



# The Euro Changeover in Estonia: Implications for Inflation

Tairi Rõõm, Katri Urke

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# The Euro Changeover in Estonia: Implications for Inflation

Tairi Rõõm and Katri Urke<sup>\*</sup>

## Abstract

Estonia changed over from the kroon to the euro in January 2011. This paper analyses the inflationary effect of this event. The analysis is based on the Harmonised Indices of Consumer Prices. The difference-in-differences method is employed where the treated group is Estonia and the control group consists of the other EU member states. The estimation results imply that the inflationary impact of the euro changeover was either insignificant or small in magnitude, depending on which treatment period is considered. The acceleration in inflation mostly occurred in the second half of 2010, during the six-month period prior to the adoption of the euro. Although the actual effect of the euro changeover on inflation was modest, most Estonian citizens felt that the introduction of the new currency increased consumer prices considerably.

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The views expressed are those of the authors and do not necessarily represent the official views of Eesti Pank.

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## **Non-technical summary**

Estonia changed over from the kroon to the euro in January 2011. The aim of this paper is to analyse the inflationary effect of this event. Empirical evidence from earlier episodes of the euro changeover indicates that their impact on aggregate inflation was modest. The analysis from other countries has also shown that price levels usually only increased in connection with euro changeovers in a limited number of sectors, most prevalent of which were some areas of personal services such as hairdressing, restaurants and catering, and dry-cleaning (Hüfner and Koske (2008)).

Although the actual effect of the euro changeover on inflation was modest, most EU citizens felt that the introduction of the new currency increased consumer prices considerably. The measure of perceived inflation provided by DG ECFIN, which is based on the EU Business and Consumer survey, increased after the euro changeover in all the countries that adopted the new currency in 2002, and this increase was much larger than the actual acceleration of inflation (Dziuda and Mastrobuoni (2009)).

The gap between actual and perceived inflation also emerged after the euro changeover in Estonia. It is not entirely clear why this difference arose, given that Estonia launched an information campaign and took several measures to diminish the price increases in response to the euro changeover. The increase in perceived inflation is partly explainable by the larger inflationary impact of the euro adoption on food prices. People pay more attention to food prices since these items tend to be purchased more frequently (Dziuda and Mastrobuoni (2009)). However, the growth in food prices that was linked to the euro changeover was still relatively small in magnitude in Estonia and cannot completely explain the large gap between actual and perceived inflation.

We employ the difference-in-differences method to estimate the inflationary impact of the euro changeover in Estonia. The control group for the estimations consists of the other EU member states. We use quarterly inflation series, which are constructed from monthly HICP indices taken from Eurostat. The regressions also include controls for cyclical dynamics and country fixed effects. Our estimation results imply that the inflationary impact of the euro changeover was either insignificant or small in magnitude, depending on which treatment period is considered.

The difference-in-differences estimate for all-items HICP was insignificant for the time period covering III quarter 2010–II quarter 2011 (six months before and six months after the euro adoption). The estimated effect for a longer time period covering nine months before and after the changeover indicates that the inflation rate was 0.35 pp higher during that time than the

rates in other countries and other time periods. The acceleration of inflation mostly occurred in the second half of 2010, during the six months prior to the euro adoption. At that time the inflation difference with other time periods was 0.55 percentage points higher in Estonia than in the control group, whereas this difference was insignificant during the first six months of 2011.

We performed consistency checks to validate the difference-in-differences estimation of the inflationary impact of the euro changeover. First, panel unit root tests were implied. They yielded the result that the time series of inflation rates are stationary. Second, we estimated the difference-in-differences effects using a set of control group countries that excluded the countries which increased their VAT rates in January 2011. The estimated difference-in-differences effects were very similar to the ones reported earlier in the paper. Third, we estimated the “placebo effects”, almost all of which were insignificant. Consequently, all consistency checks that we employed supported the use of the difference-in-differences method for estimating the inflationary impact of the euro changeover in Estonia.

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# 1. Introduction

On 1 January 2011 Estonia became the 17<sup>th</sup> EU member state to change over to the European Union's common currency, the euro. As in previous rounds of the euro cash changeover in other EU countries, this event triggered a lively discussion about its potential effect on consumer prices. The aim of the current paper is to analyse the inflationary effect of the adoption of the euro in Estonia.

Empirical evidence from earlier episodes of the euro changeover<sup>1</sup> indicates that their impact on aggregate inflation was modest. In most countries the estimated effect ranged from insignificant to 0.6 percentage points (Sturm et al. (2009), Hüfner and Koske (2008)). It has also been found that price levels usually only increased in relation to euro changeovers in a limited number of sectors, most prevalent of which were some areas of personal services such as hairdressing, restaurants and catering, and dry-cleaning (Hüfner and Koske (2008)). The first round of the euro cash changeover in 2002 might have induced an increase in food prices as well, but it has been difficult to disentangle the effect of the currency changeover from some other factors which may also have influenced food inflation, such as the exceptionally cold weather in the winter of 2001/2002 in Europe (Ehrmann (2011)).

Although the actual effect of the euro changeover on inflation was modest, most EU citizens felt that the introduction of the new currency increased consumer prices considerably. The measure of perceived inflation provided by DG ECFIN that is based on the EU Business and Consumer survey increased after the euro changeover in all the countries that adopted the new currency in 2002, and this increase was much larger than the actual acceleration of inflation (Dziuda and Mastrobuoni (2009)).

This paper provides an overview of the dynamics of actual and perceived inflation in Estonia. As was the case in the countries that changed over to the euro earlier, the standardised measure of perceived inflation is shown to have exceeded actual price changes considerably after the euro changeover in 2011. The gap between actual and perceived inflation is hard to explain, given that Estonia launched an information campaign and took several measures to diminish the inflationary impact of the euro changeover (see Section 2 for details). This is partly explainable by the larger impact of the euro adoption on food prices (see Section 6) as people pay more attention to food prices and to the prices of relatively cheaper goods since these items tend to

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<sup>1</sup> The first round of euro cash changeover took place on 1 January 2002 and involved the following 12 countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. Slovenia joined the euro area on 1 January 2007, Cyprus and Malta on 1 January 2008, and Slovakia on 1 January 2009.

be purchased more frequently (Dziuda and Mastrobuoni (2009)). However, the inflationary impact of the euro changeover on food prices was still relatively small in magnitude and cannot completely explain the large gap between actual and perceived inflation.

We employ the difference-in-differences method to estimate the inflationary impact of the euro changeover in Estonia. The control group for the estimations consists of the other EU member states. We use the quarterly time series of HICP indices, which are constructed from monthly data taken from Eurostat. The regressions also include controls for cyclical dynamics and country fixed effects. The estimation results presented in Section 6 imply that the inflationary impact of the euro changeover in Estonia was modest.

The remainder of the paper is structured as follows. Section 2 provides background information on the euro adoption in Estonia. Section 3 reviews the literature on the euro cash changeover. Section 4 compares the dynamics of actual and perceived inflation in Estonia after the euro changeover. Section 5 gives an overview of the data and estimation methodology. In Section 6 we present the empirical analysis on the inflationary impact of the euro changeover. Section 7 concludes.

## **2. The euro adoption in Estonia: Background information**

Estonia adopted the euro on 1 January 2011 in a “big bang” scenario with the euro being introduced simultaneously in cash and non-cash circulation. The euro and the Estonian kroon were in parallel use for 14 days until 14 January 2011, during which time cash payments could be made in either euros or Estonian kroons.

Estonia met the Maastricht inflation criterion for the changeover to the euro in November 2009 and by March 2010 it was clear that the budget criterion had also been met. The convergence report by the European Commission and the European Central Bank which assessed Estonia’s compliance with the Maastricht criteria was published on 12 May 2010. The report stated that Estonia fulfilled all the necessary criteria. The final decision on Estonia’s changeover to the euro was made at the meeting of the Council of the European Union on 13 July 2010.

An information campaign about the changeover to the euro was run under the communication strategy drawn up in 2010 to prepare the population for the arrival of the currency and to ensure that everyone living in Estonia was adequately informed of the circumstances and practical aspects of the

changeover. A survey by research company Faktum & Ariko in January 2011<sup>2</sup> indicated that 96% of the Estonian population were well or very well informed of the practical aspects of the changeover to the euro.

Consumer protection efforts to prevent or minimise the inflationary impact of the changeover from the kroon to the euro and to create public pressure against price increases were part of the communication strategy. One of the measures to reduce the upward pressure on prices was the requirement for merchants to display all prices in two currencies, Estonian kroons and euros, from July 2010 to June 2011. This was done to give people time to get used to the euro as the new currency and to avoid any possible misunderstandings that might arise from changes in the numeric values of prices. The government also set detailed rules for price conversion and rounding.

Voluntary consumer associations, the Consumer Protection Board, Statistics Estonia and the Estonian Institute of Economic Research all carried out price surveys both before and after the changeover to the euro to inform the public of price changes. Adherence to the rules for price conversion and rounding was also inspected. The Estonian Chamber of Commerce and Industry launched a campaign “the € will not increase the price” for traders, and more than 400 companies voluntarily joined up to indicate that they were committed to fair price setting. These traders could identify themselves with the official logo of the campaign. All the major retail chains and supermarkets joined the campaign.<sup>3</sup>

To prevent additional inflation the government rounded national taxes, fees and duties in a way that was more favourable for taxpayers and recipients of state benefits. The state set an example to merchants, encouraging them to follow good practice in converting prices from kroons to euros. Despite the communication campaign and price monitoring, 60% of the population still felt in January 2011 that there would be a general price increase and 22% thought that the prices of some goods and services might increase as a result of the changeover.<sup>4</sup>

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<sup>2</sup> [http://euro.eesti.ee/EU/Prod/Euroveeb/Avaleht/download/Euroseire\\_6.pdf](http://euro.eesti.ee/EU/Prod/Euroveeb/Avaleht/download/Euroseire_6.pdf).

