Effects and Spillovers of ECB Conventional and Unconventional Monetary Policy*

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Abstract

This paper studies the effects of ECB conventional and unconventional monetary policies –including Covid-19– on the European Monetary Union (EMU) and spillovers to the European Economic Area (EEA), Canada, Japan, Switzerland, UK and US. ECB monetary policy shocks are identified as daily shifts in the entire yield curve around monetary policy announcements. By observing the responses of industrial production, inflation and exchange rates we have three main results. First, in the EMU, both conventional and unconventional policies move industrial production and inflation as theory predicts; yet, the effect in unconventional times crucially depends on the reaction of the whole yield curve. Second, spillovers of ECB policies to non-EMU countries are significant, especially for the EEA. Third, the uncovered interest parity condition holds both in conventional and unconventional times: a monetary policy easing generates an expected future appreciation. Interestingly, the exchange rate regime is not relevant.

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KEYWORDS: ECB Monetary Policy, Yield Curve, Uncovered Interest Parity Condition

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1 Introduction

In the wake of recent economic crises (Global financial crisis, Sovereign Debt crisis and Covid-19 crisis), the European Central Bank (ECB) intervened with conventional and unconventional measures aiming at supporting the economy and restoring the transmission mechanism of monetary policy. All these measures, directly or indirectly, wanted to ease credit conditions, but each in a different way. While conventional tools focused on short-term maturities, unconventional ones targeted longer ones, being the overnight-refinancing constrained by the zero lower bound. Additionally, similar measures had very different effects on the yield curve depending on the information content of their announcement. As a result, monetary policy shocks over the last 20 years caused very heterogeneous movements of the yield curve. This paper contributes to the literature by studying the domestic and international effects of ECB's monetary policy when accounting for the entire reaction of the yield curve. Distinguishing apparently similar shocks turns out to be crucial.

Traditionally, conventional monetary policy shocks have been identified as exogenous changes in the short-term interest rate (e.g. Romer and Romer (2004) and Christiano et al. (2005)) or the difference between the expected and realized current (or future) interest rate around the policy announcement (e.g. Kuttner (2001) and Gürkaynak et al. (2005)). However, after the implementation of non-standard tools and given that the short-term interest rate has been stuck at zero, researchers have relied on alternative ones: one year government bond rates (Gertler and Karadi (2015)), changes of interest rates at longer maturities (e.g. Swanson and Williams (2014)) or shadow interest rates (e.g. Wu and Xia (2016)). Though, given that monetary policy announcements impact contemporaneously short and long term yields, have heterogeneous information content and affect agents' expectation on future rates, each shock, although similar, can have really different economic effects. To account for this, we implement the high frequency identification strategy developed by Inoue and Rossi (2021) on ECB monetary policy decisions. A monetary policy shock is identified as a shift in the whole yield curve around ECB announcements. Specifically, it is calculated as the difference between the yield curve at the end of the day of the announcement and the yield curve at the end of the day before.[1] This has the important advantage to allow us to distinguish the effects across different crises and across apparently similar policy measures.

[1]For announcements made overnight, as happened during the Covid-19 crisis, we consider the yield curve at the end of the day after the announcement with respect to the end of the day of the announcement.

We focus on the 2004-2021 period for both EMU and non-EMU countries, including European and extra-European ones. The aim of the paper is threefold: first, to examine the economic effects of ECB monetary policy shocks during conventional and unconventional periods (COVID-19 pandemic crisis period included). Our focus is on the response of industrial production, inflation and exchange rate. Second, within each period, to investigate possible differences among similar unconventional shock, by focusing on the characteristics of the shift in the yield curve. Third, study if ECB monetary spillovers to the European Economic Area countries (EEA) are different than to countries outside the European Project. In the sample of countries we have included: all EMU countries, five advanced countries that are not currently part of the EEA (Canada, Japan, Switzerland, United Kingdom and United States), a set of European Union (EU) countries (Denmark, Bulgaria, Hungary, Romania, Poland, Czech Republic, Sweden, Croatia), and two countries that are part of the EEA but not of the EU (Norway and Iceland). We are clearly not the first one to study the effects of ECB unconventional policies (see, for example, Neri and Siviero (2019); Gürkaynak et al. (2020); Rostagno et al. (2019); Altavilla et al. (2021)) but, to our knowledge, we are the first one studying broadly the domestic and international effects of ECB's monetary policies accounting for the entire behavior of the yield curve.

We have three main findings. First, the effects of ECB conventional and unconventional policies within the EMU are in line with standard theory: a tightening shock generates a decline in inflation and output while the opposite due to an expansionary shock. Yet, during unconventional period, the effects strongly depend on the way the announcements impact the yield curve. Second, spillovers of ECB policies to non-EMU countries are important, especially for the EEA; the relevant yield curve for the euro area exchange rate is the AAA-rated euro area bonds. Third, the uncovered interest parity condition holds both in conventional and unconventional times: a monetary policy easing generates an expected future appreciation. We show, interestingly, that the exchange rate regime is not a distinguishing feature for the reaction of the euro exchange rate.

The paper is structured as follows. Section 1 describes the empirical approach. Section 2 presents the empirical results on the effects of ECB monetary policy on the macroeconomic variables considered. Section 3 discusses the robustness of the results.

Related literature

Our paper relates to several strands of empirical literature studying the impact of central banks' monetary policy on macroeconomic variables. While FED's monetary policy has been extensively studied through the years (see Clarida and Gali (1994), Eichenbaum and Evans (1995), Faust and Rogers (2003), Uhlig (2005), Scholl and Uhlig (2008), Glick and Leduc (2012), Gambacorta et al. (2014), Rogers et al. (2014), Meinusch and Tillmann (2016) among others), ECB's monetary policy has only recently become more prominent (see Lenza et al. (2010),Cour-Thimann and Winkler (2012), Szczerbowicz (2015), Georgiadis and Grab (2015), Andrade and Ferroni (2016), Altavilla et al. (2016), Jäger and Grigoriadis (2017), Altavilla et al. (2019), Neri and Siviero (2019),Gürkaynak et al. (2020), Rostagno et al. (2019),Rostagno et al. (2021) among others). We want to contribute to this latter stream of literature assessing the effects of ECB monetary policy during conventional, unconventional and COVID-19 pandemic periods on three macroeconomic variables: exchange rate, inflation and output. To do this, we identify monetary policy shocks following the approach presented by Inoue and Rossi (2018). They compute monetary policy shocks as shift in the US yield curve around the day of FED monetary policy announcements. Then, they use this methodology to evaluate the impact of the shocks on US inflation and industrial production Inoue and Rossi (2018), and US exchange rate Inoue and Rossi (2019). We rely on their identification strategy and apply it to the European framework, conducting a comprehensive analysis of ECB monetary policy effects.

The second aim of this work is to investigate the existence of ECB monetary policy spillovers (see Qianying Chen and Andrew Filardo and Dong He and Feng Zhu (2016),Tillmann (2016), Peter McQuade, Matteo Falagiarda, Marcel Tirpák (2015), Gräb and Żochowski (2017), Anaya et al. (2017), Fadejeva et al. (2017), Benecka et al. (2018) among others). Bluwstein and Canova (2016) show differences in responses among advanced and CESEE economies. ECB expansionary monetary policy shocks affect output negatively in SEE economies, while positively in advanced countries and even stronger than in euro area. Inflation responses display the opposite effects: in CESEE economies there is an inflation's increase, while it decreases in advanced ones. Also Fratzscher et al. (2016) find heterogeneity in the results for advanced, emerging EU and other emerging economies in studying the effects of euro exchange rates. They show that announcements related to the Security Market Programme (SMP) led to a depreciation of the euro vis-à-vis advanced and emerging EU economies. Conversely, the ones related to the Outright Monetary Transactions

(OMT) caused a depreciation of the euro against emerging EU economies and an appreciation with respect to advanced and other emerging countries. Concerning announcements related to longer term refinancing operations, they overall caused a depreciation of the euro. Ciarlone and Colabella (2016) consider only ECB announcements related to asset purchases programmes and find evidence of spillover effects to CESEE countries. Their results show that these announcements caused an appreciation of CESEE currencies vis-à-vis the euro, an increase in the value of domestic stock market indices, and a moderate decline of 10-years sovereign bond yields. Moreover, their results suggest that these measures tend to positively affect portfolio flows into CESEE countries. Colabella (2019) further expand the analysis considering possible differences in responses according to countries' trade openness and exchange rate arrangements. He shows that an ECB tightening leads to a decline in GDP in CEE and SEE economies, and to a lesser extent to other advanced EU and extra European economies (as US and Japan). Furthermore, the decline in GDP is more pronounced and persistent in countries with a high level of trade openness or with a peg currency. Also a part of Potjagailo (2016)'s analysis focuses on investigating the heterogeneity of responses according to exchange rate regime. He shows that an expansionary ECB monetary policy shock raises output in most non-euro European countries, increases prices in Western Europe and euro area as well, while leads to a decline in most CEE economies. Considering the exchange rate regime, he finds that countries with an exchange rate pegged to euro show larger spillovers on output than economies with flexible regimes. The currencies of the latter appreciate against the euro, while peg currencies follow the exchange rate depreciation of euro area. Another difference is in the stronger reaction of output in countries with high trade openness (and fixed exchange rate regime) compared to countries with low trade openness. In contrast, Corsetti et al. (2021) find evidence of very similar responses of industrial production, unemployment rate, consumer prices and trade flows among countries that pursue a currency peg to euro and a floating arrangement. We find heterogeneous responses among countries analysing the effects of unconventional monetary policy on the euro exchange rates, while our results display no differences when assessing the impact on countries' inflation and output in both periods. Moreover, we find differences in the responses of peg countries, according to the type of peg (currency board, standard arrangement or De facto peg). Besides the differing results, there are several other differences with our work: first, we take into consideration all ECB announcements, regarding asset purchases, longer term refinancing operations and change in the set of collaterals, that include an element of surprise for market participants. Second, we take into consideration a very broad set of extra euro countries, comprehensive either of European and advanced extra-European economies. Third, the main difference lays in the identification of monetary policy shock: we consider the change in the whole yield curve around the day of ECB announcements. In this way, we are able to consider what happens at all maturities, short, medium and long term. Moreover, we take this change and further differentiate it accordingly with its shape. We want to understand not just the effect of monetary policy announcements, but also to see if different shapes lead to different effects.

We aim to contribute to the literature that investigates to what extent the term structure components can help predicting exchange rate movements. In Chen and Tsang (2010), the authors extract relative Nelson and Siegel (1987)'s factors from cross-country yield curve differences to proxy expected movements in future exchange rate fundamentals. Their results show that the three latent factors can predict future exchange rate changes and excess currency returns 1 to 24 months ahead. When the domestic yield curve becomes steeper by 1 percentage point relative to the foreign one, or shifts down, home currency can depreciate by 3% to 4% over subsequent months, and its excess return declines by even more. Conversely, a flatter relative yield curve or an upward shift in its level, predicts subsequent home currency appreciation and a high home currency risk premium. Their intuition is that the flattening of the yield curve is typically considered as a signal of economic slowdown, and a large level factor reflects high expected future inflation. Both of these scenarios can induce higher perceived risk associated with holding domestic currency. Following this intuition, they suggest that by including the longer maturity rates in the standard UIP regression, the UIP puzzle can disappear. The other main work is the one of Gräb and Kostka (2018). They find that a single factor, negatively correlated with the curvature factor of Nelson and Siegel (1987), is able to predict both surprise in money market rates and future exchange rate risk premia one to six months ahead. Specifically, a relative high curvature predicts a rise in short-term interest rates beyond expectations and an appreciation of home currency over one to six months horizon. Our work differs for a variety of reasons: first, it takes distance from them by directly considering the change in the yield curve to model its component using a non-parametric model (differently from Chen and Tsang (2010)). Then, we regress yields at different maturities directly on the deviation of spot exchange rates from forward rates, computed as the difference between spot and 1 year forward rates. Third, by using an high frequency (daily) approach, we can reasonably assume that on the same day the yield curves of the other countries considered had not changed due to domestic monetary policy shocks.

The data

We use two datasets of daily zero-coupon bond yields, provided by the European Central Bank, reflecting credit default risks: one sample considers only bonds issued in euro by AAA-rated euro area central governments, the second considers all euro area central government bonds. The two term structures include yields at 3 and 6 months and from 1 to 10 years maturities. We use yields of bonds issued by AAA-rated euro area governments for the estimation of our baseline, because they are more capable to assess fluctuations of euro nominal exchange rates against major currencies, i.e. US dollar, British pound, Swiss franc, Japanese yen, and Canadian dollar. Additionally, we use the dataset of all-bonds' yields for robustness and to calculate the euro area spread. Both datasets are from ECB Statistical Data Warehouse.

The macroeconomic variables in our dataset are: euro nominal exchange rates against a set of 15 European and extra-European currencies, inflation and output rates for 33 countries (EMU and extra-EMU). Inflation is calculated as the annual change in the (log) value of the Harmonised Index of Consumer Prices for all the countries taken into consideration, the data are monthly and seasonally adjusted. Output is measured by the (log) annual change of the industrial production index of all the countries of the sample - all items monthly data, except for the time series for Iceland, which doesn't include total construction. Both consumer price indices and industrial production monthly data are from Datastream, except for IP index of Canada and Japan from FRED data warehouse. For the two latter variables, the countries analysed in our work are the countries of the European Monetary Union, and a panel of 15 extra-euro countries. The extra-euro countries can be divided according to the distinction provided by Bluwstein and Canova (2016): (i) Advanced countries - Sweden, Norway, Denmark, Iceland, United Kingdom, Switzerland, Japan, Canada, and United States, (ii) Central Eastern European countries (CEE) - Poland and the Czech Republic, (iii) Southeastern European countries (SEE) - Hungary, Romania, Croatia and Bulgaria. We calculate the daily spot and forward exchange rate percentage change as the difference between the end of the day (log) value and the (log) value at the end of the previous day. The exchange rate is measured as units of foreign currency for one euro. Hence, when displaying the results, positive (negative) values represent an appreciation (depreciation) of the euro. The nominal exchange rates data used in our analysis consists of a panel of 15 currencies (British pound, Bulgarian lev, Croatian kuna, Czech koruna, Danish krone, Hungarian forint, Polish zloty, Romanian leu, Swedish krona, Icelandic krona, US dollar, Japanese yen, Canadian dollar, Swiss franc, and Norwegian krone) and are from Datastream.

We conduct our analysis over two subsamples: conventional and unconventional period. The conventional period goes from September 2004 to April 2009 (the starting date is dictated by the fact that the ECB yield curve had not been calculated before). The dates of monetary policy announcements are comprehensive of events related to changes in the minimum bid rate on the main refinancing operations, in the interest rate on marginal lending facility, and in the interest rate on marginal deposit facility. The unconventional sample starts on May 2009 and end on October 2021. The dates regarding the unconventional monetary policy announcements are from two existing papers (Ciarlone and Colabella (2016) and Peter McQuade, Matteo Falagiarda, Marcel Tirpák (2015)) with our updates. We have taken into consideration all monetary policy announcements made after a Governing Council meeting that provided innovation in the ECB monetary policy stance, together with dates related to speeches of the President and vice president of ECB in which they had disclosed new information that was likely to have a surprise effect to market participants. In some exceptional circumstances, announcements have been made after an extraordinary meeting of the Governing Council, when markets were closed. For these episodes[2], we take into consideration the change in the yield curve around the day after official announcement to properly reflect the reaction of investors to new disclosed information.

