Common Macroeconomic Shocks and Business Cycle Fluctuations in Euro Area Countries

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Abstract. This paper investigates the dynamic effects of common macroeconomic shocks in shaping business cycle fluctuations in a group of Euro-area countries. In particular, by using the structural (near)VAR methodology, we investigate the effect of area-wide shocks, with particular attention to monetary policy shocks, on the evolution of inflation and output of the national economies. The main conclusion is that: (a) contractionary monetary policy shocks cause similar recessionary effects in all countries; (b) as far as business cycle fluctuations are concerned, there is a separation into two distinct groups of countries, with a first group including the biggest European economies in which business cycle fluctuations are mainly explained by common, area-wide shocks and a second one, including Greece, Ireland and Portugal, in which the national shocks play, instead, a much greater role.

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1. Introduction

An important question related to the Euro-area economy concerns the possibility that aggregate macroeconomic shocks may exert different effects in specific member countries. In this context, the transmission of monetary policy shocks is, of course, a main concern, given also the existence of a central authority, the European Central Bank (ECB), to which is attributed the task of conducting the monetary policy at the Euro-area level.

In fact, around fifteen years have elapsed from the start of the European Monetary Union (EMU) and hence we begin to dispose of enough data in order to study the influence of ECB's monetary policy choices on the economic activity of Euro area countries.

More generally, in this paper we aim to study the dynamic effects of a small number of macroeconomic shocks, identified at the Euro-area level, in shaping output fluctuations in a group of EMU countries which includes Germany, France, Italy and Spain, *i.e.* the largest economies of the Euro area, plus Belgium, Greece, Ireland and Portugal. In particular, we want to investigate if the dominant source of macroeconomic fluctuation at the national level is represented by exogenous, Euro-area shocks or, alternatively, by local shocks. Clearly, this is a central question, since in order to allow a smooth functioning of a monetary union, with a central bank conducting its monetary policy at a supra-national level, the convergence of business cycles is of paramount importance.

As far as the conduct of the monetary policy is concerned, it is worth stressing that since we consider the joint dynamics of a set of national macroeconomic variables and a set of Euro-area macroeconomic variables from the start of the European Monetary Union (EMU), there is no ambiguity in the identification of monetary policy shocks, since there is one single monetary policy regime.

Further, in the specification of the monetary policy equation, concerning the Euro area, we take into account the potential influence exerted by movements in the US Federal Funds Rate. In other words, we allow for the possibility that the Federal Reserve System exerts a significant influence in the conduct of European monetary policy. In reality, this seems a quite reasonable choice since in the first years of EMU both the direction and the magnitude of monetary policy interventions in the Euro area have been clearly anticipated by the US central bank (cf. Ribba, 2012). Nevertheless, in related research, Scotti (2011) by estimating a non-linear bivariate model concludes that the interdependence of Federal Reserve and ECB does not lead to the conclusion of follower behaviour.

In this paper, we adopt a structural near-VAR approach where the equations for the Euro area include only the lags of Euro-area variables themselves while, as for the national economies, we have full VAR equations. An important implication of this approach is that each member country is subject to the same area-wide macroeconomic shocks.

A conclusion of homogeneous effects exerted by common monetary policy shocks in a group of European countries was reached by Peersman (2004), in a investigation concerning the pre-EMU period. Peersman adopted a structural VAR approach. Nevertheless, over the sample period considered by Peersman, 1980 − 1998, central banks of the European economies were still independent, national institutions. Of course, since they conducted their monetary policy in the EMS fixed exchange rate environment, the policy choices were, at least partially, constrained. Hence, in that economic context, it is not possible to identify a single monetary policy regime.

In a very recent paper, Barigozzi *et al.* (2013), by using a structural dynamic factor model, obtain instead a result of heterogeneity in the responses of Euro-area countries to ECB decisions. In particular, as far as the responses of prices and unemployment are concerned, they show that there are significant differences between North and South Europe.

To anticipate some conclusions, in the present research we obtain two main results: (a) there is no particular evidence of asymmetric effects of monetary policy shocks since an unexpected monetary tightening causes a recession in all countries; (b) business cycle fluctuations in the biggest European economies are dominantly driven by common, area-wide shocks but, and maybe not surprisingly, this conclusion does not hold for Greece, Ireland and Portugal.

Thus, our empirical investigation, covering the sample period 1999:1 - 2011:12, seems to support the conclusion that despite their recent, deep macroeconomic imbalances, both Italy and Spain have economic systems characterized by a good macroeconomic integration in the European economy.

It is important to stress that the near-VAR approach utilized in the present research implies the assumption that all the national economies considered in the investigation be small open economies interacting in a monetary union, *i.e.* there is unidirectional, macroeconomic causation (in the Granger sense) running from EMU to national economies. Clearly, at least for the case of Germany, this is a strong and hence easily falsifiable assumption.

We have tried to tackle this potential shortcoming concerning the results for the German economy by also estimating an alternative VAR model in which a full interaction between EMU and German variables is allowed and where the structural area-wide shocks are recovered by imposing sign restrictions. In fact, we find very similar results by comparing the responses of the variables to the monetary policy shock obtained by the two alternative identification strategies and hence we interpret this similarity as an encouraging indication of robustness of the econometric approach adopted in the present research.