<sup>3</sup> More information about the documentation and campaigns related to the euro changeover is available at: <http://www.euro.eesti.ee/EU/Prod/Euroveeb/application/controllers/handleSessions32e5.html?lang=en&oid=3248>

<sup>4</sup> [http://euro.eesti.ee/EU/Prod/Euroveeb/Avaleht/download/Euroseire\\_6.pdf](http://euro.eesti.ee/EU/Prod/Euroveeb/Avaleht/download/Euroseire_6.pdf).

### **3. Inflationary effects of the currency changeover: Literature review**

The impact of the changeover to the euro has been well researched for most of the countries which started using the euro earlier than Estonia. The main findings of this branch of literature are that the impact of the new currency on aggregate inflation has been small or non-existent and that the effect of the changeover was biggest in some areas of the service sector.

Hüfner and Koske (2008) review the results from several studies which estimated the inflationary impact of euro adoption on consumer prices. A common empirical finding of the studies was that price increases were not a general phenomenon but were limited to some categories of goods and services only. The aggregate effect was modest, ranging from insignificant to 0.6 percentage points. (See Appendix 1 for the empirical findings from selected studies.) The related literature also indicates that the inflationary effect of euro adoption tends to be short-lived (Hüfner and Koske (2008)).

Several reasons have been proposed to explain why currency changeovers lead to price increases. First, and most straightforwardly, the introduction of a new currency as a medium of exchange and a unit of account is costly and firms need to raise prices to compensate for this. Costs include “menu costs”, which are caused by the replacement of price labels, and IT-related costs. As the direct costs apply for a limited period of time, it follows that they should only lead to temporary increases in prices.

There has been some controversy in the related literature as to whether the price increases associated with the euro adoption were at break-even level or were higher than was justified by the underlying cost factors. A study by Deutsche Bundesbank (2004) identifies some service sectors in Germany where prices increased by more, but on the other hand, Hobijn et al. (2004) present evidence showing that the price increases tended to match closely those predicted by a model of menu costs.

A currency changeover can also raise the inflation rate because of pricing policies. One strategy which may induce a rise in the price level is “psychological pricing”, where retailers and service sector companies try to set prices that end in eight or nine. Firms also tend to round their prices and a currency changeover can lead to a change in the price level due to the rounding effect. This effect should be symmetrical as firms should round the prices up and down in equal measure. However, given that price levels increase gradually most of the time (deflationary periods tend to be very rare) and given the menu costs, rationally behaving firms that want to minimise costs in the long term should opt to round their prices up, rather than down, within reasonable

limits. The empirical evidence supports this argument; an example is a study by Folkertsma et al. (2002), which indicates that firms are more likely to round prices up than down and this leads to some inflationary pressure around the time of the changeover.

An often-cited explanation for the acceleration in the inflation rate induced by the currency changeover is the phenomenon that is labelled either “rational inattention” (Ehrmann (2006)) or “changeover confusion” (Eife (2006)). It is based on the notion that a currency changeover creates information processing costs for consumers, who may find the calculation of exact prices in the old currency on the basis of prices denominated in the new currency to be time-consuming and not always worth the effort. Therefore they tend to rely on rules of thumb rather than exact calculations when processing information about prices and they tend to be less aware of the exact costs of goods and services in the old currency denomination than firms are. This confusion, or inexactitude, of consumers may induce firms to increase prices. As Eife (2006) notes, this explanation does not require households actually to rely on rules of thumb rather than exact calculations. All that is needed is that firms believe consumers to behave in this manner and act according to this belief.

Ehrmann (2006) indirectly tested the hypothesis that price increases were induced by rational inattention from consumers by comparing price developments across the countries that changed over to the euro cash in January 2002. He found that inflation after the changeover was lower in countries where the conversion rates made it possible to convert the euro prices easily and accurately into the old currency. Price increases also tended to be relatively lower in countries where the conversion rates were complex, so that rules of thumb could not be used. The inflationary impact of the euro changeover tended to be higher in countries with medium-complex conversion rates where consumers relied on imprecise rules of price recalculation.

The literature related to this topic mostly focuses on the various reasons for inflation acceleration, as it is mostly believed that firms will try to take advantage of a currency changeover and raise prices. However, there has also been discussion of an elevated public concern about changeover-related inflation in relation to the euro adoption, which may have had an opposite effect and have induced firms to avoid price increases around the time of the new currency adoption. This is more possible in an environment where authorities have launched information campaigns with the aim of taming inflation and where firms’ pricing policies are the subject of heightened media attention.

When companies are concerned about possible negative publicity they may avoid price increases which would otherwise have been scheduled or they may even reduce prices. It is possible that this type of changeover

awareness exerts downward pressure on prices (Eife (2006)). Large firms should be more concerned about the possible negative publicity, since they are more likely to be caught and scrutinised. There is evidence that in some cases large companies with extended sales networks have indeed set lower prices in the new currency. Examples include fast food restaurants such as McDonalds (Setälä (2003), Eife (2006)). Price increases around the time of the euro changeover were negatively related with retailers' size in Estonia (Meriküll and Rõõm (2014)).

There is also some discussion in the related literature as to which aspects of public information campaigns have proved useful in reducing the inflationary impact of the euro changeover. One efficient measure has been the requirement to display prices in both the new and old currency for some time before and after the changeover event. The analysis by Ehrmann (2006) indicates that countries which made dual pricing mandatory experienced relatively lower inflation around the time of the euro adoption.

#### **4. Actual versus perceived inflation**

According to studies in this area, the changeover to the euro had a modest or insignificant effect on inflation in all the countries that adopted the euro (e.g. Hüfner and Koske (2008), Ehrmann (2006)). However, most EU citizens believed that the euro adoption led to substantial price increases. The difference between actual and perceived inflation rates in the countries that changed over to euro cash in 2002 is described by Dziuda and Mastrobuoni (2009). They show that the gap between these two variables increased during the year after the changeover in all of the 11 countries adopting the new currency (their analysis does not cover Luxembourg). The following analysis evaluates whether similar developments also took place in Estonia.

Figure 1 depicts HICP dynamics in Estonia, Latvia and Lithuania. The inflation rate was 2–3 pp higher in Estonia during the second half of 2010 and the first half of 2011 than in Latvia and Lithuania. This difference could be caused by the adoption of the euro but could also be the result of other factors. In particular, the cyclical turn from negative to positive GDP growth occurred about half a year earlier in Estonia than in the other Baltic States and this may have affected the inflation rate. The results of the regression estimates that include controls for cyclical dynamics are presented in Section 6.

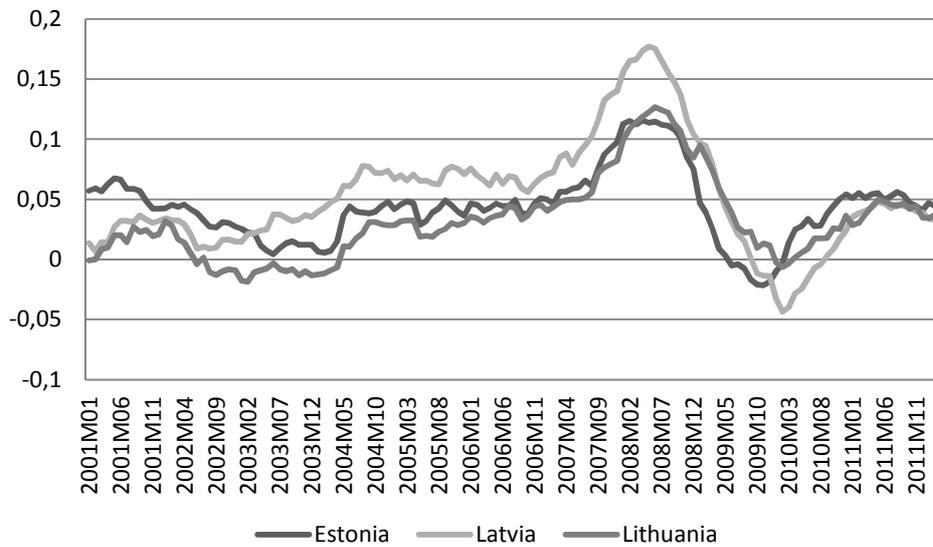


Figure 1: Change in HICP (yoy) in Estonia, Latvia and Lithuania

Source: Eurostat.

We use the data from the Consumer Confidence Survey provided by DG ECFIN to show the developments of perceived inflation. The dataset contains a balance of answers to the question: “How do you think that consumer prices have developed over the last 12 months?”<sup>5</sup> The value of this indicator for Estonia is used as a measure of perceived inflation. In Figure 2 we present measures of perceived and actual HICP-based inflation rates that have been standardised (rescaled to remain between 0 and 1). Starting from the last months of 2010 the public’s judgement of perceived inflation significantly exceeds the actual inflation rate. The opening of the gap between these two variables after the euro adoption is similar to the experience of other countries that changed over to the euro earlier. The difference between actual and perceived inflation is puzzling, especially given that Estonia launched an information campaign and took several measures to diminish the inflationary impact of the euro changeover.

<sup>5</sup> The following answer options are provided: Prices have a) risen a lot (PP); b) risen moderately (P); c) risen slightly; d) stayed about the same (M); or e) fallen (MM). The balance of answers =  $PP + P/2 - M/2 - MM$ .

