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Spillover of the ECB's Monetary Policy Outside the Euro Area: How Different is Conventional From Unconventional Policy?

Oxana Babecká Kucharčuková, Peter Claeys, and Bořek Vašíček*

Abstract

This paper studies the macroeconomic impact of ECB policy on the euro area and six non-EMU countries. The analysis is based on the evolution of a synthetic index of overall euro area monetary conditions (MCI) that can be decomposed into conventional and unconventional policy measures. A standard monetary VAR including the MCI subcomponents shows that the transmission of unconventional monetary policy in the euro area is quite different than under conventional policy: prices react quickly, but the response of output (industrial production) is muted. A block-restricted VAR analysis confirms that euro area monetary policy spills over to the macroeconomic developments of non-EMU countries. While conventional monetary policy has a generalised effect on economic activity, exchange rates and prices, unconventional measures have generated a variety of responses. Exchange rates respond rather quickly, but an effect on the real economy is found only for some countries, and inflation remains largely unaffected.

Abstrakt

Tato studie se zabývá makroekonomickými dopady měnové politiky ECB na eurozónu a šest zemí EU mimo eurozónu. Analýza je založena na vývoji syntetického indexu celkových měnových podmínek eurozóny (MCI), který lze rozložit na konvenční a nekonvenční opatření. Standardní měnový VAR zahrnující složky MCI ukazuje na odlišnost transmise nekonvenční politiky v eurozóně od politiky konvenční: ceny reagují rychle, ale dopad na výstup (průmyslovou produkci) je slabý. Analýza s využitím vektorové autoregrese s blokovou restrikcí potvrzuje, že měnová politika eurozóny se přelévá do makroekonomického vývoje zemí mimo eurozónu. Zatímco konvenční měnová politika má všeobecný dopad na reálnou ekonomiku, měnový kurz a ceny, politika nekonvenčních opatření vedla z různorodým reakcím. Měnové kurzy reagují poměrně rychle, ale důsledky pro reálnou ekonomiku lze najít jen pro některé země a cenový vývoj není významně ovlivněn.

JEL Codes: E58, F42.

Keywords: ECB, monetary policy, synthetic indicator, unconventional measures, VAR.

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Nontechnical Summary

Since the global financial crisis the ECB has implemented a variety of unconventional measures. The importance and effectiveness of individual ECB instruments in monetary policy transmission has been constantly evolving over time. However, little is known about the cross-border effect of ECB policy in general, and about these unconventional measures in particular. Most studies focus on the spillover effects of US monetary policy on large advanced economies, as well as on emerging Asian and Latin American economies. The results indicate that the various stages of QE have had very different impacts and have not always produced stock market surges, massive capital inflows or rises in domestic exchange rates. The impact across countries depends a great deal on the types of monetary policies followed, and even more so on the development of financial markets. Given the importance of the transmission of monetary policy via the banking sector in Europe, and the close economic links between the euro area and its neighbouring countries, spillover of ECB policy is a major policy question. This paper aims at providing some evidence on the transmission of conventional and unconventional ECB monetary policy shocks to three Central European countries (the Czech Republic, Hungary and Poland) and three euro "opt-out" countries (Denmark, Sweden and the UK). Although these countries share strong ties to the euro area, they differ in their degree of dependence on the euro area, which, in turn, determines their effective degree of domestic monetary policy independence.

Various techniques have been developed to measure unconventional policies implemented at the zero lower bound (ZLB). As these policies involve different instruments than the standard policy tool used in normal times (the interest rate) and are targeted at specific segments of the financial market, and as the importance and effectiveness of individual ECB instruments in monetary policy transmission have been constantly evolving over time, developing a measure is not straightforward. We calculate a monetary conditions index (MCI) that synthetises euro area monetary conditions based on a dynamic factor model of monetary policy indicators, including interest rates, monetary aggregates, selected ECB balance sheet items and the exchange rate. This index is similar to a shadow rate and so it tracks the interest rate instrument closely in normal times and tracks diverse unconventional measures – or rather their propagation to the overall monetary conditions – in times of distress. The index is composed of factors that allow us to distinguish explicitly between conventional and unconventional measures in ECB policy. Second, we use a block-restricted VAR model to assess the impact of ECB policy on industrial production, consumer price inflation, short-term interest rates and exchange rates in six non-euro area countries.

Our results show that our MCI is an intuitive synthetic measure of ECB monetary policy. The responses to conventional policies are similar to those in a classical SVAR analysis using only the short-term interest rate. The same SVAR shows that the economic responses to unconventional measures are rather different: while inflation reacts much more strongly, the effect on output is much more muted.

The results confirm that ECB monetary policy shocks have important spillover effects on the macroeconomic variables of countries outside the euro area. Conventional monetary policy primarily has a similar and significant impact on industrial output in all six countries, but this is much less the case for inflation. The unconventional measures of recent years have not affected all six economies in the same way. Exchange rates fall quickly, but a longer-term real economic effect on industrial production and consumer price inflation is only observed in some countries, and that effect is generally weak.

1. Introduction

Since August 2007, central banks have drastically cut interest rates in response to the unravelling of the financial system. In spite of the cuts, the economic recovery has been frail and inflation subdued. As policy rates have hit the zero lower bound (ZLB), central bankers have started to look for other monetary policy instruments. Major central banks have resorted to a number of unconventional policies (UMP) that have commonly implied extensive use of their balance sheets.[1] In the specific case of the ECB the balance sheet policies were originally aimed at tackling liquidity shortages in the banking sector and keeping the money market working with enhanced credit support. Later, after the debt crisis escalated, additional stimulus measures were introduced to support specific financial market segments. The importance and effectiveness of the newly developed ECB instruments have been constantly evolving over time. The recently discussed measures (e.g. purchases of asset-backed securities) to tackle disinflationary trends in the euro area are just the latest chapter. Similar to conventional monetary policy, the effects of unconventional measures work in general through a variety of channels, such as the traditional interest rate channel, the portfolio balance channel, the bank lending channel and the signalling or expectations channel (Chen et al., 2012; Fratzscher et al., 2014).

Monetary policy adjustments by a major central bank like the ECB can have unintended consequences as they spill over to other countries. For instance, easing policy by lowering the interest rate may lead to portfolio rebalancing and push investors towards foreign assets promising higher yields. This move might in turn lower foreign long-term interest rates and ease monetary conditions abroad, but might be offset by appreciation of the foreign currency. Central banks can react with further interest rate cuts. The impact on foreign variables is also ambiguous, as it depends on the relative strength of the different channels in place.

Monetary policy spillover is not a problem per se, but the transmission of UMP does cause difficulties. The sheer size of UMP programmes presents central banks in smaller open economies with challenges in handling large capital flows. One needs to further distinguish between the immediate effects of UMP on financial variables and the longer-term effects on macroeconomic variables. The effect on financial variables can be rather quick given the international integration of financial markets, but also very transitory, with little impact on the real economy. The effect on foreign macroeconomic developments can take longer to materialise, as it needs to be intermediated by the impact on domestic macroeconomic variables.

Since the euro area is a major economic player with strong financial and trade linkages to EU economies outside the euro area, the UMP adopted by the ECB in recent years may have had spillover effects. The goal of our paper is to provide some evidence on the transmission of conventional and unconventional ECB monetary policy shocks to EU countries outside the euro area. Specifically, we focus on three Central European countries (the Czech Republic, Hungary and Poland) and three euro "opt-outs" (Denmark, Sweden and the UK).[2] These countries all share strong ties to the euro area. Nevertheless, their degree of dependence on the euro area differs due

[1] Borio and Disyatat (2010) and Woodford (2012) provide a classification of different unconventional monetary policy measures. Pattipeilohy et al. (2013) and Boeckx et al. (2014) list the UMP measures taken by the ECB.

[2] We use across the text this acronym for these three „old" non-EMU countries, although Sweden does not have an official opt-out clause.

to their choice of domestic monetary policy – although with the notable exception of the UK none them has resorted to unconventional measures of its own.[3]

Various techniques have been developed to measure unconventional policies implemented at the ZLB. As these policies involve different instruments than the standard policy tool used in normal times (the interest rate) and are targeted at specific financial instruments, and as the importance and effectiveness of individual ECB instruments in monetary policy transmission have been constantly evolving over time, developing such a measure is not straightforward. We develop a synthetic indicator of the euro area monetary conditions that incorporates both conventional and unconventional instruments, following Lombardi and Zhu (2014) and Wu and Xia (2014). We calculate a monetary conditions index (MCI) that synthetises euro area monetary conditions based on a dynamic factor model of monetary policy indicators, including interest rates, monetary aggregates, selected ECB balance sheet items and the exchange rate. This index is similar to a shadow rate and so tracks the interest rate instrument closely in normal times. It shows how QE can push policy rates further down by signalling or portfolio balancing. The index is composed of factors that allow us to distinguish explicitly between conventional and unconventional measures in ECB policy.[4]

We first compare the transmission of the ECB's monetary policy to the euro area as proxied by the short-term interest rate and the synthetic indicator to study the differential effects of the ECB's conventional and unconventional measures. The results of a standard monetary VAR model show that the use of the index modifies monetary policy shock transmission in the euro area only slightly. However, unconventional measures cause the economy to respond to monetary policy shocks in a strikingly different way. Prices react quickly, but the response of output is very muted.

We then study the spillover effects of ECB policy (Fratzscher et al., 2014). We confirm that euro area monetary policy spills over to macroeconomic developments in non-EMU countries. Conventional monetary policy has a generalised effect on economic activity, exchange rates and, to a lesser extent, prices. By contrast, the effect of unconventional measures is substantially more differentiated. Exchange rates respond rather quickly, but an effect on real economy is found only for some countries, and inflation remains largely unaffected.