The rest of the paper is organized as follows. In section 2 we briefly review some results of (part of) the literature concerning the dynamic effects of macroeconomic shocks in the Euro area.

Section 3 presents the econometric approach of the paper, based on structural near-VAR models.

In section 4 we show the impulse-response functions concerning the effect of a contractionary monetary policy shock, both at the Euro-area level and at the member-country level. In particular, as far as the national economies are concerned, we show the dynamic responses of output and inflation to unexpected monetary policy decisions.

In section 5 we investigate on the sources of output fluctuations in member countries. Our results reveal that the Euro-area shocks are the dominant source of output fluctuations at the business cycle frequencies for France, Germany, Italy and Spain. Instead, the national shocks mainly explain the variability of output in Greece, Ireland and Portugal.

In section 6 a sensitivity analysis is undertaken: we estimate a VAR model in which the dynamic interaction between the Euro-area variables and the German macroeconomic variables is not restricted. Moreover, the structural shocks are identified by imposing sign restrictions on the response of variables to selected shocks. We find a strong and thus surprisingly similarity with the results obtained by using the structural near-VAR approach.

Section 7 concludes and some policy implications for the Eurozone are drawn.

2. Macroeconomic heterogeneity in the Euro area: literature summary

In this area of research, by using structural VAR technique, Peersman (2004) provides empirical evidence on the effects of a common monetary policy shock for seven Euro-area countries. The author concludes that there is similarity in the response of output to monetary shock in the individual countries. The research builds on Peersman and Smets (2001) where a Euro-area structural VAR model was estimated and identified, by using synthetic Euro-area data.

Although Peersman's paper represents an important methodological step forward in comparison to previous investigations, since it identifies a monetary policy shock which is common to individual countries, we have already stressed that it is not possible to isolate a single monetary policy regime for the period of investigation, which covers the sample period 1980 - 1998.

In a more recent paper, Cecioni and Neri (2011) have investigated on possible changes in the monetary transmission mechanism that may have affected EMU after the adoption of the Euro. According to the authors, however, the results obtained by estimating a structural, Bayesian VAR do not provide evidence of a significant change after 1999.

Instead, by using the sign restrictions approach to VAR identification, Rafiq and Mallick (2008) find that the effects of monetary policy shocks on output in France, Germany and Italy show heterogeneity, since there are significant recessionary effects associated with a contractionary, monetary policy shock only for the case of Germany. However the sample period considered, *i.e.* $1980 - 2005$, poses serious doubts on the possibility to recover a common monetary policy shock, given the existence of national central banks for the great part of the historical period $1980 - 2005$.

Weber *et al.* (2011), by using structural VAR techniques, investigate on possible changes in the transmission mechanism of monetary policy in the Euro area concerning output and inflation. They find two significant break dates, the first in 1996 and the second around 1999. The authors conclude that despite the break points, the estimates show that monetary policy affects prices in the long run while leaving output unchanged. These results, according to the authors, hold for all sub-periods considered[1].

Another empirical investigation based on structural VAR models, identified by sign restrictions, is provided by Berg (2012). The author studies the influence on Euro-area stock prices exerted by technology shocks and monetary shocks, respectively. According to Berg, over the period 1995-2003, technology shocks are the main source of fluctuations in real stock prices.

Dedola and Lippi (2005) conducted a more disaggregated investigation at industry level in five OECD countries, including France, Germany and Italy. They use VAR models identified with sign restrictions. Their main result is that the responses to monetary policy shocks are stronger in sectors producing durable goods.

A different methodological approach, in order to investigate the existence of asymmetries

[1] However, Gerlach and Svensson (2003) concludes that the Eurosystems money-growth indicator, the so-called first pillar in its monetary strategy, does not contain much information about future inflation.

in the response of Euro-area countries to common monetary policy shocks, has been recently proposed by Barigozzi *et al.* (2013). The authors use a Structural Dynamic Factor Model and find that the response of individual countries to ECB decisions exhibits heterogeneity. In particular, as far as the responses of prices and unemployment are concerned, there are significant differences between North and South Europe[2].

Although there exists a central bank, the ECB, conducting the monetary policy at Euro-area level, an interesting question concerns the possibility of a national bias affecting the members of the Governing Council. This is the subject of a recent investigation undertaken by Hayo and Meon (2013). According to their interpretation, individual members follow national objectives and bargain over the interest rate[3].

In a very recent research, Georgiadis (2014) tries to provide an explanation of the asymmetries in the monetary transmission mechanism. The author finds that the dominant part of the asymmetries across countries is explained by heterogeneity in financial structures, in labor market rigidities and differences in the industry mix.

Another recent strand of the literature has largely investigated the heterogeneity of inflation rates in Euro-area countries. Indeed, persistent inflation differentials among countries may prevent the smooth functioning of a monetary union. In particular, persistent inflation differentials provoke changes in the relative competitive position of the member countries, with a systematic depreciation in the real exchange rate for countries with inflation below the EMU average and, on the opposite side, real appreciation for those countries with inflation above the EMU average. Hence, this last group of countries will experience persistent foreign trade deficits and a growing external debt[4].