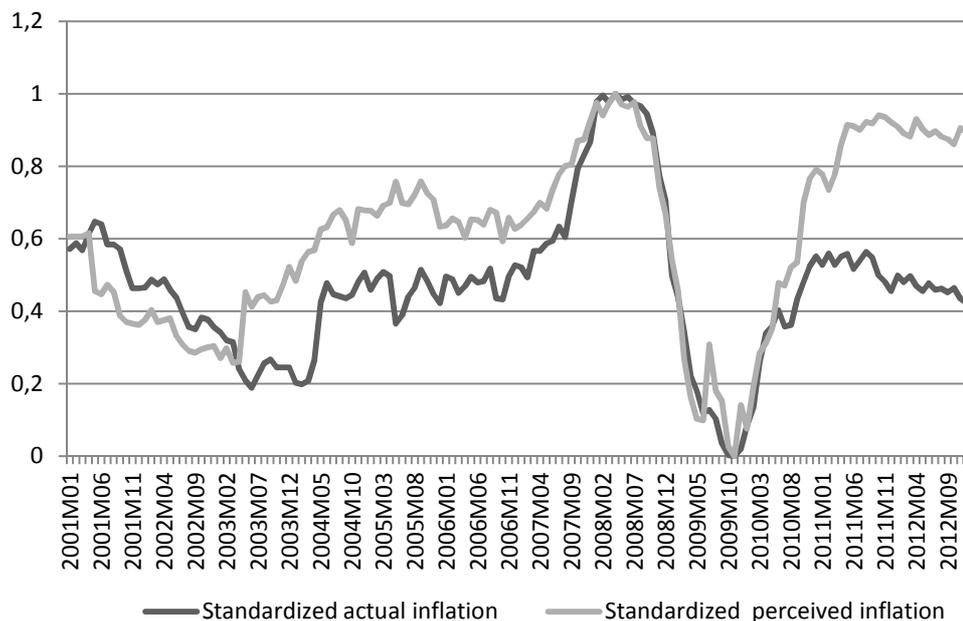


Figure 2: Actual HICP growth and inflation perceived by consumers in Estonia (standardised)

Sources: Eurostat, DG ECFIN, authors' calculations.

Dziuda and Mastrobuoni (2009) propose a possible reason for the difference in perceived and actual inflation after the euro cash changeover in January 2002. They claim that a higher level of perceived inflation than actual inflation is explainable by the regularity that people base their perception of inflation mostly on cheap, frequently purchased goods. Although the overall effect on inflation of the euro changeover was modest, price increases were more substantial for goods with low prices. This, in combination with changeover confusion, was the likely reason for a high level of perceived inflation.

Meriküll and Rõõm (2014) analysed the relationship between the relative prices of goods (compared to those of goods in other countries) and the inflationary impact of the euro changeover in Estonia. They found that the prices of relatively cheaper goods increased by more in connection with the euro adoption. The high level of perceived inflation in Estonia may also be partly explainable by cheaper goods getting more attention from consumers.

People tend to pay more attention to food prices, since these goods need to be purchased more frequently. Food prices increased somewhat more than the prices of other goods and services did (see Section 6). However, the inflationary impact of the euro adoption on food prices was still modest in comparison to the perceived increase in prices.

## 5. Data and the estimation methodology

We employ the time series of Harmonised Indices of Consumer Prices (HICP) across two and three-digit COICOP categories together with aggregate indices from Eurostat. Eurostat's consumer price data have monthly frequency, but since the other macro-level variables that we use – GDP growth and the unemployment rate – are given with quarterly frequency, we convert the data to quarterly inflation rates. We use the data for 27 EU member states (excluding Croatia, which was not a member in 2010–2011) covering the time period from I quarter 2000 to III quarter 2013.

The effect of euro adoption cannot be detected by a simple comparison of the dynamics of prices in Estonia around the time the euro was adopted with other time periods since price increases might have been triggered by other concurrent factors besides the currency changeover that are difficult to identify. Estonia came out of an exceptionally strong recession related to the financial crisis approximately three quarters prior to the euro adoption, and this cyclical turnaround coincided with a rise in the inflation rate. The lack of comparable data from previous cycles makes it difficult to disentangle the cyclical impact on the inflation rate from the effects of the euro changeover. This means that comparisons of differences across the time dimension will most likely not yield accurate estimates. To identify the effect of the euro adoption on inflation we employ the difference-in-differences method, where the treatment group is Estonia and the control group consists of other European Union member states. Under this method the difference in Estonian inflation rates between the treatment period (the time period spanning some months before and after the euro adoption) and other time periods is compared with analogous differences for other European Union member states. The identification in the difference-in-differences method relies on the assumption that, absent the euro adoption, the inflation rates in Estonia and in other EU member states should have followed parallel paths in time. The model specification that we use allows for different cyclical dynamics across countries since we include GDP growth and the unemployment rate as explanatory variables. Thus, the assumption of parallel movement should be valid in the longer run.

The effect of the euro changeover will not be correctly identified if other events occurred around January 2011 which also affected prices. For example, changes in VAT or excise taxes at the time of the euro adoption would directly affect the prices of goods and services. The excise tax for tobacco was increased in Estonia in January 2011 by approximately 8%. To eliminate the influence of this excise tax hike we look at the inflation dynamics for the overall index excluding alcohol and tobacco (see the analysis in Section 6). VAT rates remained constant in 2010 and 2011 in Estonia, but some countries in the control group experienced VAT increases. The standard VAT rates were increased on 01.01.2011 in Portugal, Latvia, Slovakia, Malta, Poland and the United Kingdom. Excise taxes for alcohol, tobacco, various fuels, or energy were also increased in several countries at the beginning of 2011.

The increases in the VAT rates in some countries in the control group mean that the estimated inflationary effect of the euro changeover for Estonia is downward biased. To account for the possible influence of the tax changes we perform consistency checks by excluding the countries which increased the VAT rates from the control group and estimating the inflationary impact of the euro changeover for price indices that do not include the goods which are subject to excise taxes: alcohol, tobacco, fuel and energy.

The cyclical dynamics of the economy around the time of the euro adoption differed in Estonia from those in most of the control group countries. First, the economy started recovering earlier. Second, the recession was steeper in 2008–2009 and the subsequent growth was stronger in 2010–2011. To control for these cyclical differences we include GDP growth and the unemployment rate in the estimated regression equation. Changes in demand affect the inflation rate with a time lag since prices are rigid. Therefore we include lagged GDP growth rates in the estimated equation. The lag structure for GDP growth and the unemployment rate is determined on the basis of the significance of estimated coefficients for lagged variables. The estimated equation also includes the lagged dependent variable to capture autocorrelation caused by inflation inertia.

We estimate the following equation:

$$\pi_{it} = \alpha_0 + \alpha_1 \pi_{it-1} + \beta_1 \Delta GDP_{it-2} + \beta_2 \Delta GDP_{it-3} + \beta_3 U_{it-1} + \beta_4 R_t + Q_t + C_i + \beta_5 T_t + \delta(E_i * T_t) + \varepsilon_{it} \quad (1)$$

In this equation  $i$  is a subindex for countries and  $t$  for time periods.  $\pi_{it}$  denotes the inflation rate;  $\Delta GDP_{it}$  is the growth rate of gross domestic product;  $U_{it}$  is the unemployment rate;  $R_t$  is the time trend;  $Q_t$  denotes quarter fixed effects and  $C_i$  country fixed effects.  $T_t$  is the dummy for the treatment

period and  $E_i$  for Estonia. The parameter of interest, the difference-in-differences estimator, is  $\delta$ . Equation (1) is estimated on various aggregate HICP series and on the price indices of two-digit and three-digit COICOP groups.

The precise length of the treatment period, i.e. the time period during which the euro changeover may have an inflationary impact, cannot be determined. Previous research on this topic has indicated that the upward pressure on prices tends to be short-lived and most of the studies focused on a period spanning a few months before and after the event (Hüfner and Koske (2008)). We consider four different treatment periods which are used in the estimations: 1) III quarter 2010–II quarter 2011; 2) II quarter 2010–III quarter 2011; 3) I–II quarter 2011; and 4) III–IV quarter 2010.

First, we focus on the period spanning six months before and six months after the euro adoption, since this was the period when dual pricing was mandatory. If the inflationary pressure was triggered by menu costs then it can be assumed that some firms would already have attempted to raise prices in July 2010 since they had to change their price labels at that time. There is anecdotal evidence that some restaurants had already increased their kroon prices before the euro adoption so that they would match the rounded euro sums.

Second, we consider a longer treatment period which covers nine months before and nine months after the euro adoption. By spring 2010 it was common knowledge that Estonia would be permitted to adopt the euro. An important milestone was passed on 12 May 2010 when the European Commission and the European Central Bank published a favourable Convergence Report. Since price setting decisions depend on expectations, it is possible that some firms started adapting prices in the second quarter of 2010. They might have done so to avoid public scrutiny on price changes later in the year. This longer time period should also capture inflationary pressure caused by the end of the dual pricing period in July 2011.

The third and fourth treatment periods are chosen in order to assess whether the inflationary pressure of euro adoption was more pronounced before or after January 2011 when the changeover to the euro took place.

The estimation specification (1) is valid when the inflation series are panel stationary. We assess the stationarity by performing panel unit root tests. To further validate the results we estimate placebo effects by assessing whether the difference-in-difference estimator was significantly different from zero for other pseudo-treatment time periods besides January 2011. The results of these validity exercises are presented in the next Section.

