Inside the black box of the Euro area monetary policy transmission: Explaining the heterogeneity [*]

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Very preliminary draft

February 2019

Since 1999, Euro area monetary policy decisions are taken by the ECB for all euro area countries together. Yet, it is still widely acknowledged that EMU is an incomplete monetary union, which may influence the transmission of monetary policy across countries. The aim of this paper is to investigate whether the transmission of monetary policy in the euro area experiences significant asymmetries and to document the potential sources of heterogeneities. To that end, we first identify monetary policy shocks by estimating the reaction function of the ECB in the spirit of Romer and Romer (2004). Then, we resort to Jordà (2005)'s local projections to assess the dynamic impact of monetary policy on GDP, inflation and several variables capturing the key mechanism of different transmission channels. Our results suggest the effects of ECB policy decisions are extremely heterogeneous with GDP impacts that vary by a factor of three and inflation impacts by a factor of five. Our analysis also suggests that these differences arise from different transmission mechanisms more than monetary shocks being different to each country.

Keywords: Monetary policy, heterogeneity, interest rate channel, credit channel, asset price channel.

JEL codes: E52.

1. Introduction

Since 1999, monetary policy decisions are taken by the ECB for all euro area countries, that is for 11 countries at the beginning and now for 19 countries. Yet, it is still widely acknowledged that EMU is an incomplete monetary union. There is no fiscal union, nor homogeneity of labour markets. Besides, even if some segments of financial markets are integrated, retail-banking market are still fragmented. Cross-border loans and deposits remain small relative to domestic ones. Such a heterogeneity may influence the effect of the common monetary policy across countries as it notably depends on how it is transmitted to sovereign yields, banking interest rates, stock prices, credit supply, wages… The aim of this paper is to assess whether the transmission of monetary policy set by the ECB is heterogeneous across Euro area (EA) countries and to document the potential sources of heterogeneities.

The issue of asymmetric monetary policy transmission has been dealt with at the early stage of EMU.[1] It was generally recognized that the effect of monetary policy was different. This literature has not developed further except through papers dealing with the transmission of monetary policy on the retail-banking interest rates.[2] The outbreak of the financial and the sovereign debt crisis has renewed interest on that issue emphasizing the role of financial fragility and the impact of the crises on the pass-through of changes in the policy rate.[3]

In this paper, we try to provide a different perspective on the issue of the heterogeneity of the transmission of monetary policy transmission in the euro area. In an introductory step, we quantify the effect of the ECB monetary policy on GDP and inflation for a sample of 9 countries.[4] We find that the effects of ECB policy decisions are extremely heterogeneous with GDP impacts that vary by a factor of three and inflation impacts by a factor of five. The main contribution of this paper is therefore to examine the potential sources of this heterogeneity. Two natural candidates are put forward. First, although monetary policy is common to the whole euro area, the stance of monetary policy may be different for each country based on different inflation and output dynamics. In more technical terms, monetary shocks orthogonal to euro area aggregate inflation and output could be different from monetary shocks orthogonal to country-specific inflation and output. The shocks hitting each economy could therefore be different even if the policy decision is common to all countries. Second, the transmission mechanism could be different because of various market structures, institutional set-ups or economic agents' preferences, among other factors.

To that end, we first estimate country-specific monetary shocks and compare their effects on the respective country to the effect of aggregate monetary shocks. Second, we estimate the effects of monetary policy on a set of variables capturing the key mechanism of different transmission channels. Thus, we are able to not only quantify the effect of the specific stance of monetary policy in each country, but also document which transmission channels matter and how much.

Since monetary policy responds to activity as well as to a range of other economic and financial variables, the estimation of the monetary policy effect cannot be made by directly regressing GDP on the monetary policy instrument. The multiplier measure initially requires the identification of exogenous monetary policy shocks for the euro area. The impact of monetary policy is then measured for each EA countries by the local projections method proposed by Jordà (2005), which consists of estimating the response function at different horizons to previously identified shocks on inflation, output and several variables capturing the role of the transmission channels.

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[1] See the collection of papers edited by Angeloni et al. (2003) and notably the contribution of Mojon and Peersman (2003).
[2] See Andries and Billon (2016) for a survey.
[3] See Ciccarelli et al. (2013), Blot and Labondance (2013), Leroy and Lucotte (2015) and Creel et al. (2016).
[4] Burriel and Galesi (2018) have recently provided an analysis on the effect of conventional and unconventional measures on output and prices of EA countries resorting to Global VAR.

We find that the ECB monetary policy has heterogeneous impacts on both inflation and output in the Euro area. Our first finding is that the effects of ECB policy decisions are extremely heterogeneous with GDP impacts that vary by a factor of three and inflation impacts by a factor of five. We provide original empirical evidence that country-specific monetary shocks (policy rate variations that are orthogonal to country's inflation and output) have similar impacts on inflation and output than aggregate monetary shocks (policy rate variations that are orthogonal to Euro area's inflation and output). Our results suggest that the differences in the effects of monetary policy stems from different transmission mechanisms.

The rest of this paper is organized as follows. Section 2 presents the empirical methodology. Then, we assess the impact of monetary policy on GDP and inflation. Section 4 investigates one source of heterogeneity: the nature of shocks hitting each economy. Section 5 examines another source of heterogeneity, about the transmission mechanisms, by analysing the impact of monetary policy on several variables capturing each different transmission channels. Section 6 concludes.

2. The empirical methodology

The effect of monetary policy decisions on economic activity is captured by the following relation:

$$y_{j,t} = \alpha + \beta_j(L).\, i_t + \epsilon_{j,t} \qquad (1)$$

where $y_{j,t}$ represents the level of activity for country (j) an time (t) and i_t the instrument of monetary policy in the euro area. Parameter $\beta_j(L)$ stands for the multiplier effect of monetary policy at each date. It accounts for the potential delay in the transmission of monetary policy.

