure 4 here)

Our second approach consists in comparing the magnitude of the perception gap directly with developments in real house prices. Comparing the average perception gap during the period 2002-2005 with real house price developments during the same period did not yield a clear correlation between both phenomena. However, as the average perception gap for the period 2002-2005 is heavily influenced by changeover-induced misperceptions, which are in principle orthogonal to house price developments, it seemed more appropriate to examine whether there is a link between

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<sup>16</sup> The inclusion of OOH is currently being examined at the expert level, but the decision on whether OOH will be included in the future has not yet been made. This also applies to the choice of the statistical method which should be used in that event.

<sup>17</sup> Obviously, constructing this group makes only sense when analysing the national CPI. Note also that in this group OOH is not always measured according to the same methodology.



the persistent part of the gap, measured as the average gap for the year 2005 only, and real house price developments during the period under consideration. This is shown in Figure 4. Pronounced real house price developments tend to be associated with relatively large perception gaps in 2005, except for Greece for which perceptions may also have been particularly perturbed by the shift in the monetary policy regime and the drastic disinflation in the run-up to EMU. However, even when excluding Greece, the correlation (0.30) is not significantly different from zero.

In sum, our analysis of national CPIs shows that they are characterized by a perception gap resembling that of the HICP. Inflation misperception therefore seems to be a fairly widespread phenomenon and not just an HICP issue. This finding is consistent with our earlier assessment that the perception gap that we are evaluating is predominantly induced by the introduction of the euro and is not due to inflation measurement. This is also true for the non-inclusion of owner-occupied housing in the HICP which does not seem to have had serious implications for the credibility of the HICP up to now. This does not mean, however, that inclusion of OOH might not be justified on other grounds, such as broadening the coverage of the HICP and enhancing cross-country comparability.

## **5. ROBUSTNESS OF THE RESULTS OBTAINED**

### **5.1. Extension of the sample period**

One might argue that the sample period considered so far is too short or somewhat random and therefore does not allow drawing strong conclusions. In particular, perhaps discrepancies during the post-changeover period were not exceptional by historical standards, once the period on which the analysis is based, is extended. For the link between inflation perceptions and national CPI inflation such an extension is possible because data are available for a relatively long time period (starting in 1986.06), at least for the countries that constitute the restricted euro area panel. We proceeded as follows. The shorter reference period, i.e. 1996.01 - 2001.12, is used for quantifying the balance statistic, just as was done when testing whether the relation between actual inflation and quantified perceptions is stable after December 2001. We then test whether this relation is stable when the estimation period is "extended" *prior* to 1996.01. We therefore performed recursive unit root tests similar to the previous ones, but now in the opposite direction. That is, we kept the end of the sample period fixed (2001.12), while at the beginning of the sample we progressively added one month, implying that in this exercise the beginning of the sample moves from 1996.01 to 1986.06.

Applied to the gap measures for the individual countries, these recursive unit root tests revealed stability in the relationship between perceived and national CPI inflation for Belgium and the Netherlands at the 5 percent significance level, i.e. for half of the countries for which the hypothesis

of a unit root could be rejected at that significance level during the reference period. Similar recursive exercises were carried out for the restricted euro area panel and for the changeover control panel. The lower part of Figure 2 shows the p-values of the recursive IPS tests. Results depend on which information criterion we use to determine the number of the lags in the test equations. Based on the AIC, which is the one for which results have been shown up to now, p-values for the restricted euro area panel are initially fairly stable and remained below the 5 percent significance level until inclusion of data prior to February 1990, i.e. after having added nearly six years of observations. When extending the period further in the past we can no longer reject the hypothesis of a unit root, which suggests instability in the relation between actual inflation and quantified perceptions. However, once data for 1986 are included, p-values again approach the 10 percent significance level, and fell below it when data prior August 1986 are included. Results based on the Schwarz Information Criterion (SIC) (Schwarz, 1978) are much more in favor of stability for the restricted euro area panel, since the unit root hypothesis can be rejected for all sample periods including pre-1996 observations. As to the changeover control panel, the unit root is rejected for all sample periods including pre-1996 observations when the estimation is based on the SIC, whereas on the basis of the AIC some instability is found. P-values continuously oscillated around the 5 percent significance level until inclusion of data prior to 1988. Afterwards they clearly exceeded the 10 percent significance level. Note, however that in this experiment the control panel is formed by two countries only, as no Swedish data on perceptions are available prior to 1996. Moreover, for one of these countries (the UK) the null hypothesis of a unit root was already not rejected during the reference period, when the AIC was used.