The paper's structure is as follows. In section 2, we discuss the literature on the international transmission of monetary policy as well as various measures of monetary policy applied in the literature. The construction of the synthetic indicator – a combined measure of the euro area monetary conditions – is described in section 3. In section 4, we apply a block-restricted VAR

[3] While the zero lower bound on interest rates was never attained in Hungary and Poland, the other four countries did hit it. Some of the unconventional measures implemented in these countries (the exchange rate commitment in the Czech Republic, negative interest rates in Denmark and "forward guidance" in Sweden) were in place for only a limited period of time in comparison with the time span we examine, and we believe they do not affect our results. The UK is the only country to have used unconventional measures extensively, but these were implemented in a rather different manner and at a rather different time than that of the ECB. Therefore, we believe that even in the case of the UK the reliability of our results is not significantly compromised.

[4] Unlike many empirical papers in this area (e.g. Lenza et al., 2010) we resist running a counterfactual experiment, i.e. what would have happened if it were not for the unconventional measures. Indeed, given that we proxy monetary policy conditions by diverse variables including monetary aggregates and the exchange rate, the nature of the "no-policy" scenario is rather debatable.

model and examine the transmission of ECB policy to six euro area neighbours. The main conclusions are summarised in the last section.

2. Related Literature

2.1 International Transmission of Monetary Policy

The literature on the international transmission of monetary policy has come to complement the predominantly "closed economy" work on monetary policy transmission based on different identification mechanisms of vector autoregressive models. These open-economy VARs, which track the dynamics of both domestic and external variables, allow the international transmission of monetary shocks and macroeconomic spillovers in general to be evaluated. Most of the evidence relates to the dynamics of external variables following monetary shocks. Identification relies in most cases on the assumption that a small economy is subject to shocks from a larger one (typically the US). This small open economy assumption implies some exogeneity restrictions by its very nature. Cushman and Zha (1997) study the effects of Canadian monetary policy. Assuming US monetary policy decisions are set regardless of the developments in Canada permits identification of shocks to monetary policy. Kim and Roubini (2000) model an open economy VAR to solve the price puzzle in a closed economy. The authors find that the nominal exchange rate appreciates in response to a monetary contraction, but depreciates after a few months in accordance with the uncovered interest parity condition. More work has focused on the effects of foreign shocks on the domestic economy. Kim (2001) shows that US expansionary monetary policy shocks lead to booms in the other G-7 countries. In this transmission, it is the decrease in world real interest rates that matters most. As a consequence, the US trade balance declines in about a year, but subsequently improves again. Giordani (2004) estimates a small open economy versus the "rest of the world" model on US-Canadian data. Applications to Latin American and Asian economies can be found in Canova (2005) and Maćkowiak (2007). Both studies find that a significant proportion of the domestic economic dynamics of these economies is driven by external shocks, even beyond US monetary policy shocks.

Given the extent of trade and financial linkages within the EU, the economic developments and common monetary policy of the euro area can be expected to have a significant impact on other EU countries even if they retain an autonomous monetary policy. Maćkowiak (2006) provides some evidence for the Czech Republic, Hungary and Poland that a significant proportion of the variation in domestic variables in Central European countries can be explained by foreign shocks, in this case to the German economy. Horváth and Rusnák (2009) find for Slovakia (before it joined the EMU) that ECB policy affects the economy even more than domestic policy. Finally, Feldkircher (2013) uses a global VAR and claims that Central Europe reacts equally strongly to US and euro area output shocks. On the other hand, ECB policy has a long-run effect on output in the region, although the impact is rather mild.

2.2 Empirical Studies on the Impact of Unconventional Measures

Given that the experience with unconventional monetary policy measures is very recent (the only historical examples being Operation Twist in the US during the 1960s and quantitative easing in Japan during the 2000s), the number of studies evaluating their economic impact is still limited. Studies – like ours – that focus on the economic impact of policy actions, rather than looking at the financial market impact of policy announcements,[5] employ mostly VAR studies. In general, quantitative easing (QE) has been found to be effective in reducing the term spread of US Treasuries. The evidence on the impact on real activity is less clear-cut (Baumeister and Benati, 2013; Gambacorta et al., 2014).

For the euro area, Lenza et al. (2010) argue that in spite of the apparent differences in execution, the practical impact of the unconventional measures of the ECB, the Fed and the BoE in 2008 was very similar to that of standard monetary policy, rather than acting as a substitute. Fahr et al. (2011) argue that the unconventional measures the ECB adopted in the post-Lehman period (fixed rate full allotment, extension of maturities) were more effective in lowering credit spreads and boosting credit creation than signalling the future policy stance. Peersman (2011) and Boeckx et al. (2014) also argue that the measures were focused on restoring credit supply and supporting the banking sector to avert a breakdown of the transmission channel. But while they argue that this has caused the transmission channel to be different than under conventional policy, Gambacorta et al. (2014) find that the economic impact of unconventional policy is similar to that of standard policy. Giannone et al. (2012) conclude in a counterfactual experiment that the current level of industrial production is 2% higher and unemployment 0.6 pp lower as compared to a hypothetical situation without unconventional ECB measures after the Lehman bankruptcy.

The study of the cross-border impact of unconventional monetary policy has been limited to the analysis of Fed policies. Neely (2010) argues that the US large-scale asset purchases (LSAP) lowered sovereign bond rates by 20–80 bp in advanced economies (as compared to 100 bp in the US), and pushed the dollar down by 4–11 pp. According to Bauer and Neely (2014), this fall is due to the predominant signalling channel in the US and Canada, but to portfolio rebalancing in Australia, Germany and Japan. Chen et al. (2012) find that the LSAP boosted the prices of a broad range of assets (equity prices, sovereign and corporate bond yields, CDS premia) across the world, but the long-run real effects were very heterogeneous across countries. The effect was particularly expansionary in emerging Asian and Latin American countries. The Fed's monetary easing stimulated capital inflows and further spurred credit growth and inflationary pressures in these countries. Structural characteristics and policy frameworks were decisive in determining this impact. Fratzscher et al. (2013) argue that these effects – lower sovereign yields and rising equity markets – only occurred after QE1, not after QE2. Importantly, these policies had mostly procyclical effects on capital flows to emerging countries. FX or capital account policies did not seem to shield countries from US monetary policy spillover. Recently, Eichengreen and Gupta (2014) show that the tapering of these measures, and specifically the communication of a possible exit, may have international effects as well. Specifically, emerging markets that allowed real exchange rates to appreciate and current account deficits to widen during US quantitative easing,

[5] See Doh (2010), Gagnon et al. (2010, 2011) for event studies of this type. Other studies focus on the short-term impacts of more recent ECB unconventional measures such as the Securities Market Programme (e.g. Eser and Schwaab, 2013; Altavilla et al., 2014), finding that these programmes were very effective in altering the path of selected financial variables.

saw the sharpest impact. The depth of financial markets made countries more vulnerable to this spillover.

Empirical evidence on the cross-border effects of the unconventional measures adopted by the ECB is practically non-existent. The single contribution so far is Fratzscher et al. (2014), who study the impact of the most important UMPs of the ECB on asset prices in the euro area and globally. The main impacts they detect are a positive boost to global equity markets and a lowering of credit risk between banks and sovereigns in G20 countries. Unlike the Fed's UMP, the actions by the ECB did not lead to international portfolio rebalancing across regions and assets. To the best of our knowledge, there is no study focusing on the international spillover of ECB policy actions to the real economy. Some of the ECB's unconventional measures are very recent, while more may yet need to be adopted in the near future as the debt crisis in the euro area drags on. In both cases, however, they may have major impacts on the monetary policy choices in neighbouring economies.

3. A Monetary Conditions Index for the Euro Area

3.1 A Synthetic Measure of the Monetary Policy Stance

In empirical studies the policy stance has been evaluated using a series of different indicators over time. The use of monetary aggregates as an indicator of the monetary policy stance has fallen into disuse due to the endogeneity of money and the unstable relationship between monetary aggregates and income. Starting with Bernanke and Blinder (1992), it became common practice to use the interest rate set by the central bank as the indicator of monetary policy action. Discretionary changes in monetary policy have been identified with a variety of techniques. Under the narrative approach, a dummy is associated with those policy actions which can be deemed exogenous (Romer and Romer, 1994). With VAR models, assumptions are made about the relation between the policy rate and a set of monetary and economic variables to identify truly exogenous policy changes (Christiano and Eichenbaum, 1992; Christiano et al., 1996; Uhlig, 2005).

The official policy interest rate is not a reliable indicator of the monetary policy stance in the current environment where the policy rate has hit the zero lower bound (ZLB) and central banks need to rely on other tools. A whole range of policies implemented by the major central banks, from credit provision to banks, through large-scale asset purchases and maturity extensions, to forward guidance, are not reflected in the official policy rate anymore. This has made economists look for alternative measures of the monetary policy stance to assess the impact of unconventional policy measures.

One strategy has been to use event studies to measure the impact of specific UMP actions on specific dates. As UMP is aimed primarily at asset prices, event studies that compare financial

market responses at short horizons around the date of policy action are the most appropriate. These studies are less suitable for looking at the response of the real economy.[6]

Another strategy has been to develop alternative indicators to the interest rate. Chen et al. (2012) infer from the behaviour of government and corporate bond spreads a proxy measure of policy measures implemented by the Fed. The drawback is that financial variables move for a couple of reasons, and actually mostly not because of policy. Another set of papers, including Meaning and Zhu (2012), resort to more monetary measures by considering the Federal Reserve balance sheet, but as the transmission of monetary policy to the financial system has broken down, it is unlikely that this measure reflects the extent of monetary easing. Bauer and Rudebusch (2014) and other studies for the US also use information embedded in the term structure of interest rates.

