Euro Area Monetary Policy Transmission in Estonia

Gertrud Errit and Lenno Uusküla*

September 23, 2013

Abstract

This paper studies the effect of a monetary policy shock in the euro area on the main Estonian economic and financial variables between 2000 and 2012. Using a standard structural vector autoregression (SVAR) model we find strong and persistent effects on Estonian GDP, private consumption, corporate investment and imports. A monetary policy shock has also strong and sluggish effects on the housing loan and consumer credit interest rates. The estimated reaction of Estonian GDP and the GDP deflator-based inflation rate is about four times stronger than the reaction of euro area-wide aggregates. The Estonian money market interest rate (the 3-month Talibor) reacts about twice as strongly as the euro area money market interest rate (the 3-month Euribor). We also show that this finding is sensitive to the inclusion of the data from the years of the recent financial and economic crisis. We conjecture that household interest rates can play an important role in propagating monetary policy shocks in Estonia.

JEL Codes: E32, E52, C32

Keywords: monetary policy, SVAR, Estonia, euro area

---

*Authors' e-mail addresses: Gertrud Errit (gertrud.errit@eestipank.ee) and Lenno Uusküla (lenno.uuskyla@eestipank.ee). The views expressed are those of the authors and do not necessarily represent the official views of Eesti Pank. We would like to thank Rasmus Kattai, Merkike Kukk, Dmitry Kulikov, Martti Randveer, Karsten Staehr and all the participants of the seminars at the Bank of Estonia, ECEE conference in Tallinn and the Baltic Central Bank meeting in Riga for their helpful comments.

1 Introduction

Understanding the effects of monetary policy shocks across the euro area countries plays a crucial role in policy making and in communicating the policy strategy. More so because the recent financial and economic crisis might have affected the transmission of monetary policy shocks. In this paper we ask how monetary policy shocks in the euro area affect the main Estonian economic and financial variables. We give some evidence of what the main possible transmission and propagation channels are in Estonia. We also look at how the recent financial and economic crisis and possible extreme observations in the data affect the results.

The estimated structural VAR model shows that a negative monetary policy shock in the euro area of one standard deviation (an increase in the 3-month Euribor of 22 basis points (bp)) has a strong impact on the Estonian economy.

- Estonian GDP follows a hump-shaped response, reaching the lowest point of –1.8% after eight quarters and converging very slowly to the baseline. Private consumption and corporate investment also contract strongly, peaking at 2.7% and 5.2% respectively, and converging slowly.
- The GDP deflator-based inflation rate initially increases by 0.4 percentage points (pp), but then falls to –0.6pp after three quarters and converges back to the baseline after three years.
- Exports and imports shrink by 2.2% and 4.2% respectively. Employment falls after 10 quarters by 1.3% and real wages by 1.2%.
- All Estonian interest rates increase over several quarters, before converging back to the baseline. The Estonian money market interest rate (the 3-month Talibor) rises on the impact by 11bp and peaks around 34bp after a year. Housing loan and consumer credit interest rates react sluggishly, reaching the peak between three and four quarters after the initial shock. The business loan interest rate reacts little, by a maximum of 13bp. The effect of the business loan interest rate is small, especially when compared to that of the housing loan and consumer credit interest rates, which increase by 38 and 40bp respectively.
- Euro area GDP falls persistently. The GDP deflator-based inflation rate drops the quarter after the shock, and converges fast. The reaction of Estonian GDP and the GDP deflator-based inflation rate is about four times stronger than that of the euro area-wide aggregates. The Estonian money market interest rate, the 3-month Talibor, reacts about twice as strongly as the euro area money market interest rate, the 3-month Euribor.

Our evidence suggests that Estonian economic and financial data is volatile at least partly because of internal amplification. By construction the identified monetary policy shock is identical for the euro area and for Estonia but money market and the three loan type specific interest rates amplify the reaction of economic variables[1]. Not only does

[1] However, our results cannot fully exclude the possibility that the risk premium component in loan type specific interest rates reacts to the substantial and persistent drop in GDP. If this were true, then the interest rate on business loans could move similarly.

the Estonian money market interest rate increases together with the 3-month Euribor at the quarter of the shock, but it continues to increase while the euro area interest rate converges in five quarters. Moreover, housing loan and consumer credit interest rates increase by about the same magnitude as the Talibor. The reaction of the business loan interest rates is more muted than that of Estonian money market interest rate.

During the last thirteen years, Estonian data has high variance, include several extreme values and possible outliers. The residuals of the estimated equations have fat tales and are skewed. As a robustness exercise, we remove some of the variance in the data by including dummies. First, we find that after adding dummies in the Estonian equations, the impact of a monetary policy shock in the euro area on the Estonian variables is smaller. By adding dummies only to the period of the global financial and economic crisis from 2007Q3 to 2010Q2, we see the strong impact of the crisis as, for example, the reaction of GDP is half what it is in the benchmark results when the crisis years are removed from the data, with Estonian GDP dropping by only 0.8%. We also estimate models for shorter time periods to see which years cause the changes in the transmission mechanism. Using the rolling time-window approach we confirm the results from the approach using dummies. We observe a strong impact from the crisis period, especially the years 2008 and 2009.

We use a 7-dimensional structural vector-autoregressive model (SVAR) to identify monetary policy shocks in the euro area. Benchmark model includes three euro area variables (GDP, the GDP deflator-based inflation rate and the 3-month Euribor) and four Estonian variables (GDP, the GDP deflator-based inflation rate, the 3-month money market interest rate Talibor[2], and one additional economic or financial variable (private consumption, corporate investment, exports, imports, employment, real wages or various loan type interest rates on housing loans, consumer credit and non-financial corporate loans)). The data cover the period from 2000Q1 to 2012Q4 and main results are shown on the impulse response functions (IRF).

We identify monetary policy shocks in the euro area using a standard short-run restriction scheme based on a simple Taylor rule based argument. The interest rate is set by a central banker who observes contemporaneous euro area GDP and inflation. The interest rate has no contemporaneous effect on economic variables. For the Estonian block we follow a similar information and impact structure, but close down feedback from the Estonian variables to the European variables. Estonian economic aggregates are not contemporaneously affected by the euro area interest rate, through as an exception we allow Estonian interest rates to react contemporaneously to the euro area interest rate.

Although Estonia has only been a member of the euro area since 2011, the currency board arrangement from 1992 to 2010 with the initial peg to the Deutsche Mark and later peg to the euro made the Estonian economy sensitive to the monetary policy shocks in the euro area and reduced local monetary disturbances. Therefore, we think that analysing the effects of monetary policy shocks using historical data is a relevant and valid exercise.

Our identification scheme is comparable to that of many SVAR papers, and for ex-

[2]The Bank of Estonia stopped collecting Estonian money market interest rate data from January 2011 as Estonia joined the euro area. We use Talibor until 2010Q4 and the 3-month Euribor thereafter.

ample Angeloni et al. (2002), Jacobs et al. (2003) and Giannone et al. (2012) estimate similar models for the euro area, while Christiano et al. (1999) and Christiano et al. (2005) do likewise for the USA. Peersman and Smets (2001) and Mojon and Peersman (2001) document the effects of a monetary policy shock in the euro area on individual countries using pre-euro data and find considerable heterogeneity across countries. Instead Elbourne and Haan (2005) estimate the effect of a monetary policy shock in the euro area on 10 accession countries, including Estonia.

Our benchmark results for Estonia are closest to the findings of Jeenas (2010) who uses a similar set-up, but for a different data period. He also finds that Estonian GDP and inflation react more strongly than the same variables for the euro area. The effects of the monetary policy shock in the euro area on Estonian and euro area inflation in his paper are close to our results. He also finds some evidence of the price puzzle in Estonian inflation. Lättemäe (2003) also finds that all Estonian interest rates increase after the shock for several quarters, before converging back to the baseline. At the same time the euro area money market interest rate starts converging immediately after the initial move. The results for housing loan and consumer credit interest rates are different from the evidence found by Giannone et al. (2012) who show that different loan type interest rates react substantially less than the money market interest rate.

The paper is organized as follows. Section 2 introduces the model. Section 3 presents the data and stylized facts. Section 4 presents the main results for the Estonian variables. Section 5 contains a discussion of the possible effects of extreme observations in the Estonian data and robustness analysis. Section 6 concludes the paper.

2 The Model

The effect of a monetary policy shock in the euro area is estimated using a structural VAR model. The reduced form VAR is given by:

$$x_t = \mathscr{B} x_{t-1} + u_t, \tag{1}$$

where x_t is a vector of variables used, subscript t refers to the time index, $\mathscr{B}$ is the reduced form parameters and u_t is a vector of reduced form errors.

We study quarterly data for Estonia and the euro area. For the main results we use the following 7-dimensional data vector:

$$x_t = [\Delta GDP_t{}^{EE} \ \ \Delta PC_t^{EE} \ \ \Delta GDPdef_t^{EE} \ \ I_t^{EE} \ \ \Delta GDP_t^{EA} \ \ \Delta GDPdef_t^{EA} \ \ I_t^{EA}], \tag{2}$$

where ΔGDP_t denotes the first difference of the logarithm of *per capita* real gross domestic product, ΔPC_t denotes the first difference of the logarithm of *per capita* real private consumption, and $\Delta GDPdef_t$ is the annualized quarter-on-quarter GDP deflator-based inflation rate. I_t is the 3-month money market interest rate. Superscripts EE and EA denote the Estonian and euro area variables respectively.

In order to identify a monetary policy shock we use a standard short-run restriction scheme based on the Taylor rule. The structural form VAR is given by:

$$\mathcal{A} x_t = \mathcal{B} x_{t-1} + \varepsilon_t, \tag{3}$$

where $\varepsilon_t = \mathcal{A}u_t$ is the vector of structural innovations, and $\mathcal{B} = \mathcal{A}\mathscr{B}$.

