Sources of Unemployment Fluctuations in the USA and in the Euro Area in the Last Decade

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Abstract. The aim of this paper is to investigate the role played by macroeconomic shocks in shaping unemployment fluctuations, both in the USA and in the Euro area, in the recent, European Monetary Union, period. The task is accomplished by estimating a VAR model which jointly considers US and European variables. We identify the structural disturbances through sign restrictions on the dynamic response of variables. Our results show that there are real effects of monetary policy shocks and of non-monetary policy, financial shocks in both economic areas. Moreover, a significant role is also exerted by business cycle, adverse aggregate demand shocks. We provide an estimation of the relative importance of the identified structural shocks in explaining the variability of inflation and unemployment. Not surprisingly, in the last decade an important role has been played by financial shocks.

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1. Introduction

In the last ten years two recessions have affected the global economy and, also as a consequence of the particular virulence of the current downturn, the rate of unemployment has reached 10 percent, both in the USA and in the Euro area.

Moreover, the recent and deep recession experienced by industrialized countries has confirmed, once again, the relevance for the world economy of the macroeconomic events affecting the US economy.

Indeed, this US influence casts serious doubt on the possibility for the European Central Bank (ECB) to conduct its monetary policy free of the influence exerted by Federal Reserve System's choices. In reality, in the first ten years of European Monetary Union (EMU), both the direction and the magnitude of monetary policy interventions in the Euro area has been systematically anticipated by the US central bank.

The leadership of the US central bank is, of course, a natural consequence of the preeminent role played by the US business cycle in shaping the evolution of the world business cycle and, in particular, of the European one.

Although nowadays this conclusion is almost common sense, it may be worth recalling that when the current global downturn began, owing mainly to financial shocks in the United States in the summer of 2007, some ECB members supported the thesis of a possible decoupling of the macroeconomic evolution in Europe with respect to United States. Unfortunately, we know that the hope of decoupling evaporated within a few months since, starting with the second quarter of 2008, the Euro area has witnessed a sharp and persistent contraction in real economic activity.

In this paper we aim to study, in a structural vector autoregressive (VAR) context, the joint dynamics of a set of US and European macroeconomic variables. In particular, we want to empirically investigate the dynamic response of unemployment, in the USA and in the Euro area, to a small number of identified macroeconomic shocks. The set of identified macroeconomic shocks includes monetary policy, financial and aggregate demand shocks.

An important indication, among others, which can be drawn from the current, great recession is that both at the empirical and theoretical level, one should pay close attention to the interaction between the real and the financial sector of the economic system since the financial sector is another, autonomous source of business cycle fluctuations. In recent years much research in the area of VAR models has been devoted to studying the dynamic effects of monetary policy shocks. On the other hand, less attention has been paid to the dynamic interaction between financial, non-monetary policy, variables and the real side of the economy.

In the present work we identify the selected group of shocks by imposing sign restrictions on the dynamic responses of the variables. In doing so, we utilize the approach to structural VAR identification recently proposed by Uhlig (2005) and further developed in Mountford and Uhlig (2009). The central idea of the approach is to impose sign restrictions, for a certain number of periods, on the response of a set of macroeconomic variables to specific shocks.

A feature of this approach to structural VAR modelling is that although the sign restrictions are derived by appealing to some economic model, the identification strategy implies

that a minimal set of information is utilized in order to recover the structural disturbances of the dynamic system. In particular, the researcher may only recover, at least in the pure sign restrictions approach, a set of structural forms which are consistent with the imposed restrictions. Moreover, the identification of the model is partial, since only a small subset of shocks is usually recovered.

Yet, from a certain point of view, imposing only mild restrictions may bring some advantages. After all, the original nature of VAR models, in the spirit of Sims (1980), is mainly a-theoretical. The structural VAR approach proposed by Bernanke (1986), Blanchard and Watson (1986) and Sims (1986), aimed to create a bridge between theory and empirics of multivariate time series analysis. For, it is well known that data, by themselves, do not speak loudly and one needs to go beyond the simple correlation structure offered by reduced-form VARs. Nevertheless, the main task of structural VAR analysis remains (or should remain) the building of a set of stylized facts to offer for theoretical analysis development. In this sense, the relatively agnostic philosophy underlying the sign restriction strategy may well fit the task.

However, the above interpretation of the sign restrictions approach may conflict with other views. For example, Canova (2007, chapter 4) has recently argued that an important feature of this methodology consists in the possibility of imposing identifying restrictions which are consistent with the predictions of standard dynamic stochastic general equilibrium models. For, these theoretical schemes do not predict the zero restrictions typically adopted in the traditional VAR approach.

In this empirical investigation which covers the sample period 1999:1 - 2009:12, we want to address, essentially, the following four questions: (a) Do monetary policy shocks as well as financial shocks exert real effects and, in the case of a positive answer, are they persistent? (b) What are the effects on unemployment and inflation of the identified macroeconomic shocks? (c) Are movements in the European variables dominated by shocks external to the Euro area and, more specifically, by US macroeconomic shocks? (d) What is the relative importance of the structural disturbances in composing the variability of cyclical unemployment?

We identify three US macroeconomic shocks: an adverse business cycle shock, a contractionary monetary policy shock and a financial shock.

An adverse business cycle shock moves unemployment and inflation in opposite directions and hence reflects unexpected movements which affect the aggregate demand.

A monetary policy shock is associated with increases in the Federal Funds rate and in a response of opposite sign in the inflation rate. Moreover, the shock causes, by construction, a temporary appreciation of the exchange rate.

A financial shock is identified as an unexpected increase in the spread between the 3-month Eurodollar deposits rate and the 3-month Treasury Bill rate. The differential between the two rates is usually small, around 30 basis points, but it rises, as shown by the events of the period 2007-2008, in the presence of increasing risks of banking default and related problems in the credit market. Hence, this indicator seems to contain relevant information for future recessions: in particular, for those recessions which are related to risks of collapse of credit markets.

Although there are other good financial indicators of business cycle downside risks, with rather well founded theoretical traditions, as is the case of the term structure of interest

rates, we believe that an indicator of problems in the banking sector is more suited, given the features of the last recession.