Other papers have attempted to restore the use of a single policy indicator by computing a so-called shadow rate. The idea is to compute a measure akin to the policy rate that moves like the interest rate when the ZLB is not binding, but also captures non-interest-rate policy actions at the ZLB. The idea of an unobserved policy index is not new and synthetic indicators have been developed before.[7] Lombardi and Zhu (2014) and Wu and Xia (2014) construct an indicator of US monetary policy by constructing a latent factor that reflects a set of real and monetary variables. The index in both papers is a shadow policy rate that can be compared directly with the federal funds rate. However, the rate is constructed so as to reflect different behaviour when the ZLB is binding. Their approach is to pool data on monetary policy actions related to both sides of the central bank balance sheet and then apply a dynamic factor model prior to the ZLB period. The simulated rate is obtained by setting the policy rate as missing in the ZLB period. In this sense, the index reflects a wide set of monetary information and assumes that the historical correlations between the policy rate and other monetary indicators would still hold in the ZLB period.[8]

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[6] This approach, however, has important limitations. First, as causality is assumed to run from the event to market prices, it cannot properly account for gradual, longer-term transmission of such measures to financial and especially macroeconomic variables. Second, the event study methodology does not account for endogenous linkages between the variables. Although events are exogenously defined and all attention is centred on the event in question, it is often difficult to identify what moment in time represents an event. Indeed, expectations about the implementation of a UMP measure have often been around for some time and the announcement often conflicts with previous beliefs. This problem is compounded by indications of the central bank that it might consider intervening in the future. Finally, with an event study there is no benchmark to compare the effect of unconventional vis-à-vis conventional monetary policy measures. We believe all these points are very relevant when one wants to study the effects and international spillover of the ECB's unconventional monetary policy. Moreover, the very diverse, discontinuous and time-diffuse nature of these measures makes any generalisation very difficult. Indeed, most of the empirical studies assessing the effectiveness of the ECB's recent unconventional measures such as the SMP (e.g. Eser and Schwaab, 2013; Altavilla et al., 2014) look at the short-term impacts of such programmes on financial variables (e.g. 10-year sovereign bond yields) and conclude that these programmes were very effective. In contrast to our analysis, these studies do not consider whether a particular programme was able to provide an overall easing of the monetary conditions and thus have a longer-term impact on economic developments.

[7] See the Divisia index of money in Barnett et al. (1992), the monetary services index by Thornton and Yue (1992) and the utility-based currency-equivalent aggregate by Rotemberg et al. (1995).

[8] Note that some papers, such as Gambacorta et al. (2014), take the classic monetarist view that all relevant information is retained solely by the total size of the central bank balance sheet and identify an unconventional monetary policy shock simply as an exogenous increase in the central bank balance sheet (i.e. a quantity-based measure). Other papers, such as Lenza et al. (2010) and Baumeister and Benati (2013), track unconventional monetary policy by means of its effect on money market rates or long-term yields (i.e. price-based measures). Given the potential pitfalls of using a single indicator to track the overall monetary conditions rather than the unconventional measure alone, we prefer to use different indicators that reflect the monetary policy stance. The

We see this approach as appealing for the euro area given the variety of measures the ECB has implemented over the last few years. The specificity of each programme calls for a broader approach to measuring the monetary conditions. Furthermore, the diversity of national interest rates, which reflects the structural diversity of the euro area, limits the usefulness of approaches based on the interest rate alone.

3.2 Estimation of Monetary Conditions in the Euro Area

We follow the logic that Lombardi and Zhu (2014) applied to the US and use factor analysis in order to construct a synthetic measure of the overall monetary conditions (MCI) for the euro area.[9] This index makes use of information from January 1999 to July 2014 based on interest rates and spreads, monetary aggregates, selected ECB balance sheet items and additionally (given the relative openness of the euro area) the exchange rate (all from Thomson Datastream). We have a set of 14 variables reflecting the monetary conditions in the euro area. These variables can be divided into the following five blocks:

I. Interest rates:

1. Main refinancing operation rate (EMPRATE)

2. 3-month Euribor (EMIBOR3)

3. 12-month Euribor (EMIBOR1Y)

4. 10-year yields on synthetic sovereign bonds of euro area countries (EMGBOND)

5. Overnight index swap (OIS)

II. Monetary aggregates:

6. M1 (EMM1NEG)

7. M2 (EMM2NEG)

8. M3 (EMM3NEG)

We use the year-on-year change in the money supply but switch the sign so that an increase corresponds to a monetary tightening, as for interest rates.

III. Selected asset items from the ECB balance sheet:

9. Total assets (EMASTOTNEG)

consideration of monetary aggregates can also be deemed consistent with the official two-pillar strategy of the ECB.

[9] One notable difference is that the ECB did not hit the effective ZLB until 2014. Therefore, unlike Lombardi and Zhu (2014) we do not aim to quantify what the policy interest rate would have been if it had not hit the ZLB, but rather construct a synthetic measure that reflects both the conventional and unconventional measures implemented by the ECB.

10. Securities held for monetary policy purposes (EMECASMNEG)

11. Long-term refinancing operations (EMALTRONEG)

We use the year-on year change with a negative sign for all these variables.

IV. Selected liabilities from the ECB balance sheet:

12. Currency in circulation (EMECLBCNEG)

13. Liabilities of ECB to euro area MFIs related to monetary operations (EMECLEMNEG)

We use the year-on year change with a negative sign for all these variables.

V. Exchange rate:

14. Nominal exchange rate of US dollar against euro (USD/EUR)

We use the year-on-year change.

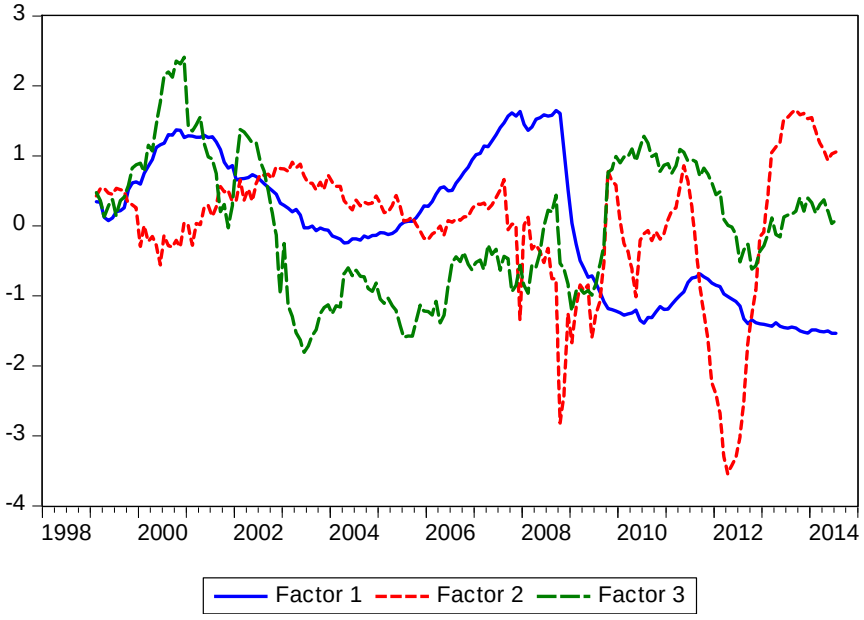
The data cover the period from January 1999 to June 2014 and come from Thomson Datastream. All the variables are year-on-year changes except for the interest rate and the MCI (like its two factors). We summarise the information contained in these 14 series into a reduced number of factors by employing the method of principal factors. The Minimum Partial Average (MPA) method determines that three factors (alternative statistical criteria point to the same number of factors) are able to explain close to 100% of the original series' variability. Table 1 provides details on the factors' unrotated loadings. The first factor explains around 62% of the total variability and according to the factor loadings can be identified as a factor representing information mainly from interest rates and to a lesser extent also from monetary aggregates. Therefore, it can be interpreted as mainly representing the conventional monetary policy stance. This can also be seen from Figure 1, which plots the factors over time (with an increase meaning a tightening of the monetary conditions). The first factor closely follows the policy interest rate of the ECB. The second factor explains around 22% of the total variability and is mostly associated with developments in the ECB's balance sheet (but also the exchange rate) and as such can be deemed to track mostly unconventional measures. The third factor explains around 16% of the variability in the data and is driven mainly by developments in monetary aggregates. There does not seem to be a direct link between this factor and conventional or unconventional measures.

The orthogonality between the first and second factors reflects the fact that unconventional measures are used as a substitute for the conventional one. Therefore, the first factor records most of the dynamics of ECB policy until 2008, whereas the second factor starts varying significantly only after 2007. The third factor seems to be tied to whichever factor has the prevailing dynamics in each sub-period, i.e. the first factor until 2008 and the second one as from 2008. The results are robust to dropping each of the 14 variables in the factor model, irrespective of their relative communality/uniqueness.