2 Empirical approach

The aim of our study is to estimate the effects of monetary policy shocks on exchange rates, inflation and output, across different periods (conventional and unconventional) and different countries (inside and outside the EMU). We do it by relying on two different methodologies. To assess exchange rate responses, we use Functional Vector Autoregressions (functional VARs) (Inoue and Rossi (2019)); while to estimate inflation and output responses, we use local projections with functional shocks

[2]The dates of the announcements made at closed markets are 18 March 2020, 7 April 2020, 22 April 2020, 4 June 2020.

(Inoue and Rossi (2018), Òscar Jordà (2005)). We have decided to use two different methodologies due to several reasons: i) the macroeconomic variables considered have different data frequency: inflation and industrial production data are monthly, while exchange rates data are daily. Moreover, we estimate the impulse responses for two different subsamples, conventional and unconventional. Especially for the conventional period, the data available for the two monthly variables (inflation and output) are very few, in fact the period comprises only 42 months (from September 2004 to April 2009). In this case, local projections are capable to provide robust estimates; ii) use a collection of projections local to each forecast horizon, instead of a VAR model, is preferable when the responses are estimated at long horizons, as in the case of our estimation of inflation and output (Òscar Jordà (2005)).

We start by describing the shock's identification methodology; next, we present the two approaches used to estimate exchange rates, inflation and output's responses.

Shock identification

It's known that the yield curve contains several information about expected inflation, growth, current and expected monetary policy actions, and about market's perception of risks. Considering that the information content of certain maturities is different, we must look at the whole yield curve to address our aim of understanding the overall effects of monetary policy. To this end, we use the methodology presented by Inoue and Rossi (2018). We identify a monetary policy shock as a shift in the whole yield curve around ECB monetary policy announcements. The shock is calculated as the difference between yield curve at the end of announcement's day and the yield curve at the end of the day before. The one-day window makes credible the assumption that during the period taken into consideration, the shock is mainly driven by monetary policy move. In fact, a narrower window will probably not be able to capture monetary policy news, since announcements of non-standard measures are often complicated and take time to be fully understood. At the same time, a wider window (as a two days window) may be biased with the effects of other shocks, and not be able to isolate the effects of monetary policy announcements[3]. Furthermore, It's useful to consider that ECB policy decisions are announced in two different steps: first, a press release containing the plain policy decision without any

[3] In some exceptional circumstances, announcements have been made after an extraordinary meeting of the Governing Council, when markets were closed. For these episodes (i.e. 18 March 2020, 7 April 2020, 22 April 2020, 4 June 2020), I take into consideration the change in the yield curve around the day after the official announcement to properly reflect the reaction of investors to new disclosed information.

explanation is published. Then, one hour later the ECB president reads the introductory statement, explaining and talking about the rationale behind the decision, informing the market participants about the future path of monetary policy. By considering a daily window, we are able to capture the market's reaction to both, i.e. to the monetary policy event as defined by Altavilla et al. (2019).

In our framework, we use the yield curve calculated by ECB that considers yields of bonds issued by AAA-rated euro area governments. The curve is composed by yields with maturities of 3 and 6 months, and from 1 to 10 years. More clearly, denote $Y_{\tau,t}$ the yield to maturity at time t, where $\tau = \tau_1, \tau_2, ..., \tau_M$ is the maturity expressed in years, and M is the number of maturities considered. Holding the assumption that, on days of monetary policy announcements changes in the yield curve are mainly caused by monetary policy actions, the shock is estimated as the change in the term structure around announcement's day:

$$\epsilon_t^{mp}(\tau) = \Delta Y_{\tau,t} * d_t$$

where $\Delta Y_{\tau,t} = Y_{\tau,t} - Y_{\tau,t-1}$ is the change in the yield curve as a function of maturity τ on day t; d_t is a dummy variable equal to one on the day of the announcement. Thus, monetary policy shock is defined as the difference between the yield curve at selected maturities on the day of announcement and yields at the same maturities on the day before.

By using this approach, we identify the very peculiarities of each shock in terms of how monetary policy actions differently influence the shape of the yield curve. As better outlined below, each monetary policy shock can be described by different movements in the term structure: the announcement can influence more short term than long term of the curve, or can mainly affect medium yields rather than the two ends, or can result in a combination of these two effects.

To better explain the methodology, let us present as an example the shock on March 12, 2020 in fig.1, where the ECB announced the unconventional measures to respond to the Covid-19 pandemic crisis. In the panel on the left, we can see the yield curve on the day before the announcement (the blue solid line) and the yield curve at the end of announcement's day (the red line with asterisks). In the second panel is illustrated the difference between the two yield curves, displaying the exact path of the monetary policy shock that would enter in my analysis. Considering that the shock is displayed as a function of the maturity (x-axis), we can see how the announcement affects the curve differently across maturities: on announcement's day, short and medium yields decrease, while the long end shifts upward. Using this approach, it is possible to highlight different effects that monetary policy actions have on the yield curve, allowing us to distinguish the characteristics of each announcement.

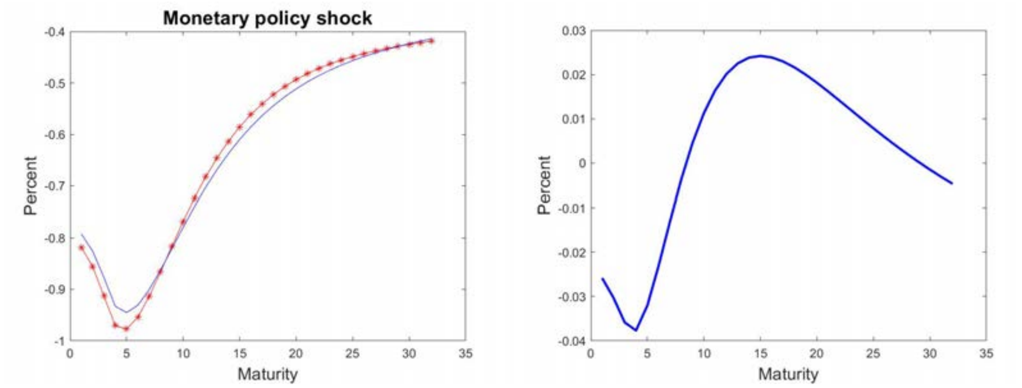


Figure 1: ECB monetary policy shock

To capture the information content of the whole yield curve, while employing a parsimonious and flexible approach, we focus on its slope and curvature. An alternative approach, proposed by Nelson and Siegel (1987) would be to use a parametric model with three latent factors, but the implementation of our methodology allows us to directly analyse the curve's movements, instead of using an approximation. When we will display the results, we will describe in depth the restrictions that we have applied, but now let us provide a visual intuition.

Starting with the slope component, we have differentiated the impact of monetary policy in two effects: steepening and flattening. To identify a steepening effect, we have imposed a positive change in the term spread (a change that is greater in the long end of the yield curve than in the short end). An example is the shock following the announcement about PEPP expansion on 4 June 2020, depicted in the first panel on the left of fig.2. It's possible to see that the announcement affects the whole term structure, and precisely, more the long end than the short one, which stays at almost the same level. In the second panel, it's represented an example of an announcement (related to TLTROs' implementation) affecting mostly the medium term of the curve, i.e. the curvature. We can see on the graph that short- and long-end of the curve are almost unaffected, the only movement that we can see is on the medium yields. In the third panel, it's displayed an example of a shock with flattening effect, representing the OMT announcement on 2 August 2012. In this case, the term spread is negatively affected, i.e. there is a negative change in the slope. The long end of the yield curve decreases more than the short one, generating a downward sloping rotation.

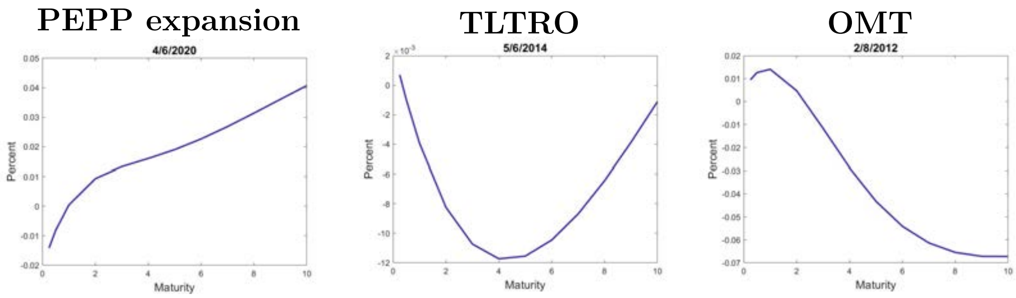


Figure 2: ECB monetary policy shocks

VAR with functional shocks

To estimate the impact of monetary policy on exchange rates, we first follow Inoue and Rossi (2018) for the identification of monetary policy shocks. As above mentioned, a monetary policy shock is defined as the combination of changes in yields at selected maturities around the day of an ECB announcement, i.e. the difference between the yield curve at the end of the announcement's day and at the end of the day before:

$$\epsilon_t^{mp}(\tau) = \Delta Y_{\tau,t} * d_t = \Delta Y_{\tau,t}^*$$

where $\Delta Y_{\tau,t}$ is the yield's change at maturity τ and time t, and d_t is a dummy variable equal to 1 on the day of a monetary policy announcement. We use an high frequency identification approach in order to make credible the assumption that on the day of the announcement, the change in term structure is mainly due to monetary policy moves. Once we have identified the shock series, we can estimate the overall effect of monetary policy event. To do it, we follow Inoue and Rossi (2018)'s functional VAR[4] and partition monetary policy shocks by applying sign restrictions to the shock series derived in the first step. We divide shocks in contractionary and expansionary for conventional period, while in shocks with steepening, flattening and curvature effects in unconventional one. The overall effect of a monetary policy event is defined as the linear combination of the product of changes in raw yields at selected maturities (the monetary policy shocks) and the partial derivative of changes in the exchange rate of country i at each horizon with respect to the yield at corresponding maturity.

[4]For further technical details about the VAR with functional shocks approach, please rely on Inoue and Rossi (2018)

Formally:

$$E\left(\Delta s_{i,t+h}\middle|\left\{Y_{\tau,t}+\epsilon_t^{mp}(\tau)\right\}_{\tau=\tau_1}^{\tau_M},I_t\right)-E\left(\Delta s_{i,t+h}\middle|\left\{Y_{\tau,t}\right\}_{\tau=\tau_1}^{\tau_M},I_t\right) \tag{1}$$

$$=\sum\nolimits_{\tau=\tau_1}^{\tau_M}E\left(\frac{\partial\Delta s_{i,t+h}}{\partial Y_{\tau,t}}|I_t\right)\epsilon_t^{mp}(\tau) \tag{2}$$

where I_t is the information set at time t, $\{Y_{\tau,t}\}_{\tau=\tau_1}^{\tau_M}$ and $\{Y_{\tau,t}+\epsilon_t^{mp}(\tau)\}_{\tau=\tau_1}^{\tau_M}$ denote the $MX1$ vector of yields before and after the shock, $E(\frac{\partial\Delta s_{i,t+h}}{\partial Y_{\tau,t}}|I_t)$ is the impulse response coefficient to a shock in the yield curve at maturity τ after h periods, where h=1,2,...,7 (in our framework, the horizon is daily). The impulse response coefficient is obtained from the estimation of a VAR with reduced form:

$$X_t=\mu+B_0+B_1X_{t-1}+...+B_pX_{t-p}+u_t \tag{3}$$

where X_t is a $nx1$ vector, $E(u_tu_t')=\Sigma$, and p=1 in our implementation. The vector X_t comprises five variables: the change in yields between the day of monetary policy announcement and the day before at maturities 3 months, 1 year, 5 and 10 years (here expressed in years); and the exchange rate daily change of country i vis-à-vis euro at time t.

$$X_t=\begin{bmatrix}\Delta Y_{\frac{1}{4},t}\\ \Delta Y_{1,t}\\ \Delta Y_{5,t}\\ \Delta Y_{10,t}\\ \Delta s_{i,t}\end{bmatrix}$$

$\Delta Y_{\tau,t}$ is expressed as the difference in raw yields at selected maturities around an announcement's day. $\Delta s_{i,t}=\Delta s_{s,i,t}-\Delta s_{f,i,t}$ is the expected exchange rate, calculates as the difference between the rates of growth of spot and forward exchange rate. Given that $s_{s,i,t}$ represents the log of spot nominal bilateral exchange rate, the rate of growth is calculated as $\Delta s_{s,i,t}=s_{s,i,t}-s_{s,i,t-1}$. It expressed as units of country i's currency for one euro, thus, positive values of the spot rate represent an appreciation of the euro against foreign currency. The same applies for the growth rate of forward exchange rate. In our results, we present the values of the expected exchange rate. Considering our calculation, positive (negative) values represent a future depreciation (appreciation) of the euro, and can be obtained in three scenarios: a major appreciation (depreciation) on impact, a depreciation (appreciation) of the spot rate followed by a bigger expected depreciation (appreciation), or an appreciation (depreciation) on impact followed by a depreciation (appreciation) of the euro.

Local projections with functional shocks

In the second part of our work, we estimate the responses of inflation and output's growth rate to a domestic[5] monetary policy shock. To this end, we follow Inoue and Rossi (2018) and use functional local projections.

As first step, we identify monetary policy shock $\epsilon_t^{mp}(\tau)$ through an high frequency identification approach as explained above. Recalling the definition, monetary policy shock is calculated as the shift in the whole yield curve around the day of a monetary policy announcement:

$$\epsilon_t^{mp}(\tau) = \Delta Y_{\tau,t} * d_t = \Delta Y_{\tau,t}^*$$

where $\Delta Y_{\tau,t}$ is the change in yields at selected maturities τ and time t, and d_t is a dummy variable equal to 1 on the day of a monetary policy announcement. Once we have identified the shock, we evaluate inflation and output responses. We estimate the variables for two sets of countries: a subset of euro zone countries, and a set of extra-euro countries. To assess the impact of ECB monetary policy shocks to inflation and output of countries that are not part of the euro zone, we estimate regression (4). Considering that euro area countries are very interrelated and the monetary policy shock impacts all of them directly, to estimate the effects on euro area's variables we add an aggregate euro-area lagged variable as control.[6]

For each country i and at each horizon h, we estimate the following regression:

$$X_{i,t+h} = \Gamma_{0,h} + \sum\nolimits_{\tau=\tau_1}^{\tau_M} \Gamma_{\tau,h}(L)\Delta Y_{\tau,t} + A(L)X_{i,t} + u_{t+h} \tag{4}$$

where $X_{i,t}$ is a $nx1$ vector, $\Delta Y_{\tau,t}$ is the change in raw yields at maturity τ expressed in years, computed as yields at time t minus yields at the previous day at given maturity. The horizon is monthly, and h=1,...18, the time lag is set equal to 2. The coefficients $\Gamma_{\tau,h}$ are the responses at each horizon to a shock in the correspondent $Y_{\tau,t}$ at time t, where τ is equal to maturities 3 months, 1, 5 and 10 years when considering conventional period, and 3 months, 5, 8 and 10 years when considering

[5] We refer to ECB monetary policy as domestic.

[6] For each country i, the control variable $Z_{i,t}$ contains the values of inflation and output of all euro area countries, except country i considered.
Precisely, we estimate the following regression:
$X_{i,t+h} = \Gamma_{0,h} + \sum_{s=1}^{k}\Gamma_{s,h}\Delta r_{s,t} + A(L)X_{i,t} + A(L)Z_{i,t} + u_{t+h}$, where $Z_{i,t}$ is the control variable.

unconventional one. The vector $X_{i,t}$ is country specific and comprises two variables: inflation and output of country i.

$$X_{i,t} = \begin{bmatrix} \Delta INFL_{i,t} \\ \Delta IP_{i,t} \end{bmatrix}$$

$\Delta INFL_{i,t}$ and $\Delta IP_{i,t}$ are expressed in annual (log) change.