In a very recent article, Bijapur (2010) estimates a vector autoregression for the US economy in order to study the effects of monetary policy rates cuts on GDP growth in periods characterized by shortages of credit. He includes in his four-variables model the spread between the rate on Eurodollar deposits and the Treasury Bill rate. According to the author, movements in this spread are typically associated with shocks to the banking system.

In addition to these shocks, external to the Euro area, we identify two macroeconomic shocks which are specific to EMU: a business cycle and a monetary policy shock. The restrictions imposed on the impulse-response functions mirror those chosen for the US economy.

For all the structural disturbances, the responses are restricted for three periods. Since we use monthly data, this amounts to an horizon of one quarter.

To anticipate some results obtained in the present investigation, monetary policy shocks are one of the forces driving unemployment fluctuations in the short run. Hence the conclusion is that there is no evidence of monetary neutrality in the US economy and in the Euro area even in the last ten years.

Aggregate demand shocks also play a significant role in shaping the business cycle evolution in the two economic areas. However, the relative weight of this group of shocks (monetary policy and demand shocks) is not overwhelming.

Instead, it seems that the identified financial shock may have played a primary role in explaining movements in both inflation and unemployment.

Thus, we find a confirmation for the strong influence exerted by US macroeconomic shocks on Euro area variables. However, we also find evidence of bidirectional causal influence between the two economies since even the Euro area shocks have significant effects on US variables.

In related literature, Favero and Giavazzi (2008) utilize a structural VAR to investigate the role of US financial shocks in explaining the evolution of long-term interest rates in the Euro area. The approach adopted in order to identify the structural disturbances is based on imposing zero contemporaneous restrictions.

A cointegration framework is instead adopted by Dungey and Osborn (2009). They find that although US shocks exert an important role for the European business cycle, one cannot exclude a significant influence running from the European shocks to the US economy.

Mountford (2005) estimates a structural VAR in order to investigate the dynamic effects of UK monetary policy shocks. The author identifies the structural shocks by imposing sign restrictions on the impulse responses and finds that monetary policy shocks have played a limited role in explaining the variability of UK macroeconomic variables.

Rafiq and Mallick (2008) use the sign restriction approach to examine the dynamic response of output to monetary policy shocks in the three largest Euro area countries. Their main conclusion is that there is a limited influence of monetary policy on output.

However, these researches, in line with the majority of studies concerning the Euro area, consider longer and, unavoidly, heterogeneous periods which run from the eighties to the more recent EMU period. Moreover, the focus of these studies does not concern the fluctuations in unemployment. The industrial production or, alternatively, the aggregate output is the

variable included in the above-mentioned studies.

The paper is organized as follows. In section 2 we discuss the identification strategy adopted in order to recover the structural disturbances of the dynamic system. Moreover, we briefly confront this strategy with the more traditional structural VAR approach. Section 3 presents the empirical specification of the VAR model and the sign restrictions which are imposed on the response of macroeconomic variables to the different shocks. In section 4 we investigate the dynamic effects of the 5 identified macroeconomic shocks on unemployment and on the other variables included in the specification. Section 5 concludes.

2. Structural VAR Identification

Let us start with the following reduced-form vector autoregressive (VAR) representation:

$$A(L)X_t = e_t \qquad [1]$$

where X_t is a $n \times 1$ vector of covariance stationary macroeconomic variables, $A(L)$ is a matrix polynomial in the lag operator L, with $A(0) = I$, and e_t is the $n \times 1$ vector of error terms, such that $E(e_t) = 0$ and $E(e_t e_t') = \Sigma_e$.

Given the assumption of covariance stationary variables included in X_t, it is then possible to obtain the reduced-form moving average representation of [1]:

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

where $C(L) = A(L)^{-1}$ and $C(0) = I$.

Representations [1] and [2] do not allow a structural economic interpretation of the interaction among variables. Hence, in VAR analysis, starting with the estimation of reduced-form models, the researcher often wishes to impose a structure in order to recover the structural disturbances affecting the economic system.

It is well known that this is not a trivial task since many alternative structures are consistent with the estimated reduced-form VAR model. Thus, in general, the conclusion concerning the dynamic responses of variables to shocks will be sensitive to the specific set of identifying restrictions imposed on the model.

The usual assumption in the VAR literature is that the $n \times 1$ vector, η_t, of the structural shocks contains orthonormal variables, *i.e.* $E(\eta_t \eta_t') = I$. Thus, the assumption is that the identified shocks are mutually orthogonal and of unit variance. There is a relation between the vector of error terms and the structural shocks which is given by $e_t = B\eta_t$. Given orthonormal innovations, this relation also implies:

$$BB' = \Sigma_e \qquad [3]$$

The structural moving-average representation is then given by:

$$X_t = C(L)BB^{-1}e_t = B(L)\eta_t \qquad [4]$$

Since C(0)=I, it is easily seen that B contains the contemporaneous, structural coefficients of the model.

Hence the general problem concerning identification attains the selection of enough restrictions, supported by some economic model, to be imposed on matrix B. Note that since the covariance matrix Σ_e contains $n(n+1)/2$ free elements, by virtue of its symmetry, one needs $n(n-1)/2$ additional restrictions in order to obtain exact identification of the model.

In Sims (1980) it is assumed that B is lower triangular and hence, in this case, B is the Cholesky factor of Σ_e. Indeed, this identification scheme implies the imposition of a recursive structure. A criticism often made of recursive VARs is that economic models rarely justify such assumption of contemporaneous causality among variables.

An important point of departure with respect to the recursive scheme, is represented by the so-called Structural VAR approach pioneered Bernanke (1986), Sims (1986) and Blanchard and Watson (1986). Under this approach, the restrictions are imposed on the contemporaneous effects of shocks. However, the set of zero restrictions which allows the structural shocks to be identified does not generate a recursive scheme. In this sense, the approach is more general.

Note that the set of zero restrictions is usually selected by appealing to macroeconomic models which include delayed response of variables to shocks, given the assumed presence in the economic system of some form of nominal or real stickiness.