Table 1: Factor Loadings for the Three Factors Retained in the Principal Factors Method

		Factor 1	Factor 2	Factor 3	Communality	Uniqueness
I	EMPRATE	0.97	0.02	0.16	0.98	0.02
	EMIBOR3	0.99	-0.00	0.12	0.99	0.01
	EMIBOR1Y	0.97	-0.06	0.18	0.98	0.02
	EMGBOND	0.70	0.02	0.42	0.66	0.34
	OIS	0.98	0.09	0.12	0.98	0.02
II	EMM1NEG	-0.02	-0.28	0.36	0.21	0.79
	EMM2NEG	-0.77	-0.04	0.53	0.89	0.11
	EMM3NEG	-0.86	-0.03	0.43	0.92	0.08
III	EMASTOTNEG	-0.17	0.92	0.22	0.92	0.08
	EMECASMNEG	0.23	0.09	-0.18	0.09	0.91
	EMALTRONEG	-0.13	0.27	0.13	0.11	0.89
IV	EMECLBCNEG	0.07	0.04	0.66	0.44	0.56
	EMECLEMNEG	0.01	0.89	0.05	0.80	0.20
V	USD/EUR rate	0.06	0.47	-0.35	0.35	0.65
	Factor	Variance	Cumulative	Difference	Proportion	Cumulative
	Factor 1	5.76	5.76	3.72	0.62	0.62
	Factor 2	2.04	7.80	0.52	0.22	0.84
	Factor 3	1.52	9.32	---	0.16	1.00
	Total	9.32	9.32		1.00	

Figure 1: Factor Model: Evolution of Three Factors of Monetary Conditions in the Euro Area

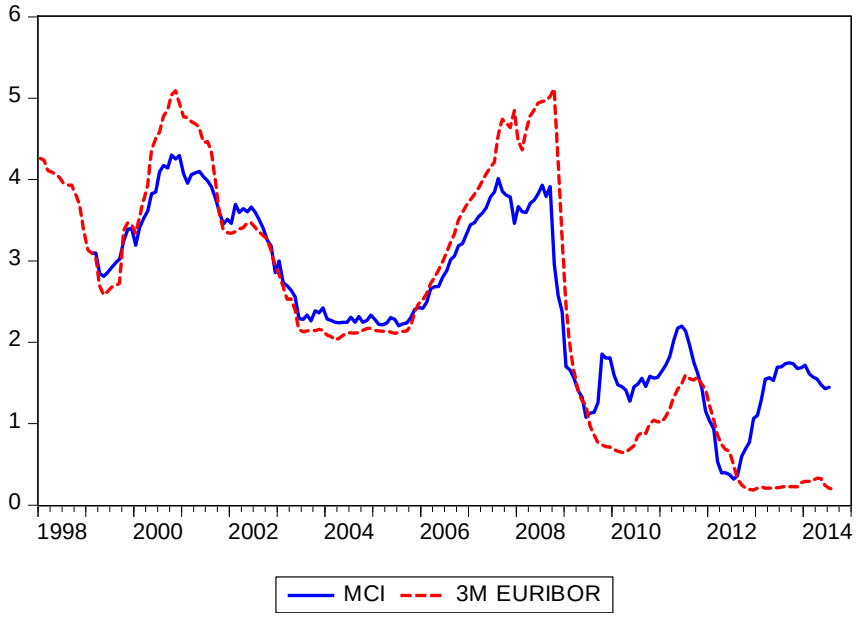


Note: The factors are standardised; an increase means a tightening of the monetary conditions.

In order to calculate the synthetic indicator, we weigh the sum of the three factors (with weights given by the percentage of the overall data variability explained by each factor, i.e. 62%, 22% and 16%) and normalise it (using the mean and standard deviation of the 3-month Euribor series). Figure 2 plots our synthetic indicator of the overall monetary conditions (MCI) in the euro area. We also plot the 3-month Euribor for comparison. It is apparent that until the onset of the global financial crisis in 2007, this aggregate measure of the monetary conditions tracks the 3-month

Euribor series very closely. This is not surprising given that in the pre-crisis period no additional measures (affecting the size or composition of the ECB's balance sheet) were in use and the monetary transmission mechanism (affecting the dynamics of monetary aggregates) was functioning well. As in Peersman (2011), we find some deviations in the MCI prior to the crisis in the 2001–2002 period. These are related to the 2001 slowdown after the US crisis, and the euro cash changeover until January 2002. Therefore, the Euribor provided sufficient information on the overall monetary conditions in the euro area.

Figure 2: Monetary Conditions Index for the Euro Area and the 3-month Euribor

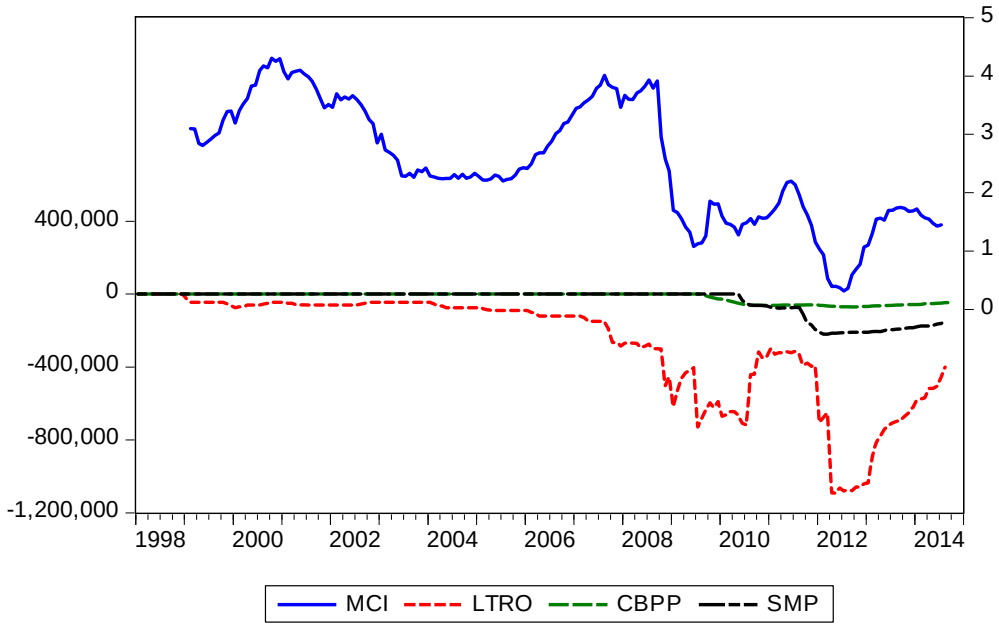


By contrast, from 2007 onwards we observe significant deviations of the MCI from the 3-month Euribor. At the onset of the global financial crisis the sharp fall in interest rates and the enhanced liquidity support provided by the ECB soften the monetary conditions as compared to the 3-month Euribor. As from 2009, we observe that the overall monetary conditions were often tighter than what can be inferred from looking at the 3-month Euribor only. It is apparent that since 2009 most of the MCI's variability is driven by the second factor in spite of the fact that the first factor has a higher weight. Whereas the variability of the first factor has been limited since the drop in interest rates in 2008, the evolution of the second factor tracking the ECB's balance sheet is much more abrupt. As from mid-2011 we observe an easing of the monetary conditions related to the implementation of the Securities Market Programme (SMP) and the Long-Term Refinancing Operations (LTRO) programme (see also Figure 3 below). Conversely, from mid-2012 onwards (curiously since Mario Draghi's "whatever it takes" statement) we observe a quite significant tightening of the monetary conditions in the euro area. The significant decrease in the ECB's balance sheet due to prepayments of LTRO loans and the maturing of securities purchased within the Covered Bonds Purchase Programme (CBPP) and the SMP drive this significant jump in the second factor and consequently the whole MCI. By contrast, the announcement of the Outright Monetary Transactions (OMT) programme significantly reduced yields on sovereign bonds (mainly of the EMU periphery; see, for example, Altavilla et al., 2014), but did not alter most of the remaining variables approximating the overall monetary conditions in our factor analysis. From the very construction of the MCI it is apparent that the gradual impairment of monetary

policy transmission did lead to a tightening of the overall monetary conditions in the euro area even when the main policy rate of the ECB could not be further altered. Orphanides (2014) and Fisher (2013) have made a similar argument: the ECB has not reacted to the endogenous tightening of policy due to shifts in risk taking in markets.

Figure 3 compares the MCI with the (inverse) volume of the ECB's previous unconventional programmes: (i) the Long-term Refinancing Operations programme (the LTRO series also includes "conventional" LTROs, i.e. loans with maturity up to 3 months, but the dynamics are clearly driven by the unconventional LTROs with longer maturities that dominated after 2008), (ii) the Covered Bond Purchase Programmes (CBPP1 and CBPP2 were implemented in 2009–2010 in order to reduce the financing costs of the banking sector; we summed the amounts of the two programmes to produce a single series), and (iii) the Securities Market Programme (the SMP was implemented in 2010 with the aim of reducing sovereign risk premia via interventions in the secondary sovereign bond market).

Figure 3: Monetary Conditions Index (Right-hand Scale) and Volume of the ECB's Main Unconventional Programmes (Billions of Euros, Inverse, Left-hand Scale)



The figure suggests that the major decrease in the MCI corresponds to the period after the implementation of the LTRO programme (in 2011) and significantly expanded the ECB's balance sheet, which was much less the case for the substantially smaller CBPP and SMP. However, subsequently (in 2012–2013) the ECB's balance sheet shrank as the LTRO loans were paid back in advance and as some bonds purchased under the CBPP and SMP gradually matured. Although the voluntary prepayment of LTRO loans by banks should perhaps not be seen as a tightening of the monetary conditions in the euro area, the difference between the ECB's programmes and the Federal Reserve's quantitative easing is evident. Whereas the purchases by the ECB were one-off ones with only a short-term impact on its balance sheet, the Fed's purchases continued for several years and had a very persistent impact on its balance sheet. Indeed, even without the prepayments

the reduction in the ECB's balance sheet would have been delayed only slightly, i.e. an endogenous exit date was embedded in the ECB's measures.[10]

4. Transmission of the ECB's Monetary Policy Outside the Euro Area

4.1 Block-restricted VAR Approach

A variety of structural VAR models have been applied to analyse unconventional monetary policy. Altavilla et al. (2013) and Boeck et al. (2014) employ short-term restrictions on ECB balance sheet data to examine the domestic effects of expansionary monetary policy. We employ a rather standard VAR, but account for the overall monetary conditions to trace both conventional and non-conventional measures, and focus on the spillover effect of ECB policies.