Since we are using data estimated at different frequencies (the term structure is daily, while inflation and industrial production are monthly), we attribute the shock to the corresponding month. There is the possibility that in the same month ECB has announced more than one monetary policy move, in that case we compute the average of the shocks.

To correctly identify the effects the shocks, we employ a high frequency identification based on the following identification conditions:

- **Shock identification condition**: inflation and output are not contemporaneously affected by yield curve shocks.
- **Relevance condition**: a change in the yield curve at the day of the announcement is only due to the monetary policy shock
- **Exogeneity condition**: the change in the yield curve after an announcement date in the sampling period is not due to the monetary policy shock.

Once we have identified the shock $\epsilon_t^{mp}(\tau)$, we use the chain rule to estimate responses of the macroeconomic variables as follows:

$$\frac{\partial X_{i,t+h}}{\partial \epsilon_t^{mp}(\tau)} = \frac{\partial X_{i,t+h}}{\partial \Delta Y'_{\tau,t}} \frac{\partial \Delta Y_{\tau,t}}{\partial \epsilon_t^{mp}(\tau)} = \sum\nolimits_{\tau=\tau_1}^{\tau_M} \Gamma_{\tau,h} \epsilon_t^{mp}(\tau) \tag{5}$$

where the first component on the right hand side, $\Gamma_{\tau,h}$, is estimated in eq.(4), and the second component, $\epsilon_t^{mp}(\tau)$, is the monetary policy shock. This result describes the effect of the monetary policy event, computed as linear combination of the product of changes in raw yields at selected maturities times a dummy variable equal to unity if there is a policy announcement at time t ($\epsilon_t^{mp}(\tau) = \Delta Y_{\tau,t} * d_t$) and the impact of changes in yields at maturity τ on the two macroeconomic variables ($\Gamma_{\tau,h}$).

We are interested in the estimation of average responses of the macroeconomic variables to a given set of shocks. To this end, once we have identified the monthly shock time series, we differentiate the shocks according to some restrictions. When estimating the sample of conventional period, the shocks are divided in contractionary and expansionary, depending on positive or negative change of the short end of the yield curve. When assessing the responses concerning unconventional period, we impose restrictions to differentiate the shocks according to their shape (steepening, flattening or curvature effects).

3 Empirical Results

The effects of Monetary Policy on exchange rates during conventional period

In this section, we examine the effects of monetary policy shocks on exchange rates during conventional period. By conventional monetary policy, we refer to circumstances whereby monetary policy's authority directly affects short-term interest rate through the use of three main tools: open market operations, standing facilities, and minimum reserves requirements. In this work, we consider conventional period enduring from the beginning of the sample (September 2004) to April 2009 (included).

Several studies suggest that monetary policy authorities were able to influence both short- and long-term interest rates well before the implementation of non-standard measures. In this perspective, we choose to look at the whole yield curve between 3 months and 10 years maturities, but to impose restrictions on just short/medium-end of the term structure. Our decision is explained by two considerations: first, examining all the shocks in our dataset that refers to standard measures, we have noticed that the major effect is on the short- medium-term. This effect can be seen in the figures representing the shocks (first row of fig.3), in fact the major impact is between 1 and 4 years yields, with effect declining with maturities. Second, we have done a robustness check enlarging the restrictions to 10 years maturity, and the responses didn't change from our baseline. These two considerations confirm our choice of modeling just short term maturities in order to effectively capture monetary policy shocks, allowing long-term yields to have either negative or positive values.

The shocks regarding conventional period are classified in contractionary or expansionary, according to the positive or negative change of yields. On the other hand, shocks corresponding of non-standard policy moves are classified according to the effect on slope and curvature of the yield curve. Our purpose with this study is to determine if shifts in the yield curve due to monetary policy announcements have a bearing on euro exchange rates. This is because when we examined the shocks in conventional period, we noticed that most of them have the same (hump) shape: the major impact is on short/medium interest rates, with a diminishing effect on long maturities. In contrast, there is a wide heterogeneity in the shapes of shocks due to non-standard measures: either they are more significant at short or long end of the yield curve, or they are primarily relevant at medium maturities. Hence, to better analyse the role of these different shapes and to allow for different effects on macroeconomic variables and transmission channels, we chose to separate conventional from unconventional period and to model the shocks differently.

Our results are represented in fig.3. In the first row, two panels represent monetary policy shocks traditionally identified as contractionary and expansionary, as they show an increase and decrease in short-term yields, respectively. Following Inoue and Rossi (2019) shock's identification, we identify contractionary (expansionary) shocks as positive (negative) difference between the announcement's day yields at selected maturities and the yields at the day before. In particular, the panel on the left represents contractionary shocks, defined as shocks contractionary at very short- (3 months), short- (1 year) and medium-term (3 years) maturities (i.e. $\Delta Y_{\frac{1}{4}} > 0, \Delta Y_1 > 0, \Delta Y_3 > 0$). On the other hand, the right panel depicts expansionary shocks, defined as shocks that are expansionary at very short-, short- and medium-term maturities (i.e. $\Delta Y_{\frac{1}{4}} < 0, \Delta Y_1 < 0, \Delta Y_3 < 0$). In each panel, jointly with the shocks, are represented the average of the shocks and the euro area spread. The latter is estimated as the difference between the yield curve calculated with the yields of all bonds issued by euro area governments and the curve calculated considering only yields of AAA-rated bonds. In displaying the results, we have divided them in two main groups. The first group is composed by results of advanced countries that are not currently in the EEA; in the second one are collected countries that are part of the European Union or are EEA partecipants. The responses are represented in fig.3 according to this categorization. In particular, in the second row are depicted euro exchange rate responses against currencies of the first group of countries: United States, Switzerland, Canada, Japan and United Kingdom. In the third and fourth rows, the second group is further divided based on the average responses of exchange rates to conventional monetary policy shocks: the third row shows currencies with non-statistically significant responses, the fourth row shows currencies with statistically significant average responses at 95% confidence interval.

Given that we are looking at the whole yield curve, we believe that its long-end gives us information about the long term. Hence, we are interested in looking at the behavior of expected exchange rates. To do so, we calculate the difference between nominal spot exchange rates and one year forward rates. Since exchange rates data are expressed in foreign currency units for one euro, positive values of spot rates indicates an appreciation of the euro relative to the foreign currency. Thus, the deviation is interpreted as: positive values indicate an expected depreciation, while negative values indicate expected appreciation.

Our results show homogeneous responses among different countries: monetary policy tightening (easing) during conventional period leads to an expected appreciation (depreciation) of the euro vis-à-vis all currencies taken into consideration. These results are consistent with the UIP condition.

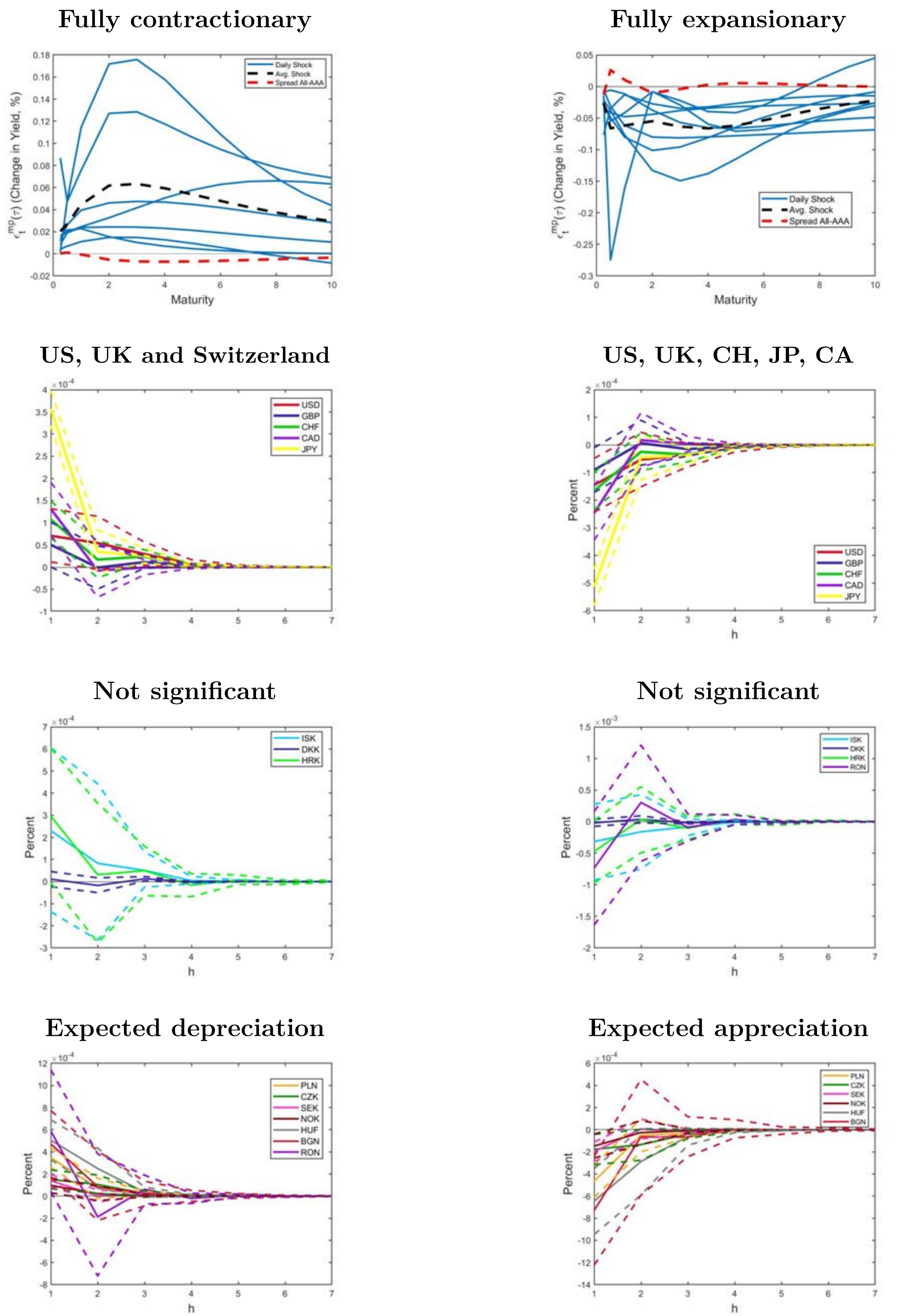


Figure 3: Responses of the expected euro exchange rates due to monetary policy shocks during conventional period

The effects of Monetary Policy on exchange rates during unconventional period

After examining the effects of conventional monetary policy measures on euro exchange rates, the same analysis is conducted for unconventional period. We refer to unconventional period as the time period when European Central Bank can't affect short term interest rates and has to apply non-standard measures to reach its main objective of price stability. In our analysis, it corresponds to the sample period from May 2009 to October 2021. We collect dates of announcements of all non-standard policy measures implemented by ECB during unconventional period and COVID-19 pandemic period, with the exception of those related to forward guidance.

To assess the effects of monetary policy on euro exchange rates, we categorize the shocks according to the impact of ECB announcements on yield curve. They represent solely expansionary shocks since non-standard measures implemented over the past decade are mostly expansionary policies. According to our framework, expansionary shocks are determined as a negative difference between the yield curve at the end of the announcement's day and the yield curve at the end of the day before. Even though they are all classified as expansionary, different monetary policy announcements may affect the yield curve in very different ways, according to the kind of information disclosed, investors' expectations and their reactions. For example, a monetary policy announcement can mainly affect long term yields as opposed to short term, or primarily middle term of the curve (affecting the curvature), or it can impact all the term structure in the same way, leading to a parallel shift. During our sample period, we are able to distinguish three kind of expansionary shocks: i) expansionary shocks with the main effect on curvature, ii) expansionary shocks with flattening effect, iii) expansionary shocks with steepening effect. An announcement that only impacts the intermediate part of the term structure represents an effect on curvature, reflecting the monetary policy stance of the central bank (Dewachter and Lyrio (2006)). On the other hand, by considering the term spread, it is possible to extract a change in the slope of the yield curve. Monetary policy authorities are able to affect short term yields through standard monetary policy measures, while empirical evidence indicates that non-standard measures mostly affect long term interest rates, considering that policy rates were stuck at the zero lower bound. By affecting solely long-term yields, the effect might be a negative (positive) pressure on the slope of the curve, that can result in a flattening (steepening) behavior of it.

In the first row of fig.4 are depicted the shocks according to their shapes. Starting from the left, we see monetary policy shocks with steepening, curvature and flattening effects. The blue lines represent shocks occurred during unconventional period (between May 2009 to February 2020), while yellow lines depict shocks that took place during COVID-19 pandemic crisis period (between March 2020 to the end of our sample, i.e. October 2021). In our framework an expansionary shock with steepening effect is identified by a negative change at very short- and short-term maturities (3 and 6 months), jointly with the specification that the shock is more expansionary at very short- than long-term (10 years) maturities ($\Delta Y_{10} - \Delta Y_{\frac{1}{4}} > 0$). In order to be sure that the end of the term structure delineates a monotonically increasing behavior, we add restrictions of a positive change at long maturity, and a bigger change at 10 years maturity than at 9 and 5 years ($\Delta Y_{10} > 0$, $\Delta Y_{10} - \Delta Y_9 > 0$, $\Delta Y_{10} - \Delta Y_5 > 0$). The shocks that reflect this effect are illustrated in the first row of fig.4, first column. At position 2 of the same row, are represented monetary policy shocks with main effect on medium rates. This type of shocks is identified through restrictions on a negative change at medium-term yields (5 years) together with the assumption that the shocks are even more expansionary at medium than short and long maturities ($\Delta Y_{10} - \Delta Y_5 > 0$ and $\Delta Y_{\frac{1}{4}} - \Delta Y_5 > 0$). Lastly, shocks with flattening effect are illustrated on the third column of the same figure. In this case, we identify the shocks as expansionary at medium- and long- term (5 and 10 years), and with an heavier expansionary effect at long than at medium and short maturities ($\Delta Y_5 - \Delta Y_{10} > 0$ and $\Delta Y_{\frac{1}{2}} - \Delta Y_{10} > 0$). To have a measure of the perceived risk within the euro area, we compute the spread between the average shock of yields of bonds issued by all euro area governments, and the average shock on yields of bonds issued by euro area governments whose rating is AAA. Therefore, the former is calculated as the difference between yields on the day of the announcement and yields on the day before, considering the bonds issued by all euro area governments, the latter is computer by the same difference, but considering only AAA-rated bonds. The spread is represented jointly with the shocks, in the first row of fig.4.

Focusing on the responses, their representation follows the same format as the previous section, organized into four rows: second row illustrates the effect on expected nominal exchange rates of major currencies (US dollar, British pound, Canadian dollar, Japanese yen and Swiss franc) against the euro; in the third row are depicted responses that are not statistically significant; in the last two rows are represented responses that are statistically significant at 95% confidence interval.

Our results show that, on average, expansionary shocks during unconventional period affect euro expected exchange rates in the same way among different currencies. Shocks with steepening effects and with main effect on curvature lead to an expected appreciation of euro exchange rate against all the currencies that display statistically significant responses, except for the euro exchange rate vis-à-vis Denmark krone which shows an expected depreciation. Regarding shocks with flattening effects, they lead to opposite results: euro exchange rates display an expected depreciation against all statistically significant currencies.