It is worth stressing that although the Cholesky decomposition is often labelled as "atheoretical identification", this identification strategy is "structural" in any sense; As, indeed, is demonstrated by its widespread use in empirical macroeconomics (see, for example, Christiano *et al.*, 1999).

If one instead assumes that the variables exhibit unit roots and hence are difference-stationary processes with stochastic trends, an alternative identification strategy, proposed by Blanchard and Quah (1989), consists in imposing long-run neutrality restrictions. In this case the dynamic system is specified with variables in first difference and the long-run zero restrictions are imposed on the accumulated impulse-response functions, *i.e.* on the level of the variables.

2.1 The Identification Strategy

In order to explain the methodology adopted in the present paper for identification of the macroeconomic structural disturbances, let us note that a general result in structural VAR analysis is that if we select B as the Cholesky factor of Σ_e, *i.e.* B is the unique lower triangular matrix such that $BB' = \Sigma_e$, then any other orthogonalization can be obtained as an orthonormal transformation of B. In other words, alternative orthogonalizations consistent with the reduced form [2] can be recovered by postmultiplying B for a non-singular

matrix V such that $VV' = I$.

In particular, in the present paper we aim to select a matrix D whose columns are represented by the identified impulse vectors. The task is accomplished by choosing a matrix V which exhibits orthonormal columns and such that the sign restrictions on the impulse responses are satisfied. It will be then possible to build a new matrix, $D = BV$, whose columns are the identified impulse vectors.

The selected structural representation is given by:

$$X_t = D(L)\epsilon_t \qquad [5]$$

In the present study we estimate a VAR model which includes eight macroeconomic variables and identify only $m = 5$ structural shocks. Thus, we have $m < n$. The shocks, and the associated impulse vectors, are then selected by discarding those vectors which do not satisfy the imposed sign restriction. Moreover the horizon, k, of the imposed restrictions is 3 periods.

Since we estimate five structural shocks, an important implication is that we leave some structural disturbances unidentified. Hence, the VAR prediction errors can be represented in the following way:

$$e_t = D_1\epsilon_t^{USMP} + D_2\epsilon_t^{USBC} + D_3\epsilon_t^{USFin} + D_4\epsilon_t^{EUBC} + D_5\epsilon_t^{EUMP} + \tilde{D}'\tilde{\epsilon}_t \qquad [6]$$

Where ϵ^{USMP} denotes the US monetary policy shock, ϵ^{USBC} the US business cycle shock, ϵ^{USFin} the financial shock. Moreover, ϵ^{EUBC} and ϵ^{EUMP} denote, respectively, the Euro area business cycle shock and the Euro area monetary policy shock. With each structural shock is associated the appropriate impulse vector D_i. Instead, there are $n-m$ shocks which are left unidentified and that are collected in the vector $\tilde{\epsilon}$. Clearly this implies that this unidentified set of shocks is associated with the remaining $n-m$ columns of matriz D which are contained in $\tilde{D}'$.

To sum up: we start by selecting the Cholesky orthogonalization and then build an orthonormal transformation on the Cholesky factor, consistent with the imposed sign restrictions on the impulse responses.

In Uhlig (2005) only the monetary policy shock is identified and hence the problem consists in selecting a single impulse vector. In the presence of a number of structural shocks greater than one, the shocks selected by imposing the sign restrictions are mutually orthogonal, by construction. Nevertheless, in the approach of Mountford and Uhlig (2009), which we follow in the present paper, they are ordered sequentially.

The specific ordering of the structural shocks identified in this paper is described in equation [6].

This sequential identification of the structural disturbances has an important implication: the shocks which are identified first enjoy a greater degree of freedom and hence the results obtained with the impulse response functions are sensitive to the particular sequence of identification adopted. As shown by equation [6], we have chosen to order first the US

monetary policy shock, thus leaving this structural shock with the widest available degree of freedom.

Another important, and to some extent limiting, feature of this agnostic approach to identification is that one can only identify a set of structural forms satisfying the sign restrictions imposed on the responses of variables. In other words, there is a set of impulse vectors which is consistent with the imposed restrictions.

However, a possible strategy aimed at circumventing this problem consists in adopting a penalty function approach. In this case there are additional criteria on which it is possible to rely in order to select the impulse vectors.

In the present paper the impulse vector related to the US business cycle shock is chosen under minimization of a criterion function which penalizes negative responses of US unemployment and positive responses of US inflation at horizons of three months. Instead, the impulse vector associated with the monetary policy shock penalizes, for the same horizon, negative responses of the US interest policy rate, positive responses of the US rate of inflation and positive responses (depreciations) of the bilateral euro-dollar exchange rate. Similar penalty functions, related to Euro area variables, characterize the selection of the Euro area shocks. Instead, the impulse vector associated with the financial shock penalizes negative responses over three periods of the spread between the Eurodollar Deposit rate and the Tbill rate[1].

3. Empirical Specification and Imposed Sign Restrictions

We estimate an eight variable VAR for the sample period 1999:1 2009:12.

For the USA the list of macroeconomic variables includes: a measure of the cyclical component of the rate of unemployment, the rate of inflation measured by the annual change in the Consumer Price Index (CPI), the federal funds rate and the spread between the 3-month rate on Eurodollar deposits and the 3-month Treasury Bill rate.

As for the Euro area the list of variables includes: the cyclical component of the rate of unemployment, the rate of inflation measured by the annual change in the Harmonized Consumer Price Index and the European overnight interest rate (Eonia).

The first difference of the (log) bilateral euro-dollar exchange rate, defined in terms of units of US dollars for one unit of the European currency, is also included in the VAR model[2].

Since we are interested in studying the fluctuations at business cycle frequencies in the rate of unemployment, we separate a cyclical from a trend component in overall unem-

[1] We use the same penalty function adopted in Mountford (2005) and Mountford and Uhlig (2009). These papers also provide a detailed presentation and discussion of the structure of the penalty function.