Moreover, since the ECB sets the level of the short-term interest rate in relation to the average inflation rate of the currency area, those countries experiencing an inflation rate persistently above the average, will receive a pro-cyclical impulse on aggregate demand, via the contraction in the real interest rates[5].

De Haan (2010) has recently provided a survey of both theoretical and empirical research on the topics of inflation differentials in EMU.

A recent paper by Cavallo and Ribba (2013) concludes that Euro-area inflation should be a predictor, in other words an anchor, for national inflations. However, this result holds only for a small group of countries, including France and Italy.

Summing up: it seems that, at this stage, the empirical research concerning the Euro area is still far from a shared conclusion on the existence of heterogeneity in the dynamic

[2]In this area of research, Carlino and De Fina (1998) proposed one of the first applications of the structural VAR methodology to the investigation of the dynamic effects of monetary policy on regional areas. The authors examined the regional responses to monetary policy in the USA. The main conclusion of their research was that there exists a group of (core) regions exhibiting similar responses. Nevertheless, heterogeneity of effects characterized three non-core regions.

[3]A related field of research concerns investigations on the existence of a stable money demand in the Euro area. See, *e.g.*, Artis and Beyer, 2004; Dreger and Wolters, 2010.

[4]An interesting result obtained by Honohan and Lane (2003) concerns the evidence that in the first years of the euro an important factor influencing inflation differentials in the European economies is represented by exchange rate effects. On the other hand, the authors find evidence of a limited role exerted by the Balassa-Samuelson effect in explaining inflation differentials.

[5]The risk of destabilizing pro-cyclical dynamics induced by the monetary policy choices in a fixed exchange rate regime was raised by Alan Walters in the 1980s, in the context of the European Exchange Rate Mechanism. See, for example, Walters (1988).

effects of area-wide shocks on member countries.

3. The approach of the paper

In this paper we estimate, by using monthly data for the period 1999 : 1 − 2011 : 12, a near-VAR in order to model the dynamic interaction between Euro-area countries[6] and the Euro-area aggregate level. More precisely, we start with the estimation of the following near-VAR model:

$$\begin{pmatrix} \pi_t \\ y_t \\ i_t - i_t^* \\ \epsilon_t \\ \pi_{it} \\ y_{it} \end{pmatrix} = \begin{pmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) & A_{14}(L) & 0 & 0 \\ A_{21}(L) & A_{22}(L) & A_{23}(L) & A_{24}(L) & 0 & 0 \\ A_{31}(L) & A_{32}(L) & A_{33}(L) & A_{34}(L) & 0 & 0 \\ A_{41}(L) & A_{42}(L) & A_{43}(L) & A_{44}(L) & 0 & 0 \\ A_{51}(L) & A_{52}(L) & A_{53}(L) & A_{54}(L) & A_{55}(L) & A_{56}(L) \\ A_{61}(L) & A_{62}(L) & A_{63}(L) & A_{64}(L) & A_{65}(L) & A_{66}(L) \end{pmatrix} \begin{pmatrix} \pi_{t-1} \\ y_{t-1} \\ i_{t-1} - i_{t-1}^* \\ \epsilon_{t-1} \\ \pi_{it-1} \\ y_{it-1} \end{pmatrix} + \begin{pmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \\ e_{6t} \end{pmatrix} \quad [1]$$

The estimated model is thus divided into two blocks. The first block includes the following variables: the Euro-area annual rate of inflation, based on the HICP index, π_t; the cyclical component of the Euro-area industrial production, y_t, obtained by applying the Hodrick-Prescott filter; the differential between the European overnight interest rate (Eonia), i_t, and the US federal funds rate,i_t^*; the nominal exchange rate, ϵ_t, defined as US dollars per currency unit[7].

The second block instead includes the macroeconomic variables at the national level: the annual rate of inflation of the country i, π_{it}, based on the HICP index; the cyclical component of the industrial production of the country i, y_{it}, obtained by applying the Hodrick-Prescott filter.

In the presence of a near-VAR system, OLS gives consistent estimates. However, some potential gain comes from estimation of the system using SUR, Seemingly Unrelated Regressions (cf. Zellner 1962) and hence, in estimating system [1], we use SUR methods. As for lag length selection, both the Schwartz and the Akaike criteria suggest one lag for the estimated VARs.

We stress that an important advantage of this specification descends from the consideration that although we estimate for each country a separate VAR system which allows the joint dynamics between area-wide variables and the national ones to be modeled, the set of aggregate Euro-Area shocks is identical for all countries. In other words, this near-VAR specification ensures a property of invariance for the common macroeconomic shocks

[6]For Greece the estimation period is 2001:1 - 2011:12

[7]Data concerning the Federal Funds rate and the nominal exchange rate are obtained from the FRED database: http://research.stlouisfed.org/, Overall inflation for the Euro area is obtained from the Harmonized Consumer Price Index (HCPI). The series concerning the HCPI, the industrial production for the Euro area and the corresponding national variables were taken from the Eurostat site: ec.europa.eu/eurostat.