More specifically we assume the contemporaneous effects matrix $\mathcal{A}$ and the parameter matrix on the lagged values $\mathcal{B}$ have the following restrictions:

$$\mathcal{A} = \begin{Bmatrix} \alpha^{EE\to EE} & \alpha^{EA\to EE} \\ \alpha^{EE\to EA} = 0 & \alpha^{EA\to EA} \end{Bmatrix}. \tag{4}$$

$$\mathcal{B} = \begin{Bmatrix} \beta^{EE\to EE} & \beta^{EA\to EE} \\ \beta^{EE\to EA} = 0 & \beta^{EA\to EA} \end{Bmatrix}. \tag{5}$$

We do not allow any feedback from Estonian variables to the euro area economic and financial variables, so the bottom left corners of the $\mathcal{A}$ and $\mathcal{B}$ matrices are restricted to zero. The other parameters in matrix $\mathcal{B}$ are left unrestricted. In order to identify the shock we allow contemporaneous GDP and the GDP deflator-based inflation rate to have an effect on the euro area interest rate, but not vice versa ($\alpha^{EA\to EA}$ is lower triangular). Again we do not allow any effect from Estonian variables on the euro area variables ($\alpha^{EE\to EA} = 0$). The block on the effects of the euro area variables on Estonian variables is:

$$\alpha^{EA\to EE} = \begin{Bmatrix} \alpha_{11}^{EA\to EE} & \alpha_{12}^{EA\to EE} & 0 \\ \alpha_{21}^{EA\to EE} & \alpha_{22}^{EA\to EE} & 0 \\ \alpha_{31}^{EA\to EE} & \alpha_{32}^{EA\to EE} & 0 \\ \alpha_{41}^{EA\to EE} & \alpha_{42}^{EA\to EE} & \alpha_{43}^{EA\to EE} \end{Bmatrix}. \tag{6}$$

We allow the Estonian money market interest rate to react contemporaneously to the changes in the euro area money market interest rate, but do not allow Estonian economic aggregates and the GDP deflator-based inflation rate to react contemporaneously to Estonian and euro area interest rates (the first three entries in the last column of the matrix are restricted to zero). If we include Estonian different loan interest rates (housing loans, consumer credit or business loans) in the equation, then we should allow the euro area interest rate to have contemporaneous effects on the different Estonian loan interest rates as follows:

$$\alpha^{EA\to EE} = \begin{Bmatrix} \alpha_{11}^{EA\to EE} & \alpha_{12}^{EA\to EE} & 0 \\ \alpha_{21}^{EA\to EE} & \alpha_{22}^{EA\to EE} & \alpha_{23}^{EA\to EE} \\ \alpha_{31}^{EA\to EE} & \alpha_{32}^{EA\to EE} & 0 \\ \alpha_{41}^{EA\to EE} & \alpha_{42}^{EA\to EE} & \alpha_{43}^{EA\to EE} \end{Bmatrix}. \tag{7}$$

Finally the contemporaneous restrictions between Estonian variables are recursive, but the restrictions have no effects on the results:

$$\alpha^{EE\to EE} = \begin{Bmatrix} 1 & 0 & 0 & 0 \\ \alpha_{21}^{EE\to EE} & 1 & 0 & 0 \\ \alpha_{31}^{EE\to EE} & \alpha_{32}^{EE\to EE} & 1 & 0 \\ \alpha_{41}^{EE\to EE} & \alpha_{42}^{EE\to EE} & \alpha_{43}^{EE\to EE} & 1 \end{Bmatrix}. \tag{8}$$

As the length of the data sample is limited, we cannot include all the Estonian variables of interest in the SVAR simultaneously, because the degrees of freedom drops rapidly. We include the additional variables in the SVAR one by one, replacing the private consumption series. We always keep the interest rate, GDP and the GDP deflator-based inflation rate in the SVAR in order to reduce omitted variable bias. Given the exogeneity restriction of Estonian data to the euro area data, the identified shock remains the same even when the composition of the SVAR changes: the reaction of the euro area variables is identical, but the effect of the Estonian variables can differ.

Our identification approach is also similar to that employed in various papers using US or euro area data, e.g. Bernanke and Gertler (1995), Soares (2011), Christiano et al. (1996) and Giannone et al. (2012). In the analysis of Estonian data, our approach is similar to the analysis done for the monetary transmission network of the ECB by Peersman and Smets (2001) and Angeloni et al. (2002). More recently Jeenas (2010) used a similar scheme for identifying the effects of monetary policy shocks in the euro area on the Estonian economy. Figure 14 in Appendix 1 reviews the estimated effects of monetary policy shocks in the euro area on the Estonian money market interest rate, GDP and the inflation rate, while Figure 15 in Appendix 1 shows the estimated effects of monetary policy shocks in the euro area. For a more detailed review of the literature about the empirical method, data and results see Tables 5, 6 and 7 in Appendix 1.

3 Data

For the main results we use data for the period from 2000Q1 to 2012Q4. The length of the time series is firmly restricted by the availability of good quality data for the Estonian economy. The data consists of the main Estonian and euro area economic variables and we use the population aged 15 to 64 for *per capita* adjustment. A list of the euro area and Estonian data is given in Appendix 2 Tables 8 and 9. The main Estonian economic variables are presented in Figure 1.

Figure 2 plots the Estonian 3-month nominal money market interest rate (I), and loan interest rates by three loan types: the housing loan interest rate (I HOME), the consumer credit interest rate (I CONS) and the business loan interest rate (I BUSN). All interest rates except consumer credit have a downward trend that is linked to falling risk premium charged by the banks. A linear trend is added to all Estonian interest rates in the estimated models and the linear trend for the consumer credit interest rate series can pick up the increasing risk premium charged by the banks.

The three euro area time series used in the SVAR are presented in Figure 3. The overall dynamics of the euro area variables are similar to those of their Estonian counterparts. However, the mean and the variance of the Estonian GDP growth rate and the GDP deflator-based inflation rate are higher.

The stylized facts about the business cycle for Estonian variables give background for understanding the relationship between the Estonian variables and Estonian and euro area GDP. Following Kydland and Prescott (1990), we use HP filtered data ($\lambda = 1600$) on levels (differently from the SVAR). Table 1 shows the volatility of Estonian and euro area economic and financial data. The HP filter is known to be a robust method of separating cycles from the trend and discussing the stylized facts of the cycle. However, as the HP filter is two-sided and uses information from future periods which is not observable to the policy maker, it should not be used in the structural