[2] Data concerning the CPI, the unemployment rate, the Federal Funds rate and the 3-month Treasury Bill rate, are obtained from the FRED database: http://research.stlouisfed.org/

The monthly series of the 3-month Eurodollar Deposits rate is compiled by the Federal Reserve. The series is taken from the Fed site: http://www.federalreserve.gov/

From the same source was obtained the nominal exchange rate, defined as US dollars per currency unit. Overall inflation for the Euro area is obtained from the Harmonized Consumer Price Index (HCPI). The series concerning the HCPI and the unemployment rate for the Euro area 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/

ployment. The cyclical component of unemployment is obtained by applying the Hodrick-Prescott filter to the series.

It is worth pointing out that one might question this separation on the ground that, in principle, it *a-priori* excludes the possibility of detecting the possible presence of long-run effects of monetary policy shocks, as well as of other demand or supply shocks, on the rate of unemployment[3].

An alternative approach might consist in avoiding such preliminary separation of trend and cycle components in unemployment by directly inserting the overall rate of unemployment in the VAR specification. In this case, one might search for the potential presence of long-run equilibrium equilibrium relations among variables. In this context, the identification of cyclical components in the variables could be done in a multivariate cointegrated system and this would also allow the possibility to separate the transitory from the permanent shocks.

Although we believe that, in general, investigating the potential presence of long-run effects on unemployment of monetary policy shocks and demand shocks is an important field of research, the limited sample horizon of the present investigation would prevent a proper identification analysis of the cointegration space[4]. Nor does it seem particularly appealing, at least in our opinion, to join pre - and post - EMU periods in order to dispose of a longer span of data.

In this paper we measure the stance of monetary policy for the US economy with the Federal Funds rate. Starting with Bernanke and Blinder (1992), this has become common practise in VAR analysis. Indeed, it is widely recognized that apart from the short experience of the period 1980-1982, when under Volcker's leadership a monetary aggregate was adopted, the monetary policy instrument has subsequently been the Federal Funds rate.

Instead, for the Euro area, we use the Euro area overnight rate (Eonia).

As far as the financial, non-monetary sector is concerned, the selected variable is the differential between the 3-month Eurodollar deposits rate and the 3-month US Treasury Bill rate.

The sign restrictions which are imposed for structural identification are reported in table 1. We restrict the responses of the indicated variables to the identified shocks for three periods, *i.e.* for one quarter.

[3]In a very recent paper, Karanassou *et al.* (2010) provide a comprehensive survey of theoretical and empirical studies concerning the short-run and long-run unemployment-inflation tradeoff.

[4]The set of potential long-run equilibrium relations which may be worth investigating certainly include some classical long-run propositions such as the Fisher Parity or the Uncovered Interest Rate Parity. Moreover, in recent years some less conventional equilibrium relations have been detected in empirical investigations concerning the US economy or the European countries. For example, a positive one-for-one relation between inflation and unemployment seems to characterize the evolution of the US economy in the eighties and ninenties as shown by Ribba (2006). Instead, for an investigation concerning the dynamic effects of macroeconomic shocks in a small open economy, in a structural cointegrated VAR framework see, for example, Ribba (2007). In this last paper, long-run effects on unemployment of monetary policy shocks in the Italian economy during the European Monetary System period are detected.

Table 1. Sign Restrictions and Identification of Structural Shocks[a]

	Structural shocks				
VAR Variables	US MP	US BC	US Fin	Euro BC	Euro MP
US unemployment rate		+			
US inflation rate	−	−			
Eurodollar Dep. - T-bill spread			+		
Federal Funds rate	+				
Euro area unemployment rate				+	
Euro area inflation rate				−	−
Eonia rate					+
Exchange rate	−				+

a: The five structural shocks are: US monetary policy shock (US MP); US business cycle shock (US BC); US financial shock (US Fin); Euro area business cycle shock (Euro BC); Euro area monetary policy shock (Euro MP).

As far as the contractionary US monetary policy shock is concerned, by construction, it is associated with an increase in the Federal Funds rate, a reduction in the US rate of inflation and an appreciation in the exchange rate. Instead, the response of the other variables and, in particular of the unemployment rate in both areas, is not restricted.

It is well known that the traditional VAR literature on monetary policy is plagued by the presence of some puzzling results concerning, in particular, the response of prices to monetary tightening. In particular, structural shocks recovered in VARs with Wold causal ordering usually exhibit a response of price to monetary policy shocks with wrong sign: prices increase in response to a contractionary shock (see *e.g.* Christiano *et al.* 1999).

The methodological proposal advanced by Uhlig (2005) consists in eliminating this puzzle in *a-priori* way, by imposing a response of prices consistent with the prevailing theoretical views on the effects of monetary policy while leaving free the response of real variables. The central idea is that once the monetary policy shock has been properly identified, one can concentrate on studying the dynamic effects on real variables.

Note, however, that under the specification adopted in the present paper the sign restriction is imposed on the rate of change of price, rather than on the price level itself. Thus, we are simply requiring that at least for the first three months associated with unexpected increases in the Federal Funds rate inflation decreases. This seems an even milder restriction.

The response of the (rate of change of) nominal exchange rate is also restricted by requiring a temporary appreciation as a consequence of the contractionary monetary shock.

Indeed, if the Uncovered Interest Parity (UIP) holds 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.

Empirical investigations including exchange rates are another area of unsettled puzzles in researches based on structural VARs. Since the works by Eichenbaum and Evans (1995) and Grilli and Roubini (1996) it has emerged that after a contractionary monetary shocks there is a small reaction reaction in the exchange rate and, moreover the appreciation exhibits persistency. Kim and Roubini (2000) proposed some alternative identification assumptions with respect to the recursivity strategy and obtained some new results more consistent with theory prediction. Nevertheless, more recently, Scholl and Uhlig (2008) have applied the sign restriction methodology to the exchange rate responses to monetary policy shocks and have found that a persistent appreciation remains a feature of the data.

The business cycle shock, *i.e.* an unexpected and adverse event on the aggregate demand side, provokes an increase for three periods of the unemployment rate and a decrease, over the same horizon, of the rate of inflation. The traditional AD-AS textbook scheme supports this prediction that is indeed consistent with a large class of economic models[5].