The estimation of equation (1) with monthly or quarterly data does not, however, make it possible to correctly measure the monetary multiplier, $\beta_j(L)$, due to simultaneous interrelationships and potential bias of omitted variables. For instance, the central bank may decide to change the stance of monetary policy in response to a change in asset prices earlier in the month or quarter that may influence the economic outlook. Alternatively, the monetary policy decision and the economic situation could react simultaneously to macroeconomic news (captured here by εₜ) published earlier in the period. It should also be taken into account that the monetary authorities determine the direction of monetary policy according to their anticipation of growth. For example, a negative demand shock - a drop in asset prices, for example - results in both a decline in activity and in the central bank's interest rate, which seeks to cushion the negative shock and responds with a monetary policy more expansionary. The estimate $(\widehat{\beta_j})$ of the parameter (β_j) in equation (1) is then biased and will be underestimated. It captures imperfectly the positive effect of the fall in the interest rate on activity since it is also affected by a negative shock. In the event that the monetary policy manages to stabilize the activity perfectly, there would be no ex-post relationship between the monetary policy instrument and the target variable even though it was entirely effective in stabilizing the shock would have resulted in a drop in GDP if the central bank had not lowered its interest rate. Put another way, $(\hat{\beta} = 0)$ whereas the theory predicts that β is significantly negative. In all cases, the basic assumption of regression (1) that the residual term (ϵ_t) is orthogonal to (i_t) is breached, which may bias the estimate of GDP elasticity to the monetary policy instrument.

The economic literature has proposed several ways to take into account, at least partially, these problems. One option is to estimate a VAR (self-regressive vector) model that includes the monetary policy instrument and the relevant macroeconomic variables. The VAR modeling makes it possible to identify, according to certain hypotheses - generally resulting from a Cholesky decomposition - monetary policy shocks. The problem with this approach is that the recursive identification restrictions do not allow the integration of financial market variables. Indeed, when the VAR model incorporates

at least two financial variables, it is difficult to assume that one - the exchange rate - is more exogenous than the other - for example stock prices. In addition, this method imposes a weak structure on the dynamics of the model, which requires a large number of observations to correctly estimate all the parameters, but a strong constraint on the restrictions allowing the identification of the structural shocks. Cochrane and Piazzesi (2002) and Faust, Swanson and Wright (2004) suggest an identification procedure based on the use of high-frequency data for which the risk of simultaneity and the bias of omitted variables is greatly reduced. Rigobon and Sack (2004) propose an identification procedure based on heteroscedasticity identified on the financial markets. The major disadvantage of these two methods is that they do not allow to analyze the effect of monetary policy on low-frequency variables, but only high frequency, that is to say essentially the reaction of financial variables.

In theory, the instrumental variables method also makes it possible to measure the causal impact of one variable on another. However, identification is based on the use of a third variable, the instrument, which must be correlated to the explanatory variable and not correlated to the explained variable. In the case of monetary policy, and because of the very strong interdependence between the interest rate and the GDP, there is no variable that satisfies this dual condition and can be used for a satisfactory instrument. This method is therefore almost never used in the literature related to monetary policy.

2.1. Estimating monetary shocks

Here, we resort to a semi-structural approach consisting in the representation of the central bank's reaction function that determines the policy rate and isolating the non-predictable (exogenous) component of monetary policy. The aim is to remove the endogenous contribution of the monetary policy instrument. To this end, it must be ensured that the usual determinants of monetary policy decisions have been taken into account and that their contribution has been subtracted. To that end, we estimate the following equation:

$$i_t = \theta + \rho . i_{t-1} + \gamma . X_t + \epsilon_t^{MP} \quad (2)$$

Equation (2) includes a delay in the monetary policy instrument as well as a vector X_t including inflation and the output gap, inflation and growth expectations of private agents, the price of oil , a financial stress indicator and the benchmark stock index of the area. The residual ϵ_t^{MP} is thus by construction the exogenous component of the evolution of the monetary policy instrument, orthogonal to the systematic component that reflects the endogenous response of monetary policy to the evolution of macroeconomic and financial variables. The purpose of this estimate is not to estimate a parsimonious relationship that would identify the key determinants of the central bank's response function. Rather, the aim is to obtain the best in-sample forecast of the monetary policy instrument taking into account all available information so that the residue ϵ_t^{MP} is the least predictable possible.

The inclusion of a delay responds to the logic of smoothing the monetary policy decisions that central bankers implement in order not to surprise too much the financial markets. The inclusion of inflation and the output gap relates directly to both the central bank mandate and the underlying economic theory described by Taylor's (1993) rule. The expectations of private agents make it possible to take into account three aspects of the monetary decision process: central bankers tend to react to future changes in the state of the economy and want to respond to private expectations. Finally, if the set of information available to the central bank and private agents is different, the monetary shock, ϵ_t^{MP}, estimated solely on the basis of information from the central bank could be predictable by the information of the central bank. private agents, which would not solve the endogeneity bias described above. The price of oil is a good indicator of future inflationary pressures and allows for imported inflation. A financial stress indicator and the stock market index are useful for measuring the central bank's response to a financial crisis.

The equation is estimated for the euro area as a whole to represent the reaction function of the ECB between 1999-Q1 and 2018-Q2. The estimate therefore covers a period during which the ECB was confronted with the Zero-to-zero (ZLB) constraint and implemented measures described as unconventional, including asset purchase programs allowing them to influence the long end of the yield curve. The overnight rate is therefore an imperfect indicator of the stance of monetary policy from the end of 2008. However, some measures allow the calculation of an implicit rate (shadow) of monetary policy - the value of which can then be negative - taking into account these unconventional measures. The calculation of these indicators is based on the term structure of interest rates. We use here the rate proposed by Wu and Xia (2016) for the euro area. A positive monetary shocks (ϵ_t^{MP}) at date (t) reflects the fact that monetary policy was more restrictive than macroeconomic conditions would have required at that time. to what is suggested by a reaction function reflecting the average behaviour of the monetary policy committee over the entire period.