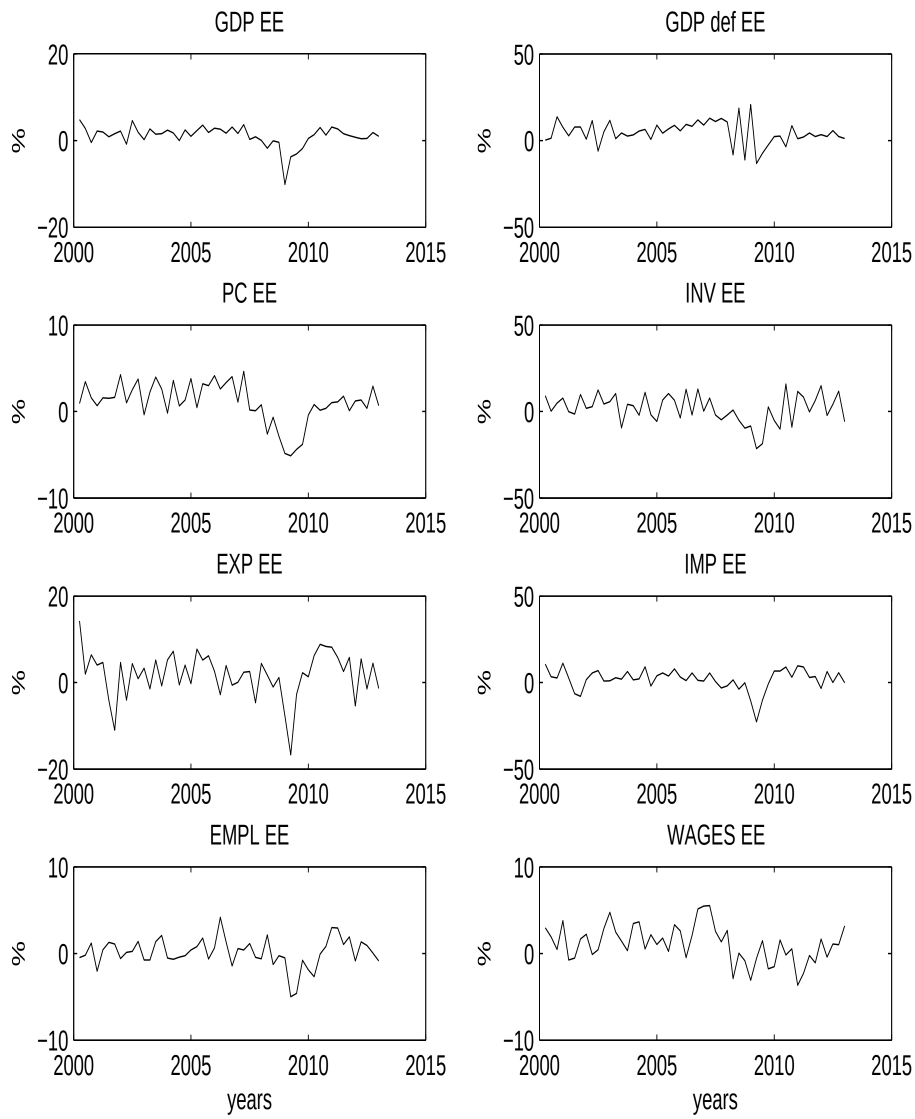

Figure 1: Estonian macroeconomic variables

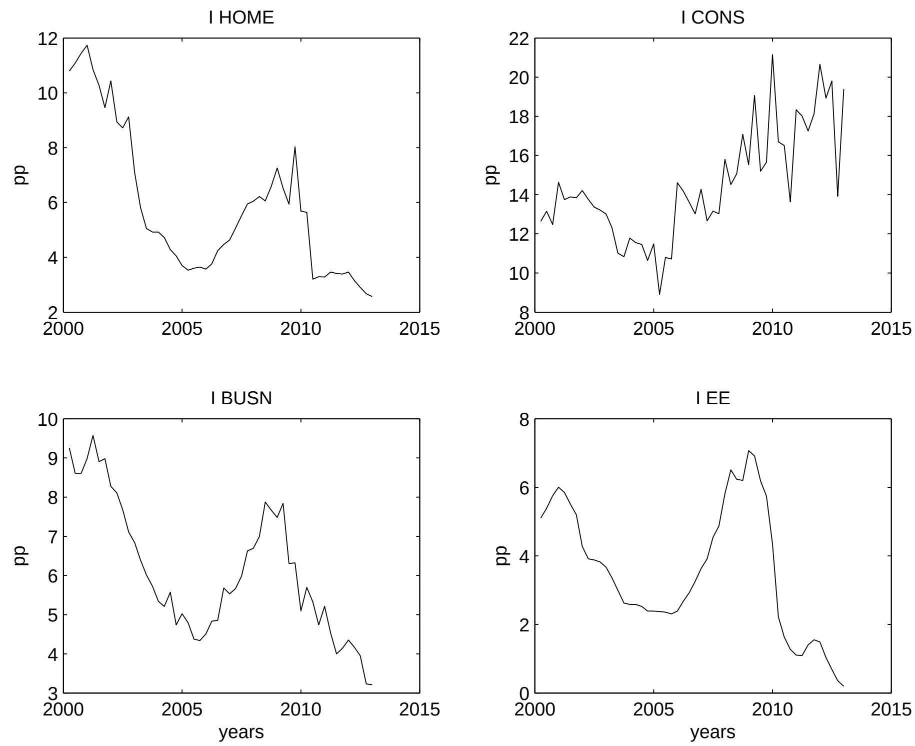

Figure 2: Estonian loan interest rates by type

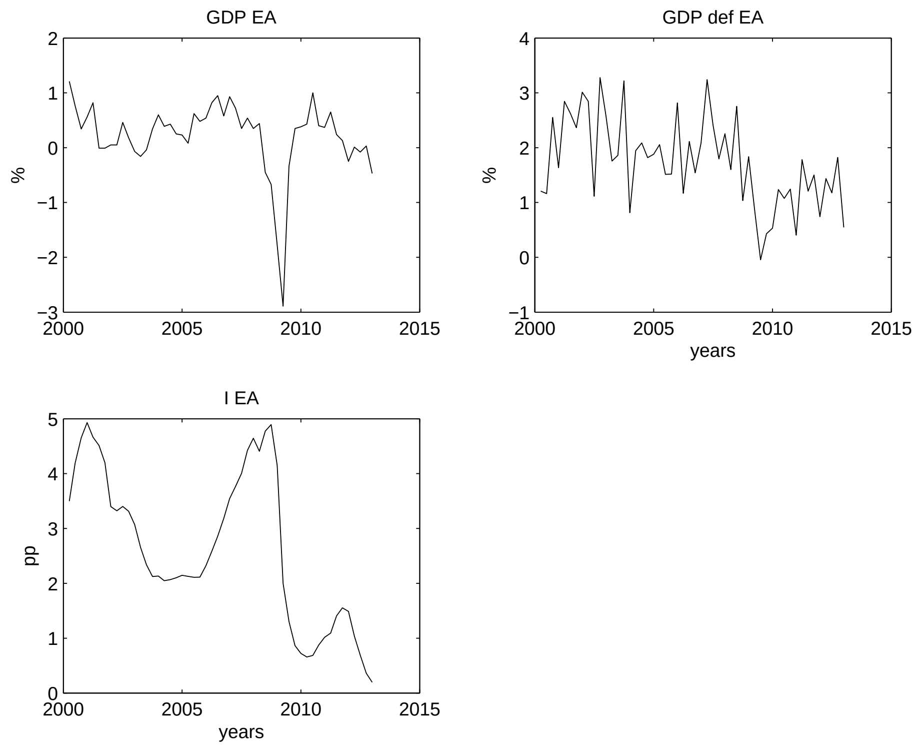

Figure 3: Euro area economic variables

estimation of VAR models.

Table 1: Business cycle indicators

Variable	St.dev.	Ratio to GDP^{EE}	Ratio to GDP^{EA}
GDP^{EE}	5.0	1.0	3.7
PC^{EE}	5.3	1.1	3.9
INV^{EE}	15.2	3.0	11.1
EXP^{EE}	8.9	1.8	6.6
IMP^{EE}	11.9	2.4	8.8
$EMPL^{EE}$	3.3	0.7	2.4
$WAGES^{EE}$	3.6	0.7	2.6
GDP def^{EE}	6.4	1.3	4.7
I $HOME^{EE}$	1.1	0.2	0.8
I $CONS^{EE}$	1.6	0.3	1.2
I $BUSN^{EE}$	0.8	0.2	0.6
I^{EE}	1.1	0.2	0.8
GDP^{EA}	1.4		1.0
PC^{EA}	0.5		0.4
INV^{EA}	3.4		2.5
$EMPL^{EA}$	0.6		0.5
$WAGES^{EA}$	0.2		0.2
GDP def^{EA}	0.7		0.5
I^{EA}	0.9		0.6

Notes: Calculated from data used in this paper for 2000Q1 to 2012Q4. GDP – real gross domestic product, PC – real private consumption, INV – real corporate investment, EXP – real exports, IMP – real imports, EMPL – employment, WAGES – real wages, GDP def – the GDP deflator-based inflation rate, I HOME – the housing loan interest rate, I CONS – the consumer credit interest rate, I BUSN – the business loan interest rate, I^{EE} – 3-month Talibor, I^{EA} – 3-month Euribor. Superscript EE stands for Estonia and EA for the euro area.

Estonian GDP is about 3.7 times more volatile than the GDP of the euro area. Although the most volatile component of GDP^{EE} is corporate investment, like in the euro area, relative volatility to GDP is lower in Estonia. In contrast to the situation in the euro area, private consumption in Estonia is more volatile than GDP. Estonian imports are also very volatile, especially relative to exports. Relative to GDP, Estonian employment is as volatile as that in the euro area, but we observe remarkable differences in wages, with Estonia having a fairly high level of wage volatility. It is not unexpected for a small country to have a relatively high level of volatility in comparison to the aggregate euro area data, but the quantitative difference is high. There are also several differences in the relative importance of the components of GDP and the volatility of macro aggregates to GDP.

Table 2 presents the correlation of economic and financial indicators with Estonian real GDP^{EE}. It shows that to some extent GDP has forecasting power on many macroeconomic aggregates. However the GDP deflator-based inflation rate seems to have predicting power for GDP dynamics. The table also shows that financial indicators have small contemporaneous correlation with GDP, but there is some evidence that interest rates lead the dynamics in GDP.

Table 2: Correlation of economic and financial indicators with Estonian real GDP^{EE}

Variable	Lags and leads								
	x_{t-4}	x_{t-3}	x_{t-2}	x_{t-1}	x_t	x_{t+1}	x_{t+2}	x_{t+3}	x_{t+4}
GDP^{EE}	0.33	0.58	0.77	0.92	1.00	0.92	0.77	0.58	0.33
PC^{EE}	0.23	0.48	0.69	0.85	0.95	0.95	0.86	0.72	0.53
INV^{EE}	0.24	0.46	0.67	0.82	0.91	0.90	0.82	0.66	0.46
EXP^{EE}	0.45	0.60	0.73	0.79	0.79	0.69	0.48	0.23	–0.01
IMP^{EE}	0.45	0.63	0.79	0.89	0.91	0.82	0.62	0.38	0.12
$EMPL^{EE}$	0.01	0.21	0.46	0.67	0.83	0.93	0.90	0.79	0.62
$WAGES^{EE}$	–0.18	0.05	0.21	0.36	0.50	0.56	0.59	0.61	0.59
GDP def^{EE}	0.30	0.33	0.34	0.39	0.25	0.33	0.14	–0.01	–0.06
I $HOME^{EE}$	–0.51	–0.43	–0.33	–0.22	–0.05	0.15	0.31	0.47	0.64
I $CONS^{EE}$	–0.18	–0.16	–0.14	–0.15	–0.06	–0.02	–0.10	0.12	0.10
I $BUSN^{EE}$	–0.64	–0.51	–0.35	–0.12	0.08	0.28	0.48	0.57	0.62
I^{EE}	–0.69	–0.57	–0.40	–0.19	0.05	0.33	0.57	0.75	0.85
GDP^{EA}	0.18	0.44	0.68	0.83	0.90	0.86	0.70	0.51	0.30

Notes: Lagging means correlation between GDP_t and PC_{t-1} (forecasting power of PC on GDP); leading means correlation between GDP_t and PC_{t+1} (forecasting power of GDP on PC). Data from 2000Q1 to 2012Q4. GDP – real gross domestic product, PC – real private consumption, INV – real corporate investment, EXP – real exports, IMP – real imports, EMPL – employment, WAGES – real wages, GDP def – the GDP deflator-based inflation rate, I HOME – the housing loan interest rate, I CONS – the consumer credit interest rate, I BUSN – the business loan interest rate, I^{EE} – 3-month Talibor, I^{EA} – 3-month Euribor. Superscript EE stands for Estonia and EA for the euro area.

4 Results

This section presents the main results. We visualise the effects of monetary policy shocks using impulse response functions. We accumulate the IRFs of the variables that are used in the SVAR in first differences (GDP, private consumption, corporate investment, exports, imports, employment and real wages) with the exception of the GDP deflator-based inflation rate, which is shown as the inflation rate. The benchmark SVAR has two lags. All point estimates of IRFs are presented together with their centred 68% confidence intervals, calculated using the non-parametric bootstrap. The 68% intervals are approximately plus/minus one standard deviation. This allows the reader to visually depict plus/minus two or three standard deviations as well. The 68% confidence intervals are also popular in the recent SVAR literature.

Figure 4 shows the reaction of Estonian and euro area GDP, GDP deflator-based inflation rates and money market interest rates. A standard deviation increase in the Euribor of 22bp dies out after five quarters. The Talibor increases on impact by 11bp, reaches 34bp by the fourth quarter, and converges back to zero by the eighth quarter.

In the quarter after the shock, the Estonian GDP deflator-based inflation rate increases by about 0.4pp, but subsequently falls to –0.6pp Inflation stays below zero for about three years. There is some evidence of the price puzzle, but it is statistically not significant. The price puzzle is well documented for many countries (for example, see Christiano et al. (2005) for the USA and Mojon and Peersman (2001) for countries in the euro area). We find no evidence of the price puzzle for the euro area GDP deflator-based inflation rate, which falls one quarter after the shock by 0.1pp, is then volatile, and converges back to zero after four years.