## 6. Changeover-related effects: Empirical estimations

We estimate the regression equation (1) separately for four different treatment periods and for each of the two and three-digit COICOP categories.<sup>6</sup> In addition, regressions are estimated on various aggregate price indices, such as all-items HICP, overall index excluding energy, overall index excluding alcohol and tobacco, and all-items index of consumer prices excluding administered prices. Selected estimation results are presented in Tables 1 and 2 and an overview of the estimations for the full set of regressions is given in Appendix 2.

The difference-in-differences estimates presented in Table 1 imply that the inflationary effect of the euro adoption in Estonia was modest. The first row of Table 1 shows the estimated effects for aggregate consumer prices (all-items HICP). Aggregate inflation in the time period covering III quarter 2010–II quarter 2011 was not significantly different from that in the other EU countries, relative to other time periods. The estimated effect for a longer time period spanning nine months either side of the euro adoption is significant and implies that the aggregate inflation rate was 0.35 percentage points higher in Estonia than in the control group. The acceleration of inflation mostly occurred in the second half of 2010, i.e. the six months prior to the euro adoption. At that time the inflation difference with other time periods was 0.55 percentage points higher in Estonia than in the control group whereas this difference was insignificant during the first six months of 2011.

We estimated separately the difference-in-differences effects for the overall index of goods and for the overall index of services. Almost none of the estimated effects turned out to be significant. The only exception is the estimated effect for the goods' index for III–IV quarter 2010. During that time period the difference of consumer goods' inflation vis-à-vis other time periods and the control group countries was higher in Estonia by 0.68 pp.

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<sup>6</sup> COICOP is an abbreviation of Classification of Individual Consumption according to Purpose.

Table 1: Inflationary impact of the euro adoption: Difference-in-differences estimates

| Treatment period   | Q3 2010 – Q2 2011 |         | Q2 2010 – Q3 2011 |         | Q1 – Q2 2011 |         | Q3 – Q4 2010 |         |
|--|-------------------|---------|-------------------|---------|--------------|---------|--------------|---------|
| All-items HICP   | 0.214             | (0.199) | 0.351**           | (0.179) | -0.169       | (0.177) | 0.554***     | (0.171) |
| Goods (overall index excluding services)   | 0.180             | (0.316) | 0.367             | (0.262) | -0.376       | (0.421) | 0.681***     | (0.224) |
| Services (overall index excluding goods)   | 0.220             | (0.479) | 0.332             | (0.364) | 0.330        | (0.553) | 0.092        | (0.749) |
| Energy   | -2.406***         | (0.927) | -1.353            | (0.839) | -3.277***    | (1.049) | -1.202       | (1.388) |
| Overall index excluding energy   | 0.658***          | (0.228) | 0.644***          | (0.198) | 0.314*       | (0.184) | 0.905***     | (0.276) |
| Overall index excluding liquid fuels and lubricants for personal transport equipment | 0.387             | (0.265) | 0.509**           | (0.217) | -0.009       | (0.254) | 0.724**      | (0.307) |
| Overall index excluding alcohol and tobacco  | 0.107             | (0.201) | 0.294             | (0.188) | -0.266       | (0.209) | 0.443**      | (0.176) |
| All-items excluding administered prices  | 0.450**           | (0.218) | 0.473**           | (0.209) | 0.096        | (0.269) | 0.716***     | (0.177) |

Notes: Estimates of the treatment effect; robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 2: Inflationary impact of the euro adoption: Difference-in-differences estimates for COICOP 2-digit categories

| Treatment period  | Q3 2010 – Q2 2011 |         | Q2 2010 – Q3 2011 |         | Q1 – Q2 2011 |         | Q3 – Q4 2010 |         |
|---|-------------------|---------|-------------------|---------|--------------|---------|--------------|---------|
| Food and non-alcoholic beverages                                      | 1.147**           | (0.537) | 1.102*            | (0.634) | 0.410        | (0.423) | 1.786***     | (0.672) |
| Alcoholic beverages, tobacco and narcotics                            | 1.472**           | (0.642) | 0.981*            | (0.544) | 0.921        | (0.928) | 1.951***     | (0.387) |
| Clothing and footwear   | -0.446            | (0.659) | -0.505            | (0.502) | -0.913       | (1.160) | 0.000        | (0.430) |
| Housing, water, electricity, gas and other fuels                      | -1.142*           | (0.602) | -0.297            | (0.641) | -1.661*      | (0.924) | -0.415       | (0.443) |
| Furnishings, household equipment and routine maintenance of the house | -0.069            | (0.196) | -0.005            | (0.287) | -0.218       | (0.282) | 0.067        | (0.200) |
| Health  | -0.962***         | (0.347) | -0.802**          | (0.331) | -1.156***    | (0.390) | -0.640*      | (0.345) |
| Transport   | -0.587            | (1.073) | -0.299            | (0.802) | -0.824       | (1.515) | -0.269       | (1.460) |
| Communications  | -0.345            | (1.571) | -0.388            | (1.170) | -1.142       | (0.858) | 0.506        | (2.862) |
| Recreation and culture  | 0.332             | (0.389) | 0.480             | (0.327) | -0.037       | (0.550) | 0.662**      | (0.320) |
| Education   | 0.052             | (0.468) | 0.107             | (0.359) | 0.067        | (0.347) | 0.023        | (0.710) |
| Restaurants and hotels  | 0.744             | (1.156) | 0.947             | (0.851) | 2.125        | (1.363) | -0.761       | (1.126) |
| Miscellaneous goods and services                                      | 0.082             | (0.290) | 0.157             | (0.235) | -0.011       | (0.495) | 0.188        | (0.175) |

Notes: Estimates of the treatment effect; robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

In 2010 and 2011 the consumer price of electricity was still regulated in Estonia. (Electricity pricing based on the market prices for private consumers was established from January 2013.) In January 2011 the cost of electricity for households declined by 2% because the renewable energy charge was reduced by approximately 25%. This decline is reflected in the difference-in-differences estimator, which shows that the energy price for consumers fell by 2.4% in III quarter 2010–II quarter 2011 in Estonia relative to the other EU countries and time periods (see Table 1). Since the share of energy costs in the consumer basket is relatively large in Estonia at about 9% of the basket, this decline had a significant impact on the change in the overall HICP index. The difference-in-differences effects for the overall price index excluding energy are significantly positive for all the treatment periods that we consider, ranging from 0.3 pp to 0.9 pp.

The excise tax on tobacco was increased in Estonia by approximately 8% in January 2011. To exclude the impact of the excise tax increase we estimated the difference-in-differences effect for the overall index of goods and services excluding alcohol and tobacco. The estimated results presented in Table 1 show that when these categories of goods were excluded the inflation rate for the rest of the basket was not significantly different from that in the control group countries, except for the treatment period spanning the second and third quarters of 2010. This indicates that the euro changeover mostly had an inflationary impact during the last six months of 2010, and this impact was short-lived.

The last row of Table 1 presents difference-in-differences estimates for the all-items inflation rate excluding administered prices. The administered prices in Estonia include water supply, sewage collection, electricity, gas, heat energy, combined passenger transport, and postal services. Since administered prices declined for electricity and gas, their exclusion from the consumer basket results in somewhat stronger difference-in-differences effects. The estimated effects are still small in magnitude, remaining in the range of insignificant to 0.7 pp.

To conclude, the difference-in-differences estimates presented in Table 1 imply that the overall effect of the euro adoption in Estonia was modest or even non-existent. The inflationary impact of this event on market prices was dampened by a decline in some administered prices. The upward pressure on prices was more evident during the half-year prior to the euro adoption.

Table 2 gives an overview of difference-in-differences estimates for two-digit COICOP categories. The estimated effects are mainly significantly positive for food and non-alcoholic beverages. The inflation rate for this consumer goods category was 1.14 percentage points higher in Estonia in III quarter 2010–II quarter 2011 than in other EU countries and other time peri-

ods. The estimated effect was stronger at 1.79 pp for the time period spanning the six months prior to the euro adoption, whereas it was insignificant during the six months following this event.

The price index of alcoholic beverages, tobacco and narcotics also grew significantly faster in Estonia vis-à-vis other countries and time periods. This inflationary effect was mostly caused by an increase in the excise tax for tobacco, but the inflation rate for alcoholic beverages and beer was also significantly higher than the rate in the control group in the second half of 2010. (See Appendix 2 for the estimated effects of three-digit COICOP categories.)

The estimated effect is negative for housing, water, electricity, gas and other fuels. This reflects the decline in electricity and gas prices in January 2011, when the electricity price declined by 2% and the gas price by 8%. Coefficients are significantly negative for health-related costs for all the treatment periods that we consider. For other COICOP categories the estimated effects are mostly insignificant. The only exception is recreation and culture, for which the difference-in-differences estimator is significantly positive for the second half of 2010, indicating that the inflation rate for this group of services was 0.66 pp higher.

Previous studies have yielded the result that the inflationary impact of the euro changeover was mostly only significant in some service sector areas. A study by Hübner and Koske (2008) that covered all the countries which switched over to euro cash in January 2002 found significant changeover-related effects for cleaning, repair and hire of clothing, hairdressing, newspapers and periodicals, recreational and sporting services, domestic and household services, and restaurants, cafes and the like. Changeover-related price hikes were identified for these categories in at least half of the countries.

Almost all of the estimated effects for the COICOP categories outlined by Hübner and Koske (2008) were insignificant in Estonia (see Appendix 2). Significantly positive results were obtained for some subcategories of food and non-alcoholic beverages, including fish and seafood, non-alcoholic beverages, and coffee, tea and cocoa. Positive significant effects were found for clothing materials, rentals for housing, purchase of vehicles, motor cars, telephone and telefax services, recreational and cultural services, package holidays and other insurance. For most of the 3-digit COICOP categories we obtained insignificant results and in several cases the estimated effects were negative (see Appendix 2).