The proposed approach assumes that the residuals of equation (2) satisfy certain conditions and in particular that the monetary shock is unpredictable, or otherwise said to be independent of other variables or economic shocks. We first evaluate whether the monetary shock is self-correlated and therefore predictable by its past values. For the euro area, the autocorrelation parameters of order 1 and 3 is respectively 0.14 and -0.13. We then assess the extent to which monetary shocks are predictable. We therefore regress them on a set of variables available in the previous period. This set includes inflation, GDP growth rate, GDP, inflation and growth forecasts, the monetary policy rate, the oil price, a financial stress indicator, the stock market index and the rates. 10-year sovereign bonds. The F-stat of this empirical model tells us about the predictive power of these variables to explain the independent variable. In our case, the p-value associated with this F-stat is 0.67, suggesting that monetary shocks are independent of the variables considered and can be used to estimate the causal effect of monetary policy.

In order to assess the dynamic effect of monetary policy, Romer and Romer (2004) and Coibion (2012) suggest substituting the static monetary shock with a dynamic measure. We therefore calculate the cumulative sum, ϵ_t^{MP}, of monetary shocks since January 1999. This cumulated sum depicts the evolution of the exogenous component of the monetary policy tool over time. In other words, this cumulative measure retraces the dynamics of the policy rate (or implicit after 2009) conditional on its endogenous fluctuations and the information set of the monetary policy committee including the macroeconomic and financial variables included in equation (2) (see figure 1).

Figure 1. Monetary policy shock in the Euro area, ϵ_t^{MP} and ϵ_t^{CMP}
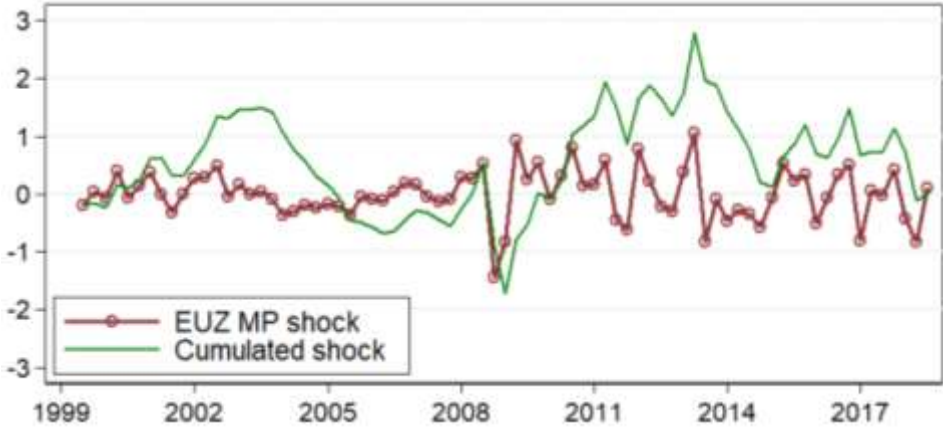
Note: The y-axis is in percentage points. Residuals from equation (2) are estimated by OLS from 1999-Q1 to 2018-Q2. Monetary policy is measured by the shadow rate estimated by Wu and Xia (2016). Source: authors' estimation.

Since the properties of the instrument that allows identification, i. e. the monetary shock, are satisfactory, we can estimate the equation (3):

$$y_{j,t} = \alpha + \beta_j . \epsilon_t^{CMP} \quad (3)$$

where the monetary shock ϵ_t^{CMP} is used as an instrument to measure the causal effect of monetary policy, i-e the effect of a rise in the monetary policy rate on GDP of each euro area country $(y_{k,t})$. The effect of monetary policy is therefore identified by its exogenous component. In a situation where the monetary policy instrument would react exactly and only to macroeconomic and financial developments and the residue ϵ_t^{CMP} would be zero, then the identification of the causal effect of monetary policy would be impossible. It is these inexplicable deviations from macroeconomic and financial conditions that allow for an unbiased measure of the effect of monetary policy. The literature sees these deviations as monetary policy errors or changes in preferences of central bankers.

2.2. Dynamic elasticities

Equation (3) allows the estimation of the contemporary effect of monetary policy on GDP for EA countries. The impact of monetary policy on the country-inflation is also estimated with equation (3). The literature has shown that monetary policy is not transmitted instantly to the real economy. The delay in transmission to GDP is around 18-24 months (see Bernanke and Blinder, 1992, or Bernanke and Mihov, 1998). At least two methods measure the dynamic effect of an economic shock: the autoregressive vector models (VAR) and the local projections proposed by Jordà (2005). The advantage of the second method over the first is that it offers more flexibility and requires a lower number of degrees of freedom. It is also more robust to poor specification of the underlying model, because it requires fewer assumptions about dynamic relationships between dependent and independent variables. It is used by Cloyne and Huertgen (2016) or Tenreyro and Thwaites (2016), among others, to estimate the dynamic effect of monetary policy.[5] The Jordà method (2005) requires the estimation of a series of k regressions for each horizon and each country (*j*), the estimated coefficient $\beta_{j,k}$ representing the response of the dependent variable, the GDP and the inflation rate of country (*j*), at horizon k to a given exogenous shock at the time t, the cumulative shock of monetary policy ϵ_t^{CMP} here. Equation (4) is therefore estimated k times for each country, one for each horizon k, as follows:

$$y_{j,t+k} = \alpha_{j,k} + \beta_{j,k} . \epsilon_t^{CMP} + \epsilon_{j,t+k} \quad (4)$$

The key assumption of this method is that the monetary shock thus identified no longer includes any information common to both GDP and interest rate so that the specification does not require assumptions about other macroeconomic relationships and / or to take into account other shocks affecting the economy. An alternative equivalent to equation (4) would be to identify the structural model of GDP including its determinants: potential growth plus budget shocks, financial variables, oil, foreign exchange, etc. However, the omission of these variables, which are relevant for predicting GDP, would only affect the estimate of the parameter $\beta_{j,k}$ if and only if the monetary shock is correlated with the residue $\epsilon_{j,t+k}$, that is, whether the information set used in equation (2) is incomplete. If this were the case, then the residues of equation (4) would be auto-correlated.