Overall, these results show that the instability found during the period 1985-1995 appears as being small compared to what was found after 2001. Our extension of the sample period therefore tends to confirm our finding that an unusually large and sudden perception gap occurred after the changeover.

## **5.2. Controlling for variations in the sixth reply option: "Do not know"**

One of the particularities of the EC balance statistic is that it ignores the sixth possible reply "do not know". As a consequence, variations in the share of this option affect the shares of the options which are actively used. In this section we test whether this has had a significant impact on our results. We investigate in particular whether the break in the relationship between perceived and measured inflation is spurious, in the sense that it may have been driven by pronounced changes in the importance of the no-answer option.

Panel unit root tests show that the share of this sixth option is stationary for both the reference period and the extended period, suggesting that nothing particular happened to this variable during

the post-changeover period. This fact alone seriously reduces the likelihood that a spurious discrepancy was found. Second, an alternative balance statistic was calculated by normalizing the percentages for the first five options, so that their sum is 100 percent. Use of this alternative balance statistic does not alter our results<sup>18</sup>.

### **5.3. Quantifying the EU survey results on the basis of the regression approach**

In section 3 we motivated our standardization for its simplicity and similarity to the graphic analysis. Our approach is moreover conceptually very similar to that of Del Giovanni and Sabbatini (2006), as they regress the balance statistic on actual inflation and use the obtained coefficients for their data transformation. Also, in this case, one would like to test for the stationarity of the residuals in order to avoid problems of spurious regressions. This corresponds conceptually to testing for a unit root in our GAP variable.

In this section we test whether our findings stand up to an alternative quantification of the results of the EC survey based on the regression approach proposed by Pesaran (1984,1987). For this alternative data transformation, actual inflation is regressed on the shares of the first five reply options and then the regression coefficients obtained are used to quantify the balance statistic. This would have the advantage that the weights of the different options can be freely determined by the data and possibly be country specific, which is not the case for the EC balance statistic.

Using this alternative approach does not challenge our results at all. On the contrary, we find now even stronger evidence in favor of a break after the changeover. Indeed, while the results of the panel unit root tests are not altered at all, the null hypothesis of a unit root in the difference between quantified perceptions and actual inflation can now be rejected during the reference period for 10 of the 11 individual countries considered. Evidently, the more flexible approach for quantifying inflation perceptions has yielded perceptions which better track actual inflation during the reference period. Notwithstanding this, for all but one country (France) the null hypothesis is no longer rejected for the longer period. Hence, this alternative approach strengthens the already available evidence in favor of a break in the relationship between perceived and actual inflation, particularly at the level of the individual countries<sup>19</sup>.

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<sup>18</sup> The results are not presented in this paper but they can be obtained from the authors on request.

<sup>19</sup> The results are not presented in this paper, but can however be obtained from the authors upon request.

## 6. CONCLUSIONS

While there is clearly no doubt about the accuracy of official inflation measures in the euro area during the recent period, there is plenty of anecdotic evidence that since 2002 consumers have tended to perceive that inflation is high, while in reality it was relatively low, albeit slightly above the quantified definition of price stability for the euro area. Apparently a perception gap has grown in the euro area since the euro cash changeover in January 2002. Using the EC balance statistic on inflation perceptions in the household surveys, we test econometrically whether there is indeed such a gap. The merit of our formal method is that it has the potential to substantially strengthen or challenge earlier conclusions, until now predominantly based on graphic evidence.

Our quantified perception measure tracks inflation in the pre-euro period (i.e. until December 2001), both for the panel of 11 euro area countries and for a control panel of three other EU countries (Denmark, Sweden and the UK). This relation was fairly stable when our test was extended backward to incorporate (out-of-sample) data for the past, while a similar test clearly reveals that the relation disappears in the euro area panel shortly after January 2002. In the control panel no such break was found. We did not find support for the claim that perceptions are systematically based on frequently purchased goods and services or that their misalignment after the changeover is substantially more pronounced for consumers with some specific socio-economic characteristics. We found that the perception gap is not fundamentally different when national CPI inflation is used instead of HICP inflation, while the non-inclusion of owner-occupied housing in the HICP does not seem to have had a serious impact on the mismatch between measured and perceived inflation up to now. All this leaves us with the picture of a predominantly euro induced perception gap, which is therefore a general phenomenon and not specific to the HICP. Given its prominent role in the monetary policy strategy of the Eurosystem, finding that the gap does not challenge the accuracy or credibility of the HICP *per se*, is an important result.