The effect of the shock on the GDP level is strong and persistent. Euro area GDP

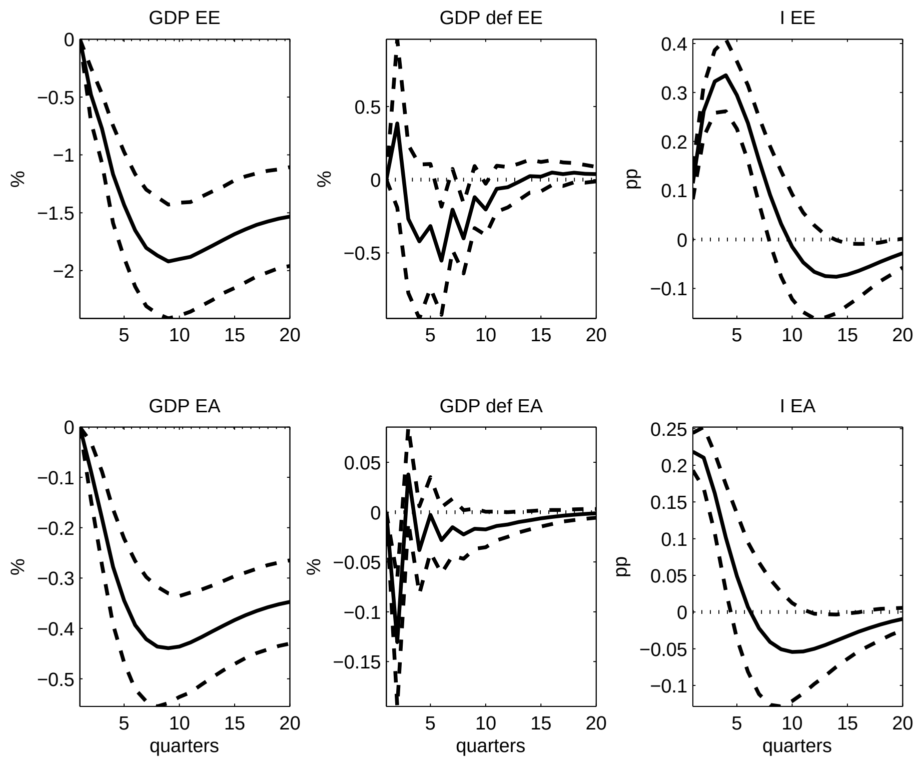

Figure 4: Estimated impulse responses of Estonian and euro area GDP, the GDP deflator-based inflation rates and the money market interest rates to a contractionary monetary policy shock in the euro area
Note: The solid line describes point estimate and dashed lines 68% confidence intervals.

falls by about 0.4%, reaching its lowest point after two years. Estonian GDP drops by 1.8% and also reaches the bottom after two years. The reaction of Estonian GDP is more than four times stronger than that of euro area GDP.

These results are similar to the estimates of Jeenas (2010). In a somewhat different 7-dimensional SVAR he also finds that a 25bp increase in the 3-month Euribor leads to a 1.5% decrease in Estonian GDP. However euro area GDP drops by more than in our model. The effects of the monetary policy shock in the euro area on Estonian and the euro area inflation are almost identical in his paper. Jeenas (2010) also finds some evidence of the price puzzle in Estonian inflation.

Our estimates for the euro area effects are about twice as strong as the findings of Weber et al. (2011) who use the same identification scheme and the euro area data from 1996 to 2006. The difference is mainly due to the inclusion of data from the great recession. In the robustness analysis we show that our estimates are very close to their estimates when we use data from 2000 to 2007.

The monetary policy shock in the euro area also has strong effects on several other Estonian economic indicators. Figure 5 plots the IRFs estimated in separate SVAR models for private consumption, corporate investment, employment, real wages, imports and exports. These Estonian variables give a broader picture of monetary policy transmission in Estonia. As Estonian variables do not affect euro area variables ($\alpha^{EE\rightarrow EA} = 0$), the IRFs for the euro area data are identical and therefore not reported.

All variables follow a hump-shaped response. Private consumption drops by 2.7% and corporate investment by 5.2%. Employment and real wages decrease to a lesser extent, falling by only 1.3% and 1.2% and reaching their lowest levels around 10 quarters after a monetary policy shock in the euro area. Exports decrease by around 2.2% by the eighth quarter and converge near the baseline after four years. Imports drop by 4.2% and stay low afterwards. The relatively small reaction of exports compared to the change in Estonian GDP leaves little room for the argument that foreign demand is the main driver of the strong reaction found in the economic aggregates. Instead the strong reaction of imports shows that there is a steep drop in domestic demand.

Figure 6 plots IRFs for the different Estonian loan interest rates. We use these three variables for two reasons. Firstly they are interesting as they show the money market interest rate pass-through to Estonian three loan type specific loan interest rates. Secondly they offer a possible explanation for the strong impact observed on the real economy.

The housing loan interest rate rises on impact by about 12bp and increases by up to 38bp the year after, later converging slowly to zero. Strong contemporaneous pass-though is expected as a majority of housing loans have interest rates that are fixed to the 6-month Euribor with an added risk premium. The pass-through to the housing loan interest rate is not direct as the dynamics of the 6-month Euribor interest rate are somewhat different to those of the 3-month Euribor and the risk premium charged on top of the Euribor is variable. The consumer credit interest rate has almost no contemporaneous pass-through, but reaches 40b. after a year and converges back to the baseline after 10 quarters. The reaction of the business loan interest rate shows that there is no contemporaneous pass-through. The business loan interest rate increases by only 13b. after two quarters.

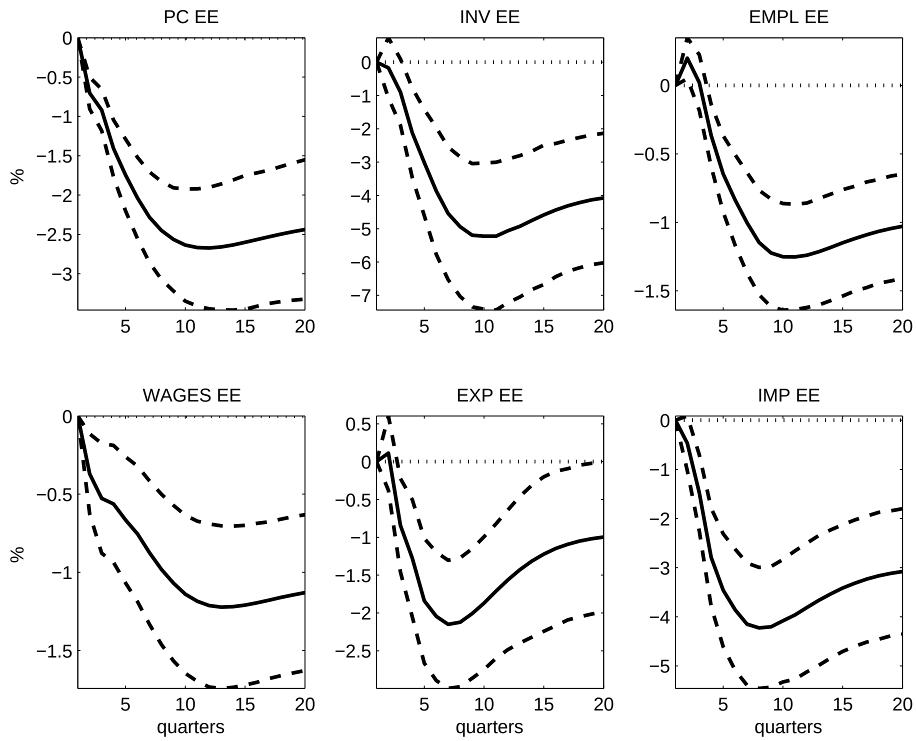

Figure 5: Estimated impulse responses of additional Estonian macroeconomic variables to a contractionary monetary policy shock in the euro area
Note: The solid line describes point estimate and dashed lines 68% confidence intervals.

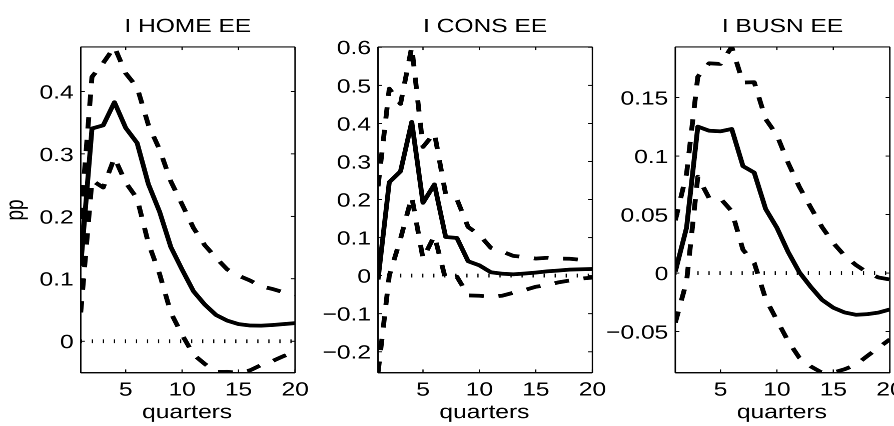

Figure 6: Estimated impulse responses of loan type specific interest rates to a contractionary monetary policy shock in the euro area
Note: The solid line describes point estimate and dashed lines 68% confidence intervals.

Our results show that Estonian data are volatile at least partly because of internal amplification. By construction the identified shock is identical for the euro area and for Estonia, but the reaction of the Estonian variables is stronger. Our conjecture is that the interest rates have been at least partly responsible for the amplification of the monetary policy shock in the euro area. In addition we find that housing loan and consumer credit interest rates react very strongly and sluggishly. An increase in the money market interest rate leads to a stronger increase in these interest rates.

The strong reaction of consumer credit and housing loan interest rates stands in contrast to the findings for the euro area of Giannone et al. (2012). They find that interest rates for consumer credit, housing and corporate loans react substantially less than the money market interest rate. Similarly, the immediate pass-through of Estonian loan interest rates is also smaller than one. In contrast the Estonian money market, housing loan and consumer credit interest rates react more than twice as strongly as the euro area money market interest rate.

This indicates that the interest rates are an important transmission and amplification channel in monetary transmission. Our results show that the foreign demand channel is of secondary importance as Estonian exports react by as much as GDP. In contrast, Estonian imports, which are affected by domestic demand, react about twice as strongly as Estonian GDP.

In this paper we have not looked at the reaction of loan quantities to monetary policy shocks in the euro area. We conjecture that Estonian private consumption and housing loan interest rates are very sensitive to financial conditions and play a substantial role in the monetary policy transmission mechanism.

5 Robustness analysis and the importance of the great recession

In this section we present the results for the stability and robustness analysis. We concentrate on the sensitivity to different lag lengths, the size of the SVAR, and possible effects of the length of the time series and of extreme observations in the sample. This sheds light on potential structural breaks without formally testing for them. Formal testing is prone to giving misleading results because of the low degrees of freedom and the possible structural break at the end of the sample.

The autoregressive model is known to be a good approximation of the underlying moving average process only when a sufficient number of lags are included. We also estimated models with three and four lags (results not shown). In the models with three and four lags the qualitative results remained the same, although the precision of the estimates deteriorated due to multicollinearity. The models with one lag SVAR were unstable and theoretically less interesting as they are not able to generate a hump-shaped response for the economic variables.

We also estimated a smaller model with six variables (Estonian and euro area GDPs, GDP deflator-based inflation rates, and money market interest rates). All other assumptions were the same as in the 7-dimensional SVAR. The results remained qualitatively unchanged. The only difference in the results was that the reaction of the Estonian variables was in some cases quantitatively somewhat smaller. Missing variable bias is likely to be small as the estimated IRFs for the main variables in the various models remain largely unchanged.