Instead, the series for the Eonia rate was taken from the ECB web site, at http://www.ecb.int/stats/

affecting the national variables.

By collecting the variables included in system [1] in the 6×1 vector

$$X'_t = \begin{pmatrix} \pi_t & y_t & i_t - i^*_t & \epsilon_t & \pi_{it} & y_{it} \end{pmatrix}$$

and by indicating with e_t the 6×1 vector of error terms, such that $E(e_t) = 0$ and $E(e_t e'_t) = \Sigma_e$, we can write the following reduced-form moving average representation of the near-VAR:

$$X_t = C(L)e_t \qquad [2]$$

where $C(0) = I$.

We recover the structural shocks at the Euro-Area level and at the national level by imposing a (contemporaneous) recursive structure to the estimated near-VAR model. Hence, the structural moving-average representation is given by:

$$X_t = B(L)\eta_t \qquad [3]$$

Where $B(L) = C(L)B$ and $\eta_t = B^{-1}e_t$. B is the Cholesky factor of Σ_e, *i.e.* is the unique lower triangular matrix such that $BB' = \Sigma_e$.

The economic interpretation of this set of identifying restrictions is that, as for the block of Euro-Area variables, a monetary policy shock does not influence within the period (one month) either inflation or industrial production. In turn, a demand shock exerts a delayed effect on inflation. Moreover, the exchange rate does not exert a contemporaneous effect on the differential between Eonia and the federal funds rate.

Such an orthogonalization of the structural shocks is widely adopted in the literature studying the dynamic effects of monetary policy shocks (see, for example, Eichenbaun and Evans, 1995). We must add that, at least in our opinion, using zero contemporaneous restrictions in order to obtain exact identification of the model, in the context of sample data at monthly frequencies, imposes a lesser strait jacket on data than in the cases with quarterly or annual data.

As far as the national block is concerned, the imposed causal structure implies that a local aggregate demand shock does not exert a contemporaneous effect on the national inflation.

However, as an exercise of robustness of both the identification strategy and the assumption that the Euro-area block is independent from national variables, in a next section of the paper we also recover the structural shocks affecting the Euro-area block and the German variables block, in an alternative way, by using sign restrictions.

In order to get the impulse response functions with the confidence bands, we utilize Monte Carlo integration and Gibbs sampling. The Gibbs sampler is a particular technique recently developed to tackle situations in which it is not possible to make direct draws based on random Normals (see Doan, 2010).

4. Estimation results: the responses of variables to monetary shocks

We have organized the set of impulse-response functions in three figures. In figure 1 we report the response of the Euro-area macroeconomic variables to a contractionary monetary policy shock. Instead, figures 2 and 3 show the responses of national variables, respectively, output and inflation, to the contractionary monetary policy shock.

Median responses are reported together with the error bands. In the spirit of Sims and Zha (1999) we consider the 16th and the 84th percentiles.

As shown in figure 1, a monetary tightening provokes a recession in the Euro area, since there is a significant contraction of both the output and the inflation rate for about three years following the tightening.

It is worth noting that the identifying restrictions impose the absence of contemporaneous effects, *i.e.* within the month, of the exogenous monetary policy shock on inflation and output. More precisely, in order to recover the structural shocks, we have imposed a recursive, causal structure. However, despite this identification strategy, the response of inflation is not plagued by the puzzling, wrong sign which often affects structural VAR analysis of monetary policy. In particular, the wrong sign in the response of price usually characterizes structural VARs in which shocks are recovered by imposing Wold causal orderings (see *e.g.* Christiano *et al.* 1999).

On the other hand, we find that in response to the contractionary monetary policy shock there is a small reaction in the exchange rate in the first months following the shock. Further, the appreciation exhibits persistency. Thus, the response exhibits a correct sign but the persistent appreciation of the national currency is at odds with the Uncovered Interest Parity (UIP). For, if UIP holds, then an increase in the domestic rate with respect to the foreign rate should cause an appreciation of the national currency followed over time by a movement of opposite sign. The persistent appreciation of the national currency in response to a monetary tightening is another known result in the structural VAR approach based on contemporaneous restrictions literature, at least since the works by Eichenbaun and Evans (1995) and by Grilli and Roubini (1996). More recently, Scholl and Uhlig (2008) have applied the sign restrictions methodology to the exchange rate responses to monetary policy shocks and have found that a persistent appreciation remains a feature of the data.

Insert Figure 1 about here

Figure 2 collects the responses of inflation and output to the monetary policy shock for the major Euro-area economies. The remarkable result is that there are no appreciable differences in the timing and in the profile of the responses among countries. Instead, as far as the size of the response of national output is concerned, some differences arise. For, as shown in table 1, a one point percentage increase in the differential between the Eonia rate and the federal funds rate causes a negative, maximum effect on German output of 1.82 and a maximum effect on French output of -.96 (for Italy and Spain the values are, respectively, -1.48 and -1.27).

Insert Figure 2 about here

In figure 3 the results for the other four countries are reported. The recessionary effects of the common monetary policy shock are confirmed as well as, also for these countries, the contractionary effects exerted on the inflation rate.