The difference-in-differences estimation method that is used in the current paper is valid when the time series are stationary. To assess whether this is the case we use the panel unit root test developed by Levin, Lin and Chu (2002). The null hypothesis of this test is that the series contain a unit root

and the alternative is that the series are stationary. We use this test since it is valid under the assumption that the ratio of panels to time periods approaches zero asymptotically. Since the time dimension is longer in our panel than the cross-sectional dimension, this is an appropriate test to use. We apply the test separately for each of the inflation rate series that are used in the regressions. The test results in almost all cases strongly reject the null hypothesis of a unit root. We conclude from the tests that the series are stationary and that regression equation (1) can be applied.

As a robustness check, we estimate regressions on a reduced sample, where countries that increased their VAT rates in January 2011 are left out. These countries were Latvia, Portugal, Slovakia, Malta, Poland and the UK. The estimation results are presented in Appendix 3. The difference-in-differences effects that are estimated on the reduced sample tend to be somewhat larger in magnitude, but the differences with the previous results are small, remaining mostly in the range of 0.1–0.3 percentage points. Importantly, all the conclusions that were drawn from the results presented in Tables 1 and 2 still remain valid when the reduced sample is used for the estimations.

The final validity check that we perform is the estimation of the so-called placebo effects. We test whether the difference-in-differences estimates for time periods other than the treatment periods used in the estimations described above turn out to be significant. Our estimated model is valid when this is not the case. The placebo effects are presented in Appendix 4. Almost all the estimated effects for the aggregate HICP indices (all-items HICP; the overall index for goods, the overall index for services, etc) are insignificant. We also get mostly insignificant estimates for COICOP two-digit categories. It can be concluded from this exercise that the estimated treatment effects presented in Tables 1 and 2 reflect the inflationary impact of the euro changeover in Estonia.

## **7. Conclusion**

Estonia changed over from the kroon to the euro in January 2011. The aim of the current paper is to analyse the inflationary effects of this event. We employ difference-in-differences analysis where Estonia is the treated group and the other EU member states form the control group. The estimated regressions include GDP growth and the unemployment rate as explanatory variables, which capture differences in cyclical dynamics. Our estimation results imply that the inflationary impact of the euro changeover was either insignificant or small in magnitude, depending on which treatment period is considered.

The difference-in-differences estimate for all-items HICP was insignificant for the time period covering III quarter 2010–II quarter 2011 (six months before and six months after the euro adoption). The estimated effect for a longer time period covering nine months before and after the changeover indicates that the inflation rate was 0.35 pp higher during that time, compared to rates in other countries and other time periods.

The acceleration of inflation mostly occurred in the second half of 2010, during the six months prior to the euro adoption. At that time the inflation difference with other time periods was 0.55 percentage points higher in Estonia than in the control group, whereas this difference was insignificant during the first six months of 2011.

The difference-in-differences estimation picks up not only the impact of the euro changeover but also the influence of other concurrent events which may have affected prices. Estonia increased its excise tax for tobacco by approximately 8% in January 2011. To eliminate the impact of this event, we carried out estimations for the overall index of goods and services excluding alcohol and tobacco. The index of administered prices decreased in Estonia in January 2011, mainly because of a decline in the cost of electricity and gas. To control for this, we estimated the difference-in-differences effects of the all-items price index excluding administered prices. The regression on the overall index excluding alcohol and tobacco would underestimate and that on the all-items index excluding administered prices would overestimate the actual effect of the euro changeover. These estimates can be taken as the upper and lower bounds of the actual inflationary impact. They imply that the effect of the euro adoption during III quarter 2010–II quarter 2011 remains in the range of 0–0.5 percentage points.

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## Appendix 1: The inflationary impact of the euro changeover in selected countries: findings from previous studies

| Study                              | Country             | Sample period   | Estimated impact on<br>consumer prices (pp) |
|------------------------------------|---------------------|-----------------|---|
| Folkertsma et al.<br>(2002)        | Netherlands         | 01/2002         | 0.2–0.4                                     |
| Santos et al. (2002)               | Portugal            | 01/2002–03/2002 | 0.24  |
| National Bank of<br>Belgium (2002) | Belgium             | 06/2001–04/2002 | 0.18  |
| Deutsche Bundes-<br>bank (2004)    | Germany             | 01/2002         | 0.3   |
| Ercolani and Dutta<br>(2006)       | Euro area members   | 12/2001–01/2002 | 0.1–0.6 <sup>7</sup>                        |
| Eurostat (2003)                    | Euro area aggregate | 12/2001–01/2002 | 0.09–0.28                                   |
| Eurostat (2007)                    | Slovenia            | 12/2001–01/2002 | 0.3   |
| IMAD (2007)                        | Slovenia            | 12/2006–02/2007 | 0.24  |
| Eurostat (2008)                    | Malta               | 12/2007–01/2008 | 0.2–0.3                                     |

Source: Hufner and Koske (2008).

<sup>7</sup> The range reverts to those countries where the impact is significantly different from zero (France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain).

## Appendix 2: Inflationary impact of euro adoption: Difference-in-differences estimates for COICOP 2-digit and 3-digit categories

| Treatment period   | Q3 2010 – Q2 2011 | Q2 2010 – Q3 2011 | Q1 – Q2 2011    | Q3 – Q4 2010   |                 |                |                 |                |
|--|-------------------|-------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
| <b><i>Food and non-alcoholic beverages</i></b>           | <b>1.147**</b>    | <b>(0.537)</b>    | <b>1.102*</b>   | <b>(0.634)</b> | <b>0.410</b>    | <b>(0.423)</b> | <b>1.786***</b> | <b>(0.672)</b> |
| Food   | 1.032*            | (0.562)           | 0.970           | (0.678)        | 0.200           | (0.383)        | 1.778***        | (0.666)        |
| Bread and cereals  | 1.133             | (2.154)           | 1.296           | (1.487)        | -2.120          | (1.831)        | 4.217*          | (2.446)        |
| Meat   | 0.808             | (0.582)           | 0.385           | (0.520)        | 0.588           | (1.075)        | 0.964***        | (0.246)        |
| Fish and seafood   | 1.360**           | (0.679)           | 1.311*          | (0.706)        | 1.784***        | (0.617)        | 0.753           | (0.528)        |
| Milk, cheese and eggs                                    | 0.295             | (1.223)           | 1.009           | (1.230)        | -1.646          | (1.166)        | 2.199           | (1.351)        |
| Oils and fats  | 2.119             | (1.669)           | 0.565           | (1.617)        | 1.698           | (2.986)        | 2.224*          | (1.303)        |
| Fruit  | 0.683             | (3.670)           | 0.264           | (2.680)        | -0.450          | (6.705)        | 1.406           | (1.289)        |
| Vegetables   | 1.557             | (1.742)           | 2.035           | (3.025)        | 3.832**         | (1.720)        | -0.560          | (1.932)        |
| Sugar, jam, honey, chocolate and confectionery           | 1.168             | (1.079)           | 0.523           | (1.146)        | 1.620**         | (0.814)        | 0.494           | (0.969)        |
| Food products n.e.c.                                     | 1.179*            | (0.642)           | 1.015**         | (0.477)        | 2.096***        | (0.363)        | 0.139           | (0.363)        |
| <b><i>Non-alcoholic beverages</i></b>                    | <b>2.601***</b>   | <b>(0.677)</b>    | <b>2.628***</b> | <b>(0.571)</b> | <b>2.872***</b> | <b>(0.958)</b> | <b>1.976***</b> | <b>(0.576)</b> |
| Coffee, tea and cocoa                                    | 4.591***          | (0.786)           | 3.785***        | (1.110)        | 4.224***        | (1.059)        | 4.131***        | (0.751)        |
| Mineral waters, soft drinks, fruit and vegetable juices  | 0.287             | (0.503)           | 1.111**         | (0.490)        | 0.825           | (0.665)        | -0.261          | (0.336)        |
| <b><i>Alcoholic beverages, tobacco and narcotics</i></b> | <b>1.472**</b>    | <b>(0.642)</b>    | <b>0.981*</b>   | <b>(0.544)</b> | <b>0.921</b>    | <b>(0.928)</b> | <b>1.951***</b> | <b>(0.387)</b> |
| Alcoholic beverages                                      | 0.598             | (0.518)           | 0.806*          | (0.423)        | -0.234          | (0.497)        | 1.380***        | (0.270)        |
| Spirits  | -0.021            | (0.500)           | 0.285           | (0.556)        | 0.253           | (0.716)        | -0.263          | (0.381)        |
| Wine   | 0.192             | (0.453)           | 0.395           | (0.405)        | -0.305          | (0.743)        | 0.592           | (0.485)        |
| Beer   | 1.856             | (1.379)           | 1.758*          | (0.951)        | -0.786*         | (0.417)        | 4.378***        | (0.402)        |
| Tobacco  | 3.793***          | (1.159)           | 1.803           | (1.374)        | 3.609*          | (1.948)        | 3.707***        | (0.741)        |
| <b><i>Clothing and footwear</i></b>                      | <b>-0.446</b>     | <b>(0.659)</b>    | <b>-0.505</b>   | <b>(0.502)</b> | <b>-0.913</b>   | <b>(1.160)</b> | <b>0.000</b>    | <b>(0.430)</b> |
| Clothing   | -0.373            | (0.526)           | -0.195          | (0.475)        | -0.718          | (0.804)        | -0.045          | (0.522)        |
| Clothing materials                                       | 1.671**           | (0.776)           | 1.885**         | (0.884)        | 2.001***        | (0.734)        | 1.053           | (0.834)        |
| Garments   | -0.399            | (0.563)           | -0.050          | (0.515)        | -0.808          | (0.786)        | -0.000          | (0.666)        |
| Other articles of clothing and clothing accessories      | -1.303            | (1.285)           | -2.745**        | (1.349)        | -1.792          | (1.942)        | -0.868          | (1.492)        |
| Cleaning, repair and hire of clothing                    | 1.146             | (1.049)           | 0.634           | (0.779)        | 0.952           | (1.781)        | 1.248           | (1.098)        |
| Footwear including repair                                | -0.501            | (1.459)           | -1.239          | (1.052)        | -1.178          | (2.463)        | 0.131           | (1.397)        |