5.1 Sensitivity to extreme observations

Ordinary least squares estimations are known to be sensitive to outliers and extreme values in the data. As the Estonian data have high variance, especially during the recent crisis episode, we therefore remove some of the variance by including dummies as a robustness exercise. The residuals of the benchmark model also have fat tails and are somewhat skewed. The use of dummies will give an indication of how much IRFs depend on the extreme observations. Dummies are used only in the Estonian data, because the aim is to analyse the euro area monetary policy transmission mechanism in Estonia, and from the benchmark model we saw stronger reactions in the Estonian variables than in the euro area aggregates.

After estimating the model we identify potential extreme observations in the data by analysing the residual time series and histograms. After that we include dummies for the most extreme observations and then re-estimate the model and repeat the residual analysis and dummy introduction. The maximum number of dummies allowed by the equation was set at 12, but in some cases fewer dummies were used if the quantitative results remained unchanged or reversed the sign of the impulse response. Table 3 shows how many dummies are included in the final models.

Table 3: Number of dummies in models

Model with	GDP	Additional variable	GDP def	I
PC	8	6	7	7
INV	8	3	5	3
EXP	12	8	7	7
IMP	11	8	10	6
EMPL	9	8	8	7
WAGES	6	9	9	6
I HOME	8	11	7	7
I CONS	8	12	7	7
I BUSN	8	8	7	7

Figure 7 plots the results with the dummies included for the three main Estonian variables. The observed increase in GDP is somewhat lower. The GDP deflator-based inflation rate declines after the shock and does not show the price puzzle. The money market interest rate behaviour is largely unchanged, increasing by only a few basis points less than in the benchmark model.

Figure 8 plots the results for private consumption, corporate investment, exports, imports, employment and wages. The use of dummies reduces the impact of monetary policy shock the most in private consumption and corporate investment (see benchmark results, Figure 5).

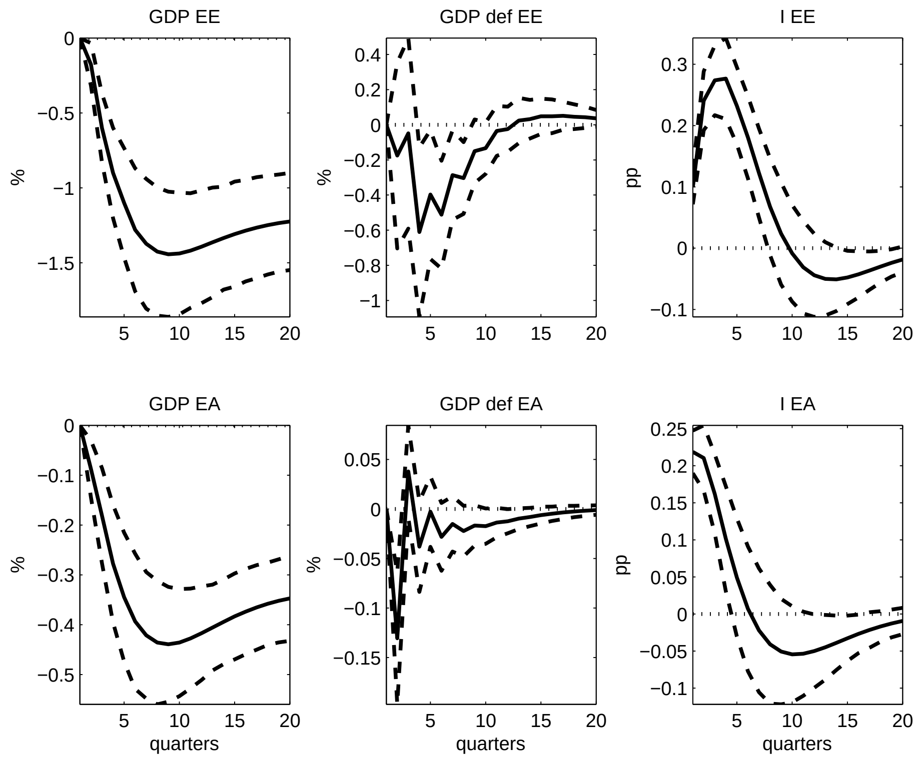

Figure 7: Estimated impulse responses of Estonian and euro area GDPs, the GDP deflator-based inflation rates and the money market interest rates to a contractionary monetary policy shock in the euro area. Dummies used in the Estonian data equations
Note: The solid line describes point estimate and dashed lines 68% confidence intervals.

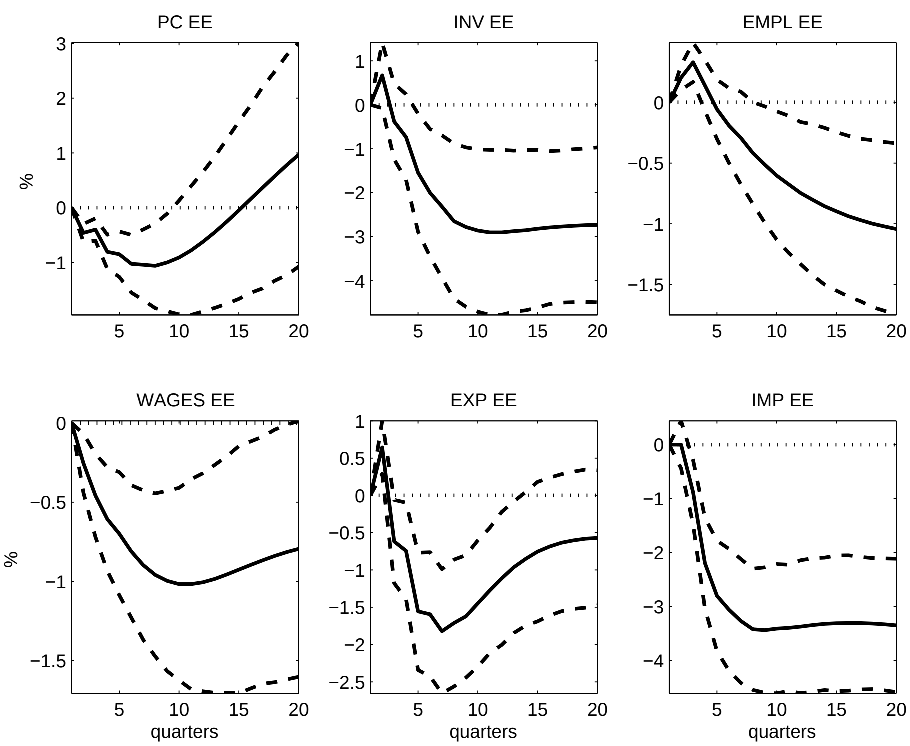

Figure 8: Estimated impulse responses of additional Estonian macroeconomic variables to a contractionary monetary policy shock in the euro area. Dummies used in Estonian equations
Note: The solid line describes point estimate and dashed lines 68% confidence intervals.

Figure 9 plots the results for the different loan interest rates. Dummies did not reduce the reactions (for comparison see benchmark results Figure 6). On the contrary, all variables showed stronger movements after the shock.

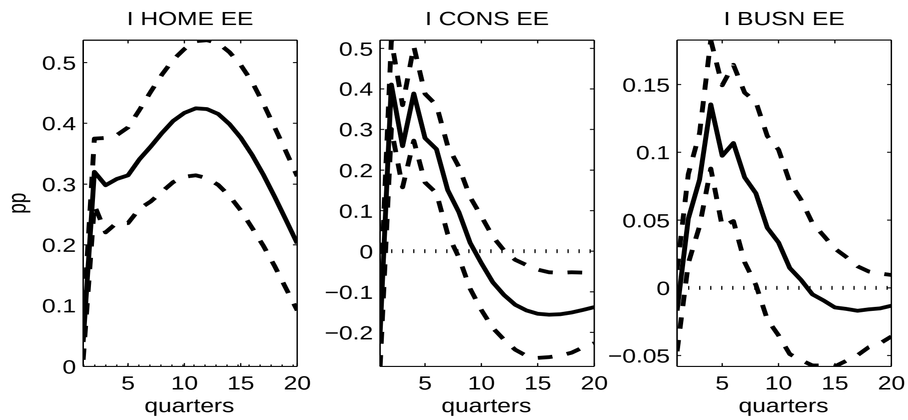

Figure 9: Estimated impulse responses of loan type specific interest rates to a contractionary monetary policy shock in the euro area. Dummies used in Estonian equations
Note: The solid line describes point estimate and dashed lines 68% confidence intervals.

We can also discuss the effects of the recent financial and economic crisis on monetary transmission. By looking at the Estonian time-series dynamics we use dummies for the period from 2007Q3 to 2010Q2. Dummies are used for three different sub-periods – 2007Q3 to 2008Q2, 2007Q3 to 2009Q2, and 2007Q3 to 2010Q2 – and named the one-year, two-year and three-year models with dummies.

The three panels in Figure 10 plot the results with the dummies included for the three main Estonian variables. The money market interest rate dynamic is largely unchanged from the benchmark model, but the increase on impact is somewhat stronger at 19bp. The GDP deflator-based inflation rate does not show the price puzzle, but the decline is stronger in all models with dummies than in the benchmark results. The reaction of GDP is smaller in the two-year and three-year models with dummies, hinting that the amplified reaction in the benchmark model was due to the strong impact of the crisis years.

The effects of the shock on additional Estonian economic and financial variables depend on the inclusion of crisis years in the data. The differences are bigger when dummies are used for the period from 2007Q3 to 2009Q2 and from 2007Q3 to 2010Q2 (results not presented). Estonian macroeconomic variables react less strongly, and for example the reaction is smaller in the one-year model with dummies for employment, which falls after the shock by 0.7%, and for real wages, which fall after the shock by 0.8%. In the two-year model with dummies the reaction is smaller for private consumption, which falls after the shock by 0.3%, and for imports, which fall after the shock by 1.2%. However, there are still signs of the price puzzle in the GDP deflator-based inflation rate.