Insert Figure 3 about here

However, it is worth noticing that the response of output to the common monetary policy shock exhibits some peculiarity for the Greek economy. For, in this case, the maximum effect on output is exerted in the contemporaneous period. Moreover, for Greece, Ireland and Portugal the maximum effect of monetary policy on output is less than one for one.

Insert Table 1 about here

5. Estimation results: the dominant sources of fluctuations in country members

By using the structural representation [3], it is possible to build the error in forecasting X_t for each horizon k:

$$X_{t+s} - E_t X_{t+s} = B_0 \eta_{t+s} + B_1 \eta_{t+s-1} + B_2 \eta_{t+s-2} + ... + B_{s-1} \eta_{t+1} \qquad [4]$$

From [4] and given the orthonormality of the structural disturbances, the variance of the forecasting error is:

$$Var(X_{t+s} - E_t X_{t+s}) = B_0 B_0' + B_1' + B_2 B_2' + ... + B_{s-1} B_{s-1}' \qquad [5]$$

From this formula, it is possible to decompose the total variance of the forecast error, for each variable, which is ascribable to the variance of each structural shock. In particular, we would like to use equation [5] to answer the following question: is the dominant source of variability in domestic output attributable to the set of common, area-wide shocks or, alternatively, do the local, specific structural shocks explain much of the variability of the national output? This amounts to investigating the degree of integration of the national business cycles into the European one.

According to the results shown in table 2, there are two distinct groups of countries: the first, which includes Germany, France, Italy, Spain and Belgium, is characterized by a dominant role played by Euro-area structural shocks in composing the variability of the national outputs; the second group, including Greece, Ireland and Portugal in which the relative importance of local, structural shocks is dominant at different horizons with respect to Euro-area common macroeconomic shocks.

Although Italy, Spain and Belgium start with a higher importance of local shocks in comparison to France and Germany, there is a quick convergence, in around 12 months, to a weight of the Euro-area common shocks which is on average of 80 percent for the three countries.

The case for Greece, Ireland and Portugal is quite different: even after seven years, the majority of the variability in national output is largely explained by the sum of the local, specific shocks.

As a whole, these results tell us that Italy and Spain, despite their macroeconomic imbalances, exhibit business cycle fluctuations which are integrated in the European business cycle. Instead, for Greece, Ireland and Portugal the asymmetric shocks are still a significant problem, 15 years from the start of EMU.

Insert Table 2 about here

6. An alternative identification strategy based on sign restrictions

The near-VAR specification presented in the previous sections has some advantages, in the context of the present investigation, with respect to traditional VAR models specification. In particular we have stressed the main strong point of this approach, which is associated with the invariance of the common area-wide shocks affecting the national economies.

Nevertheless, a potential weakness of this methodology consists in treating all the EMU member-countries as small open economies. Clearly, this choice might fit well to Greece or Ireland but is highly questionable, for example, for France and above all for Germany.

Thus, in this section we undertake a sensitivity analysis and estimate a VAR model including the variables of the exogenous block in system [1] jointly with inflation and output for the German economy. First, we estimate a traditional, reduced-form VAR model, *i.e.* in this case the estimation of the equations for the Euro-area variables also include lags of German variables. Then we proceed to the identification of a contractionary monetary policy shock by imposing sign restrictions on the responses of (some) variables (cf. Faust, 1998; Canova and De Nicoló, 2002; Uhlig 2005).

A presentation of the sign restrictions approach, in the context of a discussion of alternative identification schemes, is given in Canova (2007, chapter 4).

The logic behind this sensitivity analysis is the following: if in the case of Germany, *i.e.* the biggest Euro-area country member, the results obtained by imposing sign restrictions in a traditional VAR specification were not so different from those obtained in the near-VAR specification then, *a-fortiori*, this result can be interpreted as an encouraging indication of robustness for the empirical results obtained in the first part of this paper for all the European countries included in the investigation.

In the first step we estimate the following reduced form of a VAR model of order 1:

$$X_t = A_1 X_{t-1} + e_t \qquad [6]$$

where vector X_t includes the four endogenous variables related to the Euro area, *i.e.* inflation, output, the differential between the Eonia rate and the federal funds rate, and the exchange rate, and the two German variables, *i.e.* inflation and output. The covariance matrix of the vector of residuals, e, is given by Σ_e.

In the second step, the matrix Σ_e is randomly drawn from the posterior distribution of the matrix of the VAR coefficients. In the structural VAR approach, the relation between the error terms, e_t, and the exogenous macroeconomic shocks, ϵ_t, is given by: $e_t = F\epsilon_t$. The sign restrictions method proposed by Uhlig (2005), given $FF' = \Sigma_e$, aims to identify an impulse vector, f, such that $f = F\alpha$, where $\|\alpha\| = 1$, which is consistent with some standard macroeconomic theory. The minimal set of restrictions imposed by this approach implies that there exists a space of impulse vectors consistent with the chosen macroeconomic model. However, in order to select a unique impulse vector, it is possible to introduce a penalty function. In this investigation we use a penalty function which is similar to the one introduced by Uhlig[8] (2005).