We examine small open economies that are mostly recipients of the exogenous shocks generated by ECB policy. Any shock affecting these economies will not be transmitted to the euro area. To account properly for the direction of the causality, we estimate a block-restricted structural VAR model in the spirit of Kim (2001), Canova (2005) and Maćkowiak (2007). The identification of the spillover effect of monetary policy shocks from the large economy on the small open economy comes from the restriction of the impact of domestic shocks on the foreign economy. The VAR model is estimated separately for each of the six non-euro area countries. Each VAR contains euro area variables and the corresponding domestic variables. Say we have a simple VAR model with m variables in vector y and with ε as a vector of structural disturbances, as in (1):

$$A(L)y(t) = \varepsilon(t), \tag{1}$$

For a two-country model, vector y contains the m_1 exogenous variables and the m_2 variables of an economy outside the euro area from the selected sample (henceforth the domestic economy). The model can then be re-written in the following form:

$$A(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix},\ y(t) = \begin{bmatrix} y_1(t) \\ y_2(t) \end{bmatrix},\ \varepsilon(t) = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix}, \tag{2}$$

where subscript 1 corresponds to the euro area and subscript 2 to the domestic economy. If we assume that euro area developments are exogenous, the effect of the domestic economy on the euro area is zero (i.e. $A_{21}(L)=0$). We otherwise assume simple Cholesky ordering for the variables, in line with Bernanke and Blinder (1992): output and consumer prices react to monetary policy shocks with a lag, but innovations in output and prices have an immediate effect on the monetary policy stance.

[10] This explains the difference between our results and those of Lombardi and Zhu (2014), who estimated their MCI (shadow policy rate) as being significantly negative for extended periods of time, whereas our MCI features an endogenous monetary policy tightening.

Similarly to Mojon and Peersman (2001), the endogenous block of the VAR consists of four domestic variables with the standard VAR ordering: the industrial production index, the HICP, the 3-month interbank interest rate and the exchange rate of the domestic currency vis-à-vis the euro.[11] The exogenous block includes the euro area's industrial production index, the HICP and the monetary instrument. We compare the impulse responses based on the model containing the 3-month Euribor with the alternative specification where it is replaced by the MCI we derived in section 3.

In order to disentangle the effects of conventional and unconventional policies, instead of the MCI we use its first two factors, accounting for the conventional (first factor) and unconventional policies (second factor) of the ECB. We use both factors in the VAR at the same time.[12] Our identification strategy for conventional and unconventional monetary policy rests in this case on the same assumption as before. Our ordering of the first factor before the second one implies that an innovation in the second factor (unconventional policy) has no contemporaneous effect on conventional policy, and thus unconventional policy shocks are orthogonal to conventional ones.[13] On the contrary, an innovation in the first factor is allowed to have a contemporaneous impact on the second one in order to track the endogenous variation in the second factor in response to an innovation in the first.[14]

The model is estimated by generalised least squares. The Schwarz and Hannan-Quinn criteria suggest using just one lag, while the Akaike Info Criterion and the Final Predicted Error suggest that the number of lags should always be the maximum we allow for. Given the relatively short time series of our dataset (175 observations at monthly frequency), we estimate the VAR model with 1 lag.[15] To control for the potential structural change following the collapse of Lehman Brothers and the global financial crisis we use a shift dummy from September 2008.

4.2 Euro Area Impact of ECB Policy

Let us first consider the impact of applying the MCI as compared to using the 3-month Euribor (i.e. the common proxy for the main policy rate of the ECB) on the euro area economy. The plots in the upper panels a) and b) of Figure 4 show the responses up to 48 months after a shock to the 3-month Euribor and the MCI respectively. We then also estimate a VAR using instead the first two factors, representing around 85% of the variation in the MCI. The results are shown in panel c) for the shock to conventional monetary policy and in panel d) for the shock to unconventional

[11] Due to higher frequency of the data we use industrial production instead of GDP.

[12] In this sense, our motivation for using the factors in the structural VAR is different from Bernanke et al. (2005). Whereas they aim to include all the information monetary policy incorporates when making policy decisions, we want to include all the information describing the monetary policy stance.

[13] Note that when performing the factor analysis (section 3.2) we do not rotate the factors in order to make them fully orthogonal. This is because economically there is interplay between conventional measures (first factor) and unconventional measures (second factor) which we make use of in our VAR identification scheme.

[14] Given that the dynamics of the second factor are also driven by the euro exchange rate this assumption is needed in order to take into account potential endogenous responses of the euro exchange rate to interest rate adjustments.

[15] The Im, Peasaran and Shin unit root test does not find the presence of non-stationarity in the data.

policy. All the plots show the central impulse responses with a 67% confidence band using the Efron percentile.[16]

The results in panel a) show that a monetary tightening results in a rapid drop in industrial production and prices, peaking after 12 months and 20 months respectively. This is in line with most studies of euro area monetary policy (Peersman and Smets, 2003) and reflects a well-functioning transmission mechanism where output and prices show a hump-shaped response after some delay. Using the MCI instead of the 3-month Euribor (panel b) does not significantly change the picture. If anything, when the full monetary policy conditions are considered, the effect of a monetary tightening seems to be more persistent, but there is also more uncertainty about the impact. It should also be noted that our VAR results do not feature the price puzzle, which has often been found even for the euro area. Indeed, with a growing number of lags the price puzzle becomes more pronounced.[17] In that case the difference between using the 3-month Euribor and using the MCI becomes larger. Specifically, the puzzle is weakened and largely insignificant with the MCI.[18] This result is also in line with Sims (1992), who argues that the price puzzle is a result of imperfectly controlling in a VAR model for information that the central bank may have about the future inflation path.

The split of the MCI into conventional and unconventional parts produces quite contrasting responses to monetary policy, as shown in panels c) and d). The first factor is mostly driven by interest rate developments, and hence we observe a rather similar response as for the standard Euribor in panel a). By contrast, the second factor is driven mainly by ECB balance sheet items (panel d) and shocks to unconventional policy result in a much weaker response of industrial production yet a much quicker and pronounced response by prices (albeit with much wider confidence bands).[19] The significance of the impulse responses for inflation has one evident implication for the current situation. If the euro area monetary conditions have tightened substantially since 2012, as evidenced by the evolution of the second factor, then this unconventional monetary policy shock is one of the key drivers of the disinflation in the euro

[16] Figure 4 and the figures in the appendix show the forecast error impulse responses. These results are similar to the orthogonal impulse responses (available upon request). The confidence bands are bootstrapped and for this reason they are asymmetric.

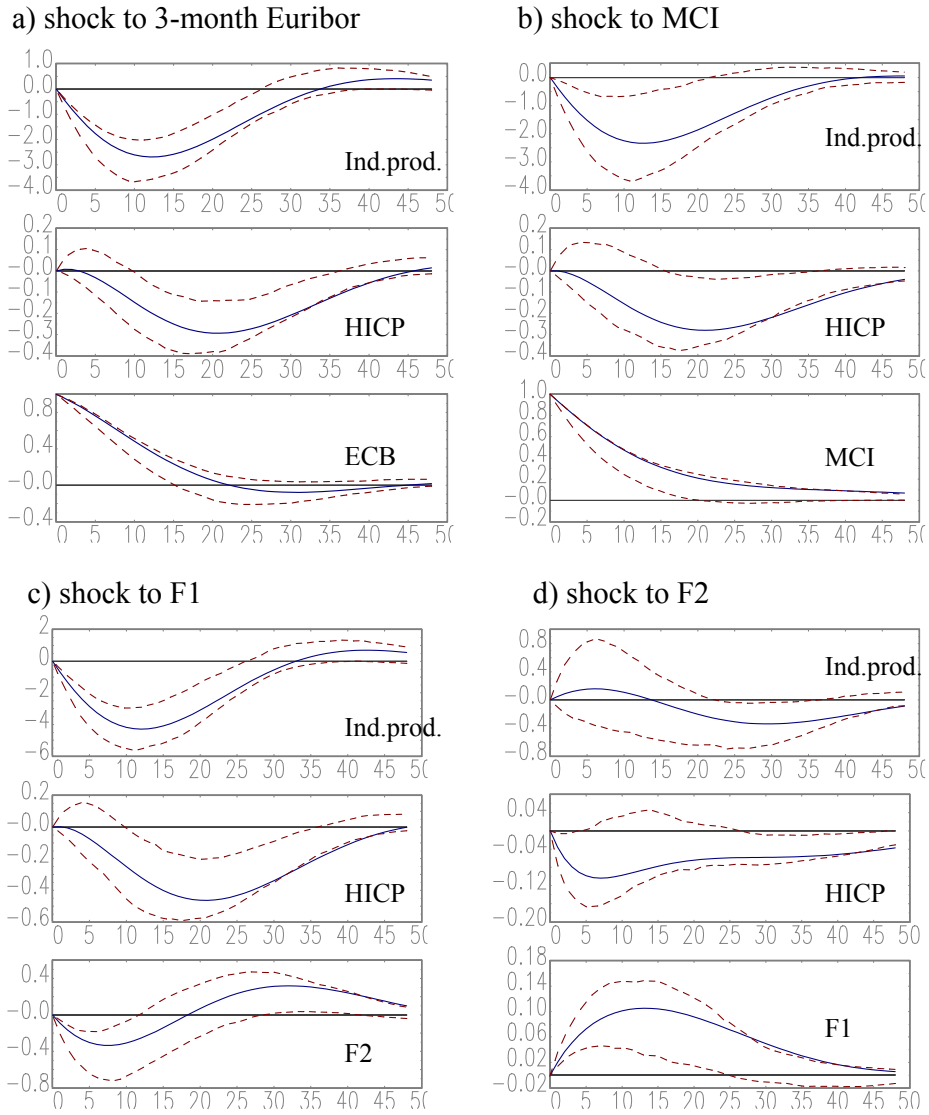
[17] We tried an alternative specification with 3 lags. We also estimated a model where we added an exogenous variable (the Brent crude oil price, or alternatively the world commodity price index or VIX). We also replaced industrial production by the GDP gap obtained using the HP filter and interpolated on monthly frequency, and by the industrial production gap. We also tried to place the exchange rate before the interest rate. Our robustness check shows that the only cure for the price puzzle is to reduce the number of lags to 1 in the VAR.