Although we are considering the dynamic interaction of large open economies, we do not restrict at any horizon the responses of the variables concerning the foreign economy since we want to impose only a minimal set of restrictions on the impulse responses. Of course, we expect that as a consequence of the US business cycle shock the Euro area unemployment increases and that the rate of inflation decreases, by virtue of the transmission of the recessionary effect induced by the US shock. Another expected result concerns the response of the policy rates: the Federal Funds rate and the Euro area overnight rate should decrease in response to the contraction in the US aggregate demand.

A business cycle shock is also identified in Mountford and Uhlig (2009). Nevertheless, the authors do not characterize the shock as an unexpected change on the aggregate demand side since they impose an increase for one year which is common to aggregate output, government revenue and consumption, leaving the price level unrestricted.

Our (partial) different choice for the identification of the business cycle shock reflects the implicit assumption of this paper that the last two global recessions are mainly explained by movements on the demand side, be they of real, monetary or financial nature.

As for the financial shock, we impose a positive innovation for three periods on the spread between the government bond rate and the corresponding market rate, without imposing further restrictions on the other variables included in the VAR estimation.

The Euro area business cycle shock is associated with an increase of the Euro area unemployment rate and a decrease of the Euro area inflation rate. Both sign restrictions are imposed for three months. Thus, in order to identify adverse exogenous effects on the aggregate demand side in the Euro area, we are simply extending the set of restrictions imposed for the identification of the US aggregate demand shock on the Euro area variables.

The restrictions imposed on the responses of Euro area inflation rate to an unexpected increase in the Eonia also mirror those selected for the United States. We also impose a temporary appreciation of the European currency. After all, although subject to strong US influence, the Euro area remains a large open economy.

It is worth stressing that since we consider the joint dynamics of a set of macroeconomic variables from the start of the European Monetary Union (EMU), there is no ambiguity in

[5]For an assessment on theory and empirics concerning the short-run tradeoff between inflation and unemployment see, for example, Mankiw (2001).

the identification of monetary policy shocks concerning the Euro area, since there is a single monetary policy regime.

As for lag length selection, both the Schwartz and the Akaike criterion suggest one lag for the estimated VAR[6].

4. The Dynamic Effects of the Identified Macroeconomic Shocks

Figures 1 to 5 report the results attaining the dynamic responses of each variable to the identified macroeconomic shocks[7].

The response of the variables to the US monetary policy shock deserves some attention. There is an immediate increase in the cyclical unemployment and the effects of this structural shock are persistent since after around four years it is still significant. The response of unemployment is similar in the two economies. However, it seems that at horizons of one to two years unemployment decreases as a consequence of the monetary tightening and this is difficult to rationalize.

It is worth stressing that ambiguous effects of contractionary monetary policy shocks on output have been also detected by Uhlig for the US economy (2005). Unclear results also characterize the work by Rafiq and Mallick (2008) concerning the three largest Euro area countries. In this last research a sign restriction approach is also adopted.

Another feature which is worth pointing out is that the Federal Funds rate at around three years following the monetary policy tightening shows a movement which is consistent with a reduction in the policy rate. Although this effect is nearly insignificant, a possible interpretation is that, given the real consequences exerted by monetary policy shocks, the central bank is forced to reverse the course of its monetary policy.

The response of inflation is reasonable: it decreases for at least three quarters after the shock. Let us recall that only the response for the first quarter is restricted being negative.

It is interesting to analyze the dynamic response of the Euro area overnight rate. For around six months it is not significant but for the subsequent eighteen months the Euro area policy rate moves toward an increase, thus following the direction of the Federal Funds rate. More precisely, an unexpected increase around 1 percent (in annual terms) in the Federal Funds rate translates almost one for one in an increase in the Eonia rate within an horizon of two years.

The dynamic responses of the Euro area inflation and unemployment rate are quite similar to those of the US variables and hence the important conclusion is that a contractionary US monetary policy shock has significant influence on the European macroeconomic variables.

[6]However we also estimated a VAR model with two lags and the results concerning the impulse-response functions and the variance decomposition are very similar.

[7]The confidence bands were generated from 500 draws using the Monte Carlo Integration approach seggested by Sims and Zha (1999). The procedure is included in the RATS manual for drawing error bands (see Doan, 2007). Figures 1-5 report the median responses together with the 16th and 84th percentiles.

Insert figure 1 about here

The US business cycle shock causes a persistent decrease in the inflation rate, both in the U.S. and in the Euro area. It is worth recalling that only the response of inflation in the United States is restricted for the first three months following the shock. Moreover, this external demand shock causes a significant increase in the Euro area cyclical unemployment. Thus, as a consequence of shocks which hit the aggregate demand, we observe the typical movements in opposite direction between inflation and unemployment at the business cycle horizons. This feature is common to both the economic areas.

As far as the policy rates are concerned, there is a fall in the Federal Funds rate following the negative demand shock. Moreover, in response to this adverse US business cycle shock, there is a quick reduction in the policy rate also in the Euro area. Indeed, the profile of monetary policy response in the two economies is very similar. Another feature which is worth stressing is that, according to the impulse-response functions, there is a significant, negative contemporaneous effect on the short-term rates.

This adverse aggregate demand shock also causes a temporary depreciation of the bilateral exchange rate and a persistent decrease in the spread between the three months Eurodollars deposits and the Treasury Bill rate.

Insert figure 2 about here

Some interesting results also emerge from the analysis of the response of variables to the financial shock. It is possible to summarize the results in the following way: the adverse financial shock is deflationary, causes a significant increase in unemployment and induces a movement of the policy rate in the opposite direction. Once again, the results are very similar for the two economic systems.

It is worth recalling that we impose a restriction only on the sign of the financial shock, leaving unrestricted the dynamic responses of all the other included variables.

As for the response of the exchange rate, there is a temporary appreciation of the national currency. This result is not surprising since it implies that, as a reaction to negative financial events and in the presence of credit risks, there are significant international capital flows towards the United States. Indeed, this is a typical reaction to the financial turmoil which has been observed in recent years.

Hence, as expected, the recent business cycle evolution in the two economic areas has had an important driver in the turmoil affecting the financial sector.

Insert figure 3 about here

Figures 4 and 5 display the responses of the eight variables to Euro area business cycle shocks and monetary policy shocks.