This does not mean, however, that there is no problem at all. On the contrary, we showed that the perception gap at the level of the euro area as a whole was still equivalent to 1.1 percent HICP inflation during the second half of 2005, notwithstanding a clear reduction since early 2003 when it reached a maximum of 2.7 percent. Appropriate communication on this issue by Eurostat, by the national statistical agencies compiling the HICPs and by the Eurosystem seems a promising way to address this gap. In this respect, it would be very interesting to examine whether differences observed among countries in the persistence of the gap are related to national communication practices. While we leave this issue for future research, there is no doubt that it is a very relevant topic, not only for addressing the remaining gaps in the countries which form the euro area at the current juncture, but definitely also in order to assure a smooth introduction of the euro in new EU member states.

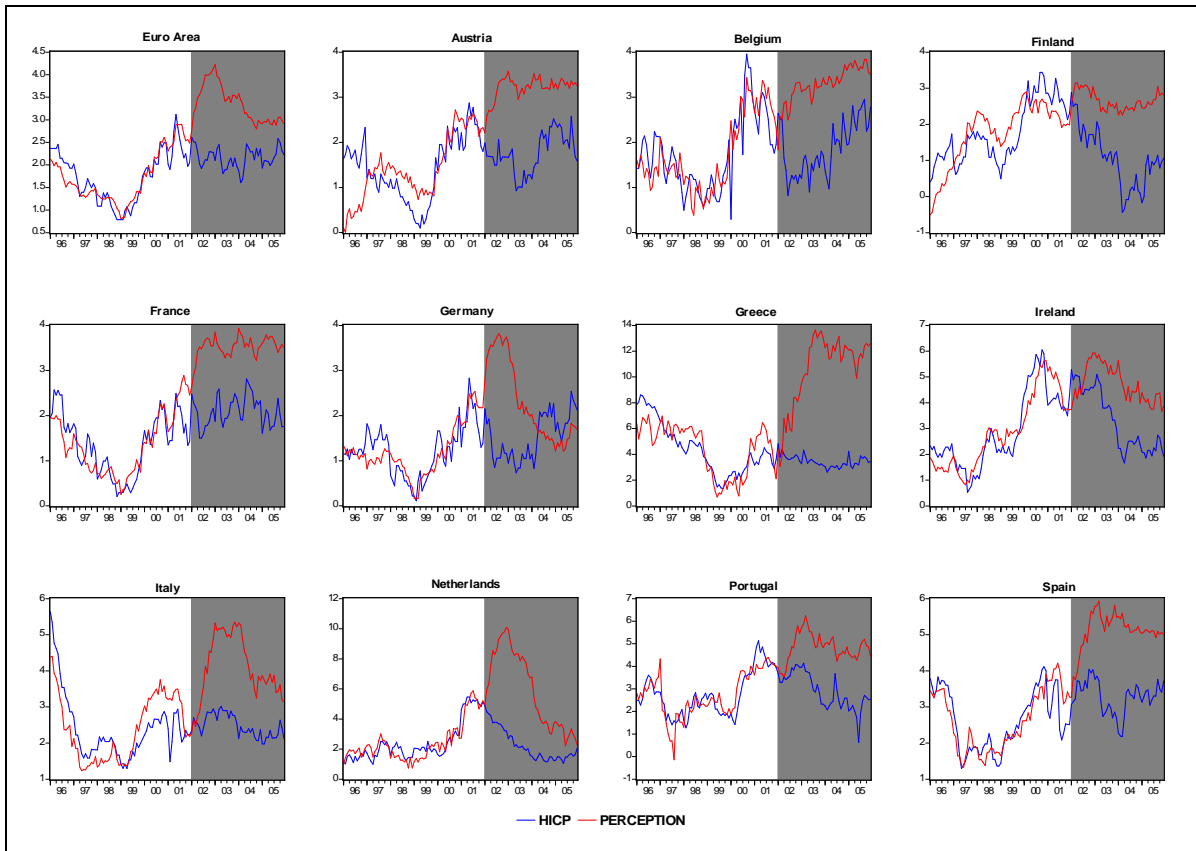
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**Figure 1 - HICP inflation and quantified inflation perceptions (standardized survey data)**