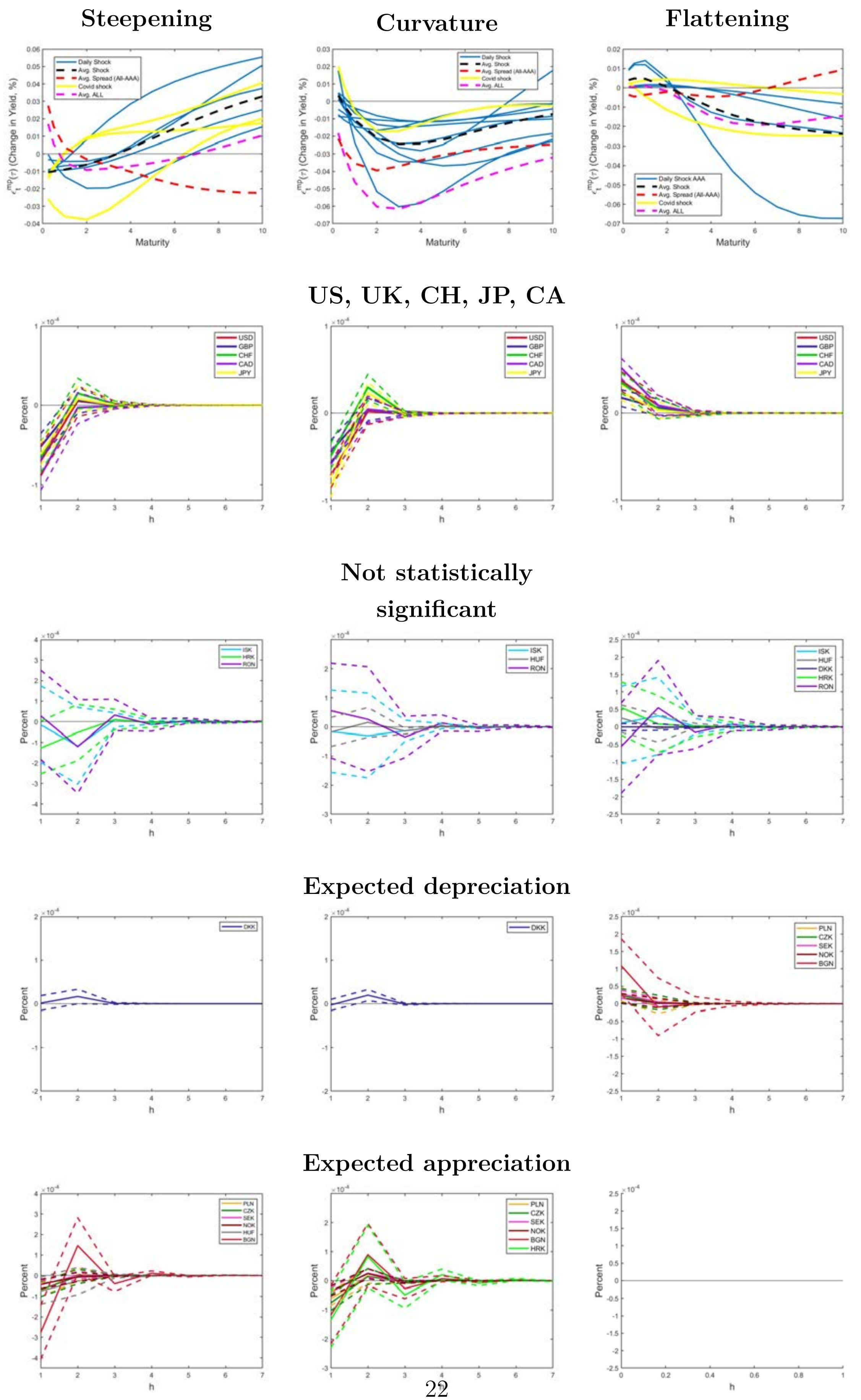


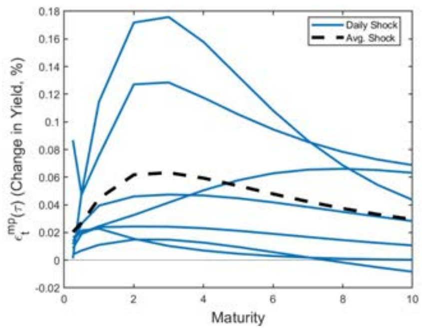
Figure 4: Responses of the expected euro exchange rates due to monetary policy shocks during unconventional period

The effects of Monetary Policy on inflation and output during conventional period

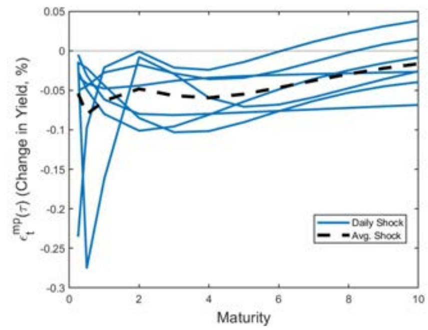
In this section we present the results of contractionary and expansionary shocks during conventional time on euro area inflation and output, and check for spillover effects to countries outside the EMU. In the figures below, we present a subset of the two groups for brevity: for euro area countries we have included three core countries (Germany, Belgium, and Italy), and a peripheral country (Portugal); while for non-euro area we have inserted as representatives one country that has a currency peg to the euro (Denmark), one advanced country that is outside Europe (United States), one country that is part of the European Union and has a flexible exchange rate arrangement (Poland), and lastly Norway, that has a flexible exchange rate arrangement as well but it's not part of the European Union. We use the same shocks as in the previous chapter for estimating the impact of standard monetary policy on euro exchange rates. Shocks delineated as tightening are captured by a positive shift in very short-, short- and medium-term yields (3 months, 1 year and 3 years respectively), while easing shocks are delineated as negative shifts at the same maturities. Comparing the shocks represented in fig.**??** with the ones depicted in fig.3, is possible to note that they are different. This is because we had to cope with a mismatch in data frequency: the bonds' yields are daily data, while HICP and industrial production data are monthly. To handle this problem, we have assigned each announcement to the month in which it occurred, and in the case that two or more announcements were disclosed in the same month, we computed the mean. Therefore, it's possible that the shocks shown in this section don't match the ones depicted in the section before. In fig.5 are presented contractionary and expansionary shocks in the first row, and the responses at 90% confidence interval of the growth rate of inflation and output for the selected euro area countries in the following rows.

Overall, our results are consistent with traditional literature, according to which domestic tightening in monetary policy leads to a decrease in inflation and industrial production, while an accommodating monetary policy stance produces an increase in the two variables after 16 months. All euro area countries considered respond in an homogeneous way, we haven't find evidence of differences in responses between core and peripheral countries.

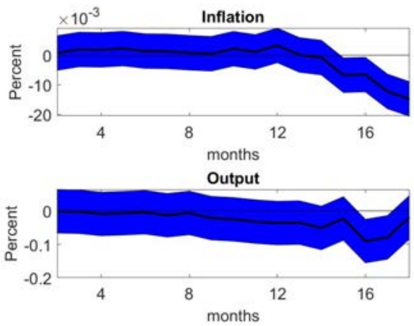
Contractionary



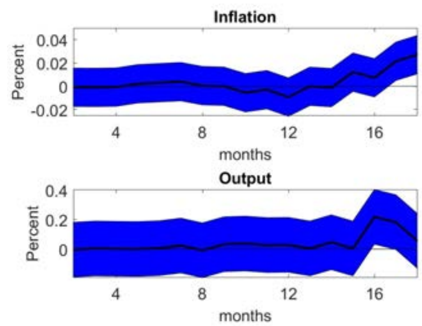
Expansionary



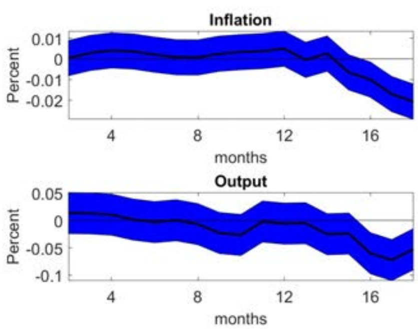
Italy



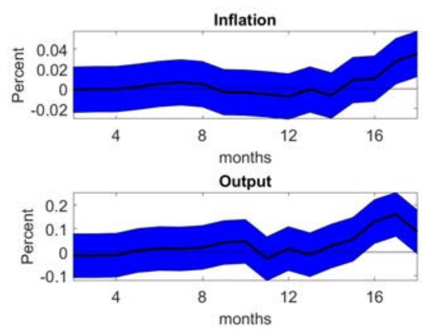
Italy



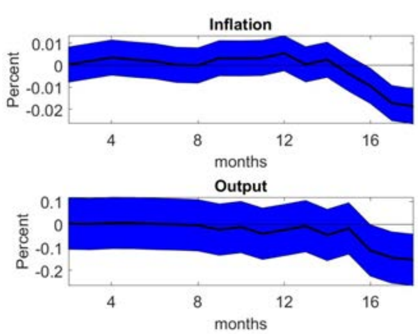
Belgium



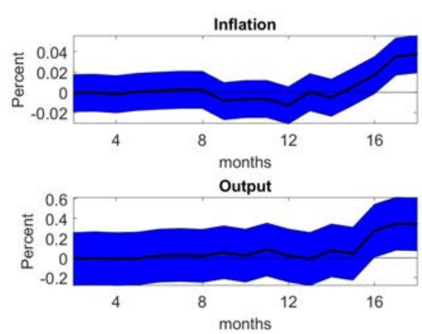
Belgium



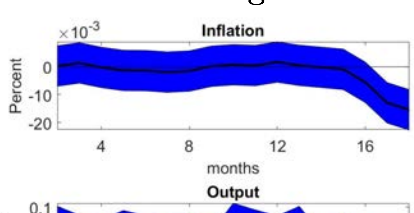
Germany



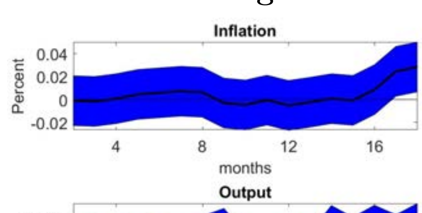
Germany



Portugal



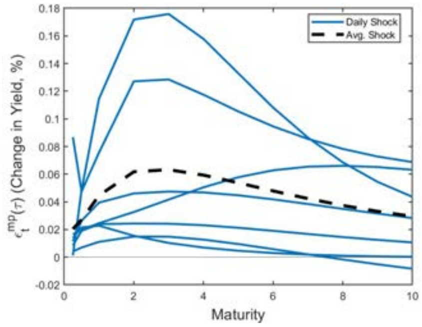
Portugal



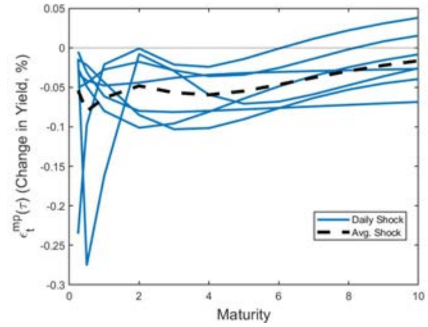
In fig.6 we present the results for United States, Denmark, Norway, and Poland. We have selected these countries as representatives due to their heterogeneous characteristics: the US is included to provide a benchmark of possible spillovers to a large western economy that has a relationship with the European Monetary Union but doesn't have it as major trading partner; Denmark and Poland are both part of the EU, but they differ in the exchange rate regime: the former has a currency peg to the euro, while the latter follows a flexible arrangement; lastly, Norway belong to the European Economic Area.

Our results display evidence of spillover effects to all countries considered due to the implementation of ECB conventional measures. On average, all countries react to foreign shocks as domestic one: inflation and output decline and rise after several periods in response to ECB tightening and easing measures respectively. Moreover, when we consider the magnitude of the responses, we can note that output is more heavily affected than inflation in all countries.

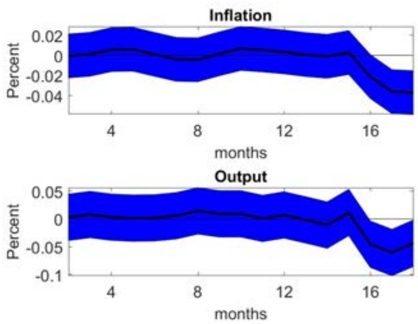
Contractionary



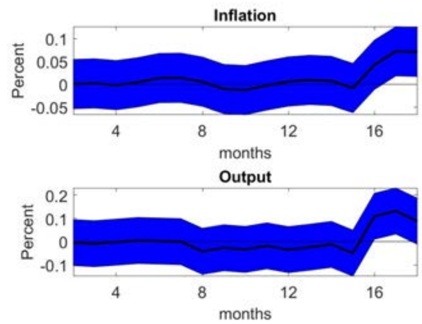
Expansionary



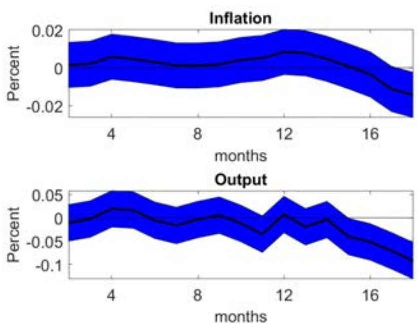
United States



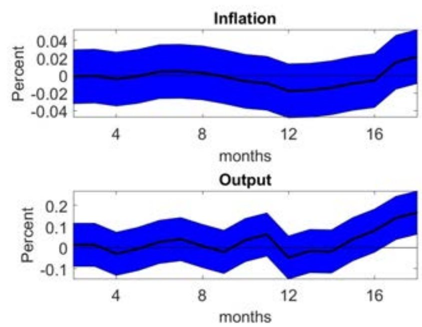
United States



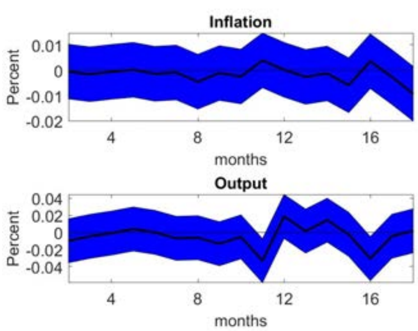
Denmark



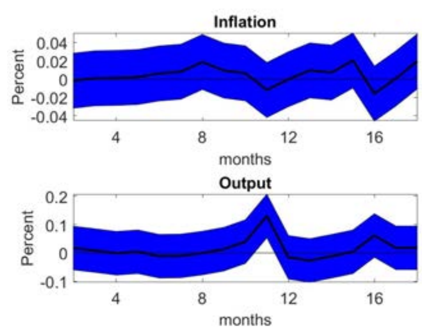
Denmark



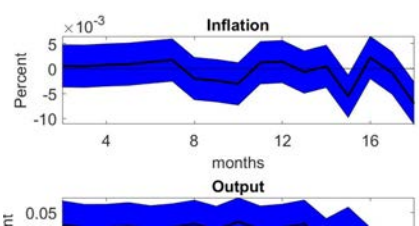
Norway



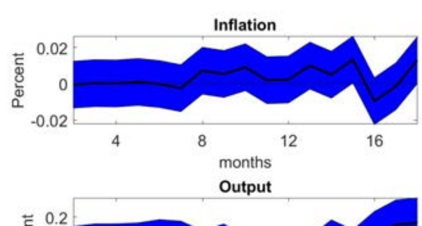
Norway



Poland



Poland



The effects of Monetary Policy on inflation and output during unconventional period

In this section we aim to assess how monetary policy shocks affect inflation and output during unconventional period. In this framework, we define unconventional period as the period between May 2009 and October 2021, which encompasses both the financial crisis and the covid-19 pandemic crisis. Monetary policy shocks are defined as in the previous sections and represented in fig.7 and fig.8, first row. In particular, shocks with steepening effect are characterised by a negative change at very short- and short-term maturities (3 and 6 months), jointly with the specification that the shocks are more expansionary at very short than long maturities. In order to be sure that the end of the term structure delineates a monotonically increasing behavior, we add the restriction of a positive change at long maturity, and that the change at 10 years interest rate is bigger than changes at 9 and 5 years. Regarding shocks with curvature effect, they are identified through a negative change at medium- and long-term interest rates (5 and 10 years) together with the assumption that the shocks are even more expansionary at medium than short and long maturities. Lastly, at position three of the first row of fig.7 are represented shocks with flattening effect. They are characterised by a negative change at medium and long term (5 and 10 years), and the expansionary effect is heavier at long than medium and short end of the term structure. In the remaining rows of fig.7 are depicted responses of inflation and output in the selected euro area countries. The responses are significant at 90% confidence interval and present the results for Italy, Germany, Belgium and Portugal. Our results show that expansionary shocks with steepening effects cause an increase of inflation and output in all EMU countries considered; while expansionary shocks with flattening effects lead to a decrease in both macroeconomic variables.