After a negative demand shock there is a decrease in the short-term interest rate in the Euro area which lasts around one year. Moreover, there is a gradual depreciation, i.e. the unit of dollars for one unit of euro reduces. The response of Euro area inflation is restricted for three periods, but the reduction in the inflation rate, following the increase in the unemployment rate, persists and is significant over one year.

As far as the responses of US variables are concerned, the impact effect on inflation is negative, i.e. the demand shock affecting the Euro area contributes to a reduction of inflation in the US economy but is characterized by limited persistence.

The Federal Funds rate seems to follow the response of the Eonia rate, by initially decreasing, but after around one year it begins to increase.

There are significant and persistent effects exerted by the Euro area business cycle shock on the US cyclical unemployment. Yet the contemporaneous response exhibits a wrong sign, since there is a reduction in the US unemployment. Nevertheless, at a horizon of 4 to 10 months unemployment increases.

The monetary policy shock originating in the Euro area exhibits real effects since there are significant responses both in the Euro area and in the US unemployment. Once again there is a wrong sign in the impact response of the variables since cyclical unemployment decreases in both areas as a consequence of a contractionary monetary policy shock. However, after 10 months the unemployment rate begins to increase and this effect is persistent, lasting for around two years.

Summing up the results from the impulse-response functions: on the whole, interesting results emerge, with significant real effects of monetary policy shocks and financial shocks and a clear bidirectional interdependence between the economic areas.

Instead, further investigation is required in order to explain some unexpected results concerning the dynamic effects of the identified structural shocks affecting the Euro area. In particular, the impact response of the US cyclical unemployment exhibits a wrong sign, *i.e.* there is a decrease in the unemployment rate in response to a Euro area negative demand shock and in response to a contractionary Euro area monetary policy shock.

Insert figure 4 about here

Insert figure 5 about here

4.1 Variation Explained by the Structural Shocks

Figures 6 to 10 show the fraction of variance explained by each structural shock.

Before discussing the role played by the identified structural shocks, it is worth stressing that the overall results reveal that there is no a single, dominant source of business cycle fluctuations in the two economic areas in the last decade.

Nevertheless, an important role in the last eleven years, according to the innovation accounting of this study, has been played by the financial shock, i.e. by unexpected movements

in the spread between the 3-months rate on Eurodollar deposits and the 3-months Tbill. For, this shock explains, in terms of median response, around 25 percent of the Forecast Error Variance (FEV) of the Eonia rate at 12 months horizon and, respectively, the 20 percent of inflation and 25 percent of the Euro area unemployment rate. Although in the US economy the results are similar, the peaks are reached at horizons of four-five years.

These results may suggest that further adverse effects on unemployment are to be expected in the next few years. For, note that important and unexpected increases in this measure of credit risk appeared in the summer of 2007, i.e. some months before the official date of the beginning of the recession, and hence we are still far from the peaks in the negative effects, revealed by the FEV analysis, which seem to be associated with shocks of this kind in the banking sector.

Instead, the US monetary policy shock provides only a modest contribution to the variability of macroeconomic variables, ranging from the 15 percent in the FEV of the exchange rate and inflation rate at different horizons to around 10 per cent for the other variables, both domestic and concerning the Euro area.

Such a limited contribution is common to the Euro area monetary policy shock. Indeed, the limited role played by monetary policy shocks in composing the variability of real variables at business cycle frequencies is a robust result of empirical investigations conducted within the structural VAR approach.

A relevant role has also been played by the US business cycle shock. On impact, the negative demand shock explains 50 percent of the FEV of the cyclical US unemployment and after one year the fraction of variance explained remains around 30 percent. As for inflation, at a horizon of one to two years the demand shock explains around 25 percent of variability. A more limited influence is exerted on the exchange rate fluctuations and on the variability of Euro area variables, in particular as regards the unemployment rate and the short-term interest rate. Instead, as far as the European inflation rate is concerned, the negative US aggregate demand shock explains around 20 percent of variability at shorter horizons but thereafter there is a decline towards 10 percent of the FEV explained.

In explaining the variability due to the Euro area business cycle shock, the conclusions are similar to those for the US shock. Nevertheless, it may be worth noting that the fraction of variance concerning the policy rate is small for the first year but thereafter steadily increases, reaching 20 percent at horizons of three years. Hence, it seems that abstracting from a certain communicative rhetoric on price stability by ECB members, concerns about fluctuation in the unemployment rate have exerted a significant influence on ECB's monetary policy decisions in recent years. Indeed, this seems quite reasonable since, despite the formal mandate which is attributed to the central bank, the monetary authority is likely forced to take into account the social and economic implications of an increasing rate of unemployment.

5. Concluding Remarks

In this paper we have investigated the sources of business cycle fluctuations in the United States and in the Euro area in the last decade. We have estimated and identified a structural VAR by imposing sign restrictions on the impulse-responses of macroeconomic variables.

Our main findings are that monetary policy shocks exerted real effects in both economic areas and that financial turmoils, expressed in this VAR context by an unexpected increase in the spread between the 3-month rate on Eurodollar deposits and the 3-month Treasury Bill rate, have played an important role in determining the deflationary evolution of the last recession.

Overall, the identified macroeconomic shocks which also include adverse, real demand shocks explain around 70 percent of the variability of inflation and unemployment at different horizons, both in the US and in the Euro area, as measured by the Forecast Error Variance.

In composing the variability of inflation and unemployment a pre-eminent role has been played in recent years by financial shocks, which exerted both a deflationary and a recessionary effect on the economic systems.

Our results confirm the importance of considering US macroeconomic variables when analyzing the European economy, given the significant effects displayed by US shocks. Nevertheless, to some extent, the reverse is also true since there are significant effects exerted on US inflation and unemployment by monetary policy shocks and demand shocks originating in the Euro area.

Indeed, this should not be a surprising result, given the weight of the Euro area economy in the global context. Yet our conclusion differs, at least in part, from some studies which conclude that the Euro area economy is strongly dominated by external, US shocks (see, for example, Favero and Giavazzi, 2008).

An important implication of this result is that empirical investigations, in particular those aiming to study the dynamic effects of monetary policy shocks, which take the US as a closed economic system may fail in a proper identification of structural disturbances.