In particular, in order to identify the monetary policy shock, we impose a negative response of Euro-area inflation to a contractionary monetary policy shock. More precisely, we impose a negative response of inflation for a period of three months to a unexpected increase in the differential between the Eonia rate and the federal funds rate. Instead, the responses of the Euro-area output and of the exchange rate are left free. Moreover, we do not impose restrictions on the responses of German variables.

As shown in figure 4, a contractionary monetary policy shock causes a recession both in the Euro area and in Germany. Further, there is a persistent decrease in inflation. However, the really surprising result is that both the response profile of impulse-response functions and the size of the dynamic effects of the monetary shock, are very similar to those obtained by using the near-VAR specification and the recursive structure strategy to recover the structural shocks.

Undoubtedly, an implication of this result is that the recursive assumption adopted to identify the set of structural shocks, and in particular the monetary policy shock, in the context of the near-VAR specifications of sections 4 and 5 does not impose an excessive strait jacket on data.

Insert Figure 4 about here

In the light of the results presented in this section, as a subject of future research it could be interesting to isolate a general set of conditions under which a recursive, causal structure

[8] See also Mountford (2005).

(cf. Sims 1980) and a sign restrictions approach generate shocks which cause identical responses in some variables; of course, identical responses except for the zero restrictions imposed in the causal structure.

7. Conclusion

In this research, by using structural VAR techniques, we have identified a set of common, and invariant, macroeconomic shocks at the Euro-area level and then we have studied their effects on national output and inflation for a group of EMU countries.

The results obtained in the present investigation reveal that macroeconomic heterogeneity is still alive in EMU: fifteen years after the outset of the Monetary Union, a group of countries including Greece, Ireland and Portugal exhibits output fluctuations dominated by national, local shocks rather than by Euro-area, common shocks.

The other five member countries included in the present investigation, *i.e.* Belgium, France, Germany, Italy and Spain, instead show a good integration in the Euro-area business cycle, since the variability of their national output is dominated at the different frequencies by area-wide, macroeconomic shocks.

However, more encouraging results for the economic and monetary integration in the Euro area come from the conclusion that the ECB's decisions on the short-term interest rates transmit their effect in a relatively homogenous way to all the member countries included in the present empirical analysis.

More precisely, we find that a contractionary monetary policy shock pushes into recession all the eight economies and causes a significant decrease both in output and inflation for around three years. Nevertheless, the response of the national variables to the monetary shock seems to be more pronounced in Belgium, Germany, Italy and Spain, since in these countries an increase of 100 basis points in the short-term interest rate provokes a negative, maximum effect on output ranging between 1.27 and 1.82 percent.

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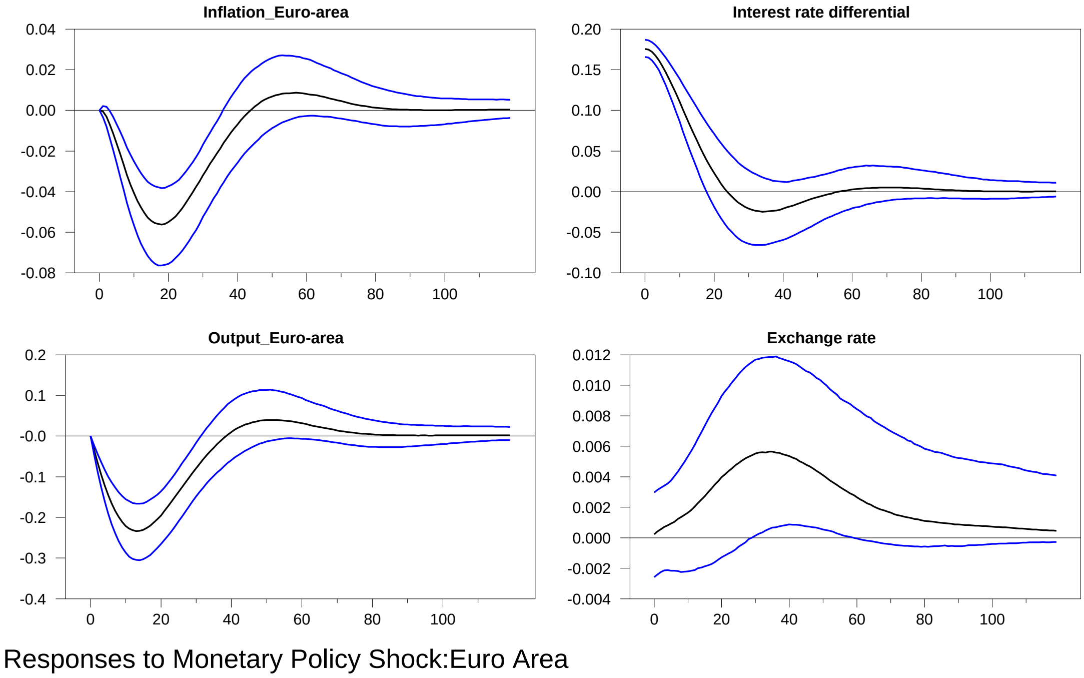

FIGURE 1: Impulse-response functions for the Euro Area: response of output, inflation, interest rates and exchange rate to a contractionary monetary policy shock.