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[5] This method is also widely used to measure the impact of fiscal policy. See Owyang et al. (2013) or Auerbach and Gorodnichenko (2013).

3. The heterogeneous monetary policy transmission in the Euro area

We estimate equation (4) for 9 EA countries and for ($k = 0, … , 16$) since 1999 to assess whether monetary policy transmission to the GDP and the inflation rate is asymmetric.[6] Results are synthetized in figures 2-3-4 for the GDP and in figures 5-6-7 for the inflation rate.[7]

3.1. The GDP response to monetary policy

Figure 2 shows the response of the EA-GDP (black-solid line) while the blue area represents the interval of the response for the 9 EA countries. The upper and the lower bounds indicate the maximum effect and the minimum effect estimated. For the euro area as a whole, the peak effect is after 7 and 8 quarters confirming the long transmission delays of monetary policy. It must yet ne noticed that the effect is significant from the 2nd to the 10th quarters after the shock. The large area between the larger and the weaker effect suggest an important heterogeneity among EA countries.

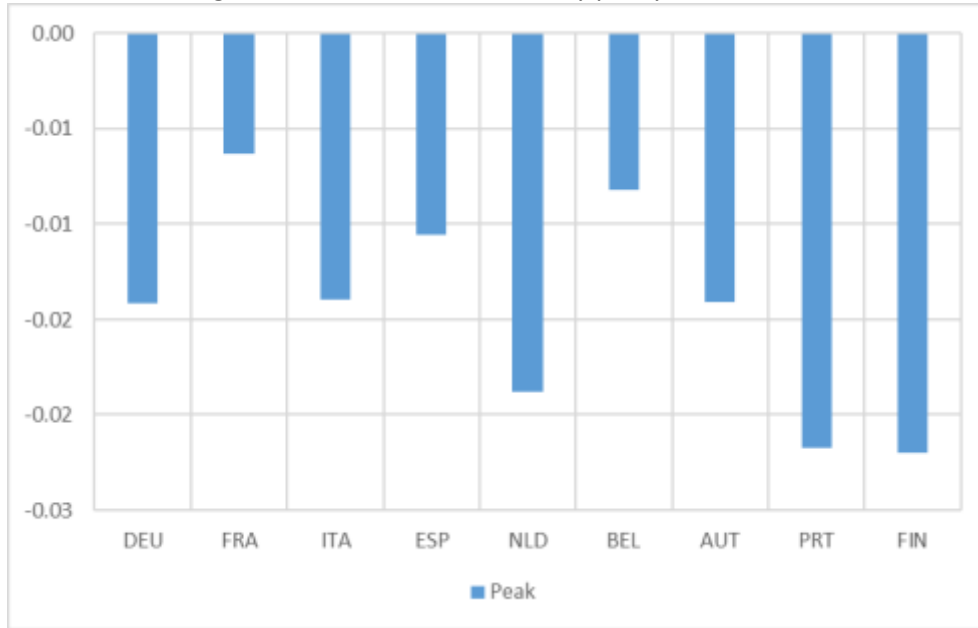Figure 2. Response of the GDP to a monetary policy shock in the EUZ
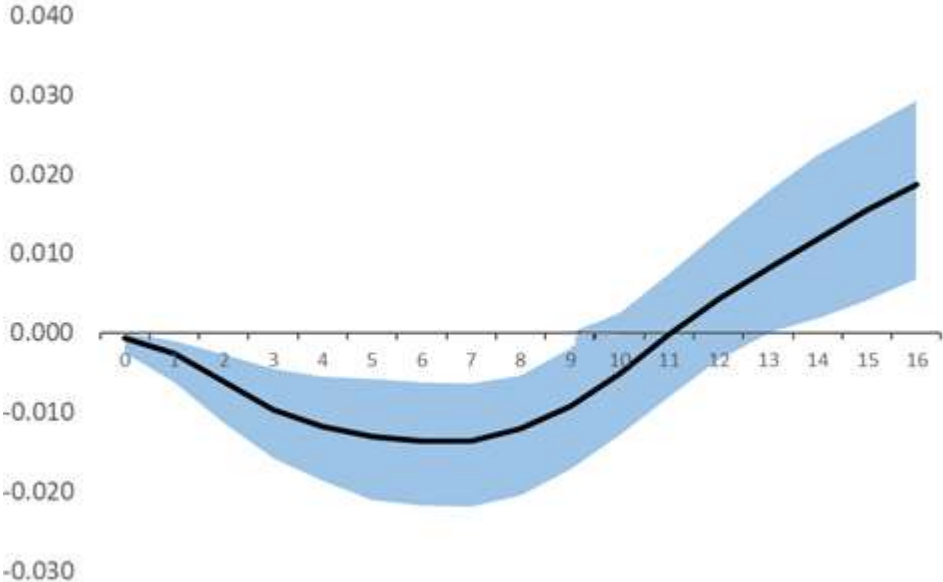
Source: authors' estimations.

The impact of the ECB monetary policy decisions would be larger in the Netherlands, Portugal and Finland and weaker in France and Belgium. Compared to Germany, the peak effect is 1.6 larger for Finland, 1.5 for Portugal and 1.3 for the Netherlands. It is roughly equivalent in Italy and Austria and 1.3 weaker in Spain and 2.2 weaker for France (figure 3). The 3-year cumulative effect of monetary policy confirms the hierarchy between EA countries (figure 4).