[18] The price puzzle has been reported in a number of studies (see, for example, Jarocinski, 2010, or the studies discussed in Coricelli et al., 2006). Using more information by including different factors has been suggested as a way of solving the price puzzle for the euro area (Soares, 2013). One should note that in our case it is also problematic to add any additional variables (a factor capturing global development or simply an exogenous variable) due to the relatively large model (seven equations) compared to the series length. For complex treatment of price puzzle see Rusnák et al. (2013).

[19] It is important to note that unlike the Fed, the ECB reached the effective ZLB only at the end of our sample. Therefore, during the recent financial crisis, conventional and unconventional tools de facto coexisted. However, as is apparent from Figure 1, while most of the dynamics of the first factor, interpreted here as a measure of conventional monetary policy, relate to the pre-2008 period, the dynamics of the second factor are apparent mostly in the post-2008 period, given that they are driven mainly by the ECB's balance sheet operations, which were not in use before 2008. The number of variables included in the VAR, as well as our focus on individual countries, makes it impossible to look solely at the crisis period, in contrast to Gambacorta et al. (2014), who use a four-variable panel VAR.

area, which since 2013 has decoupled from international price developments (see also Fisher, 2013).

Figure 4: Impulse Responses of Euro Area Variables



This result stands in contrast to what other studies have argued, namely that the output response has been strong but the effect on inflation has been muted. In our view, an intuitive explanation for the quicker transmission of UMP to prices is the speed of transmission. Whereas conventional monetary policy affects the short-term interest rate first and its impact is intermediated by long-term interest rates and finally investment, in the case of UMP the transmission starts immediately by affecting long-term interest rates via portfolio balancing and signalling, which affects inflation expectations. This can substantially shorten the horizon at which the impact occurs.[20]

[20] This finding is at odds with the evidence for the US (e.g. Bauer and Rudebusch, 2014) suggesting that the transmission of the Fed's unconventional measures is rather slower. The difference might be explained by the different nature of the unconventional measures adopted by the Fed and the ECB. While the former relied extensively on forward guidance alongside asset purchases, the ECB adopted one-off measures whose effect was

The subdued effect on output is rather puzzling. One potential explanation for the limited impact on output is that in spite of the series of unconventional measures adopted in recent years, additional negative shocks have hit the real economy of the euro area. A prime candidate is tight fiscal policy; another one is the fragility of the financial sector, which might have prevented the extra liquidity from being transformed into additional lending. Those effects are not modelled here, but might potentially offset the positive effects of monetary policy (Boeckx et al., 2014).

4.3 Spillover Effects of ECB Policy

We now apply the same VAR model to look at the impact of an EMU monetary shock on macroeconomic developments in each of the six EU countries outside the euro area. In all cases we report only the impulse response functions for the non-euro area countries (endogenous block) given that the responses for the euro area (exogenous block) due to the block restriction remain unaltered vis-à-vis Figure 4. We report detailed country plots for the four euro area monetary shocks in the Appendix and summarise the key features – signs and horizon – of the impulse responses for all six countries in Table 2 in four panels: a) the 3-month Euribor, b) the MCI, c) the first factor and d) the second factor. Besides industrial production and prices we also look at the effects on domestic interest rates and the exchange rate of the domestic currency vis-à-vis the euro. We report when the response attains its peak together with the sign of the response. Only significant responses are reported.

We first analyse the responses to a positive shock to the standard policy instrument, the 3-month Euribor. A monetary tightening leads consistently to a drop in industrial production in all six countries. The speed of transmission is surprisingly quick, as the responses attain their bottom after roughly one year, at the same time as the response for the euro area. By contrast, the response of prices is much less homogeneous and often not intuitive. For four out of the six countries (the Czech Republic, Hungary, Poland and Sweden) we find a pronounced price puzzle. Prices eventually fall in the Czech Republic and Poland after about two to three years, but they do not do so significantly in the case of Hungary and Sweden.[21] The delayed response is a consequence of the high correlation of business cycles within the EU. Furthermore, it is also associated with a corresponding tightening of domestic policy: the response of the domestic rate is almost immediate, occurring within a few months following the change in ECB policy (Hungary, Poland, Denmark and to a lesser extent the Czech Republic). A final effect comes from the differential impact on exporting firms and the economy as a whole. This is supported by evidence on the impact on exchange rates. The ECB policy leads to a significant depreciation in five countries except Denmark. This boosts exporting firms more than the rest of the economy. The effect is again intermediated partially by the endogenous response of domestic short-term interest rates. Tighter ECB policy is followed by further domestic tightening, but the domestic interest rate response is not unity, hence the negative interest rate differential vis-à-vis the euro area implies mostly depreciation of the domestic currency, peaking after around seven months.

almost immediate and in turn did not rely much on the signalling channel in general and forward guidance in particular. Indeed, the first signs of forward guidance by the ECB do not appear until July 2013, when it issued a statement saying that key interest rates would remain at or below their current levels for an extended period of time.

[21] One more reason for the price puzzle, as noted in Cushman and Zha (1997) and also found in other papers, such as Kim and Roubini (2000), Coricelli et al. (2006) and Rusnák et al. (2013), is that central banks of small open economies do react to exchange rates. We experimented with this option by ordering the interest rate after the exchange rate, but this does not help reduce the price puzzle.

Table 2: Impulse Responses of Macroeconomic Variables

	Euro area	Czech Republic	Hungary	Poland	Denmark	Sweden	UK
a) Shock to Euribor							
Ind. prod.	12 -	12 -	12 -	15 -	12 -	9 -	10 -
HICP	20 -	7 + / 28 -	10 +	14 + / 40 -	26 -	9 +	24 -
Interest rate		12 +	8 +	6 +	5 +	26 -	20 -
Exch. rate	n.a.	5 +	5 +	8 +	4 -	7 +	7 +
b) Shock to MCI							
Ind. prod.	13 -	12 -	12 -	15 -	15 -	2 -	10 -
HICP	20 -	4 + / 24 -		12 + / 40 -		12 +	
MCI or int. rate		10 +	9 +	13 +	7 +	6 +	
Exch. rate	n.a.	0 +		7 +	7 -	6 +	7 +
c) Shock to F_1: conventional monetary policy							
Ind. prod.	10 -	12 -	10 -	15 -	12 -	9 -	10 -
HICP	20 -	6 + / 26 -	12 + / 35 -	12 +	25 -	10 +	24 -
Interest rate		10 +	10 + / 33 -		6 +	25 -	22 -
Exch. rate	n.a	4 +	5 +	7 +	10 -	6 +	34 -
d) Shock to F_2: unconventional monetary policy							
Ind. prod.	30 -		26 -		22 -	2 -	3 + / 25 -
HICP	5 -	6 -	6 -			13 +	
Interest rate		20 +	22 +	4 +	12 +	15 +	10 +
Exch. rate	n.a.	0 +	4 - / 15 +	4 - / 24 +	10 -	5 +	4 +

Note: The numbers in the table show the period when the impulse response function attains its peak and the sign of the impulse response around this peak, "**—**" denotes minimum, impulse response below zero, "+" denotes maximum, impulse response above zero. The impulse responses of the euro area macroeconomic variables are impulse responses to a domestic shock. For other countries the impulse responses are responses to a foreign shock. n.a. stands for not available: the exchange rate is not included in the foreign block. Only statistically significant peaks are reported here. For the detailed impulse responses, see the Appendix.

Unsurprisingly, given the similar results for the euro area we obtained using the MCI, the transmission to non-euro area countries occurs in very similar ways. The slight differences in the responses are not significant. By contrast, the impact of conventional versus unconventional ECB policy is quite different. While the responses to shocks to conventional policy are largely similar to those for the 3-month Euribor, the effects of shocks to unconventional policy are transmitted in a very different way and are rather diverse across countries.

The response of industrial production to unconventional ECB policy shock is similar to that in the euro area, i.e. slow and rather muted, and entirely insignificant for the Czech Republic and Poland. Inflation does not fall, and only in two countries (the Czech Republic and Hungary) do prices react at a similar horizon and in the same direction as in the euro area. In Sweden, after the ECB implements UMP, inflation even rises over the following year. This might come as a surprise given that in all six countries we find a significant endogenous response of the domestic interest rate. Even if these responses are much slower than for a conventional monetary policy shock, the tightening should have resulted in a stronger impact on prices. One explanation might be that the exchange rate depreciates significantly and strongly. This is no surprise given that

under unconventional monetary a tightening should be understood mainly as a contraction in the ECB's balance sheet and as a decrease in liquidity in the financial system, liquidity which, at least in part, may have been withdrawn from EU countries outside the euro area. As domestic prices are to a large extent dependent on the euro exchange rate, this could feed into domestic inflation. The exchange rate effect occurs rather quickly, as the peak effect is reached within a few months. The exception is Denmark, where the krone responds significantly, albeit within limited bounds, as the central bank closely followed the ECB's policies due to participation in ERM II.