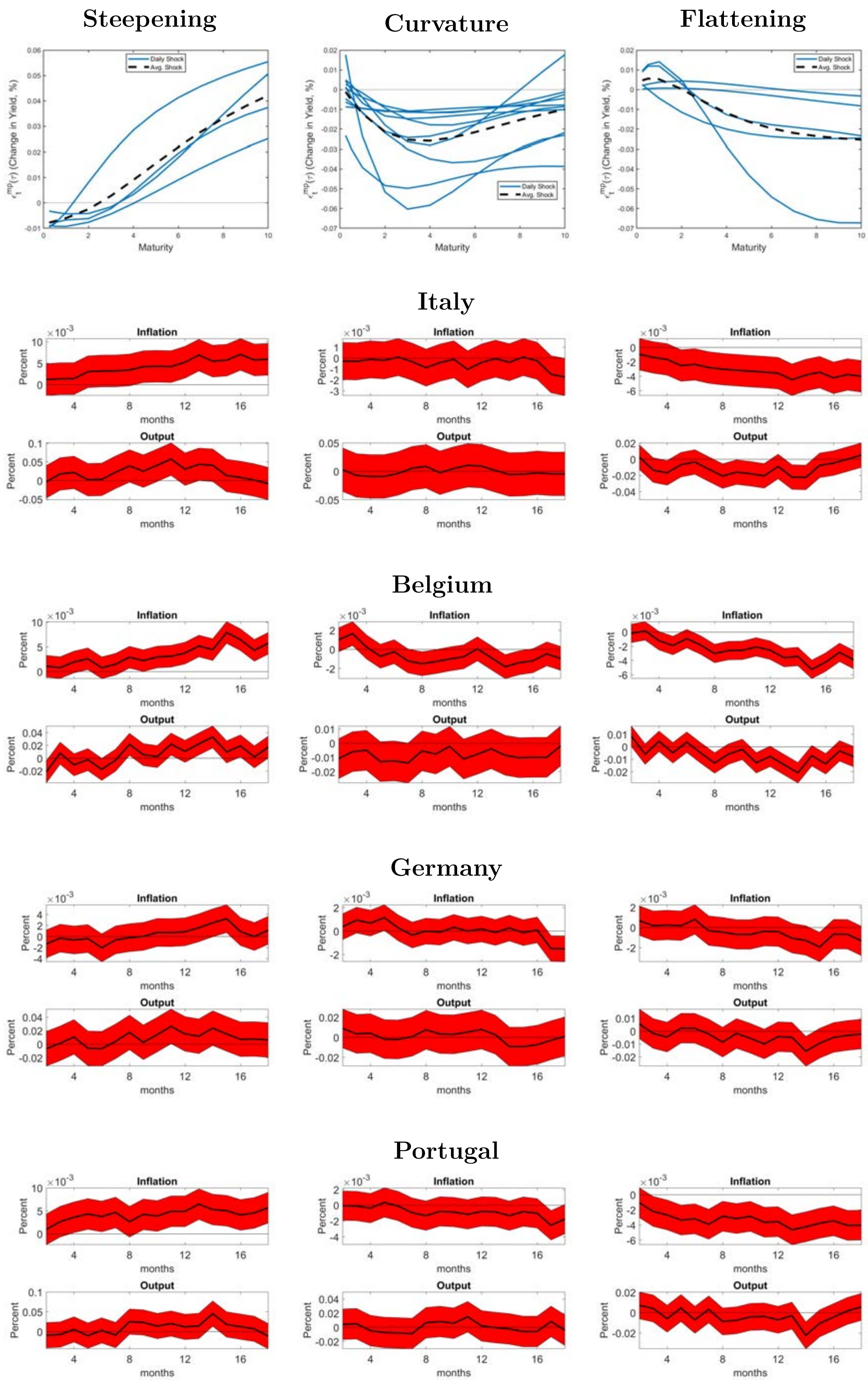


Figure 7: Inflation and output responses of **Euro area** countries due to non-standard monetary policy measures

In fig.8 are depicted non-euro countries' responses to the same set of shocks, namely: United States, Denmark, Norway, and Poland. Also during unconventional times, our results display evidence of spillovers for several countries considered. The effects are comparable to the ones of euro area countries: steepening and flattening shocks lead to an increase and decrease in inflation and output, respectively. Shocks with effect on curvature display on average less statistically significant impact on both variables.

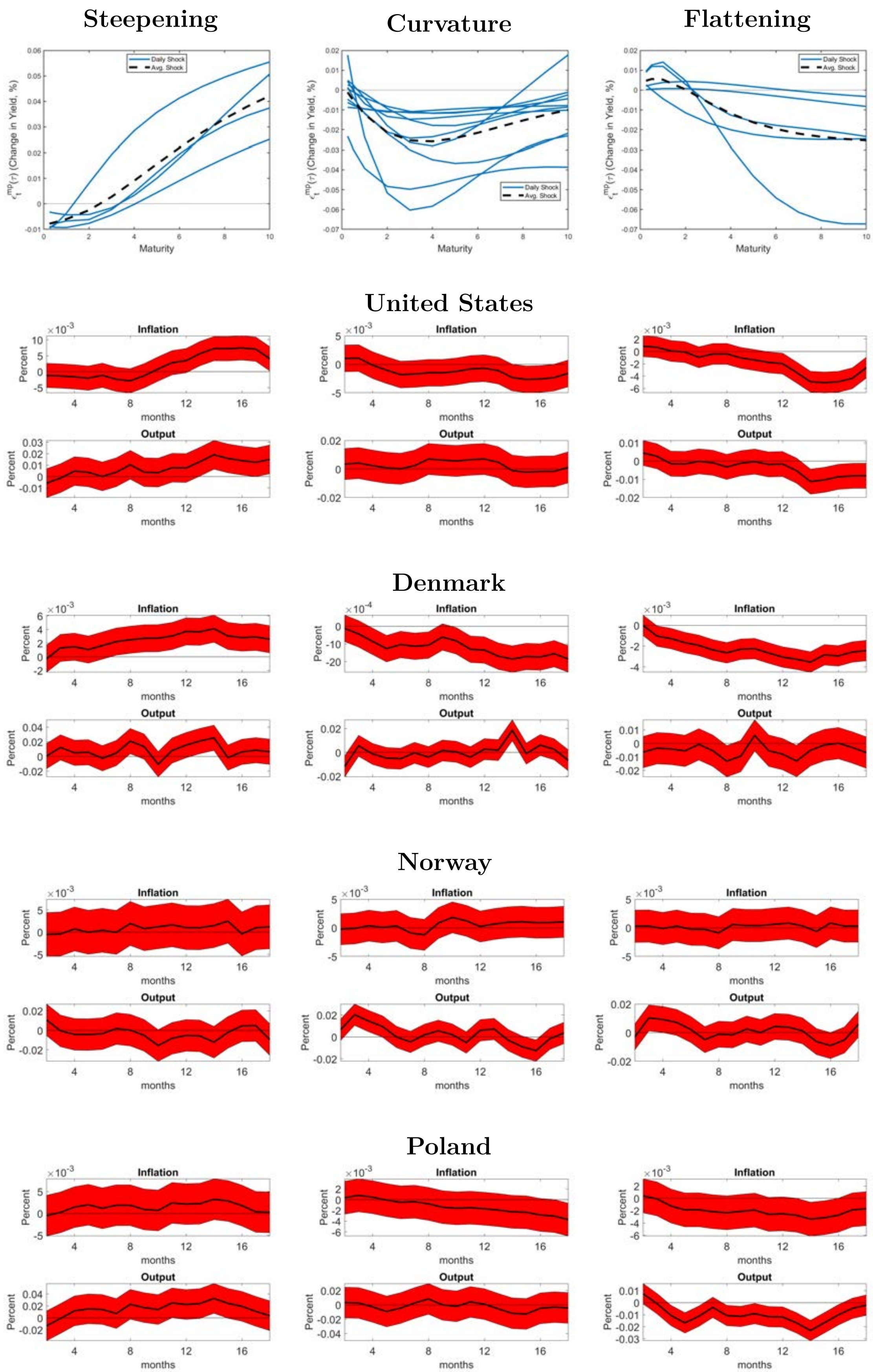


Figure 8: Inflation and output responses of **extra euro area** countries due to non-standard monetary policy measures

4 Robustness

I tested the robustness of the results obtained from my baseline by a number of alternative specifications: changing the yield curve's maturities considered in all the three periods (conventional, unconventional, COVID-19 pandemic); considering a narrower set of unconventional monetary policy's measures, comprehensive of just the announcements regarding the purchase of assets (following Ciarlone and Colabella (2016)); changing the set of controls for the estimation of the EMU countries' inflation and output responses; inserting in the regression the euro area spread and a dummy variable controlling for monetary policy's announcements by the foreign monetary policy authorities; changing the restrictions relatively to the monetary policy shocks' identification in the conventional period, in order to consider shocks that are contractionary and expansionary at all maturities of the term structure. My results demonstrated to be robust to all these checks.

In addition, I have conducted some tests to appropriately choose which ECB yield curve to use to compute monetary policy shocks. The ECB provides two yield curves: one is calculated taking into consideration the yields of bonds issued by all euro area governments, the other using the yields of bonds' issued by AAA-rated euro area governments. What I find is that to correctly evaluate the effects of monetary policy shocks on the exchange rate vis-à-vis the two major currencies, i.e. US dollar and Swiss franc, only the AAA yield curve should be considered. Instead, if we use the yields of bonds of all issuers, the effects are not statistically significant.

5 Conclusions

[tbc]

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A Exchange rate regimes classification

Table 1: Exchange rate regimes following the classification of Ilzetzki et al. (2017)

Country	Exchange rate regime
Bulgaria	peg (currency board) (1) Partecipant of ERM II
Czech republic	de facto moving band (+/- 2%). (3) **Inflation targeting**
Denmark	De facto peg (+/- 2.25%) (1) Partecipant of ERM II
United Kingdom	from 2001-2008 de facto moving band. (3) 2009-2016 freely floating. **Inflation targeting framework**
Croatia	de facto peg (1) Partecipant of ERM II
Hungary	june 2003-march 2009 de facto crawling band, +/- 5% band (announced 15%). (3) april 2009-december 2016 de facto crawling band (+/- 2%). (2) **Inflation targeting**
Iceland	Managed floating/De facto crawling band, De facto reference/anchor currency transitions to US dollar-euro basket in November 2008. (3) **Inflation targeting**
Norway	De facto moving band(+/- 2%). (3) **Inflation targeting**
Poland	2000-february 2012 de facto band (+/- 5%). (3) march 2012-august 2016 de facto band (+/- 2%). (3) **Inflation targeting**

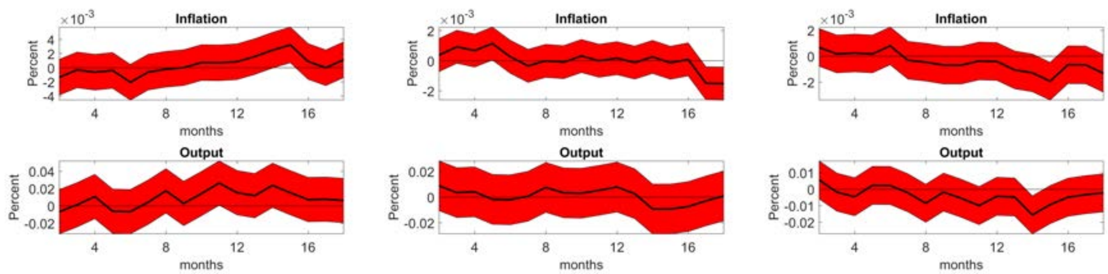
Country	**Exchange rate regime**
Romania	2001-june 2006 managed floating/de facto band (+/- 5%). (3) july 2007-nov 2012 de facto crawling band (+/- 2%) (2) Dec 2012-dec 2016 de facto peg (1) **Inflation targeting** from 2005
Sweden	99-2008 de facto band (+/- 2%) (3) or (2) 2008-sep 2016 de facto moving band (+/- 2%). (3) **Inflation targeting**
Switzerland	99-sep 2011 de facto moving band (+/- 2%). (3) 2011-jan 2015 de facto peg (There is a ceiling, which is binding throughout this period). (1) jan 2015-dec 2016 de facto moving band (+/- 2%). (3)
United States	Freely floating (4)