The money market interest rate increases less, though interest rates for some loan type increase by more than in benchmark model. The reaction of some variables (cor-

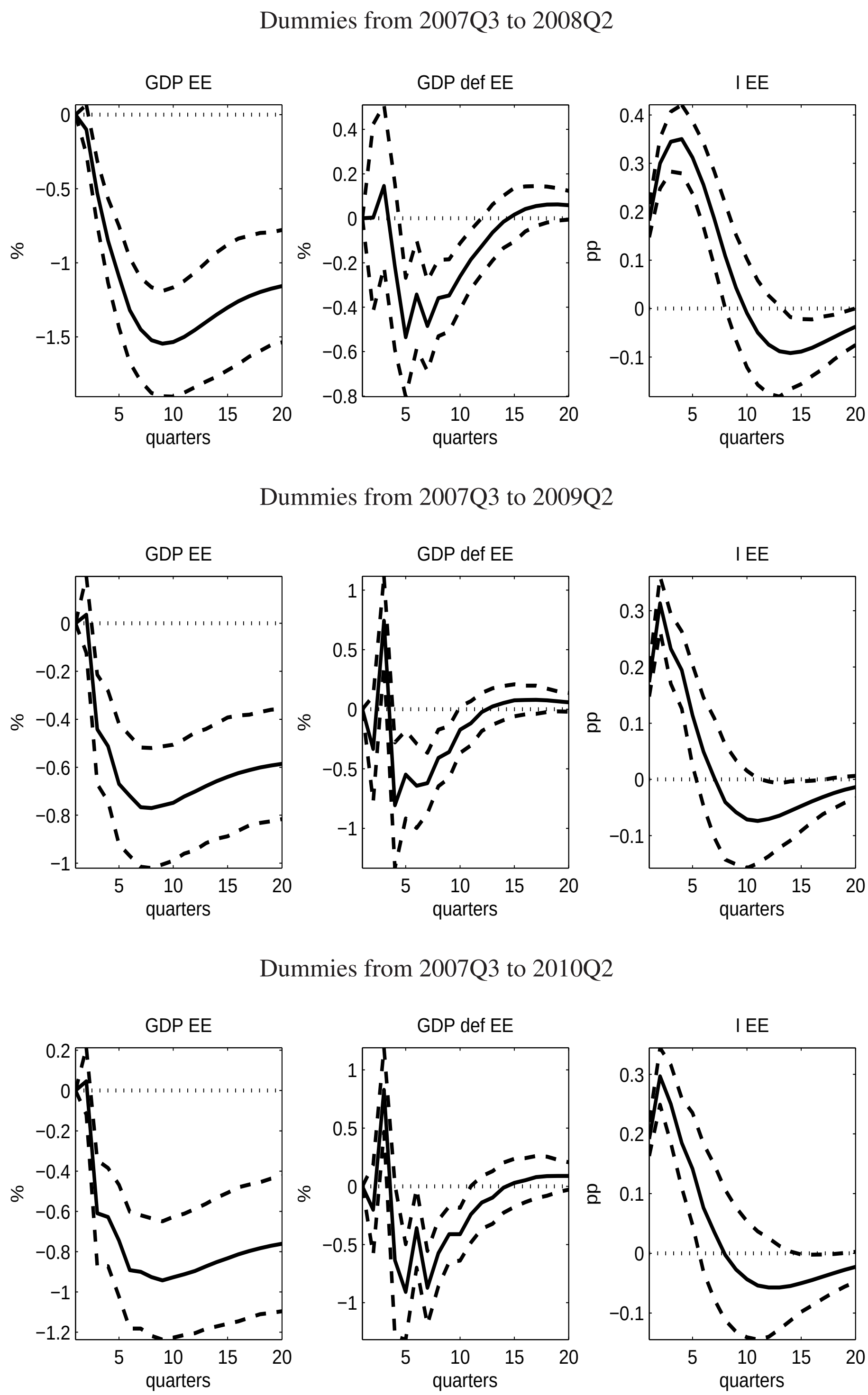

Figure 10: Estimated impulse responses of Estonian GDP, the GDP deflator-based inflation rate and the money market interest rate to a contractionary monetary policy shock in the euro area. Dummies used in the Estonian data equations for different time periods indicated for each panel separately

Note: The solid line describes point estimate and dashed lines 68% confidence intervals.

porate investment, exports and real wages) change signs when dummies are used for the period from 2007Q3 to 2009Q2 and from 2007Q2 to 2010Q2.

5.2 Stability of results over time

Giannone et al. (2012) find evidence that during the crisis period, from August 2007 to August 2010, the cyclical behaviour in some financial variables, such as longer term loans, deposits and longer term interest rates, changed. Ciccarelli et al. (2013) also find that the crisis years have affected economic and financial developments in individual countries.

Testing for the changes in transmission with limited time series and a possible structural break in the later part of the sample is statistically complicated. However, in order to get some indication of possible changes, we use the simple approach of estimating the model in different rolling time-windows. The approach gives an intuitive understanding of possible changes in the euro area monetary policy transmission mechanism.

Table 4 shows how the whole period is divided into 24 rolling time-windows of 29 quarters (7 years and 1 quarter). The first period is from 2000Q1 to 2007Q1, the second is from 2000Q2 to 2007Q2, etc. We use 29 quarters of data as it allows us to estimate the first SVAR model in a period with no financial crisis reaching up to the second half of 2007. By adding quarters to the end and subtracting from the beginning, the initial stage of the financial crisis and the subsequent sovereign debt crisis are covered. Shortening the period further becomes difficult as the degrees of freedom drop drastically.

Estimation of the models for the early period showed no (or even reverse) effects of monetary policy in either the euro area or Estonia. If we look at the periods until 2009, a contractionary monetary policy shock leads to a small but persistent increase in the GDP deflator-based inflation rate and the GDP level in both the euro area and Estonia (see Figure 11). The euro area result is similar to the result of Weber et al. (2011) for the period 1999–2006. The Estonian results are in line with the anectotal evidence that probably monetary policy shocks in the euro area did not play an important role in the Estonian economy until the economic slowdown. Contradicting the spirit of our results, Männasoo (2007) finds that during the years between 1994 and 2004 the number of firms failing in Estonia decreases after an interest rate hike.

For the period before the crisis years we also get opposite reactions from those of the benchmark results for other Estonian macroeconomic variables (see Figures 12 and 13). The dynamics of exports, imports, real wages, corporate investment and private consumption follow the behaviour of Estonian GDP. The results for exports and real wages are somewhat stronger in the models with time-windows, meaning the impact of the beginning of the 2000s is important for the benchmark model.

The estimated effects look very close to our benchmark results when the data from the last quarters of 2008 and first quarters of 2009 are included in the sample. Some of the models for data periods ending in the middle of the crisis are hard to estimate and the SVAR models become unstable. But then the results stabilize and stay close to our benchmark results for the later samples, although the magnitude might be a little muted. This holds again both for the euro area and for Estonia.

Table 4: Time-windows

Time-window	Beginning		Ending	
1	2000	Q1	2007	Q1
2		Q2		Q2
3		Q3		Q3
4		Q4		Q4
5	2001	Q1	2008	Q1
6		Q2		Q2
7		Q3		Q3
8		Q4		Q4
9	2002	Q1	2009	Q1
10		Q2		Q2
11		Q3		Q3
12		Q4		Q4
13	2003	Q1	2010	Q1
14		Q2		Q2
15		Q3		Q3
16		Q4		Q4
17	2004	Q1	2011	Q1
18		Q2		Q2
19		Q3		Q3
20		Q4		Q4
21	2005	Q1	2012	Q1
22		Q2		Q2
23		Q3		Q3
24		Q4		Q4

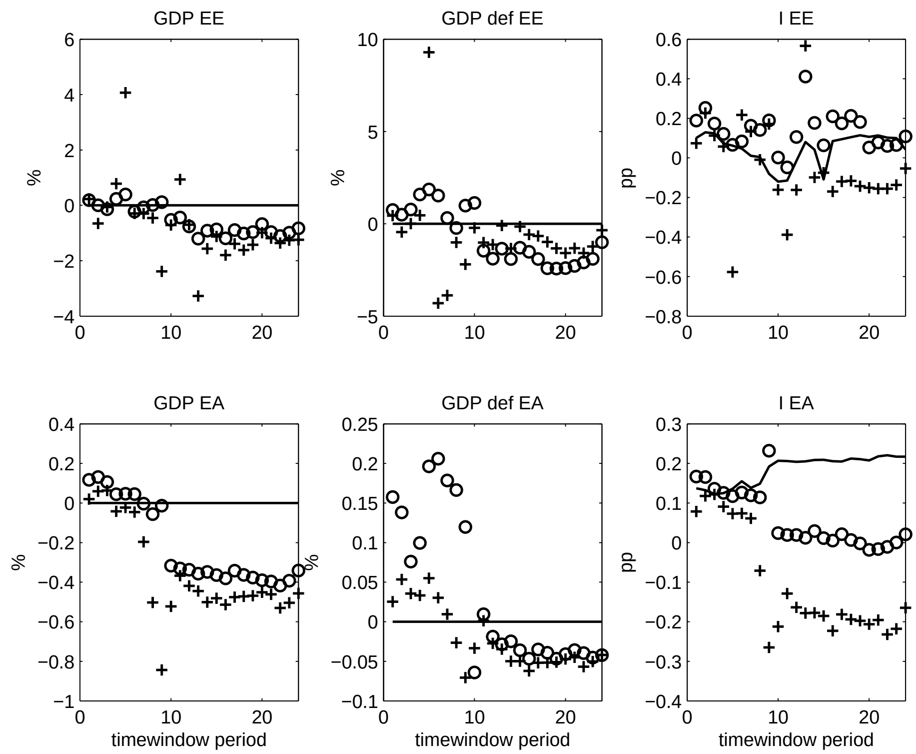

Figure 11: Estimated impulse responses of Estonian and euro area GDP, the GDP deflator-based inflation rates and the money market interest rate to a contractionary monetary policy shock in the euro area using rolling time-windows

Note: The solid line (—) describes the immediate IRF to the variable of each time-window. The circle (❍) describes the IRF after 4 quarters (1 year) of each time-window. The cross (✛) describes the IRF after 8 quarters (2 years) of each time-window.