Finally, some caveats in the interpretation of the results are due. We dispose of a sample period which covers only eleven years, i.e. the period of existence of the European Monetary Union. While this is a period characterized by relevant economic events, including the worst recession since the Second World War and, moreover, characterized by a homogeneous monetary policy regime in the Euro area, clearly, we simply need more data in order to draw more robust conclusions on the business cycle properties of the USA and of the Euro area.

References

Bijapur M (2010) Does Monetary Policy Lose Effectiveness During a Credit Crunch? *Economics Letters* 106: 42-44.

Bernanke B (1986) Alternative Explanations of the Money-Income Correlation. *Carnegie-Rochester Conference Series on Public Policy* 25, 49-100.

Bernanke B, Blinder AS (1992) The Federal Funds Rate and the Channels of Monetary Transmission. *American Economic Review* 82: 901-927.

Blanchard OJ, Quah D (1989) The Dynamic Effects of Aggregate Demand and Supply Disturbances. *American Economic Review* 79: 655-673.

Blanchard OJ, Watson MW (1986) Are Business Cycles all Alike? in Robert J. Gordon ed., The American Business Cycle. University of Chicago Press.

Canova F (2007) Methods for Applied Macroeconomic Research. Princeton University Press.

Christiano L, Eichenbaum M, Evans CL (1999) Monetary Policy Shocks: What Have We Learned and to What End? in J.B. Taylor and M.Woodford, Eds., *Handbook of Macroeconomics*, North Holland, Amsterdam, pp. 65-148.

Doan TA (2007) RATS User's Manual, Version 7, Estima, 1560 Sherman Avenue, Suite 510, Evanston, IL 60201.

Dungey M, Osborn DR (2009) Modelling International Linkages for Large Open Economies: US and Euro Area. *CAMA Working Paper 24*, Australian National University.

Eichenbaum M, Evans C (1995) Some Empirical Evidence on the Effects of Monetary Policy on Real Exchange Rate. *Quarterly Journal of Economics* 110: 975-1009.

Favero CA, Giavazzi F (2008) Should the Euro Area Be Run as a Closed Economy? *American Economic Review* 98: 138-145.

Grilli V, Roubini N (1996) Liquidity Models in Open Economies: Theory and Empirical Evidence. *European Economic Review* 40: 847-859.

Karanassou M, Sala H, Snower D (2010) Phillips Curves and Unemployment Dynamics: A Critique and a Holistic Perspective. *Journal of Economic Surveys* 24: 1-51.

Kim S, Roubini N (2000) Exchange Rate Anomalies in the Industrial Countries: A Solution with a Structural VAR Approach. *Journal of Monetary Economics* 45: 561-586.

Mankiw, N.G., 2001. The Inexorable and Mysterious Tradeoff between Inflation and Unemployment. Economic Journal 111, C45-C61.

Mountford A (2005) Leaning into the Wind: A Structural VAR Investigation of UK Monetary Policy. *Oxford Bulletin of Economics and Statistics* 67: 597-621.

Mountford A, Uhlig H (2009) What Are the Effects of Fiscal Policy Shocks? *Journal of Applied Econometrics* 24: 960-992.

Rafiq MS, Mallick SK (2008) The Effect of Monetary policy in EMU3. A Sign Restriction Approach. *Journal of Macroeeconomics* 30: 1756-1791.

Ribba A (2006) The Joint Dynamics of Inflation, Unemployment and Interest Rate in the Unites States since 1980. *Empirical Economics* vol. 31, pp. 497-511.

Ribba A (2007) Permanent Disinflationary Effects in a Small Open Economy: Italy 1979-1995. *Economic Modellling* vol. 24, pp. 66-81.

Scholl A, Uhlig H (2008) New Evidence on the Puzzles: Results from Agnostic Identification on Monetary Policy and Exchange Rates. *Journal of International Economics* 76: 1-13.

Sims CA (1980) Macroeconomics and Reality. *Econometrica* 48:1-48.

Sims CA (1986) Are Forecasting Models Usable for Policy Analysis? *Federal Reserve Bank of Minneapolis Quarterly Review* 2-16.

Sims CA, Zha T (1999) Error Bands for Impulse Responses. *Econometrica* 67: 1113-1156.

Uhlig H (2005) What Are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure. *Journal of Monetary Economics*, 52 (2), 381-419.