B Other countries' results

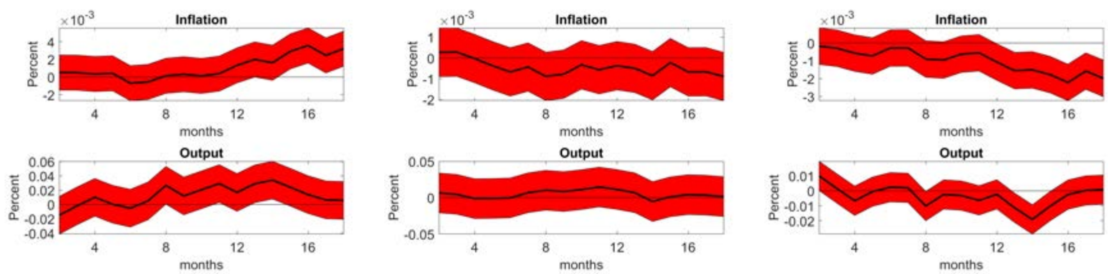
B.1 Unconventional

Curvature

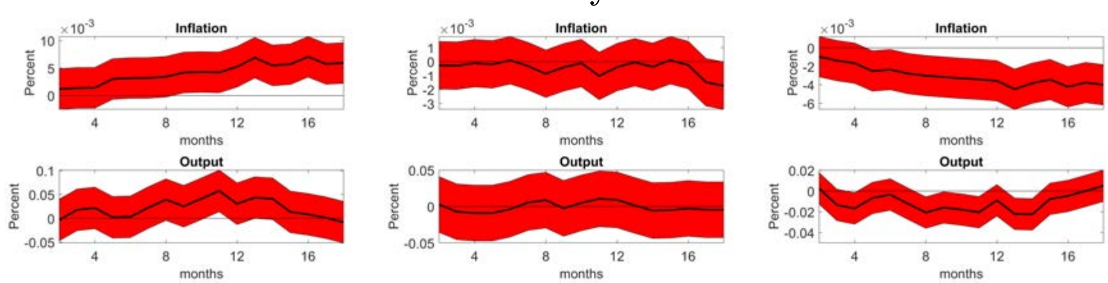
Steepening Germany Flattening



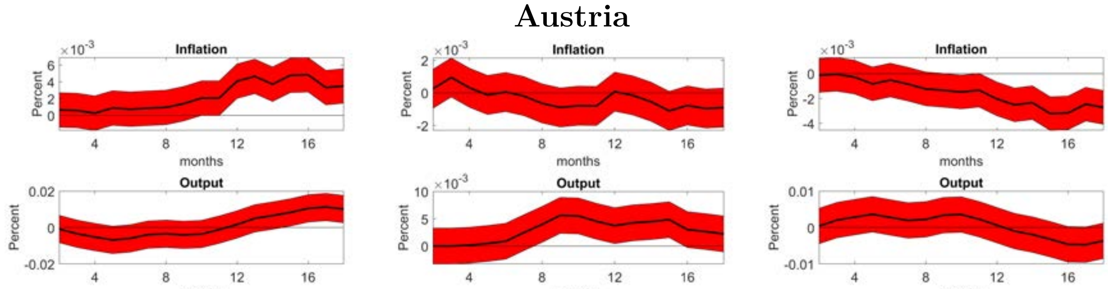
France



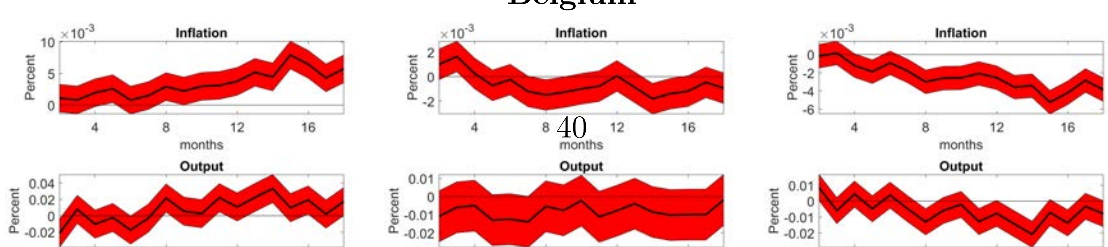
Italy



Austria



Belgium



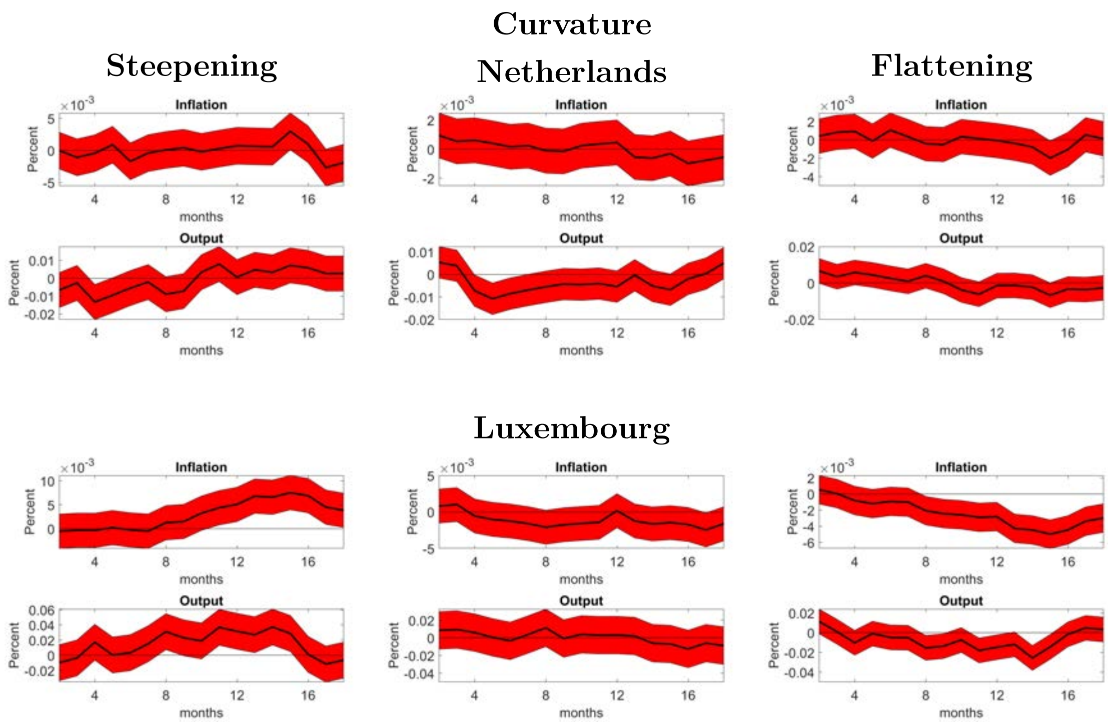


Figure 10: EMU - core countries

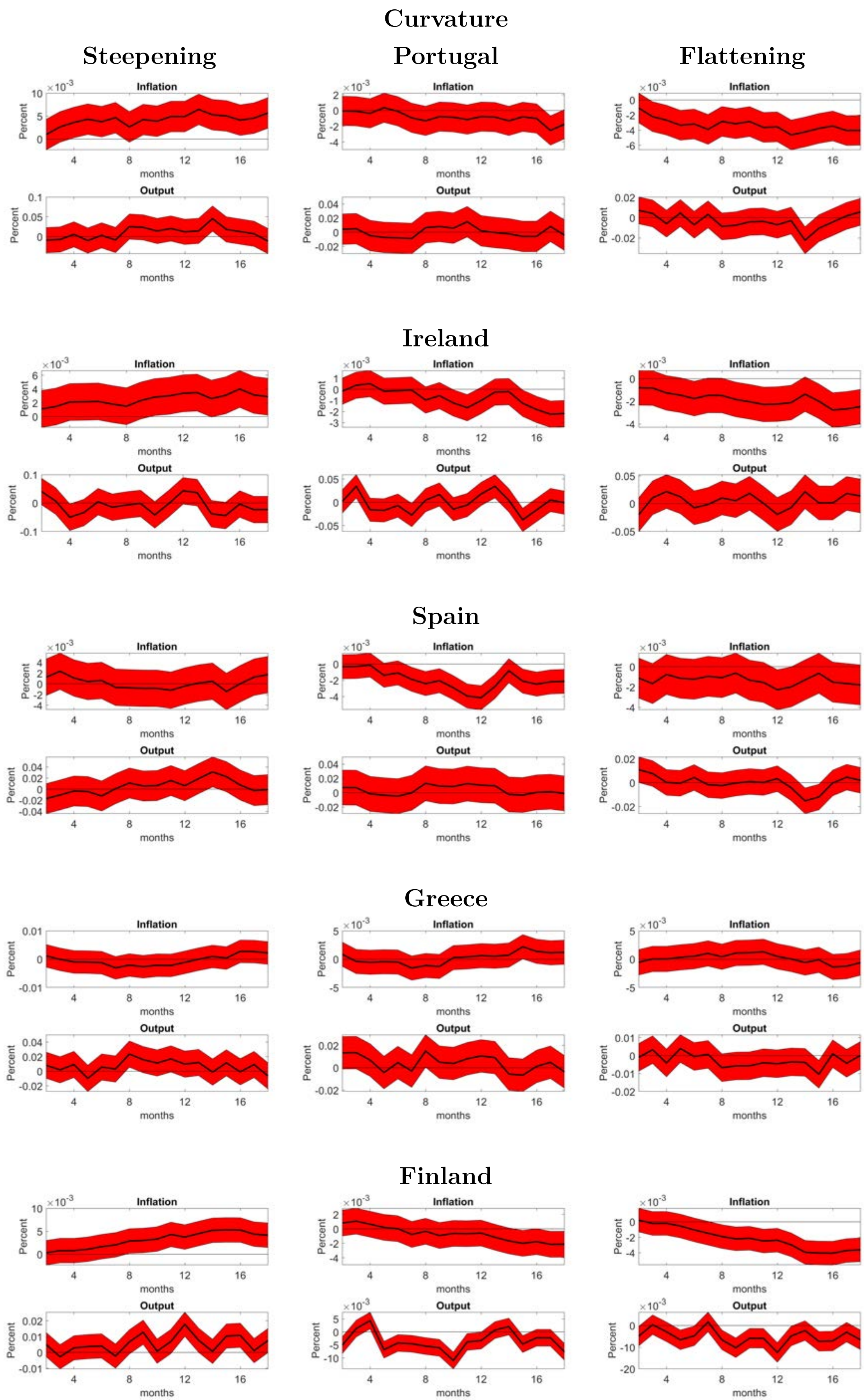


Figure 11: EMU - peripheral countries

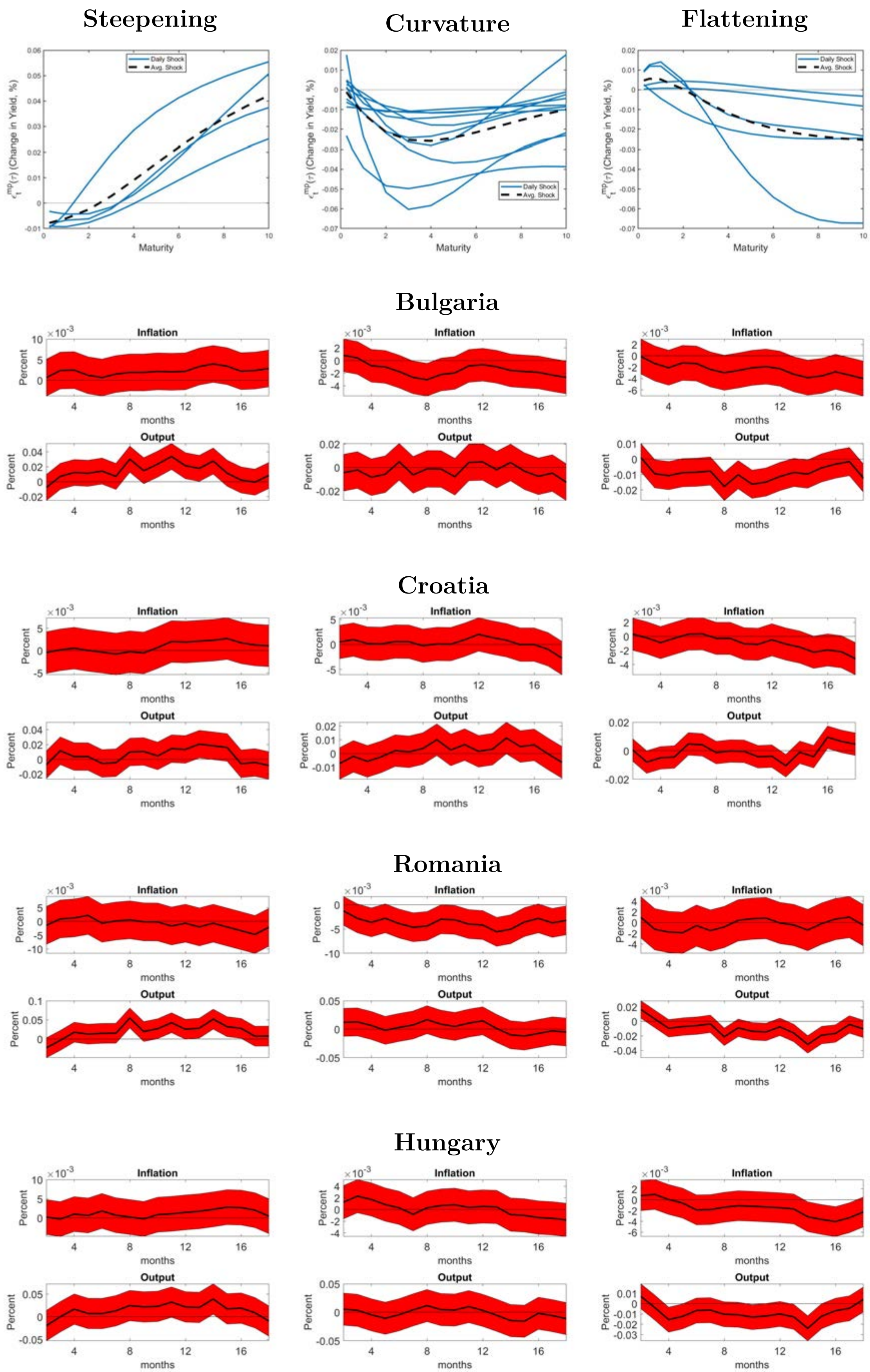


Figure 12: Inflation and output responses of countries that are peg to euro

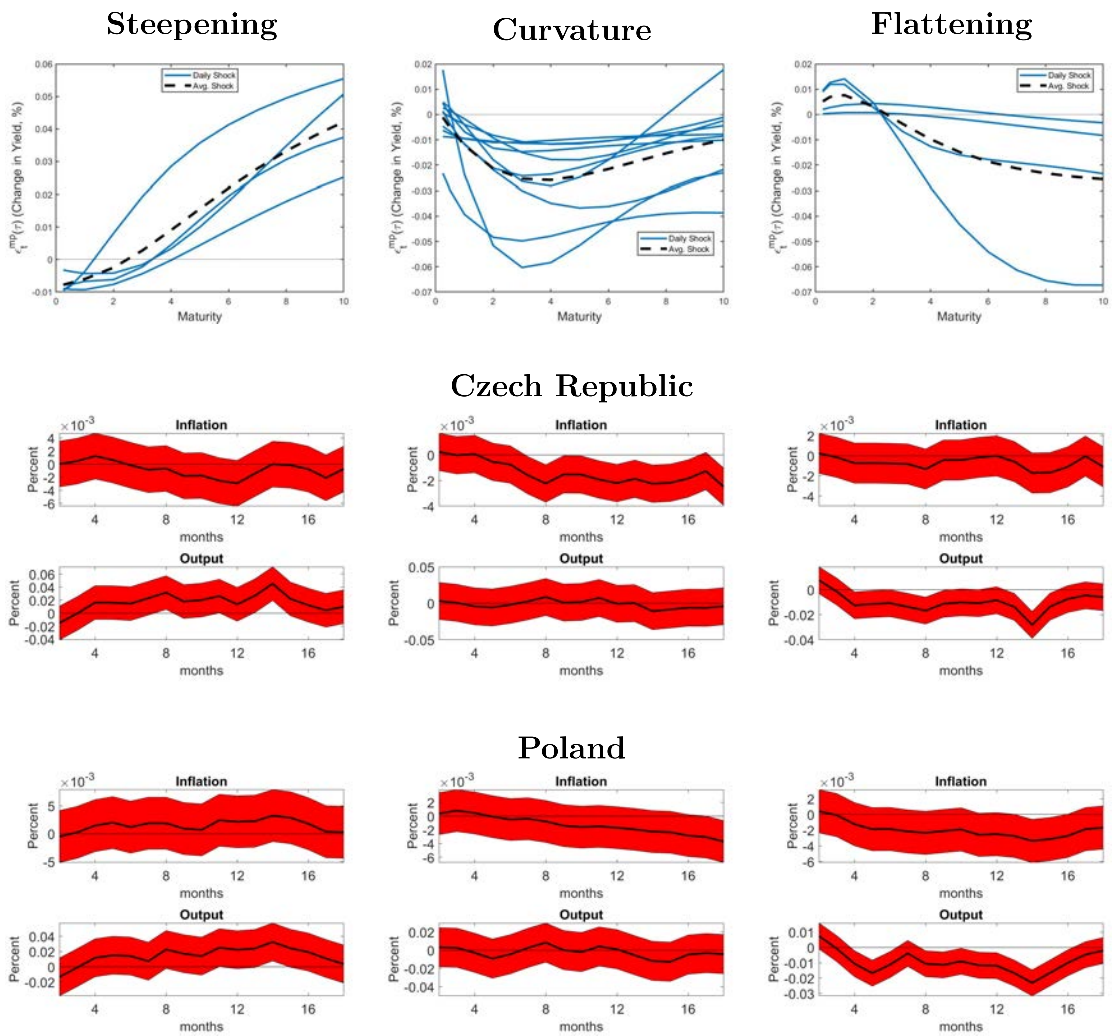


Figure 13: Inflation and output responses of (non euro) Central Eastern European countries