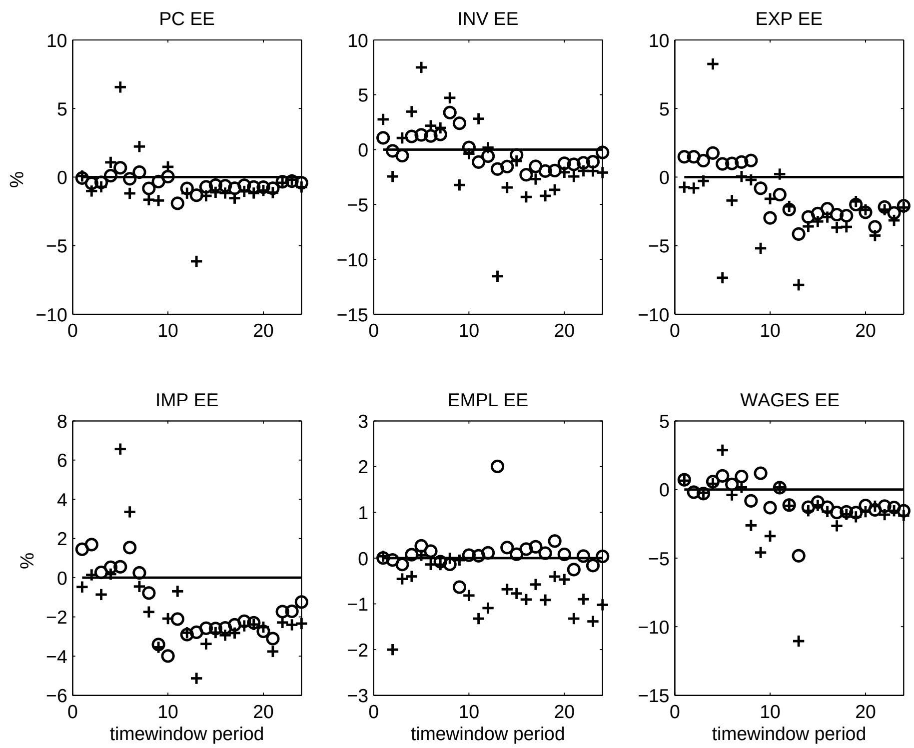

Figure 12: Estimated impulse responses of additional Estonian macroeconomic variables to a contractionary monetary policy shock in the euro area using rolling time-windows

Note: The solid line (—) describes the immediate IRF to the variable of each time-window. The circle (❍) describes the IRF after 4 quarters (1 year) of each time-window. The cross (✛) describes the IRF after 8 quarters (2 years) of each time-window.

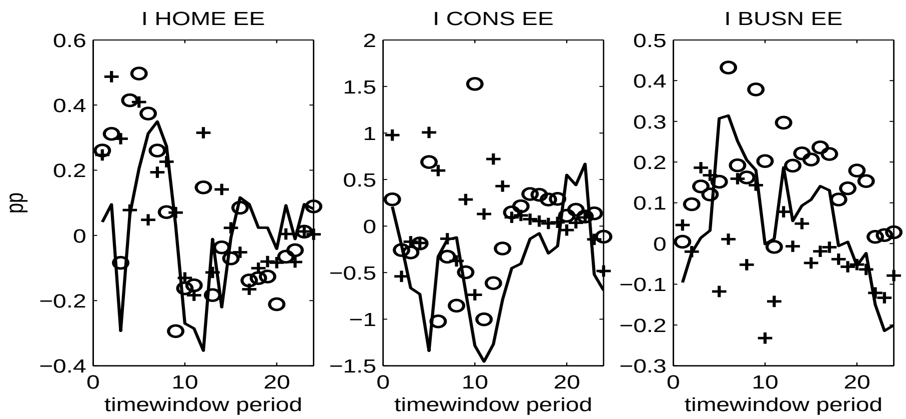

Figure 13: Estimated impulse responses of Estonian loan type specific interest rates to a contractionary monetary policy shock in the euro area using rolling time-windows
Note: The solid line (—) describes the immediate IRF to the variable of each time-window. The circle (❍) describes the IRF after 4 quarters (1 year) of each time-window. The cross (✛) describes the IRF after 8 quarters (2 years) of each time-window.

6 Conclusion

In this paper we estimate the transmission of the monetary policy shocks in the euro area to Estonian economic and financial variables. We find that a 22 basis points increase in the euro area money market interest rate increases the Estonian money market interest rate by a maximum of 34 basis points and leads to a substantial increase in the housing loan and consumer credit interest rates. The shock brings down Estonian GDP by almost 1.9% and the GDP deflator-based inflation rate by 0.6 percentage points.

We conclude that the trade channel is less likely to be responsible for the large effects observed in the macroeconomic aggregates. Exports decrease by substantially less than imports, private consumption or GDP. We conjecture that the strong reaction of GDP and its components can be partly assigned to a large increase in housing loan and consumer credit interest rates.

References

Angeloni, I., Kashyap, A., and Mojon, B. (2002). Monetary policy transmission in the euro area. *Cambridge University Press*.

Bernanke, B. S. and Gertler, M. (1995). Inside the black box: the credit channel of monetary policy transmission. *Journal of Economic Perspectives*.

Christiano, L. J., Eichenbaum, M., and Evans, C. (1996). The effects of monetary policy shocks: Some evidence from the flow of funds. NBER Working Paper no. 4699.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. (1999). Monetary policy shocks: what we have learned and to what end? Handbook of Macroeconomics, Volume 1A, pp 65-148.

Christiano, L. J., Eichenbaum, M., and Evans, C. L. (2005). Nominal rigidities and the dynamic effects of a shock to monetary policy. *Journal of Political Economy*.

Ciccarelli, M., Maddaloni, A., and Peydró, J.-L. (2013). Heterogenous transmission mechanism: monetary policy and financial fragility in the euro area. European Central Bank Working Paper no. 1527.

Elbourne, A. and Haan, d. J. (2005). Modeling monetary policy transmission in accession countries: Var vs svar. mimeo.

Giannone, D., Lenza, M., and Reichlin, L. (2012). Money, credit, monetary policy and the business cycle in the euro area. CEPR Discussion Papers no. 8944.

Jacobs, J., Kuper, G. H., and Sterken, E. A. (2003). Structural var model of the euro area. presentation at the CPB Workshop on Economic Policy Modelling.

Jeenas, P. (2010). Analysis of estonian aggregate data using var models. Eesti Pank, mimeo.

Kydland, F. E. and Prescott, E. C. (1990). Business cycles: Real facts and a monetary myth. *The Federal Reserve Bank of Minneapolis quarterly review*.

Lättemäe, R. (2003). Monetary transmission mechanism in estonia. Kroon and Economy, no. 1.

Männasoo, K. (2007). Determinants of firm survival in estonia. Bank of Estonia Working Paper no. 4.

Mojon, B. and Peersman, G. (2001). A var description of the effects of monetary policy in the individual countries of the euro area. ECB Working Paper no. 92.

Peersman, G. and Smets, F. (2001). The monetary transmission mechanism in the euro area: more evidence from var analysis. ECB Working Paper no. 91.

Soares, R. (2011). Assessing monetary policy in the euro area: a factor-augmented var approach. Bank of Portugal Working Paper no. 11.

Weber, A. A., Gerke, R., and Worms, A. (2011). Changes in euro area monetary transmission? *Applied Financial Economics*.

Appendix 1. Literature overview

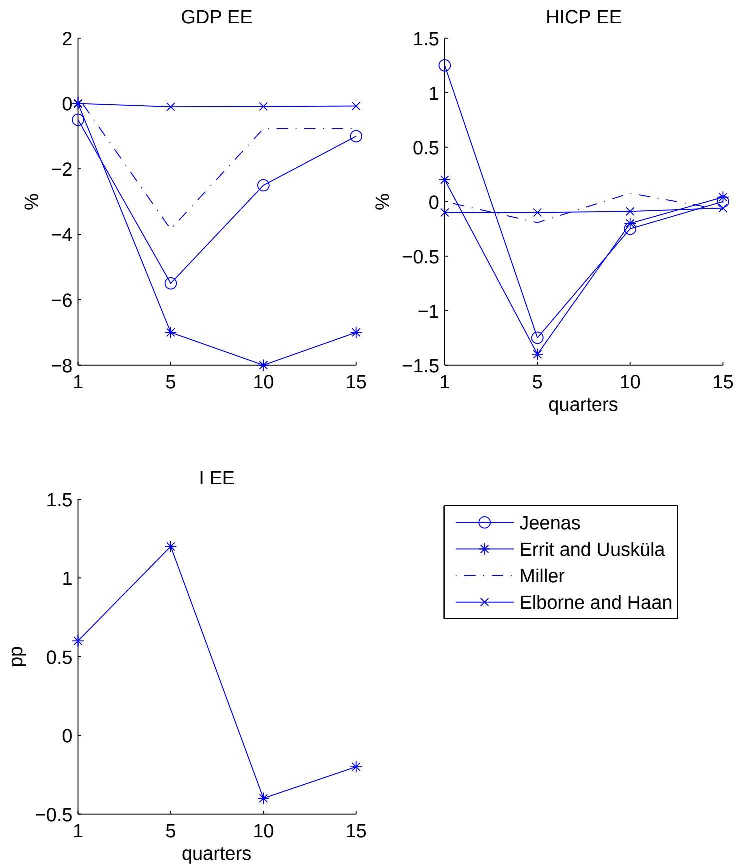

Figure 14: Effects of a monetary policy shock in the euro area on the Estonian money market interest rate, GDP and the inflation rate, literature overview

Notes: Horizontal axis represents quarters after the shock. For the interest rate, 1 quarter signifies the reaction at the time of the shock. For GDP and inflation, 1 quarter stands for the effect the quarter after.

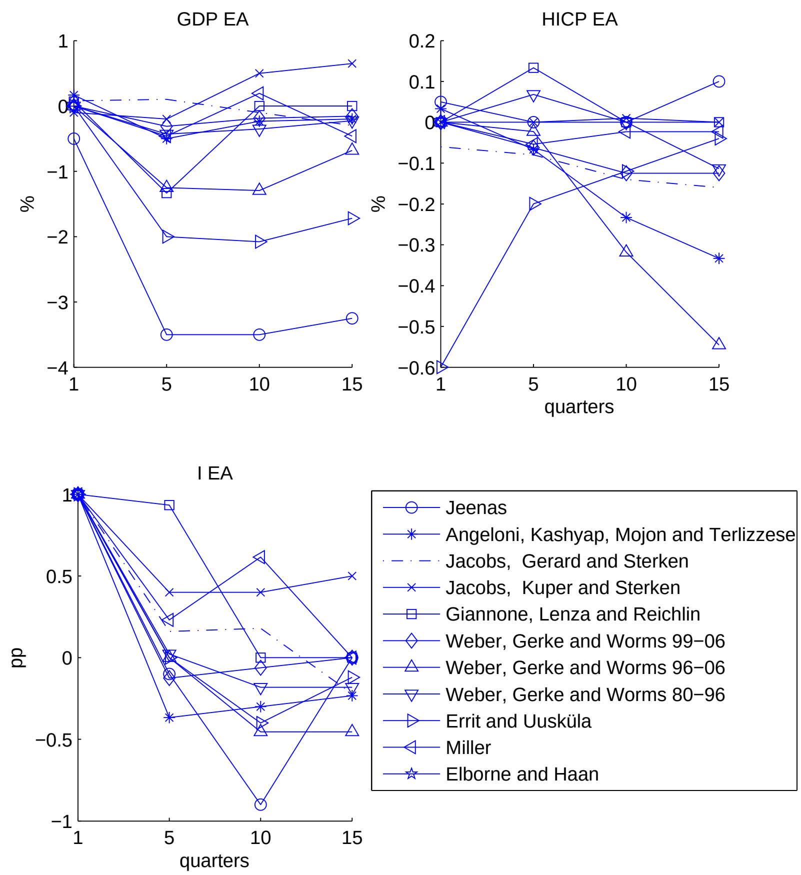

Figure 15: Effects of a monetary policy shock on the euro area variables, literature overview

Notes: Horizontal axis represents quarters after the shock. For the interest rate 1 quarter signifies the reaction at the time of the shock. For GDP and inflation, 1 quarter stands for the effect the quarter after.