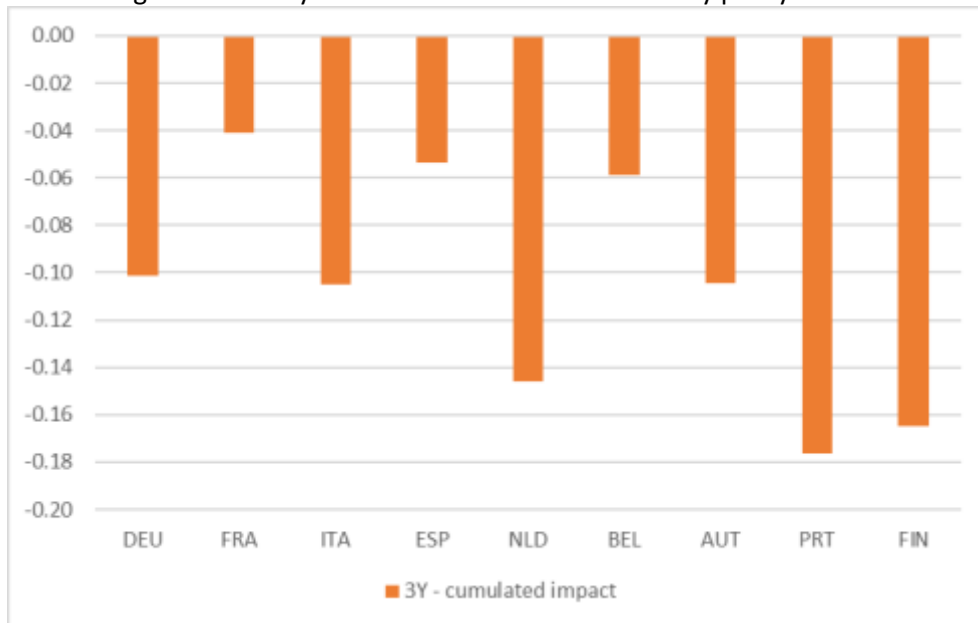[6] Germany, France, Italy, Spain, the Netherlands, Belgium, Austria, Portugal, Finland.
[7] See appendix for the detailed impulse response for each country.

Figure 3. Peak effect of monetary policy on the GDP

Source: authors' estimations.

Figure 4. The 3-year cumulated effect of monetary policy on GDP

Source: authors' estimations.

3.2. The inflation response to monetary policy

Turning to the inflation rate, Figure 5 also shows the response of the EA-GDP (black-solid line) with the maximum and minimum country effect at each horizon k. It illustrates that there is also heterogeneity in the response of the inflation rate among EA-countries. For the euro area as a whole, the peak effect for inflation is reached 9 quarters after the shock. Besides, the effect is less significant than for the GDP since it is only significant at the 5% level for quarters 8-9 and 10.

Figure 5. Response of the inflation rate to a monetary policy shock in the EUZ
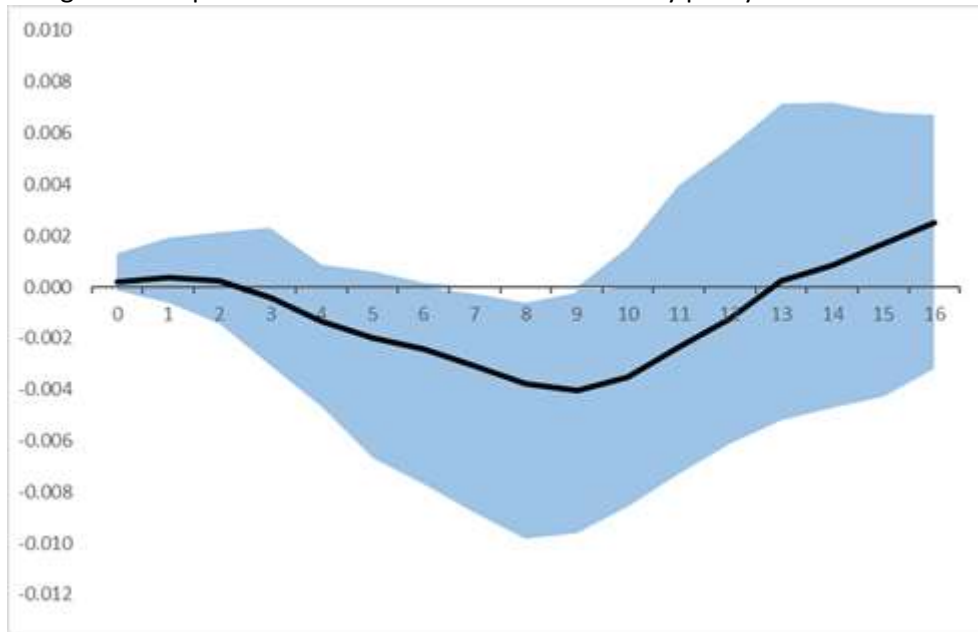
Source: authors' estimations.

For inflation, the peak effect is gain larger for Finland (figure 6). However, the impact of the common monetary policy on the inflation rate are the weakest for Portugal and the Netherlands. Compared to Germany, inflation responds less to monetary policy in France and Italy but more for Spain. Though inflation is measured with CPI rather than with the GDP deflator, those results provide information on the impact on nominal GDP and on the share between price and quantity effects. Our results suggest here that price and quantity effects would be large for Finland. For Portugal and the Netherlands, the quantity effect is large but not the price effect. For the Netherlands, the 3-year cumulative is even positive (figure 7).