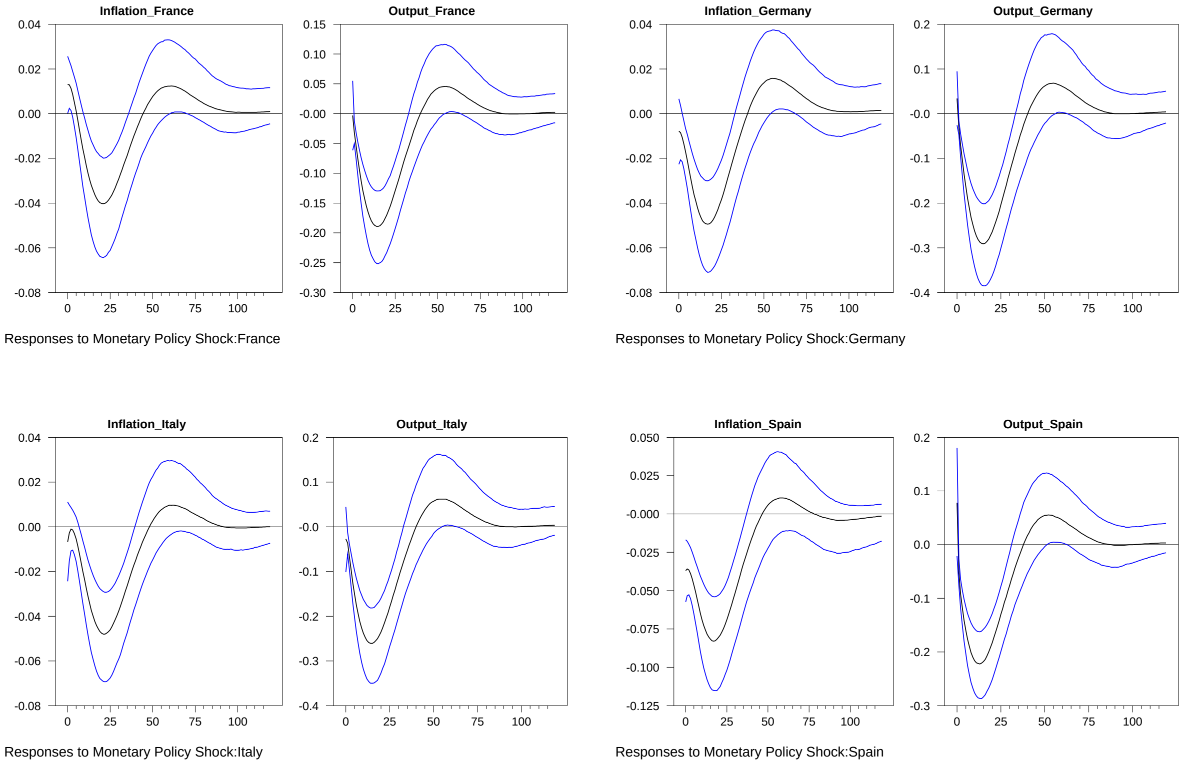

FIGURE 2: Impulse-response functions for France, Germany, Italy and Spain: response of national output and inflation to a contractionary monetary policy shock.