5. Conclusions

In this paper we assess the impact of ECB monetary policy on macroeconomic developments in six non-euro area EU countries. In order to account for the ECB's monetary policy stance more broadly, we construct a monetary conditions index (MCI) based on factor analysis (Lombardi and Zhu, 2014). We use information on the developments in key interest rates and monetary aggregates, the euro exchange rate and changes in the ECB balance sheet. The results suggest that the first factor of the MCI reflects conventional policy while the second factor is an approximation of unconventional policy. We show that unconventional measures play a dominant role in determining the monetary policy conditions in the euro area in recent years. More specifically, we document a very significant monetary policy tightening related not only to a limited expansion of the ECB balance sheet, but also to a strengthening of the euro in 2011 and 2012 (Orphanides, 2014).

Subsequently, we use four alternative measures of the monetary policy stance in a block-restricted VAR model to assess the impact of ECB policy shocks on the euro area and six non-EMU countries. The VAR results show that accounting for broad monetary policy changes monetary policy shock transmission only slightly. This is driven by the fact that in most states of the world the 3-month Euribor is a good proxy for the overall monetary policy conditions. However, in periods when the overall monetary conditions are driven mainly by unconventional measures, the response of the economy to the monetary policy shocks identified is strikingly different. Specifically, for the euro area we find a quicker response of prices and only a very muted response of the real economy. This suggests that the ECB's unconventional measures, i.e. mainly balance sheet operations, are at least partially able to affect the economy in a similar way to the interest rate tool.

The results confirm that ECB monetary policy shocks spill over to the macroeconomic variables of countries outside the euro area. Conventional monetary policy primarily has a similar and significant impact on industrial output and the exchange rate in all six countries, but its impact on inflation is less significant or completely insignificant. In the case of unconventional measures one can observe substantial variation in the responses across countries and macroeconomic variables. Exchange rates respond quickly, but the effect on industrial production is less generalised than that after a conventional monetary policy shock. Foreign consumer price inflation generally reacts in the supposed way, but the response is mostly insignificant. Many of these responses are related to the policies pursued by the central banks in these countries, as well as to structural characteristics that explain trade and financial integration.

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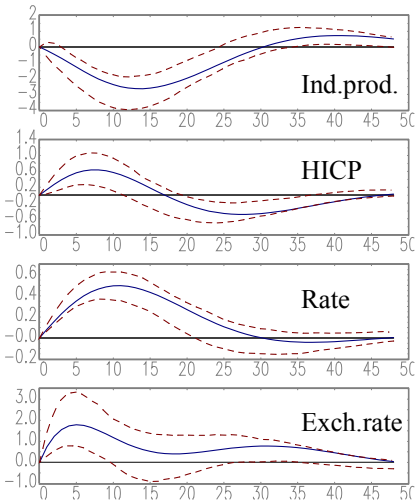
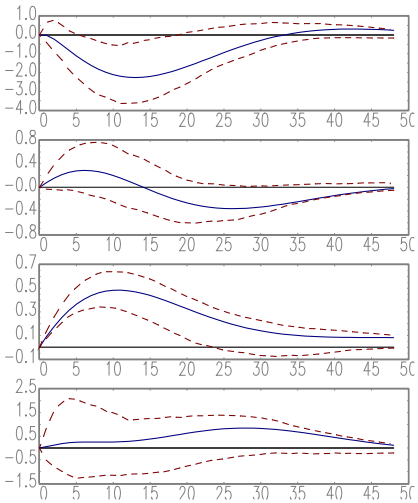
Appendix

Table A1: Czech Republic

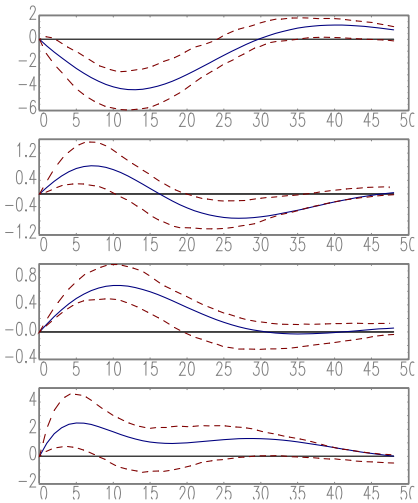
a) shock to 3-month Euribor



b) shock to MCI



c) shock to F1



d) shock to F2

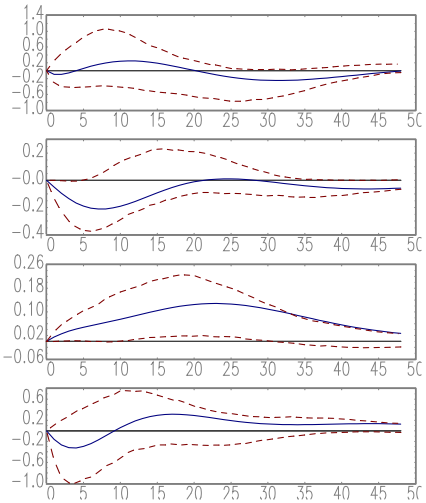
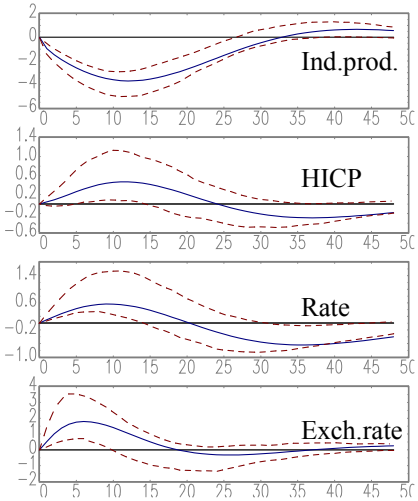


Table A2: Hungary

a) shock to 3-month Euribor



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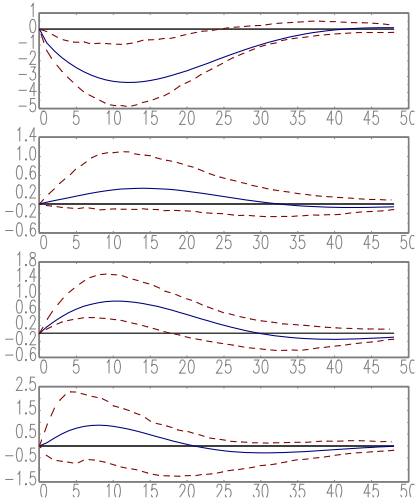
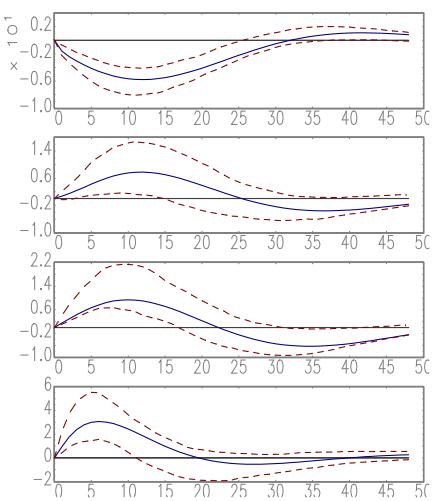


c) shock to F1



d) shock to F2

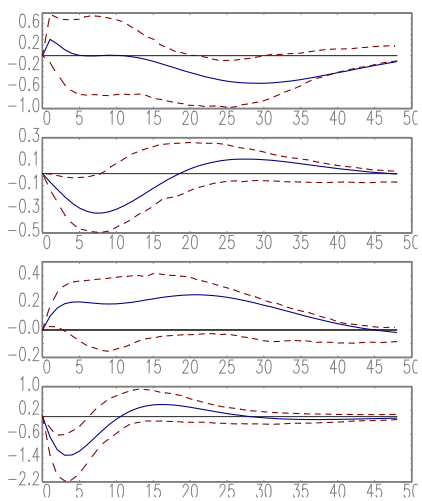
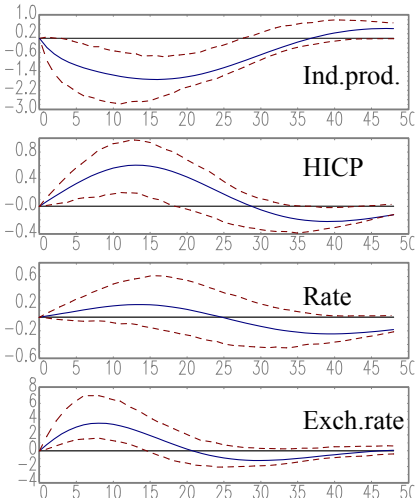
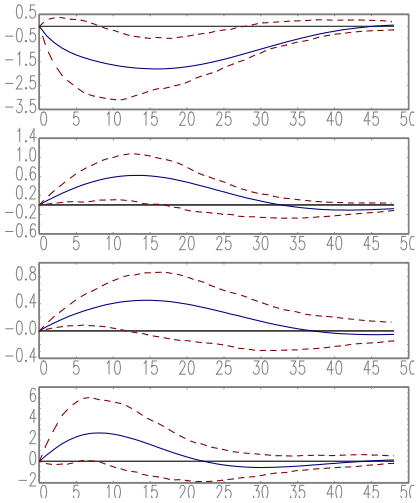