Figure 6. Peak effect of monetary policy on the CPI inflation rate
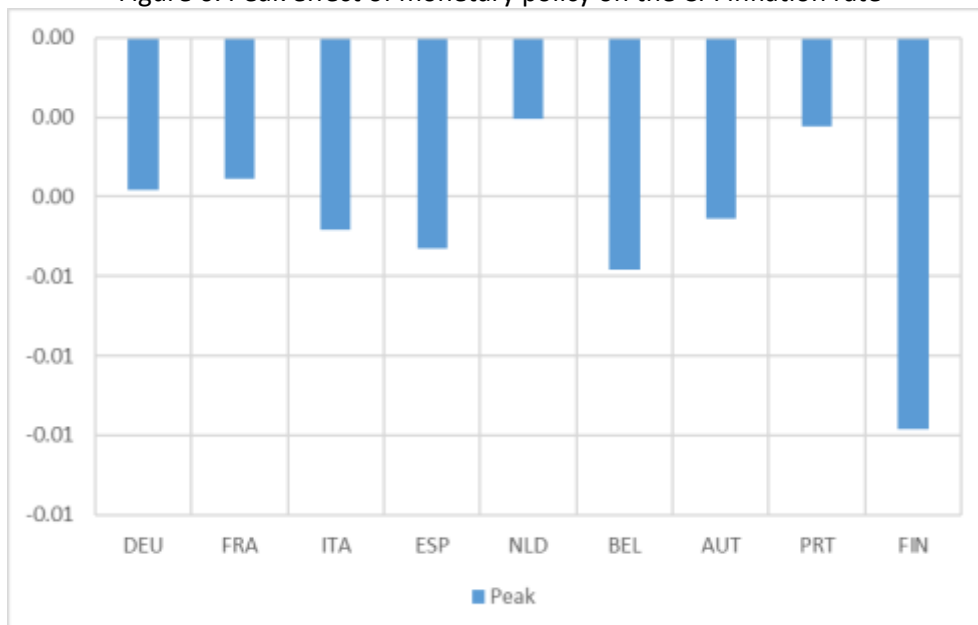
Source: authors' estimations.

Figure 7. The 3-year cumulated effect of monetary policy on GDP
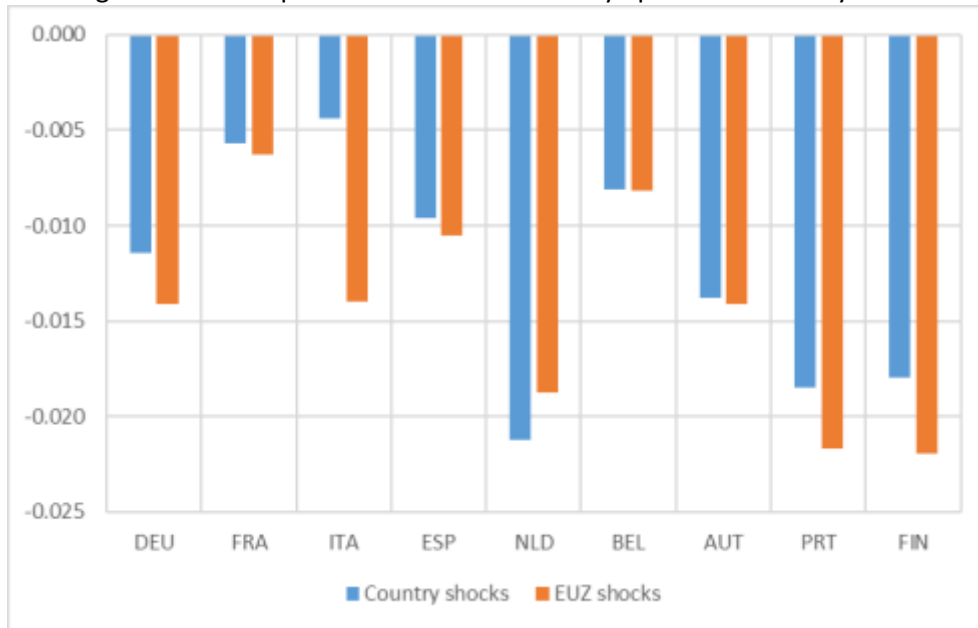

Source: authors' estimations.

4. The heterogeneous shocks hypothesis

The results indicate that there is still some degree of heterogeneity of the impact of monetary policy among EA countries. Yet, it is not clear whether the heterogeneity stems for an asymmetric different transmission or if it is due to the heterogeneity of shocks. The shocks from with equation (2) are residuals from an equation estimated for the Euro area as a whole. It is fully justified by the fact that the ECB is supposed ensure macroeconomic stability for the euro area and should then decide on the stance of monetary policy based on the economic situation of the euro area. However, such a rule may induce different shocks in EA countries. Let's suppose that inflation and output are higher in Germany than in the Euro area. Then a reduction in the interest rate justified by the economic situation of the Euro area is an expansionary monetary policy shock for Germany. Consequently, it may be that the transmission channel of monetary policy is the same across countries but that due to different economic outlook the stance of the common level of the policy rate induces asymmetric monetary shocks. Therefore, we may compute "country-specific" monetary policy shocks by correcting the EA shock by the difference between EA inflation and GDP and country inflation and GDP. Those shocks are then simply calculated as follows for each country (j):

$$\epsilon_t^{MP-j} = \epsilon_t^{MP-EUZ} + \widehat{\beta_\pi}.\left(\pi^{EUZ} - \pi^j\right) + +\widehat{\beta_y}.\left(y^{EUZ} - y^j\right)$$

Then, equation (4) is estimated with the cumulated "country-specific" shocks instead of the common monetary policy shock. The peak effect for GDP would be larger when we consider the common shocks for all countries but the Netherlands. We may also notice that differences are quite small except for Italy, where the impact estimating with a "country-specific" shock is 3.2 weaker than the one estimated with the common shock. For inflation, differences are also generally small except for Italy.

Figure 8. GDP response to EA versus "country-specific" monetary shock

Source: authors' estimations.