| Treatment period   | Q3 2010 – Q2 2011 | Q2 2010 – Q3 2011 | Q1 – Q2 2011  | Q3 – Q4 2010   |                |                |               |                |
|--|-------------------|-------------------|---------------|----------------|----------------|----------------|---------------|----------------|
| <b><i>Housing, water, electricity, gas and other fuels</i></b>                             | <b>-1.142*</b>    | <b>(0.602)</b>    | <b>-0.297</b> | <b>(0.641)</b> | <b>-1.661*</b> | <b>(0.924)</b> | <b>-0.415</b> | <b>(0.443)</b> |
| Actual rentals for housing   | 3.305**           | (1.597)           | 3.946**       | (1.532)        | 1.446          | (1.953)        | 4.890***      | (1.660)        |
| Maintenance and repair of the dwelling   | 0.538             | (0.457)           | 0.469         | (0.352)        | 1.181**        | (0.555)        | -0.133        | (0.178)        |
| Materials for the maintenance and repair of the dwelling                                   | 0.563             | (0.532)           | 0.337         | (0.419)        | 1.408***       | (0.367)        | -0.326        | (0.319)        |
| Services for the maintenance and repair of the dwelling                                    | 0.103             | (0.718)           | 0.510         | (0.570)        | 0.279          | (1.333)        | -0.025        | (0.422)        |
| Water supply and miscellaneous services relating to the dwelling                           | -0.383            | (0.425)           | -0.312        | (0.410)        | -0.345         | (0.445)        | -0.293        | (0.498)        |
| Water supply   | -0.575            | (0.940)           | 0.109         | (0.819)        | -1.453*        | (0.749)        | 0.505         | (1.019)        |
| Refuse collection  | -0.699            | (0.949)           | -3.189*       | (1.708)        | -0.857         | (1.125)        | -0.387        | (0.765)        |
| Sewerage collection  | -0.841            | (0.900)           | 0.105         | (0.760)        | -1.471*        | (0.882)        | -0.041        | (0.845)        |
| Other services relating to the dwelling n.e.c.   | -0.040            | (0.359)           | -0.062        | (0.312)        | 0.555*         | (0.293)        | -0.608*       | (0.368)        |
| Electricity, gas and other fuels   | -2.712***         | (0.940)           | -1.232        | (1.063)        | -3.598**       | (1.423)        | -1.399**      | (0.663)        |
| Electricity  | -3.335**          | (1.481)           | -1.827        | (1.566)        | -4.788***      | (1.792)        | -1.467        | (1.265)        |
| Gas  | -2.571            | (3.552)           | -1.326        | (2.936)        | -7.703*        | (4.188)        | 3.038**       | (1.527)        |
| Liquid fuels   | -2.054            | (5.164)           | -3.515        | (4.155)        | -0.580         | (8.810)        | -3.081        | (3.322)        |
| Solid fuels  | 0.569             | (0.770)           | 1.791*        | (0.961)        | 0.687          | (0.749)        | 0.350         | (0.831)        |
| Heat energy  | -1.709            | (1.649)           | 0.186         | (1.723)        | -0.906         | (2.154)        | -2.057        | (1.975)        |
| <b><i>Furnishings, household equipment and routine maintenance of the house</i></b>        | <b>-0.069</b>     | <b>(0.196)</b>    | <b>-0.005</b> | <b>(0.287)</b> | <b>-0.218</b>  | <b>(0.282)</b> | <b>0.067</b>  | <b>(0.200)</b> |
| Furniture and furnishings, carpets and other floor coverings                               | 0.004             | (0.461)           | -0.385        | (0.438)        | -0.388         | (0.747)        | 0.377         | (0.232)        |
| Furniture and furnishings  | -0.017            | (0.486)           | -0.423        | (0.466)        | -0.470         | (0.760)        | 0.419*        | (0.247)        |
| Carpets and other floor coverings  | 0.200             | (0.643)           | 0.358         | (0.553)        | 0.675          | (0.588)        | -0.278        | (0.815)        |
| Household textiles   | -0.529            | (0.864)           | 0.045         | (0.902)        | 0.614          | (0.374)        | -1.709***     | (0.327)        |
| Household appliances   | 0.172             | (0.239)           | 0.261         | (0.212)        | -0.047         | (0.390)        | 0.363**       | (0.175)        |
| Major household appliances whether electric or not and small electric household appliances | 0.163             | (0.244)           | 0.251         | (0.222)        | -0.061         | (0.393)        | 0.361**       | (0.181)        |

| Treatment period  | Q3 2010 – Q2 2011 |                | Q2 2010 – Q3 2011 |                | Q1 – Q2 2011     |                | Q3 – Q4 2010   |                |
|---|-------------------|----------------|-------------------|----------------|------------------|----------------|----------------|----------------|
| Repair of household appliances                                | -0.065            | (0.523)        | -0.055            | (0.444)        | 0.343            | (0.736)        | -0.453         | (0.348)        |
| Glassware, tableware and household utensils                   | 0.523             | (0.407)        | 0.648             | (0.416)        | -0.157           | (0.500)        | 1.149***       | (0.300)        |
| Tools and equipment for house and garden                      | 0.154             | (0.506)        | 0.346             | (0.367)        | -0.806*          | (0.412)        | 1.104***       | (0.247)        |
| Goods and services for routine household maintenance          | -0.190            | (0.634)        | 0.078             | (0.520)        | 0.342            | (0.264)        | -0.702         | (1.078)        |
| Non-durable household goods                                   | -0.197            | (0.719)        | 0.013             | (0.575)        | 0.416            | (0.329)        | -0.784         | (1.237)        |
| Domestic services and household services                      | -0.224            | (0.683)        | -0.406            | (0.578)        | -0.220           | (1.200)        | -0.204         | (0.429)        |
| <b>Health</b>   | <b>-0.962***</b>  | <b>(0.347)</b> | <b>-0.802**</b>   | <b>(0.331)</b> | <b>-1.156***</b> | <b>(0.390)</b> | <b>-0.640*</b> | <b>(0.345)</b> |
| Medical products, appliances and equipment                    | -0.876**          | (0.376)        | -0.784**          | (0.348)        | -1.015**         | (0.426)        | -0.660         | (0.457)        |
| Pharmaceutical products                                       | -0.747            | (0.460)        | -0.747*           | (0.430)        | -0.966*          | (0.523)        | -0.432         | (0.496)        |
| Other medical products; therapeutic appliances and equipment  | -1.965***         | (0.538)        | -1.016            | (0.685)        | -1.842***        | (0.263)        | -1.919*        | (1.009)        |
| Out-patient services  | -1.546*           | (0.834)        | -1.324*           | (0.715)        | -2.166*          | (1.275)        | -0.722         | (0.565)        |
| Medical services; paramedical services                        | -2.679**          | (1.104)        | -2.723**          | (1.113)        | -3.038***        | (1.158)        | -1.969*        | (1.022)        |
| Dental services   | -2.084            | (1.669)        | -1.458            | (1.227)        | -3.562           | (3.072)        | -0.472         | (0.700)        |
| Hospital services   | -0.798            | (1.110)        | 0.073             | (1.346)        | -1.290           | (1.014)        | -0.187         | (1.026)        |
| <b>Transport</b>  | <b>-0.587</b>     | <b>(1.073)</b> | <b>-0.299</b>     | <b>(0.802)</b> | <b>-0.824</b>    | <b>(1.515)</b> | <b>-0.269</b>  | <b>(1.460)</b> |
| Purchase of vehicles  | 0.999***          | (0.338)        | 0.639*            | (0.378)        | 0.355            | (0.325)        | 1.511***       | (0.280)        |
| Motor cars  | 1.072***          | (0.373)        | 0.670*            | (0.398)        | 0.332            | (0.341)        | 1.676***       | (0.262)        |
| Motor cycles, bicycles and animal drawn vehicles              | -0.338            | (2.290)        | 1.193             | (2.120)        | 3.951***         | (0.709)        | -4.723***      | (1.716)        |
| Operation of personal transport equipment                     | -1.101            | (2.026)        | -0.809            | (1.484)        | -1.051           | (3.108)        | -0.980         | (2.515)        |
| Spares parts and accessories for personal transport equipment | 0.271             | (0.242)        | 0.495**           | (0.213)        | 0.439            | (0.389)        | 0.095          | (0.195)        |
| Fuels and lubricants for personal transport equipment         | -1.808            | (3.000)        | -1.493            | (2.194)        | -2.041           | (4.578)        | -1.319         | (3.792)        |
| Maintenance and repair of personal transport equipment        | -0.263            | (0.394)        | 0.034             | (0.341)        | -0.466           | (0.547)        | 0.004          | (0.255)        |
| Other services in respect of personal transport equipment     | -1.127**          | (0.537)        | -0.658            | (0.572)        | -0.458           | (0.525)        | -1.640**       | (0.688)        |