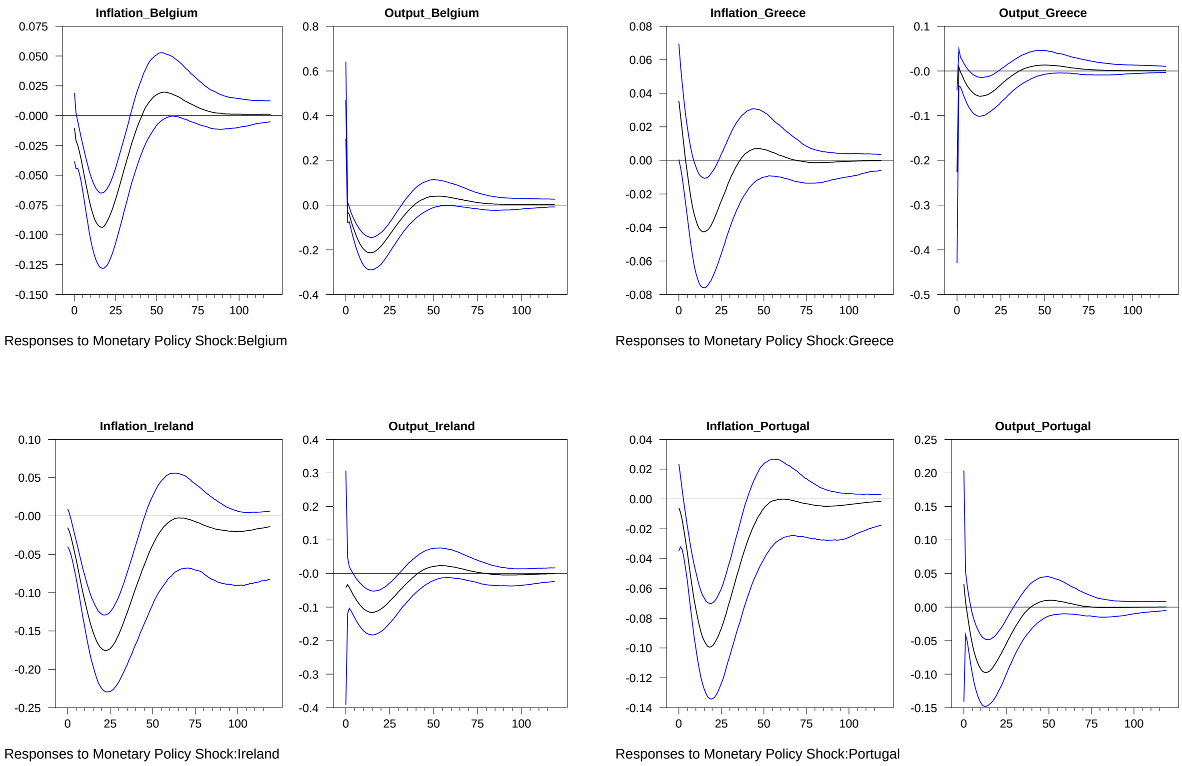

FIGURE 3: Impulse-response functions for Belgium, Greece, Ireland and Portugal: response of national output and inflation to a contractionary monetary policy shock.

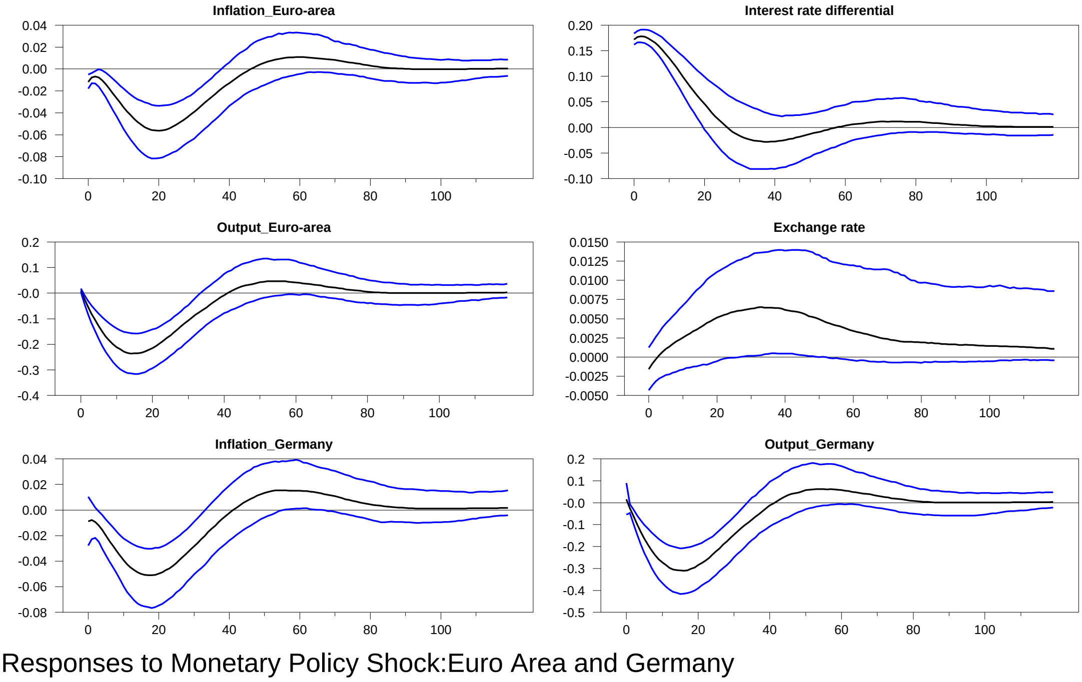

FIGURE 4: Impulse-response functions for Euro Area and German variables: contractionary monetary policy shock identified by sign restrictions.

Table 1. Estimated maximum effect of a monetary policy shock

	DE	FR	IT	ES	BE	GR	IR	PO
Maximum effect	-1.82	-.96	-1.48	-1.27	-1.75	-.94	-.92	-.81
Months	17	16	16	19	17	1	21	14

Note: The first row reports the maximum responses of output in each country to a monetary policy shock. The size is a one percent increase in the differential between Eonia and the federal funds rate. The second row indicates the number of months required to reach the maximum effect.

Table 2. Fraction of the forecast error variance of national output attributable to common Euro-area shocks at different horizons.

Horizon	DE	FR	IT	ES	BE	GR	IR	PO
1	66.7	71.2	59.8	56.2	50.1	10.8	11.8	26.8
12	94.2	88.9	88.2	77.4	75.7	28.1	18.5	42.4
24	95.3	91.2	91.1	87.8	80.8	31.5	18.9	47.1
36	96.1	92.1	94.0	85.6	86.4	32.6	22.1	48.3
48	96.3	92.3	95.5	85.9	86.9	32.8	22.2	48.4
60	96.3	92.3	96.2	86.1	88.1	33.4	23.5	48.6
84	96.4	92.5	96.5	85.3	88.9	33.6	24.6	48.7

Note: For each country, the total variance of the forecast error for output is computed and then decomposed in the part attributable to each structural shock (cf. formula [5]). The table presents the fraction of variability at various horizons which is due to the four Euro-area common macroeconomic shocks.