**Euro area**



**Non-euro area EU countries**

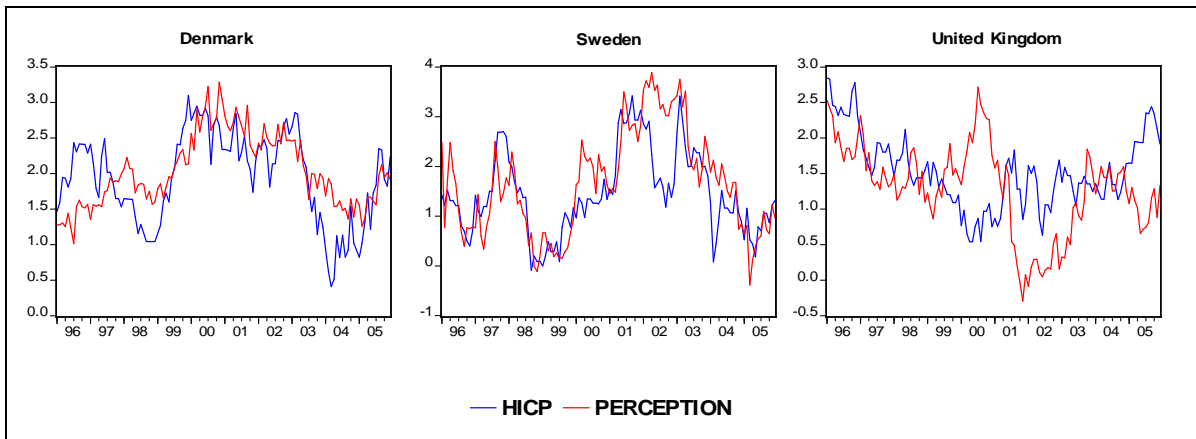
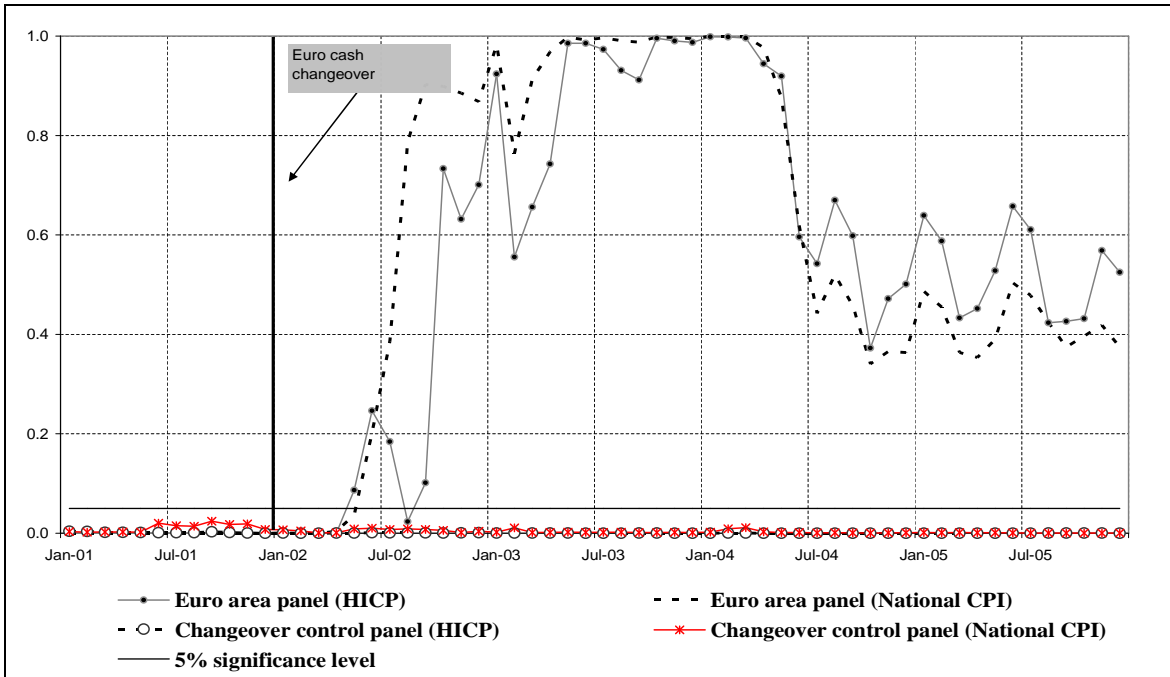