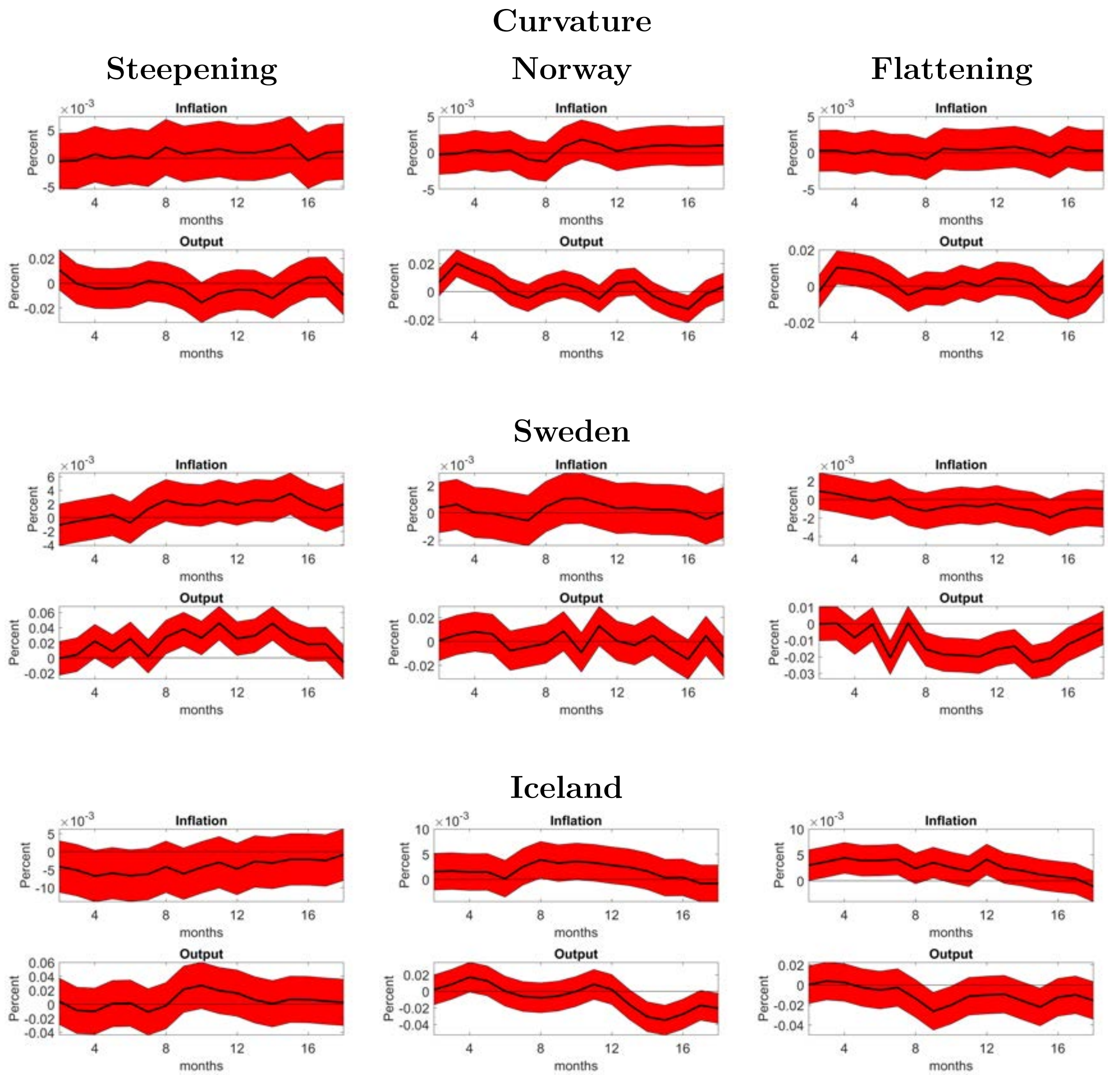


Figure 14: Inflation and output responses of major currencies

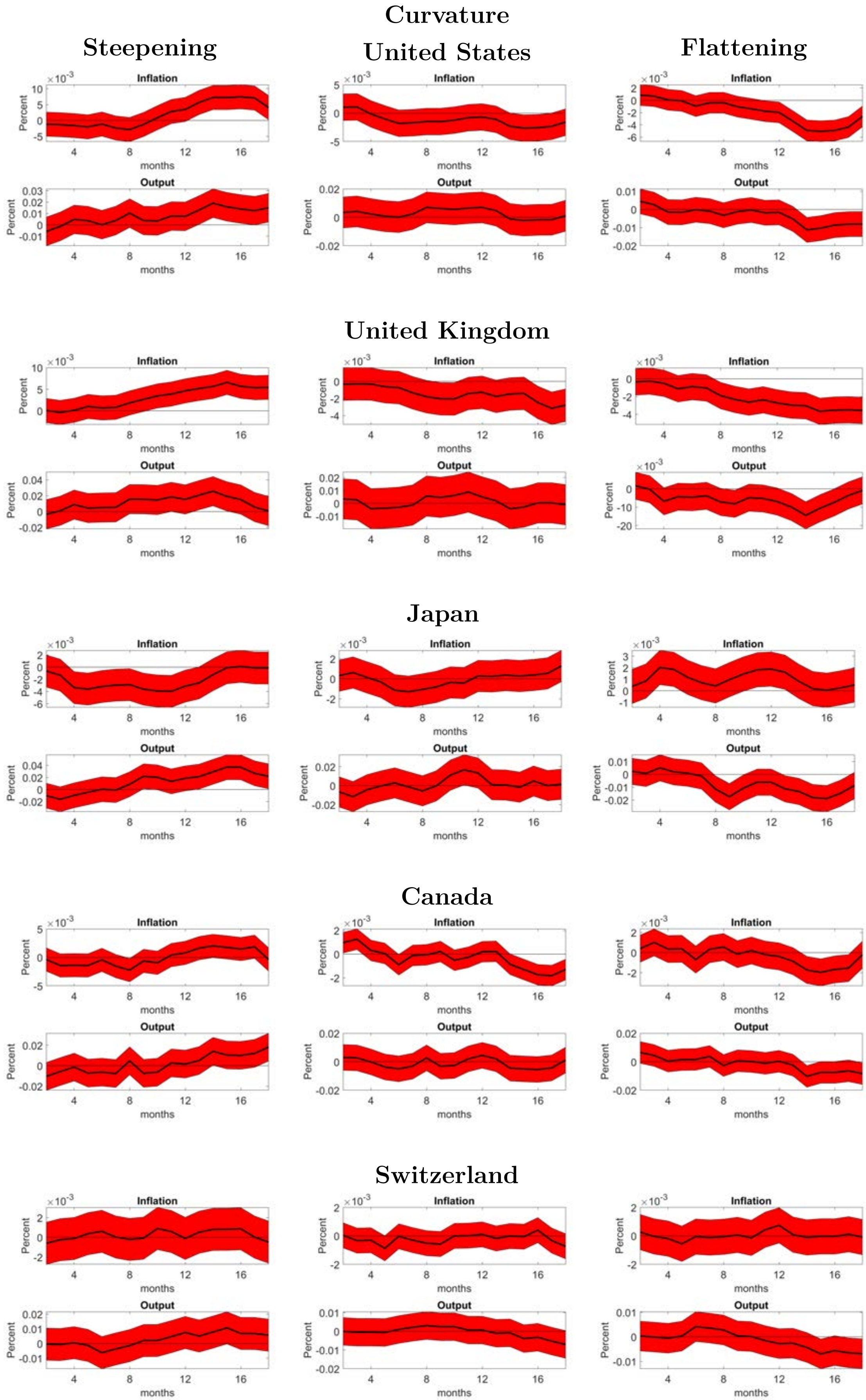
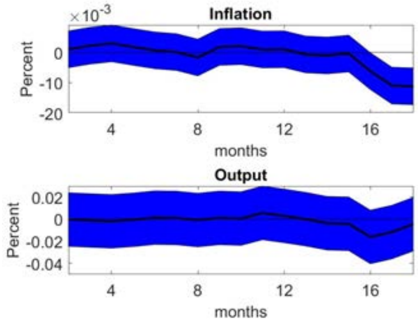