Table 5: Selected literature review. Monetary policy effects in the US

Paper	**Data/Question**	**Model description**	**Results**
Christiano, L.J., and Eichenbaum, M., and Evans, C.L. (2005) Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy.	Estimates the dynamic response of macroeconomic variables to a monetary policy shock. Can models with moderate degrees of nominal rigidities generate inertial inflation and persistent output movements in response to a monetary policy shock?	DSGE model, shock of 1 std to Federal funds interest rate	The FFR moves up by 60bp: - inflation reacts slowly in a hump-shaped fashion, decreases by 0.1% and is volatile; - hump-shaped output response, after 1.5 years stays at –0.6%, returning to pre-shock levels after three years; - hump-shaped private consumption response, after 1.5 years stays at –0.2%, returns to pre-shock levels after three years; - hump-shaped corporate investment, after 1.5 years stays at –1.1%, returning to pre-shock levels after three years.
Christiano, L.J., and Eichenbaum, M., and Evans, C.L. (1999) Monetary policy shocks: what have we learned and to what end?	Estimates the dynamic responses to a monetary policy shock of Federal Funds Rate	SVAR model, shock of 1 std to the Federal funds rate.	The FFR increases 65bp on impact, then falls to benchmark for six quarters and stays below the initial value: - GDP moves down, reaching the through of –0.35% in five quarters; - GDP deflator stays near the base value for the first year, then declines, four years after the shock is at –0.4%.

Table 6: Selected literature review. Monetary policy effects in the euro area

Paper	**Data/Question**	**Model description**	**Results**
Angeloni, I., and Kashyap, A., and Mojon, B., and Terlizzese, D. (2002) Monetary Transmission in the euro area: where do we stand?	A comprehensive description of how monetary policy affects the euro area economy. Can the *classic* interest rate channel (IRC) alone, without capital market imperfections, explain these facts or is the bank lending channel a likely candidate to complete the story. Data from 1997Q1 to 2000Q4.	SVAR model, shock of 25bp to 3-month Euribor.	Interest rate increases 30bp on impact: - prices respond slowly, inflation hardly moves during the first year and then falls gradually over the next few years to –0.1%; - output falls for a few quarters (by –0.15%) and recovery occurs within 1.5 years; - corporate investments decline by 0.53% after a year and stay at –0.08% after three years; - private consumption declines by 0.09% after a year and stays at –0.03% after three years; the delayed response of prices relative to output suggests that studying the transmission of monetary policy to spending and output is a logical step, even if the aim of monetary policy is defined primarily or exclusively in terms of prices. Corporate investment are more important for the euro area monetary policy transmission than in the US, where much of the output adjustments appears to be due to changes in private consumption. The interest rate channel (IRC) completely characterises transmission in a few countries. In countries where the IRC is not dominant, there is some evidence supporting the presence of a bank lending channel (or other financial transmission channel).
Jacobs, J., and Kuper, G.H., and Sterken, E.A. (2003) Structural VAR model of the euro area.	Studies the main macroeconomic policy issues in the euro area and analyses the impact of a policy-imposed fiscal closure rule and its consequences on the effectiveness of monetary policy with various impulse responses. EA 11 data from 1991M1 to 2000M12.	SVAR model, domestic interest rate. Assumptions: (1) economic activity interaction of the EU-US describes the relevant world economic development; (2) oil price is exogenous; (3) theoretical restrictions (PPP, arbitrage conditions etc) determine the long-run properties of the model.	Interest rate increases 100bp and stabilizes after five years around 50bp: - output is reducing after a year by 0.35%; - prices decline after a year by 0.1%.
Soares, R. (2011) Assessing monetary policy in the euro area: a factor-augmented VAR approach.	The effect of monetary policy shocks in the euro area during the single monetary policy period. Balanced panel of 150 economic time series for the EA 16 from 1999M1 to 2009M3.	SVAR and FAVAR models, shock to Eonia.	Eonia rises on impact 22bp: - inflation declines (in FAVAR model by 0.15%), strongly driven by the component energy and unprocessed food, the response of the HICP excluding energy and unprocessed food reveals a price puzzle (without factors increases by 0.025%); - GDP is hump-shaped below the initial value and after 1.5 years reduces by 0.55%.
Giannone, D., and Lenza, M., and Reichlin, L. (2012) Money, credit, monetary policy and the business cycle in the euro area.	Estimated large VARs with Bayesian technique (BVAR) to explain the reaction of money and credit variables to cyclical shocks, such as changes in interest rates. Mostly euro area aggregated data from 1992M1 to 2010M8.	BVAR model, shock to 3 month Euribor.	The interest rate increases on impact by 10bp and converges after two years: - industrial production starts declining significantly after 10 months and declines steadily for about a year before flattening; - HICP does not react significantly; - the business loan interest rate has hump-shaped movement, increases by 4bp after seven months and converges back after two years; - the consumer credit interest rate has hump-shaped behaviour, increases by 2bp after eight months and converges after two years; - the housing loan interest rate is above its' initial value during the first year, increases by 2bp

Table 7: Selected literature review. Euro area monetary policy effects in Estonia

Region/Paper	**Data and question**	**Model description**	**Results**
Jeenas, P. (2010) Analysis of Estonian aggregate data using VAR models.	The effect of fiscal, technology and liquidity shock on Estonian economic variables. Data from 1996Q1 to 2008Q4.	SVAR model, shock to 3-month Euribor, benchmark model with 3 lags.	Euribor increases by 20bp on impact and converges to its initial value about 15 quarters after the shock: - employment follows a hump-shaped path, reduces by 0.15% after six quarters, converges back to its initial level by the 10th quarter; - output falls by 1.4%; - inflation increases by 0.2% after a year and then follows a damped oscillation pattern, reaching the baseline after 10 quarters.
Miller, O. (2011) Interest rate shock in a Small Open Pegged Economy. Parameter estimation for Estonia via impulse response matching in Dynare.	Is the impact of euro area interest rate shock different from some other euro area countries, because Estonia is a small and open economy and by how much? Estonian data from 1996M1 to 2010M12.	SVAR model, shock to 3 month Euribor.	A negative shock to the 3 month Euribor (1 std.): - inflation decreases by 0.25% and returns to the baseline slowly after four years, - industrial production decreases by 0.6%. The Estonian economy is more sensitive to the euro area monetary policy shock than the euro area. The euro area and Estonian variables convergence to the steady state in more than 40 months.
Elbourne, A., and de Haan, J. (2005) Modelling Monetary Policy Transmission in Accession Countries: VAR vs SVAR.	Estimated monetary transmission for 10 new and future EU member countries in Central and Eastern Europe (including Estonia). Data from 1994M1 to 2004M9.	VAR and SVAR, shock to the domestic short-term interest rate, CI bootstrapped.	A negative shock to the domestic interest rate 100bp: - Estonian industrial production declines by 0.55% after 12 months in SVAR, - Estonian CPI declines by 0.14% after 6 months.

Appendix 2. Data sources

Table 8: Data sources for Estonia from 2000Q1 to 2012Q4

Variable	Transf.	Source
GDP	log diff.	Eurostat: GDP and main components - volumes [namq_gdp_k] (gross domestic product at market prices, chain linked volumes, 2005=100, seasonally adjusted and adjusted data by working days).
GDP deflator	log diff.	Eurostat: GDP and main components - volumes [namq_gdp_k] and GDP and main components - Current prices [namq_gdp_c] (gross domestic product at market prices, chain linked volumes, 2005=100, seasonally adjusted and adjusted data by working days).
Talibor	level	Eurostat: 3-month rates for Estonia, quarterly data [irt_h_mr3_q].
Private consumption	log diff.	Eurostat: GDP and main components - volumes [namq_gdp_k] (final consumption expenditure of NPISH, chain linked volumes, 2005=100, seasonally adjusted and adjusted data by working days).
Corporate investment	log diff.	Eurostat: GDP and main components - volumes [namq_gdp_k] (gross fixed capital formation, chain linked volumes, 2005=100, seasonally adjusted and adjusted data by working days).
Exports	log diff.	Eurostat: GDP and main components - volumes [namq_gdp_k] (exports of goods and services, chain linked volumes, 2005=100, seasonally adjusted and adjusted data by working days).
Imports	log diff.	Eurostat: GDP and main components - volumes [namq_gdp_k] (imports of goods and services, chain linked volumes, 2005=100, seasonally adjusted and adjusted data by working days).
Wages	log diff.	ECB: Estonia - Compensation Per Employee, current prices, national currency, working day and seasonally adjusted, Index [ESA.Q.EE.Y.1000.COMEMP.0000.TTTT.V.N.I]; deflated by the consumer price index.
Employment	log diff.	Eurostat: Population and employment - quarterly data [namq_aux_pem] (total employment, domestic concept, 1000 persons, seasonally adjusted and adjusted data by working days).
The housing loan interest rate	level	Eesti Pank: Table 3.7.3 Interest rates of loans granted to households by loan type and currency.
The consumer credit interest rate	level	Eesti Pank: Table 3.7.3 Interest rates of loans granted to households by loan type and currency.
The business loan interest rate	level	Eesti Pank: Table 3.7.2 Interest rates of loans granted to non-financial corporations by borrower's main economic activity.

Table 9: Data sources for the euro area from 2000Q1 to 2012Q4

Variable	**Transf.**	**Source**
GDP	log diff.	Eurostat: GDP and main components - volumes [namq_gdp_k] (gross domestic product at market prices, chain linked volumes, 2005=100, seasonally adjusted and adjusted data by working days).
GDP deflator	log diff.	Eurostat: GDP and main components - volumes [namq_gdp_k] and GDP and main components - Current prices [namq_gdp_c] (gross domestic product at market prices, chain linked volumes, 2005=100, seasonally adjusted and adjusted data by working days).
3-month Euribor	level	ECB: Money market rates/Euribor three-month funds/Monthly average [SU0316].