| <b>Treatment period</b>   | <b>Q3 2010 – Q2 2011</b> |                | <b>Q2 2010 – Q3 2011</b> |                | <b>Q1 – Q2 2011</b> |                | <b>Q3 – Q4 2010</b> |                |
|---|--------------------------|----------------|--------------------------|----------------|---------------------|----------------|---------------------|----------------|
| Transport services  | -1.031*                  | (0.603)        | -0.430                   | (0.740)        | -1.751**            | (0.740)        | -0.250              | (0.681)        |
| Passenger transport by railway  | 0.911                    | (1.143)        | 2.015*                   | (1.075)        | 0.600               | (1.773)        | 1.279               | (1.012)        |
| Passenger transport by road   | -0.016                   | (0.608)        | 0.339                    | (0.648)        | 0.020               | (0.751)        | 0.007               | (0.763)        |
| Passenger transport by air  | -5.966***                | (1.883)        | -5.825***                | (1.842)        | -7.493***           | (1.985)        | -4.366              | (2.657)        |
| Passenger transport by sea and inland waterway                                | -2.717                   | (2.459)        | -2.863                   | (1.885)        | -4.637*             | (2.400)        | -0.695              | (3.831)        |
| Combined passenger transport  | -0.097                   | (1.614)        | 3.174                    | (2.710)        | -0.763              | (1.725)        | 0.799               | (1.596)        |
| <b>Communications</b>   | <b>-0.345</b>            | <b>(1.571)</b> | <b>-0.388</b>            | <b>(1.170)</b> | <b>-1.142</b>       | <b>(0.858)</b> | <b>0.506</b>        | <b>(2.862)</b> |
| Postal services   | -1.157                   | (1.174)        | -1.041                   | (1.141)        | -1.677              | (1.332)        | 0.565               | (1.052)        |
| Telephone and telefax equipment and services                                  | -0.403                   | (1.577)        | -0.454                   | (1.177)        | -1.136              | (0.819)        | 0.397               | (2.903)        |
| Telephone and telefax equipment   | -0.757                   | (1.212)        | -2.127                   | (1.507)        | -0.576              | (1.579)        | .                   | .              |
| Telephone and telefax services  | 1.269***                 | (0.372)        | 0.056                    | (0.973)        | 1.310***            | (0.455)        | .                   | .              |
| <b>Recreation and culture</b>   | <b>0.332</b>             | <b>(0.389)</b> | <b>0.480</b>             | <b>(0.327)</b> | <b>-0.037</b>       | <b>(0.550)</b> | <b>0.662**</b>      | <b>(0.320)</b> |
| Audio-visual, photographic and information processing equipment               | -0.320                   | (0.549)        | -0.214                   | (0.416)        | -0.273              | (0.282)        | -0.368              | (1.005)        |
| Equipment for the reception, recording and reproduction of sound and pictures | -0.727                   | (0.785)        | -0.526                   | (0.670)        | -1.312*             | (0.783)        | -0.131              | (1.017)        |
| Photographic and cinematographic equipment and optical instruments            | -2.212*                  | (1.339)        | -2.472**                 | (1.055)        | 0.173               | (1.159)        | -4.458***           | (0.936)        |
| Information processing equipment  | 0.018                    | (0.797)        | -0.168                   | (0.736)        | 0.201               | (0.420)        | -0.101              | (1.455)        |
| Recording media   | 0.790                    | (0.700)        | 0.877*                   | (0.510)        | -0.184              | (0.833)        | 1.594***            | (0.325)        |
| Repair of audio-visual, photographic and information processing equipment     | -0.001                   | (0.451)        | 0.072                    | (0.392)        | 0.322               | (0.721)        | -0.303              | (0.304)        |
| Other recreational items and equipment, gardens and pets                      | 0.235                    | (0.546)        | 0.835                    | (0.605)        | 0.580               | (0.524)        | -0.074              | (0.865)        |
| Games, toys and hobbies   | 0.439                    | (0.537)        | 1.114**                  | (0.463)        | 0.615               | (0.438)        | 0.165               | (0.950)        |
| Equipment for sport, camping and open-air recreation                          | 0.539                    | (0.831)        | 0.387                    | (0.598)        | -0.587              | (1.240)        | 1.454**             | (0.600)        |
| Gardens, plants and flowers   | 0.127                    | (1.387)        | 0.591                    | (1.050)        | 0.608               | (2.065)        | -0.113              | (1.562)        |

| <b>Treatment period</b>  | <b>Q3 2010 – Q2 2011</b> |                | <b>Q2 2010 – Q3 2011</b> |                | <b>Q1 – Q2 2011</b> |                | <b>Q3 – Q4 2010</b> |                |
|--|--------------------------|----------------|--------------------------|----------------|---------------------|----------------|---------------------|----------------|
| Pets and related products; veterinary and other services for pets                                  | 0.290                    | (0.411)        | 1.056                    | (0.781)        | 0.690               | (0.455)        | -0.088              | (0.349)        |
| Recreational and cultural services   | 0.721*                   | (0.407)        | 0.312                    | (0.394)        | 1.223***            | (0.349)        | 0.176               | (0.333)        |
| Recreational and sporting services   | 0.610                    | (0.788)        | 0.132                    | (0.609)        | 1.318               | (1.011)        | -0.148              | (0.891)        |
| Cultural services  | 1.051*                   | (0.600)        | 0.691                    | (0.484)        | 1.489               | (0.984)        | 0.545               | (0.352)        |
| Newspapers, books and stationery   | -0.215                   | (0.557)        | -0.041                   | (0.428)        | -0.984              | (0.796)        | 0.569**             | (0.269)        |
| Books  | 0.402                    | (0.919)        | 0.745                    | (0.674)        | -1.412***           | (0.387)        | 2.132***            | (0.498)        |
| Newspapers and periodicals   | -0.441                   | (0.576)        | -0.475                   | (0.484)        | -0.597              | (0.964)        | -0.222              | (0.373)        |
| Miscellaneous printed matter; stationery and drawing materials                                     | 0.525                    | (0.686)        | 0.325                    | (0.522)        | 0.806               | (1.151)        | 0.159               | (0.636)        |
| Package holidays   | 4.401*                   | (2.411)        | 5.906**                  | (2.587)        | 0.462               | (2.506)        | 7.835***            | (2.157)        |
| <b>Restaurants and hotels</b>  | <b>0.744</b>             | <b>(1.156)</b> | <b>0.947</b>             | <b>(0.851)</b> | <b>2.125</b>        | <b>(1.363)</b> | <b>-0.761</b>       | <b>(1.126)</b> |
| Catering services  | 0.582                    | (0.474)        | 0.612*                   | (0.333)        | 1.013               | (0.675)        | 0.117               | (0.242)        |
| Restaurants, cafés and the like  | 0.676                    | (0.547)        | 0.459                    | (0.412)        | 1.393*              | (0.742)        | -0.091              | (0.272)        |
| Canteens   | 0.987                    | (0.619)        | 1.197**                  | (0.510)        | 0.501               | (0.557)        | 1.459               | (1.072)        |
| Accommodation services   | 0.823                    | (3.733)        | 1.747                    | (2.944)        | 4.111               | (5.934)        | -2.795              | (3.424)        |
| <b>Miscellaneous goods and services</b>  | <b>0.082</b>             | <b>(0.290)</b> | <b>0.157</b>             | <b>(0.235)</b> | <b>-0.011</b>       | <b>(0.495)</b> | <b>0.188</b>        | <b>(0.175)</b> |
| Personal care  | 0.013                    | (0.298)        | 0.273                    | (0.249)        | -0.002              | (0.535)        | 0.045               | (0.207)        |
| Hairdressing salons and personal grooming establishments   | 0.861                    | (0.850)        | 0.594                    | (0.616)        | 0.790               | (1.258)        | 0.869               | (1.099)        |
| Electrical appliances for personal care; other appliances, articles and products for personal care | -0.188                   | (0.372)        | 0.206                    | (0.326)        | -0.108              | (0.346)        | -0.240              | (0.637)        |
| Personal effects n.e.c.  | -0.054                   | (0.542)        | -0.279                   | (0.516)        | -0.270              | (0.718)        | 0.197               | (0.716)        |
| Jewellery, clocks and watches  | 1.679                    | (1.118)        | 1.087                    | (0.940)        | -0.058              | (0.617)        | 3.237***            | (1.180)        |
| Other personal effects   | 0.248                    | (0.442)        | 0.030                    | (0.385)        | -0.212              | (0.464)        | 0.614               | (0.576)        |
| Social protection  | -1.953*                  | (0.998)        | -2.007*                  | (1.037)        | -1.998**            | (0.908)        | -1.614*             | (0.975)        |
| Insurance  | -0.054                   | (0.611)        | -0.247                   | (0.529)        | -0.374              | (0.785)        | 0.402               | (0.619)        |
| Insurance connected with transport   | -1.313                   | (1.104)        | -1.678*                  | (0.927)        | -1.208              | (1.446)        | -1.156              | (1.365)        |
| Other insurance  | 1.021*                   | (0.545)        | 1.037**                  | (0.452)        | 0.736               | (0.697)        | 1.141*              | (0.684)        |
| Financial services n.e.c.  | 0.283                    | (0.452)        | 0.292                    | (0.415)        | 0.298               | (0.553)        | 0.258               | (0.431)        |
| Other services n.e.c.  | 0.063                    | (0.809)        | -0.184                   | (0.747)        | 0.500               | (1.144)        | -0.330              | (0.622)        |