Figure 15: Inflation and output responses of major currencies

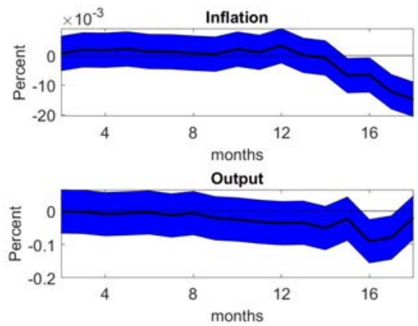
B.2 Conventional

Contractionary

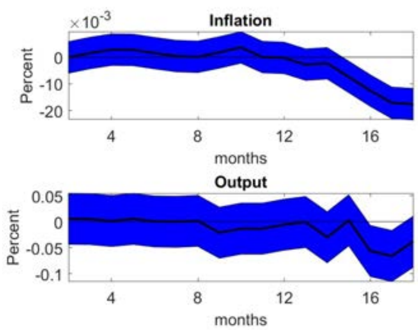
Austria



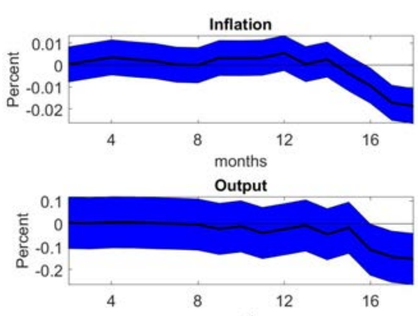
Italy



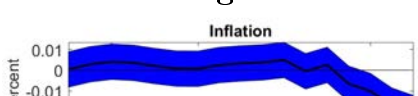
France



Germany

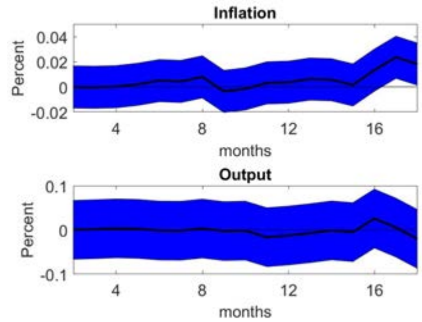


Belgium

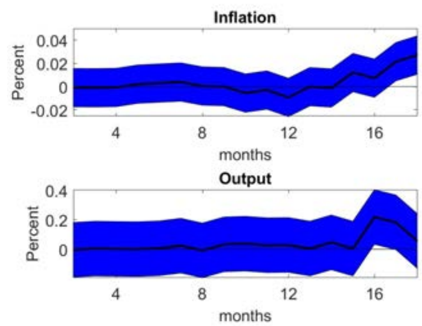


Expansionary

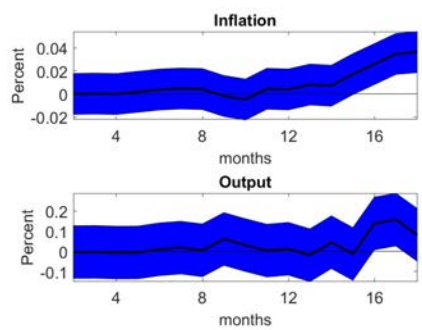
Austria



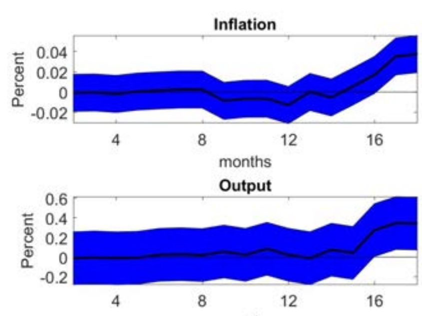
Italy



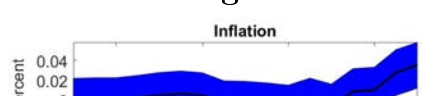
France



Germany

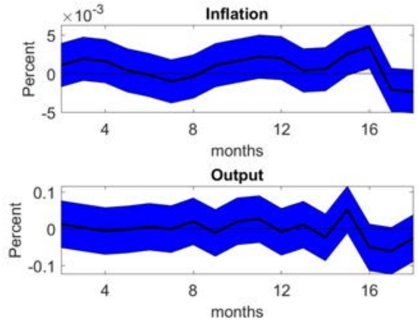


Belgium



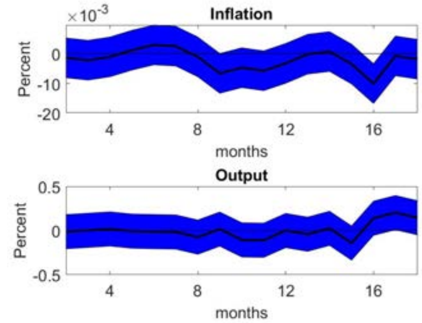
Contractionary

Netherlands

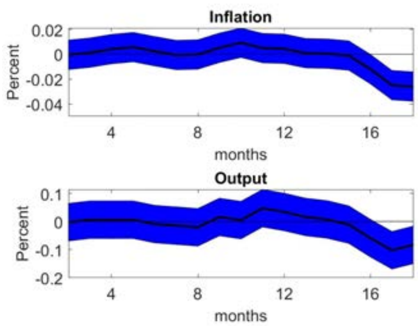


Expansionary

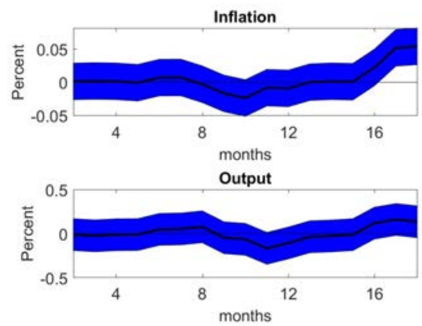
Netherlands



Luxembourg

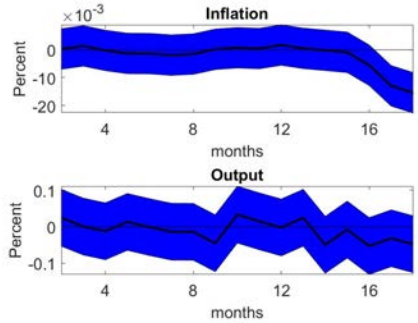


Luxembourg

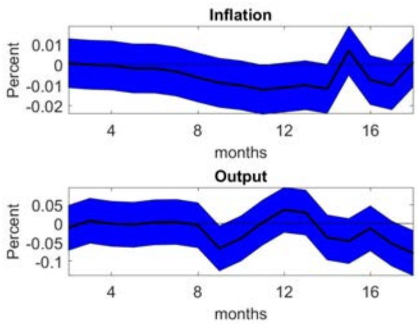


Contractionary

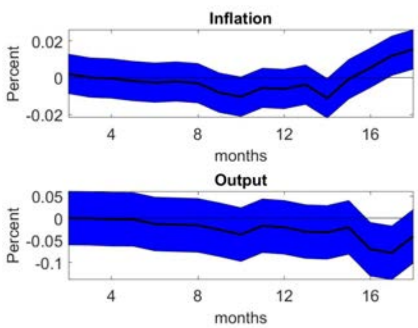
Portugal



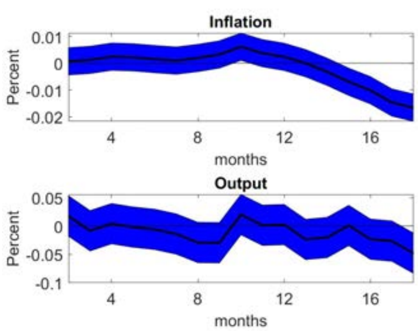
Ireland



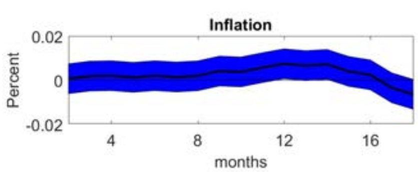
Spain



Greece

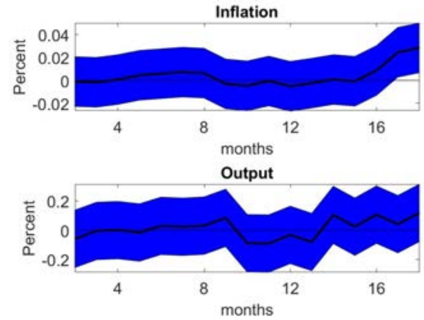


Finland

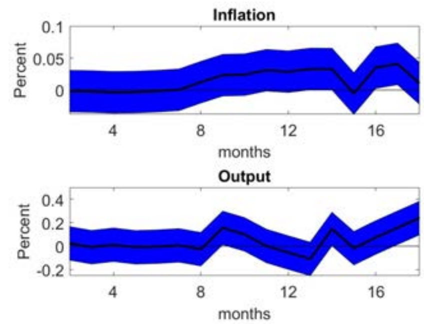


Expansionary

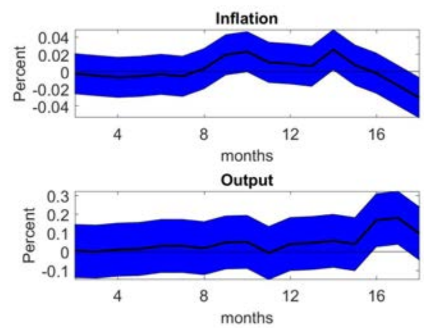
Portugal



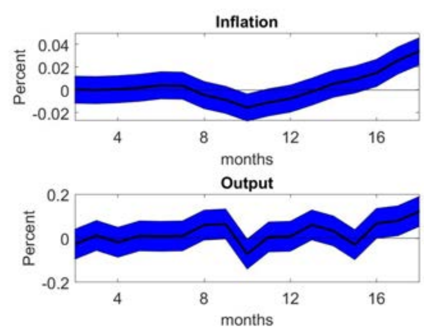
Ireland



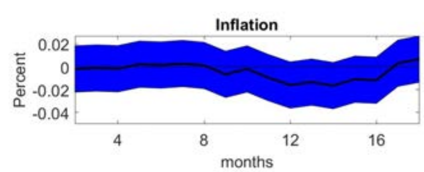
Spain



Greece

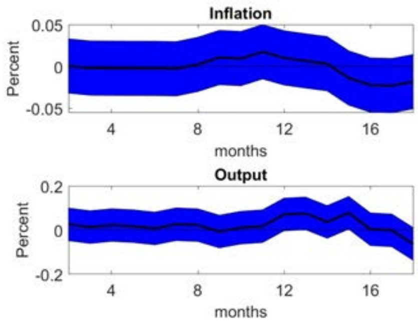


Finland

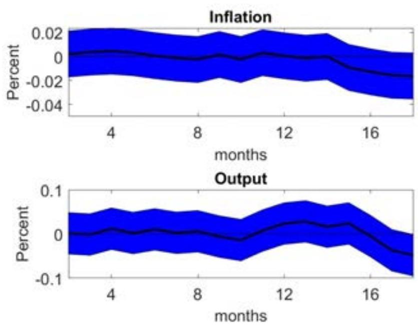


Contractionary

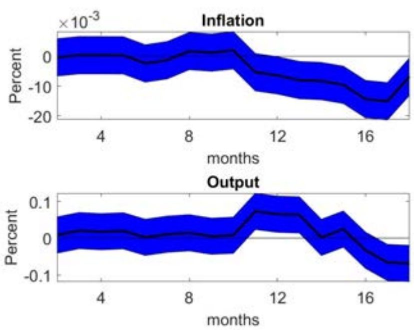
Bulgaria



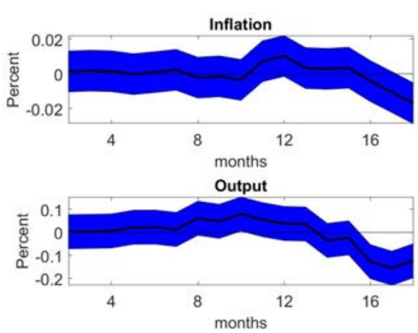
Croatia



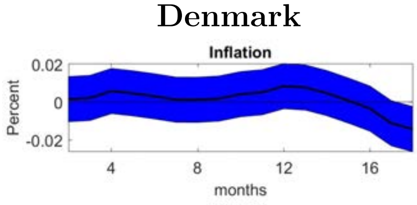
Romania



Hungary

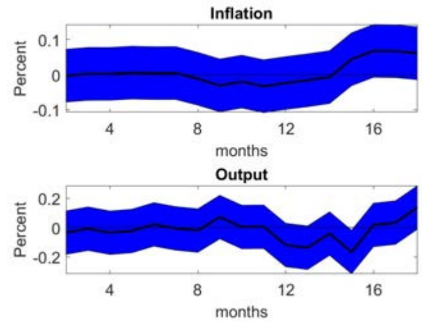


Denmark

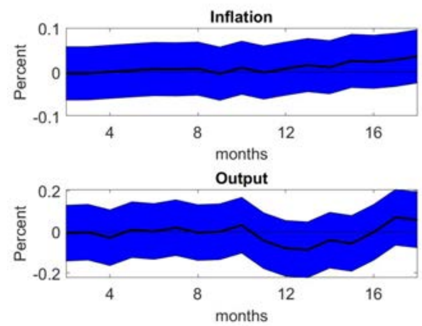


Expansionary

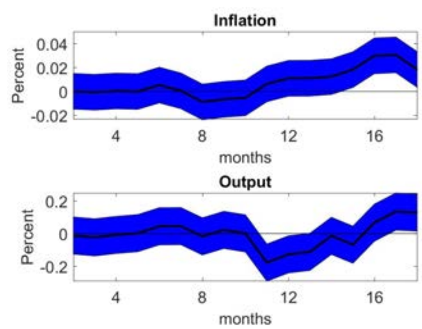
Bulgaria



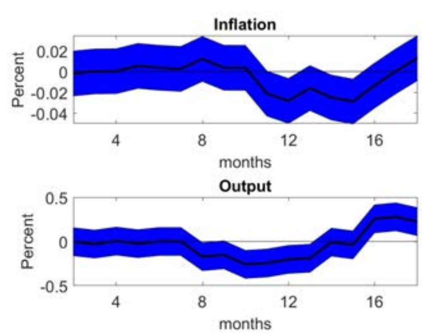
Croatia



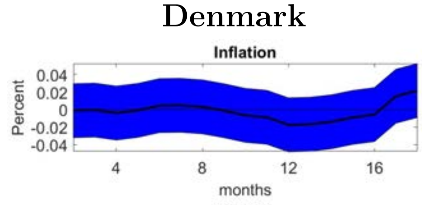
Romania



Hungary

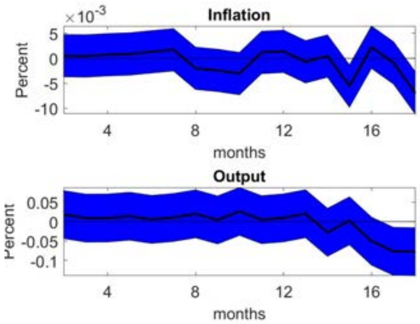


Denmark

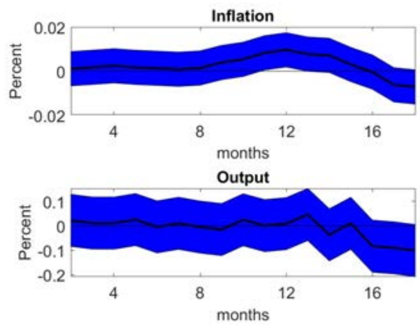


Contractionary

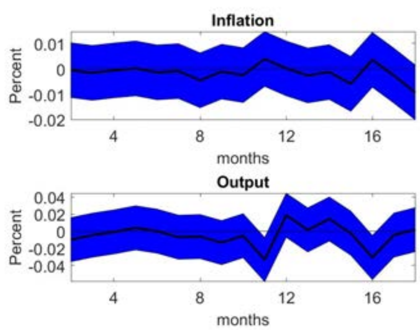
Poland



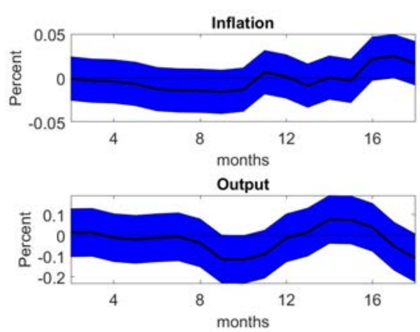
Sweden



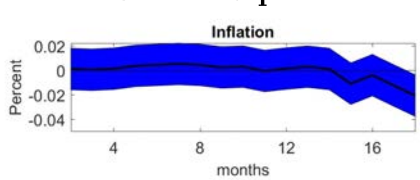
Norway



Iceland

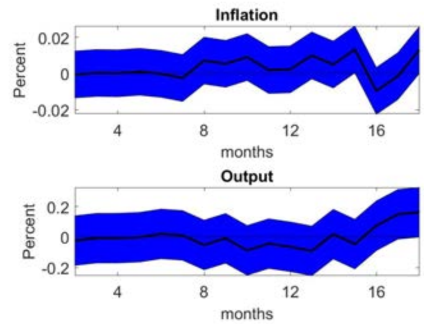


Czech Republic

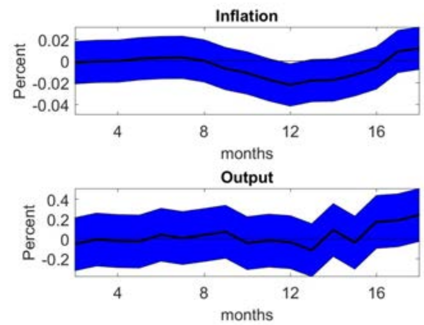


Expansionary

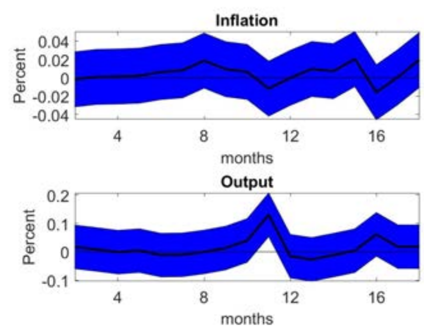
Poland



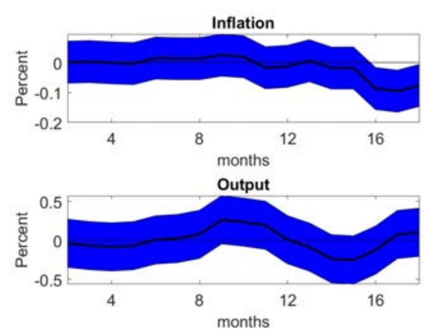
Sweden



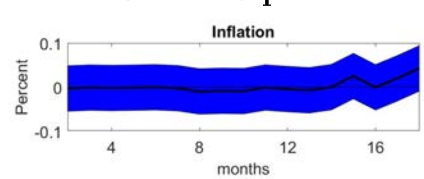
Norway



Iceland



Czech Republic



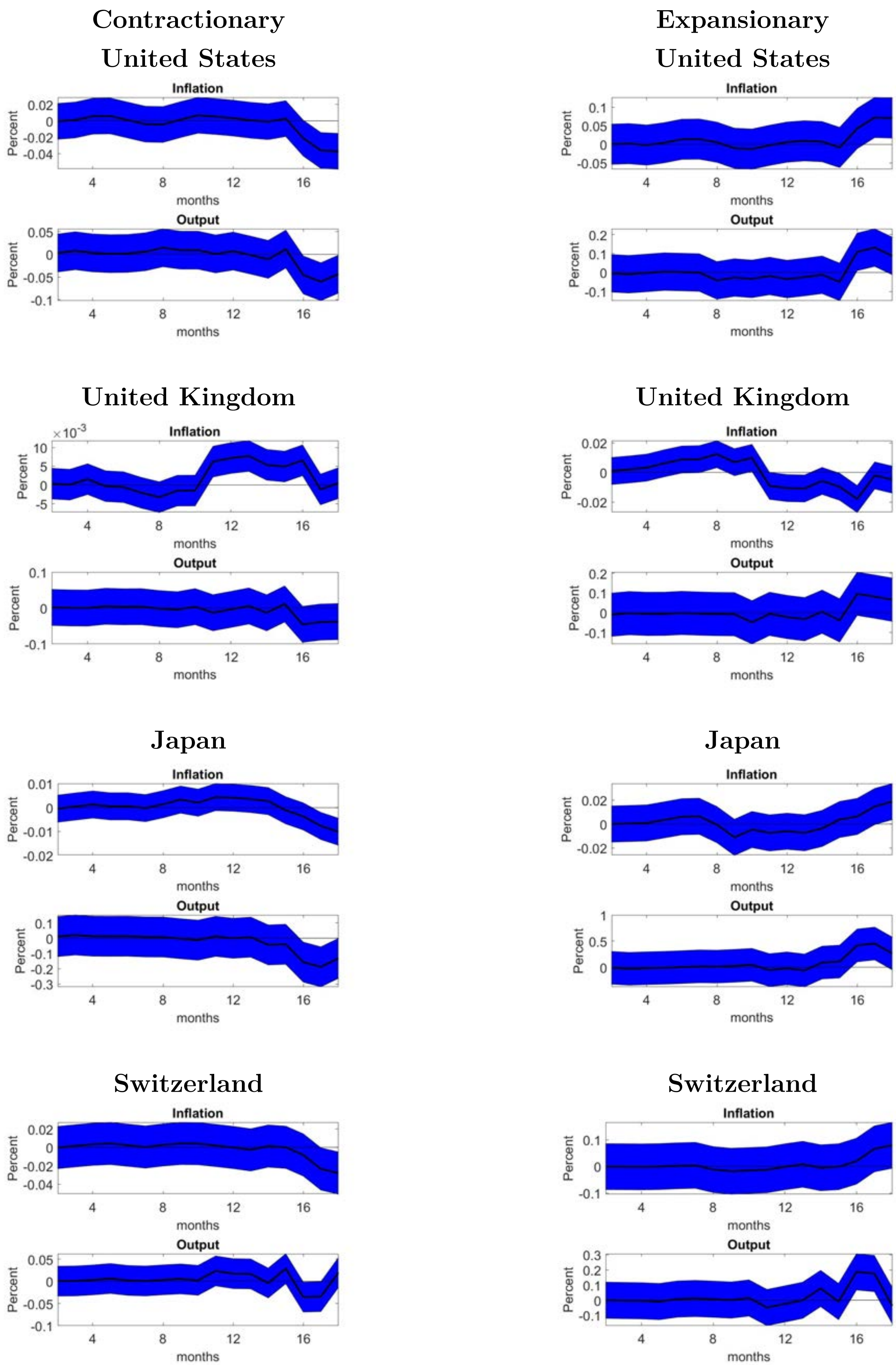


Figure 21: main currencies