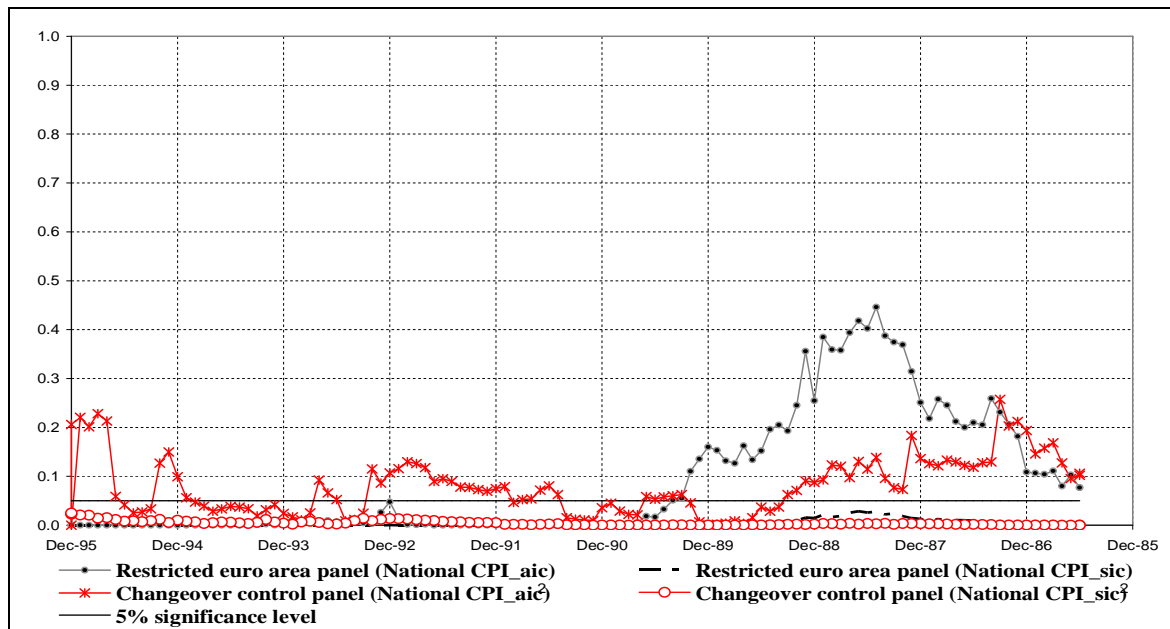
Figure 2 - Panel unit root tests: p-values for recursive IPS tests

A. Extending the samples forward: including data after December 2000<sup>1</sup>



<sup>1</sup> The first sample period refers to the period 1996.1-2001.01 and the last one to the period 1996.1-2005.12. The dates plotted on the x-axis refer to the end of each of the windows considered.

B. Extending the samples backward: including data before January 1996<sup>1</sup>



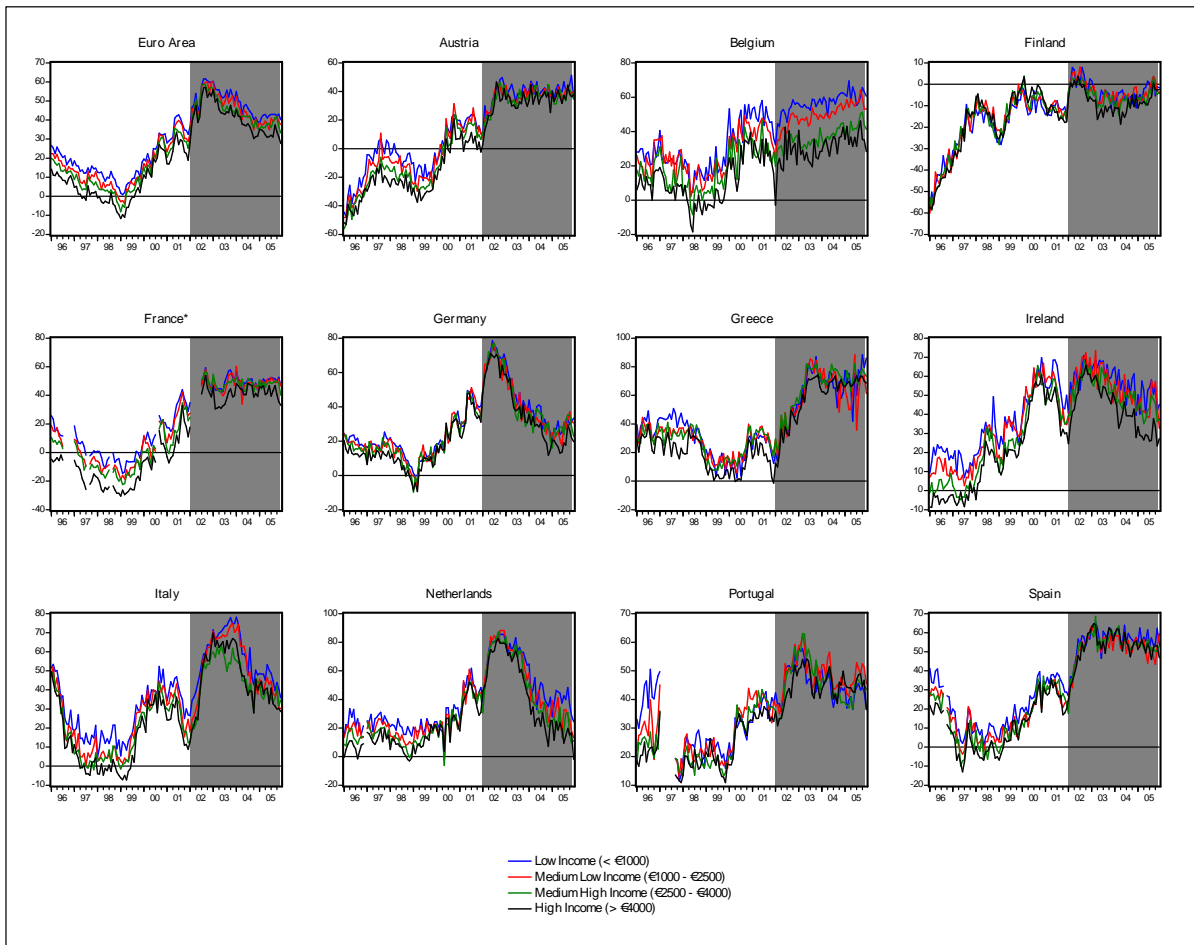
<sup>1</sup> The first sample period refers to the period 1995.12-2001.12 and the last one to the period 1986.06-2001.12. The dates plotted on the x-axis refer to the beginning of each of the windows considered.