Notes: Estimates of the treatment effect; robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

### Appendix 3: Inflationary impact of the euro change-over: Difference-in-differences estimates on a reduced sample excluding the countries that increased their VAT rates in January 2011

| Treatment period   | Q3 2010 – Q2 2011 |         | Q2 2010 – Q3 2011 |         | Q1 – Q2 2011 |         | Q3 – Q4 2010 |         |
|--|-------------------|---------|-------------------|---------|--------------|---------|--------------|---------|
| All-items HICP   | 0.366*            | (0.216) | 0.465**           | (0.186) | -0.055       | (0.174) | 0.598***     | (0.203) |
| Goods (overall index excluding services)   | 0.320             | (0.347) | 0.456             | (0.281) | -0.291       | (0.463) | 0.784***     | (0.230) |
| Services (overall index excluding goods)   | 0.356             | (0.553) | 0.486             | (0.442) | 0.627        | (0.648) | -0.061       | (0.827) |
| Energy   | -2.305**          | (1.048) | -1.367            | (0.871) | -3.239***    | (1.120) | -1.148       | (1.463) |
| Overall index excluding energy   | 0.909***          | (0.268) | 0.801***          | (0.214) | 0.442**      | (0.210) | 0.996***     | (0.342) |
| Overall index excluding liquid fuels and lubricants for personal transport equipment | 0.578*            | (0.305) | 0.648***          | (0.237) | 0.115        | (0.286) | 0.795**      | (0.372) |
| Overall index excluding alcohol and tobacco  | 0.251             | (0.216) | 0.413**           | (0.197) | -0.166       | (0.193) | 0.497**      | (0.210) |
| All-items excluding administered prices  | 0.575***          | (0.222) | 0.616***          | (0.210) | 0.209        | (0.243) | 0.797***     | (0.206) |

| Treatment period  | Q3 2010 – Q2 2011 |         | Q2 2010 – Q3 2011 |         | Q1 – Q2 2011 |         | Q3 – Q4 2010 |         |
|---|-------------------|---------|-------------------|---------|--------------|---------|--------------|---------|
| Food and non-alcoholic beverages                                      | 1.326**           | (0.571) | 1.156*            | (0.662) | 0.347        | (0.476) | 1.891***     | (0.716) |
| Alcoholic beverages, tobacco and narcotics                            | 1.661**           | (0.689) | 1.088*            | (0.565) | 1.202        | (0.949) | 2.056***     | (0.436) |
| Clothing and footwear   | -0.239            | (0.653) | -0.299            | (0.527) | -0.852       | (1.194) | 0.385        | (0.416) |
| Housing, water, electricity, gas and other fuels                      | -0.990*           | (0.579) | -0.246            | (0.622) | -1.562*      | (0.860) | -0.344       | (0.442) |
| Furnishings, household equipment and routine maintenance of the house | 0.007             | (0.208) | 0.099             | (0.291) | -0.131       | (0.306) | 0.170        | (0.194) |
| Health  | -0.792*           | (0.409) | -0.748**          | (0.358) | -1.089**     | (0.455) | -0.632*      | (0.367) |
| Transport   | -0.439            | (1.084) | -0.149            | (0.802) | -0.611       | (1.503) | -0.201       | (1.438) |
| Communications  | -0.322            | (1.613) | -0.392            | (1.190) | -1.216       | (0.889) | 0.480        | (2.899) |
| Recreation and culture  | 0.549             | (0.413) | 0.611*            | (0.352) | 0.091        | (0.592) | 0.777**      | (0.350) |
| Education   | 0.313             | (0.440) | 0.156             | (0.357) | 0.029        | (0.336) | 0.131        | (0.663) |
| Restaurants and hotels  | 0.994             | (1.312) | 1.196             | (0.973) | 2.578*       | (1.484) | -0.921       | (1.170) |
| Miscellaneous goods and services                                      | 0.141             | (0.299) | 0.234             | (0.239) | 0.063        | (0.494) | 0.272        | (0.183) |

Notes: Estimates of the treatment effect; robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

## Appendix 4: Difference-in-differences estimations of “placebo effects”

### Aggregate indeces

| Pseudo treatment period  | Q3 2001 –<br>Q2 2002 |         | Q3 2003 –<br>Q2 2004 |         | Q3 2005 –<br>Q2 2006 |         | Q3 2008 –<br>Q2 2009 |         | Q3 2009 –<br>Q2 2010 |         | Q3 2011 –<br>Q2 2012 |         |
|--|----------------------|---------|----------------------|---------|----------------------|---------|----------------------|---------|----------------------|---------|----------------------|---------|
| All-items HICP   | -0.168               | (0.355) | -0.359               | (0.304) | -0.216               | (0.350) | -0.413               | (0.738) | 0.617                | (0.427) | -0.048               | (0.267) |
| Goods (overall index<br>excluding services)  | -0.042               | (0.493) | -0.547               | (0.458) | -0.310               | (0.519) | -0.171               | (0.969) | 0.879*               | (0.483) | -0.069               | (0.417) |
| Services (overall index<br>excluding goods)  | -0.611               | (0.625) | -0.377               | (0.309) | -0.195               | (0.218) | -0.551               | (0.439) | 0.096                | (0.457) | -0.145               | (0.438) |
| Energy   | 0.752                | (1.407) | -0.157               | (1.461) | -0.893               | (1.257) | -0.493               | (2.142) | 1.947                | (1.488) | 0.233                | (1.231) |
| Overall index excluding energy   | -0.270               | (0.444) | -0.466*              | (0.255) | -0.203               | (0.239) | -0.334               | (0.616) | 0.356                | (0.354) | -0.113               | (0.286) |
| Overall index excluding liquid<br>fuels and lubricants for personal<br>transport equipment | -0.158               | (0.370) | -0.554**             | (0.258) | -0.338               | (0.247) | -0.313               | (0.773) | 0.512                | (0.379) | -0.060               | (0.288) |
| Overall index excluding alcohol<br>and tobacco   | -0.137               | (0.381) | -0.374               | (0.339) | -0.214               | (0.357) | -0.689               | (0.584) | 0.747                | (0.461) | -0.116               | (0.257) |
| All-items excluding administered<br>prices   | -0.356               | (0.414) | -0.346               | (0.341) | -0.138               | (0.375) | -0.503               | (0.723) | 0.573                | (0.389) | -0.163               | (0.260) |

Notes: Estimates of the treatment effect; robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

## COICOP 2-digit categories

| Pseudo treatment period   | Q3 2001 –<br>Q2 2002 |         | Q3 2003 –<br>Q2 2004 |         | Q3 2005 –<br>Q2 2006 |         | Q3 2008 –<br>Q2 2009 |         | Q3 2009 –<br>Q2 2010 |         | Q3 2011 –<br>Q2 2012 |         |
|---|----------------------|---------|----------------------|---------|----------------------|---------|----------------------|---------|----------------------|---------|----------------------|---------|
| Food and non-alcoholic beverages                                      | 0.153                | (0.798) | 0.053                | (0.938) | -0.500               | (0.457) | -1.318***            | (0.394) | 1.457*               | (0.764) | -0.768               | (0.695) |
| Alcoholic beverages, tobacco and narcotics                            | -0.662               | (0.636) | -0.848               | (0.728) | -0.379               | (0.494) | 1.901                | (2.683) | -0.934               | (0.654) | 0.466                | (0.538) |
| Clothing and footwear   | 0.162                | (0.542) | -1.593***            | (0.557) | 0.696                | (0.586) | 0.470                | (0.541) | 1.066*               | (0.646) | 0.315                | (0.605) |
| Housing, water, electricity, gas and other fuels                      | 0.410                | (0.941) | -0.955**             | (0.434) | -0.750               | (0.505) | -0.327               | (2.362) | 1.032                | (0.855) | 0.217                | (0.529) |
| Furnishings, household equipment and routine maintenance of the house | -0.302               | (0.239) | -0.705***            | (0.210) | 0.238                | (0.200) | 0.258                | (0.388) | 0.293                | (0.595) | 0.632***             | (0.240) |
| Health  | -0.303               | (0.345) | 0.266                | (0.716) | -0.731**             | (0.334) | -0.235               | (0.495) | -0.772**             | (0.337) | -1.199**             | (0.583) |
| Transport   | -1.204*              | (0.653) | 0.645                | (1.645) | 0.693                | (1.241) | -1.617               | (1.802) | 0.967                | (0.987) | 0.144                | (0.815) |
| Communications  | -0.159               | (1.420) | 0.754                | (0.577) | -0.645               | (0.582) | 0.079                | (0.399) | 0.923*               | (0.509) | -1.545***            | (0.492) |
| Recreation and culture  | -0.285               | (0.577) | -0.684               | (0.427) | 0.834                | (0.536) | -0.432               | (0.360) | -0.246               | (0.516) | 0.002                | (0.212) |
| Education   | -0.120               | (0.481) | -0.705               | (0.438) | -0.077               | (0.577) | 0.194                | (0.414) | -0.446               | (0.642) | 0.830                | (1.055) |
| Restaurants and hotels  | -0.353               | (0.592) | -0.837               | (0.534) | -0.994**             | (0.388) | -0.863               | (0.795) | 0.398                | (0.743) | 0.522                | (1.012) |
| Miscellaneous goods and services                                      | 0.381                | (0.650) | -0.191               | (0.291) | 0.015                | (0.239) | 0.312                | (0.636) | 0.102                | (0.512) | 0.162                | (0.313) |

Notes: Estimates of the treatment effect; robust standard errors in parentheses; \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

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