Figure 9. Inflation response to EA versus "country-specific" monetary shock
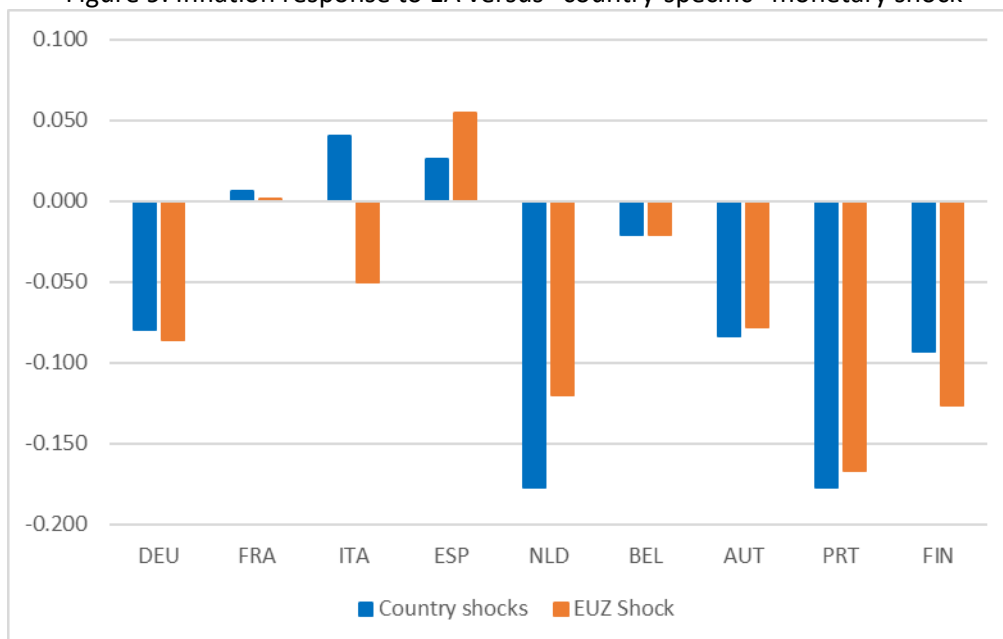
Source: authors' estimations.

5. Inside the black box: the heterogeneous transmission hypothesis

The next step is to document the sources of heterogeneity. To that end, we resort to the same empirical approach but instead of assessing the impact of monetary policy shocks on GDP and inflation, we estimate the impact of shocks on several variables capturing the transmission channels of monetary policy. The literature on monetary policy generally identifies four main transmission channels: the interest rate channel, the credit channels (credit and balance sheet channels), the asset price channel and the exchange rate channel. To assess the relative importance of each channel, we select several variables capturing the effect of monetary policy.

[To be added]

Five monetary policy transmission mechanisms are studied:
- interest rate channel
- credit channel (balance-sheet and credit channels)
 -asset price channels
- exchange rate channel

We assess the Impact of monetary shocks on:
- domestic demand (C+I) versus net external demand (X/M)
- 10-year sovereign yield, retail banking interest rates (Households and non-financial corporations), spread (retail – 10-year sovereign)
- credit to households and non-financial corporations (flows or outstanding amounts), households and non-financial corporations' debt (or net financial wealth)
- stock prices, house prices
- the exchange rate (real effective)

6. Conclusion

[To be added]