<sup>2</sup> Excluding Sweden.



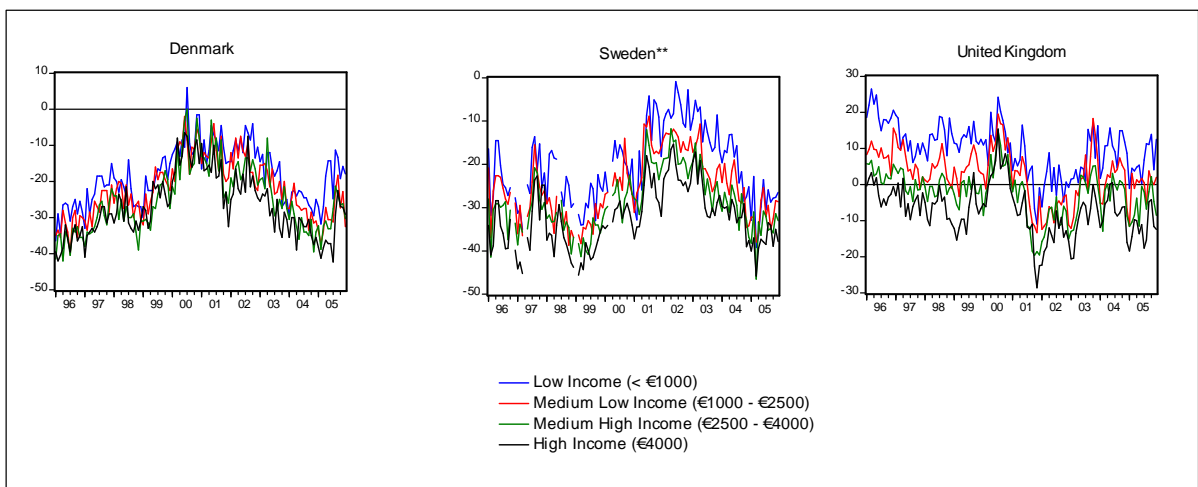
**Figure 3 - Original balance statistic on inflation perceptions per income category**

**Euro area**



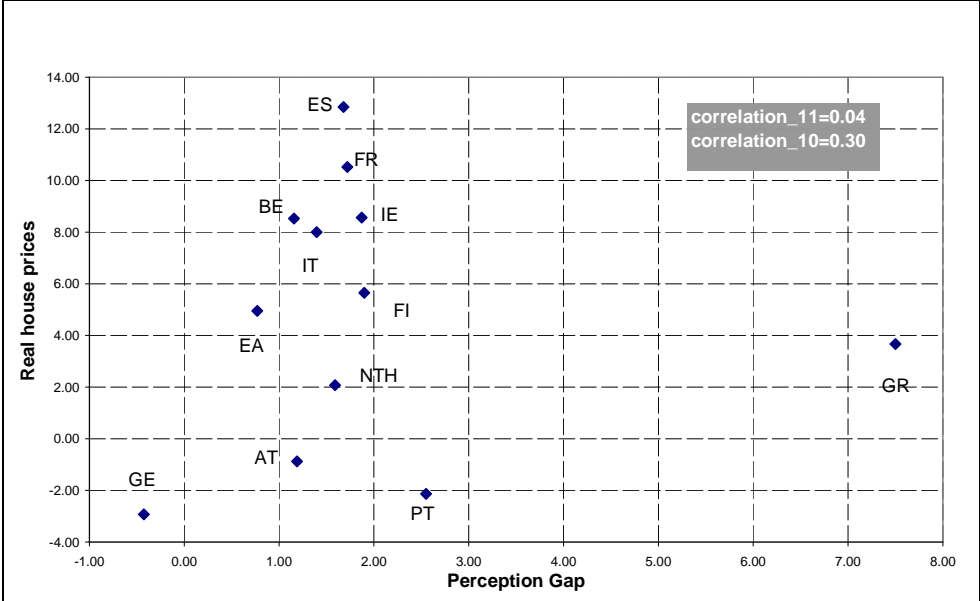
\* For France the outlying observations of May and July 2002 were dropped.