Table A3: Poland

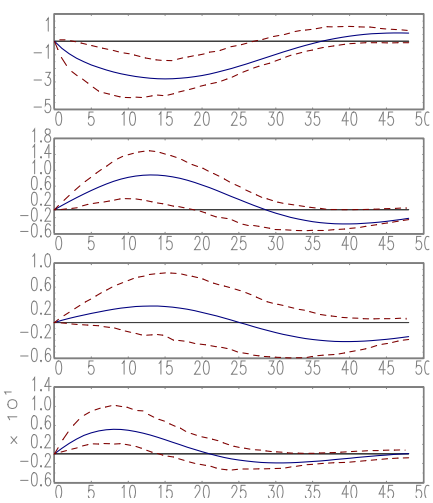
a) shock to 3-month Euribor



b) shock to MCI



c) shock to F1



d) shock to F2

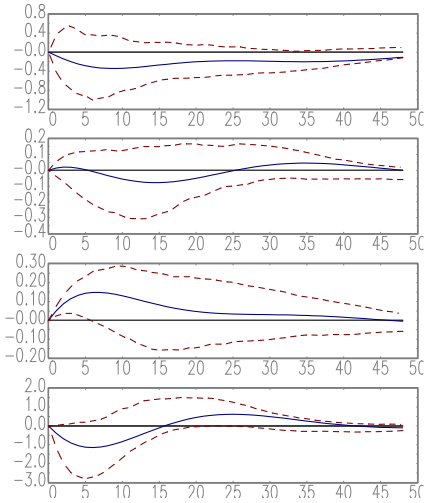
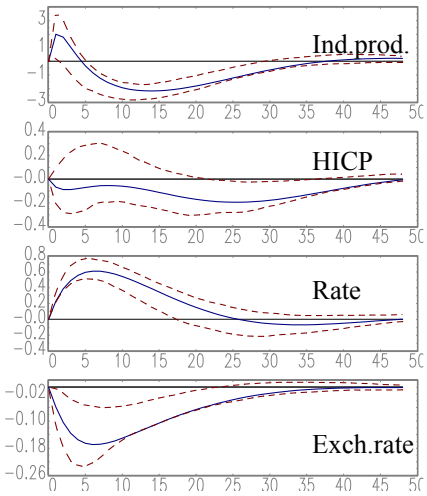
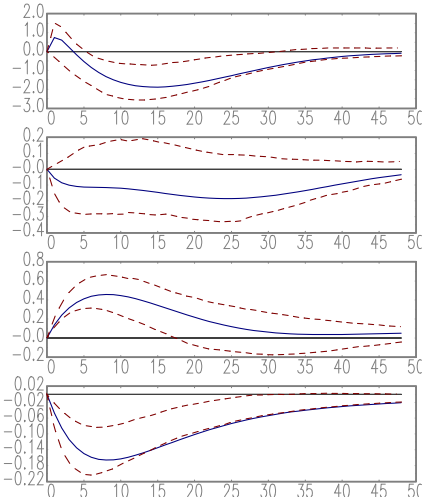


Table A4: Denmark

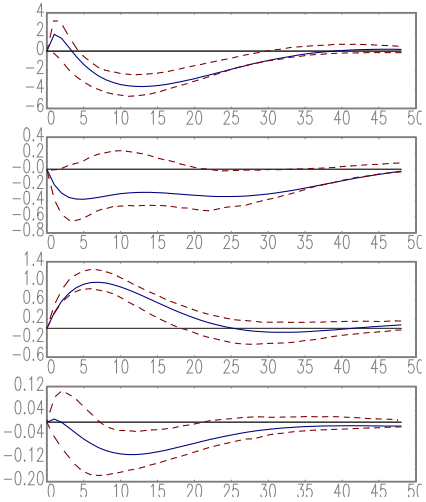
a) shock to 3-month Euribor



b) shock to MCI



c) shock to F1



d) shock to F2

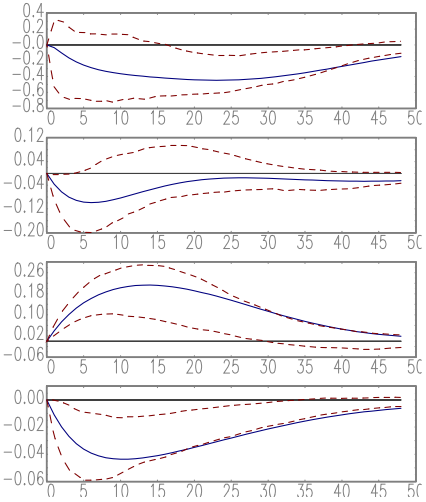
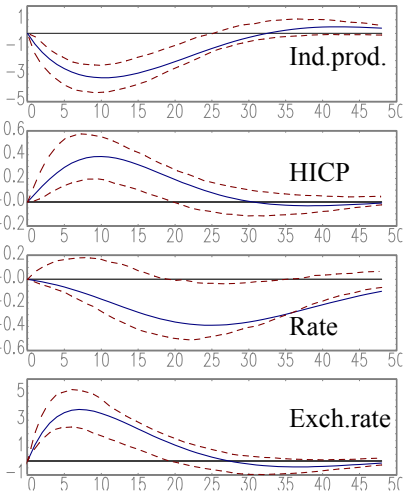
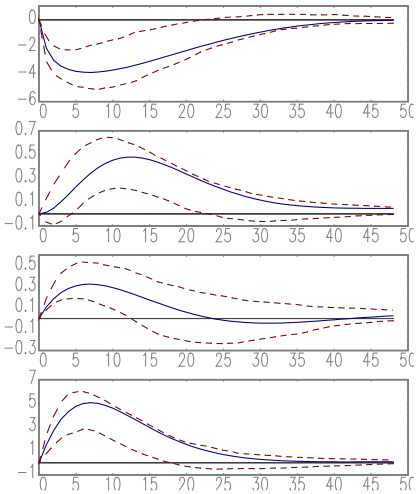


Table A5: Sweden

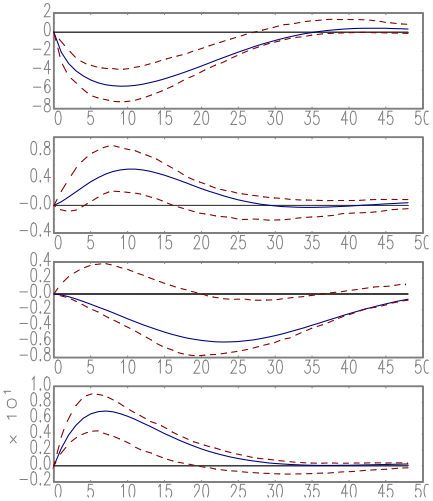
a) shock to 3-month Euribor



b) shock to MCI



c) shock to F1



d) shock to F2

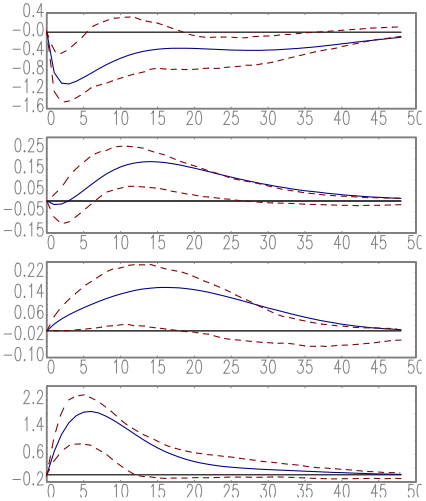
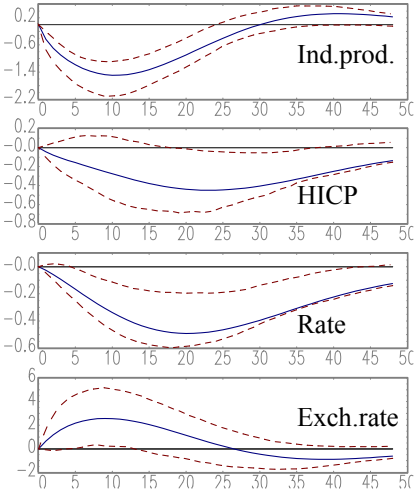
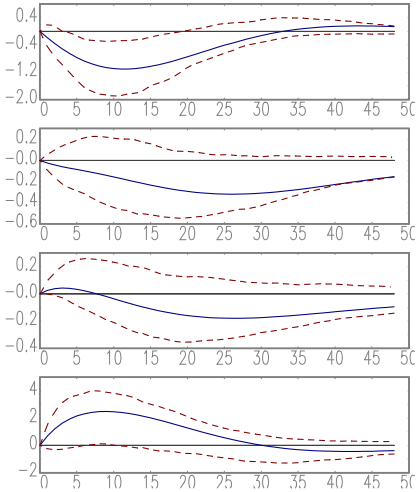


Table A6: United Kingdom

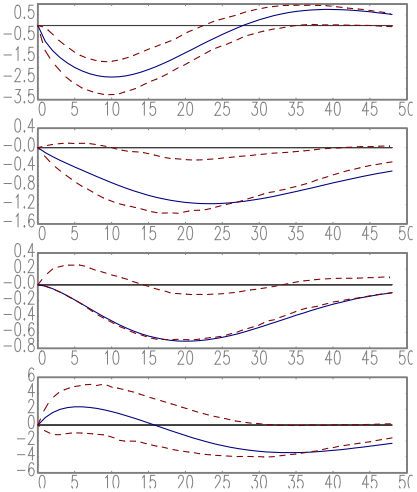
a) shock to 3-month Euribor



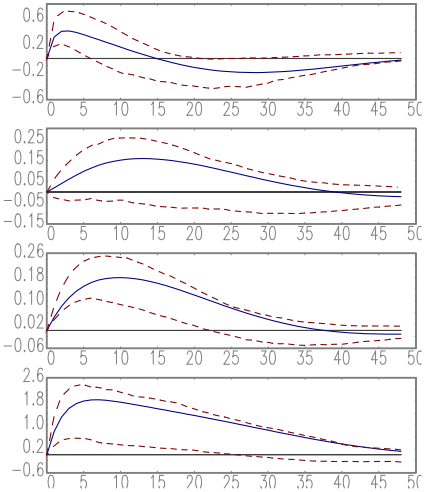
b) shock to MCI



c) shock to F1



d) shock to F2



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