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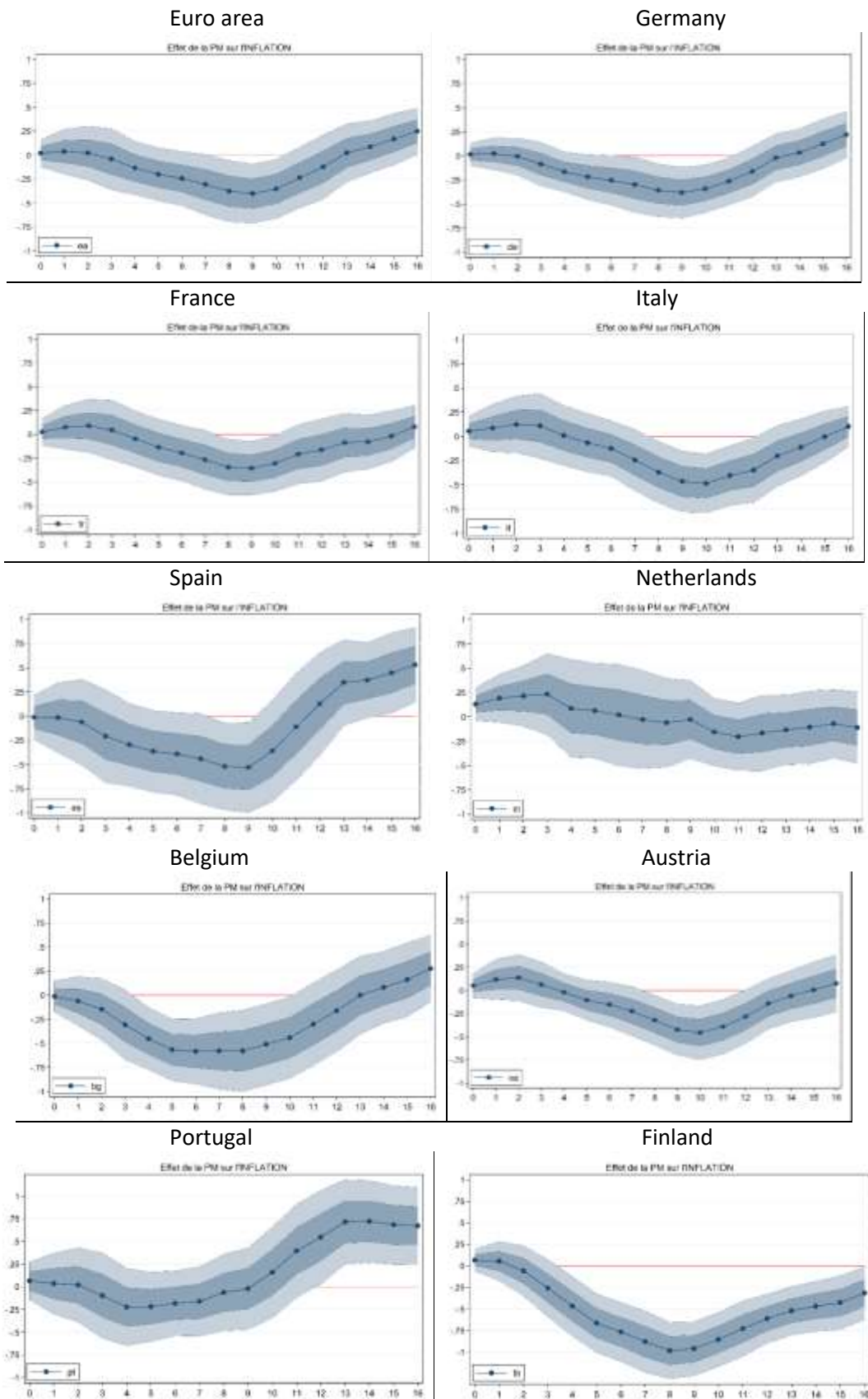
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Appendix 1. EA and country impulse response functions - GDP
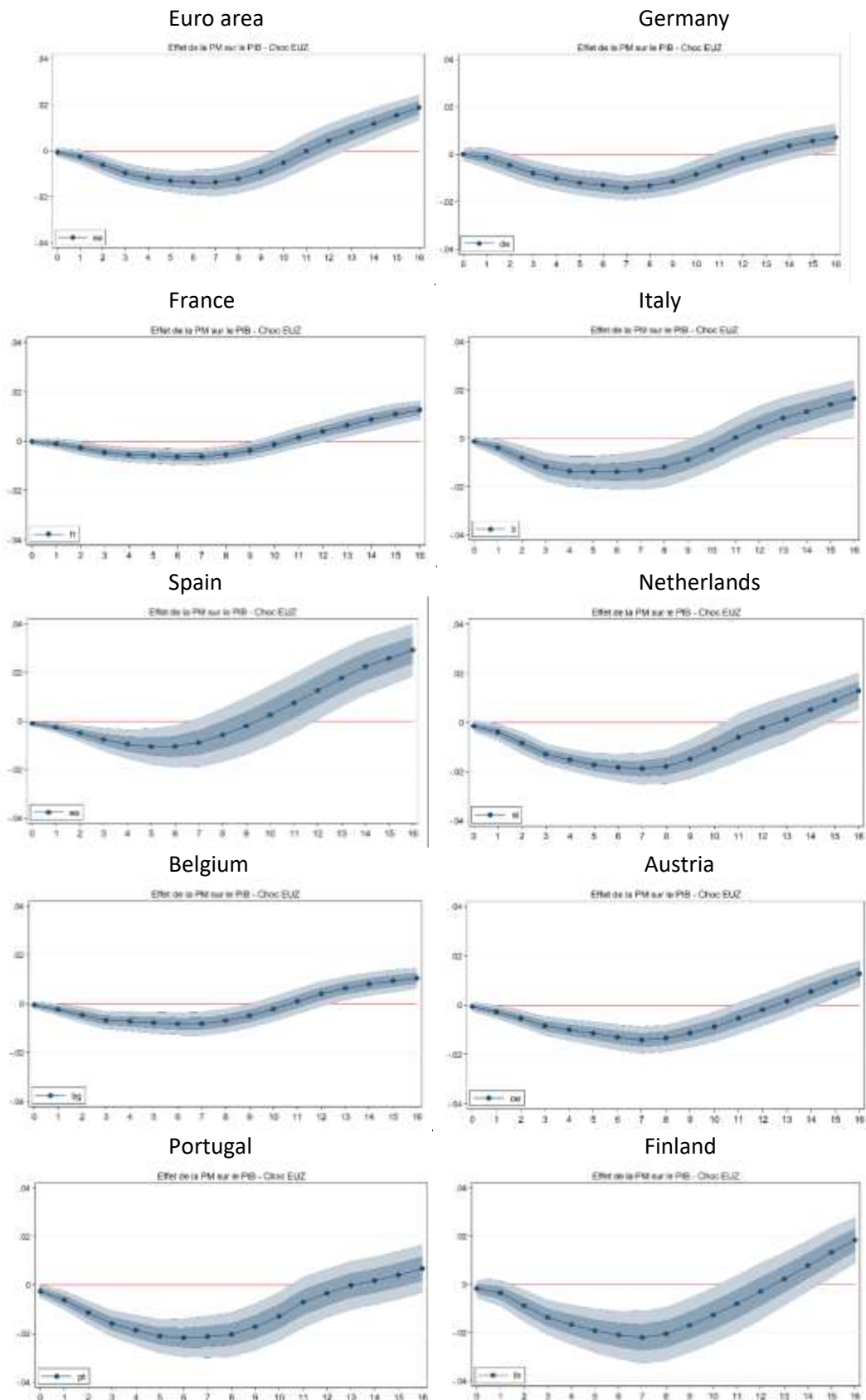
Euro area	Germany

France	Italy

Spain	Netherlands

Belgium	Austria

Portugal	Finland

Note: Response functions are estimated with equation (4) up to k=16. Each point stands for the GDP response at the horizon k after a one-point increase in the interest rate. Confidence intervals are at 68 and 95% respectively. Source: Authors' estimations.

Appendix 2. EA and country impulse response functions - Inflation

Euro area

Germany

France

Italy

Spain

Netherlands

Belgium

Austria

Portugal

Finland

Note: Response functions are estimated with equation (4) up to k=16. Each point stands for the GDP response at the horizon k after a one-point increase in the interest rate. Confidence intervals are at 68 and 95% respectively. Source: Authors' estimations.