**Non-euro area EU countries**



\*\* For Sweden the outlying October 1999 observation for the high-income category was dropped.

**Figure 4 - Link between the persistent part of the perception gap (average gap of 2005) and real house price developments (2002-2005)<sup>1</sup>**



<sup>1</sup> For Greece, Ireland and Portugal, the residential property prices are not available for 2005; therefore an average for the periods up to 2004 is used.

**Table 1 - Difference between quantified inflation perceptions and HICP inflation**

**A. Unit root tests at the country level**

*(non-rejection of the unit root hypothesis at the 5 percent significance level is in bold)*

	1996.1-2001.12		1996.1-2005.12	
	<i>PERSISTENCE</i>	<i>P-VALUES</i>	<i>PERSISTENCE</i>	<i>P-VALUES</i>
<b>1. Euro area</b>	0.82	<b>0.48</b>	0.96	<b>0.43</b>
Belgium	0.38	0.00	0.92	<b>0.56</b>
France	0.85	<b>0.27</b>	0.96	<b>0.75</b>
Germany	0.71	0.02	0.95	<b>0.43</b>
Italy	0.90	<b>0.38</b>	0.96	<b>0.41</b>
Netherlands	0.64	0.00	0.96	<b>0.32</b>
Portugal	0.57	0.00	0.97	<b>0.83</b>
Spain	0.82	<b>0.28</b>	0.95	<b>0.42</b>
Austria	0.88	<b>0.11</b>	0.93	<b>0.17</b>
Finland	0.90	<b>0.34</b>	0.96	<b>0.61</b>
Greece	0.86	<b>0.18</b>	0.99	<b>0.84</b>
Ireland	0.80	<b>0.07</b>	0.93	<b>0.40</b>
<b>2. Non-Euro area countries</b>				
Denmark	0.64	0.00	0.66	0.00
Sweden	0.53	0.00	0.79	0.04
UK	0.91	<b>0.42</b>	0.90	<b>0.13</b>

**B. Panel unit root tests**

*(p-values and pooled persistence parameter between brackets; non-rejection of the unit root hypothesis at the 5 percent significance level is in bold)*

	1996.01-2001.12		1996.01-2005.12	
	LLC*	IPS**	LLC*	IPS**
Euro area panel	0.00 (0.82)	0.00	<b>0.30 (0.96)</b>	<b>0.52</b>
Restricted euro area panel <sup>1</sup>	0.00 (0.78)	0.00	<b>0.30 (0.96)</b>	<b>0.66</b>
Changeover control panel	0.00 (0.78)	0.00	0.03 (0.83)	0.00

<sup>1</sup> Belgium, France, Germany, Greece, Italy, the Netherlands, Spain and Portugal

\* The Levin, Lin and Chu test assumes a common persistence parameter among individuals in the panel.

\*\* In the Im, Pesaran and Shin test no pooled persistence parameter is available (heterogeneity across individuals in the panel).

**Table 2 - Inflation perceptions per income category**

(panel unit root tests for the variables defined below; p-values and pooled persistence parameter between brackets; non-rejection of the unit root hypothesis at the 5 percent significance level is in bold)

**A. Difference between quantified inflation perceptions per income category and HICP inflation**

	1996.01-2001.12		1996.01-2005.12	
	LLC*	IPS**	LLC*	IPS**
<i>Low Income</i>				
Euro area panel <sup>1</sup>	0.00 (0.77)	0.00	0.02 (0.93)	<b>0.12</b>
Changeover control panel	<b>0.07 (0.73)</b>	0.00	0.00 (0.74)	0.00
<i>Medium Low Income</i>				
Euro area panel <sup>1</sup>	0.00 (0.79)	0.00	<b>0.14 (0.94)</b>	<b>0.23</b>
Changeover control panel	<b>0.98 (0.91)</b>	<b>0.98</b>	0.01 (0.76)	0.00
<i>Medium High Income</i>				
Euro area panel <sup>1</sup>	0.00 (0.81)	0.00	0.03 (0.94)	<b>0.10</b>
Changeover control panel	0.03 (0.77)	0.02	0.04 (0.78)	0.00
<i>High Income</i>				
Euro area panel <sup>1</sup>	0.01 (0.81)	0.00	<b>0.28 (0.95)</b>	<b>0.31</b>
Changeover control panel <sup>2</sup>	<b>0.18 (0.82)</b>	0.03	<b>0.51 (0.81)</b>	0.00

**B. Difference between quantified inflation perceptions per income category**

	1996.01-2001.12		1996.01-2005.12	
	LLC*	IPS**	LLC*	IPS**
<i>Δ1 = (Low-High)</i>				
Euro area panel <sup>1</sup>	0.00 (0.59)	0.00	<b>0.11 (0.79)</b>	0.00
Changeover control panel <sup>2</sup>	0.00 (0.36)	0.00	0.00 (0.43)	0.00
<i>Δ2 = (Medium Low-High)</i>				
Euro area panel <sup>1</sup>	0.00 (0.30)	0.00	0.00 (0.58)	0.00
Changeover control panel <sup>2</sup>	0.00 (0.07)	0.00	0.00 (0.27)	0.00
<i>Δ3 = (Medium High-High)</i>				
Euro area panel <sup>1</sup>	0.00 (0.21)	0.00	0.00 (0.53)	0.00
Changeover control panel <sup>2</sup>	0.00 (0.18)	0.00	0.00 (0.24)	0.00

<sup>1</sup> For France the outlying observations of May and July 2002 were dropped.

<sup>2</sup> For Sweden the outlying October 1999 observation for the high income category was dropped.

\* The Levin, Lin and Chu test assumes a common persistence parameter across individuals in the panel.

\*\* In the Im, Pesaran and Shin test no pooled persistence parameter is available (heterogeneity across individuals in the panel).

**Table 3 - "Out of pocket" inflation and the national CPIs as references for inflation perceptions**

(panel unit root tests for the variables defined below; p-values and pooled persistence parameter between brackets; non-rejection of the unit root hypothesis at the 5 percent significance level is in bold)

**A. Difference between quantified inflation perceptions and "out of pocket" inflation**

	1996.01-2001.12		1996.01-2005.12	
	LLC*	IPS**	LLC*	IPS*
Euro area panel	<b>0.63 (0.83)</b>	0.00	<b>0.08 (0.94)</b>	<b>0.09</b>
Restricted euro area panel <sup>1</sup>	<b>0.93 (0.86)</b>	0.04	<b>0.12 (0.95)</b>	<b>0.22</b>
Changeover control panel <sup>2</sup>	0.02 (0.76)	0.00	<b>0.43 (0.82)</b>	0.00

**B. Difference between quantified inflation perceptions and national CPI inflation**

	1996.01-2001.12		1996.01-2005.12	
	LLC*	IPS**	LLC*	IPS*
Euro area panel	0.00 (0.83)	0.00	<b>0.09 (0.96)</b>	<b>0.37</b>
Restricted euro area panel <sup>1</sup>	0.02 (0.81)	0.00	<b>0.20 (0.97)</b>	<b>0.53</b>
Changeover control panel	<b>0.10 (0.82)</b>	0.00	<b>0.57 (0.83)</b>	0.00
Owner occupied housing control panel <sup>3</sup>	0.00 (0.83)	0.00	<b>0.17 (0.95)</b>	<b>0.22</b>

<sup>1</sup> Belgium, France, Germany, Greece, Italy, the Netherlands, Spain and Portugal.

<sup>2</sup> Excluding Sweden.

<sup>3</sup> Austria, Germany, Finland, Ireland and the Netherlands.

\* The Levin, Lin and Chu test assumes a common persistence parameter across individuals in the panel.

\*\* In the Im, Pesaran and Shin test no pooled persistence parameter is available (heterogeneity across individuals in the panel).

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Limited liability company  
RLP Brussels – Company's number: 0203.201.340  
Registered office: boulevard de Berlaimont 14 – BE-1000 Brussels  
[www.nbb.be](http://www.nbb.be)

Editor

**Jan Smets**

Member of the board of Directors of the National Bank of Belgium

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Layout: Research – Analysis and Research Group  
Cover: NBB TS – Prepress & Image

Published in April 2007