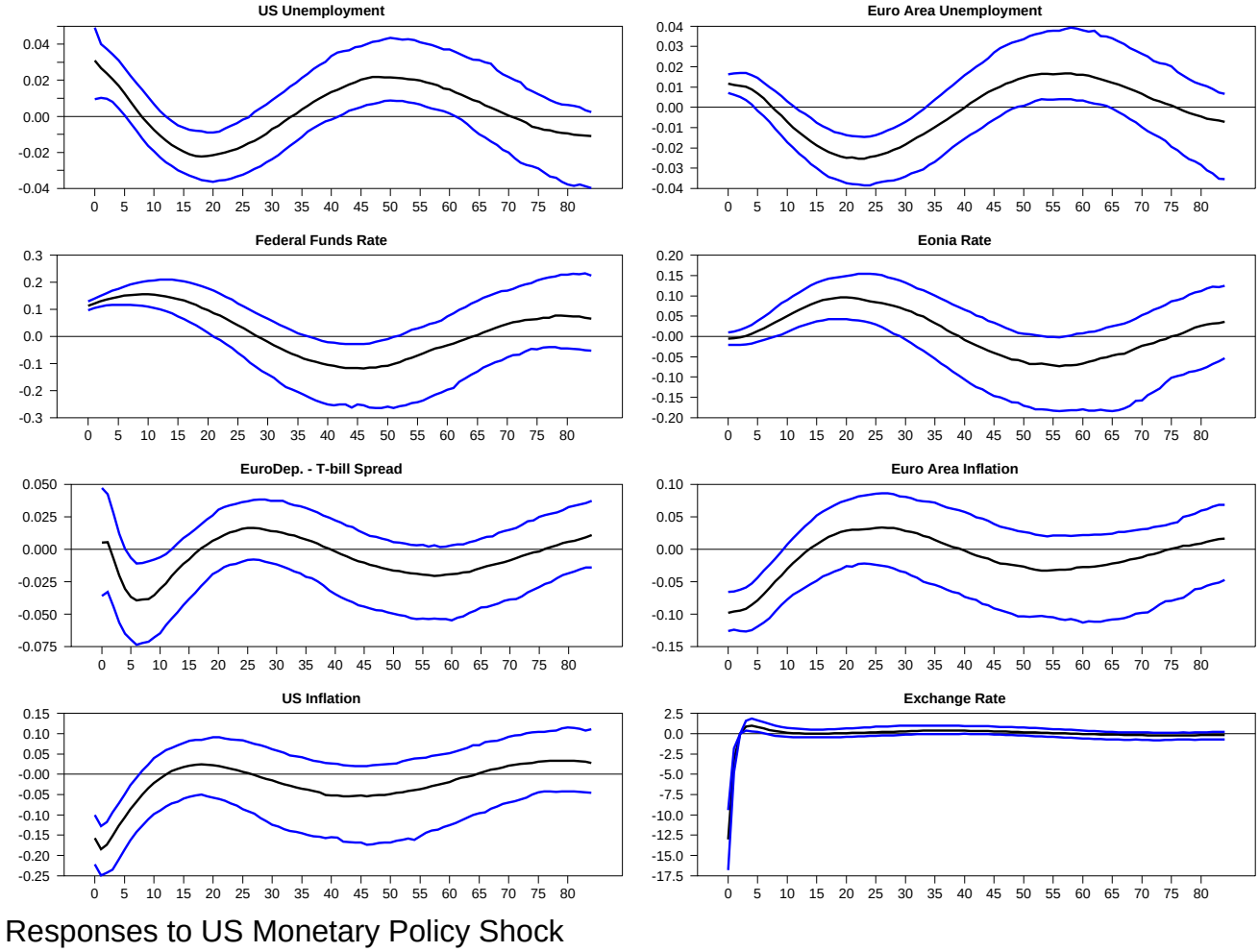


FIGURE 1. Dynamic responses of the macroeconomic variables included in the estimated VAR to the US monetary policy shock orderer first. In all figures are reported the median responses together with the 16th and the 84th percentiles.

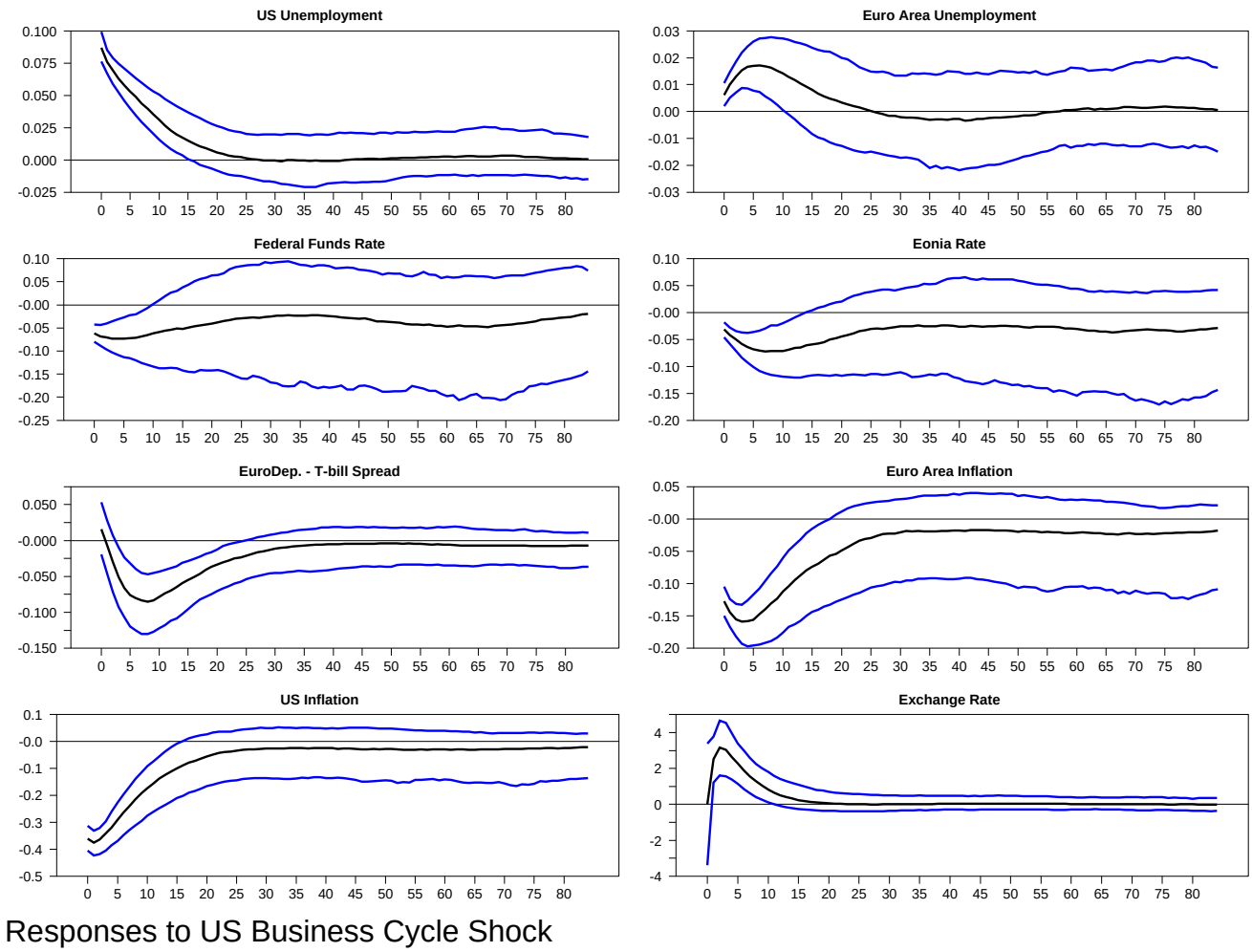


FIGURE 2. Dynamic responses of the macroeconomic variables included in the estimated VAR to the US business cycle shock orderer second.

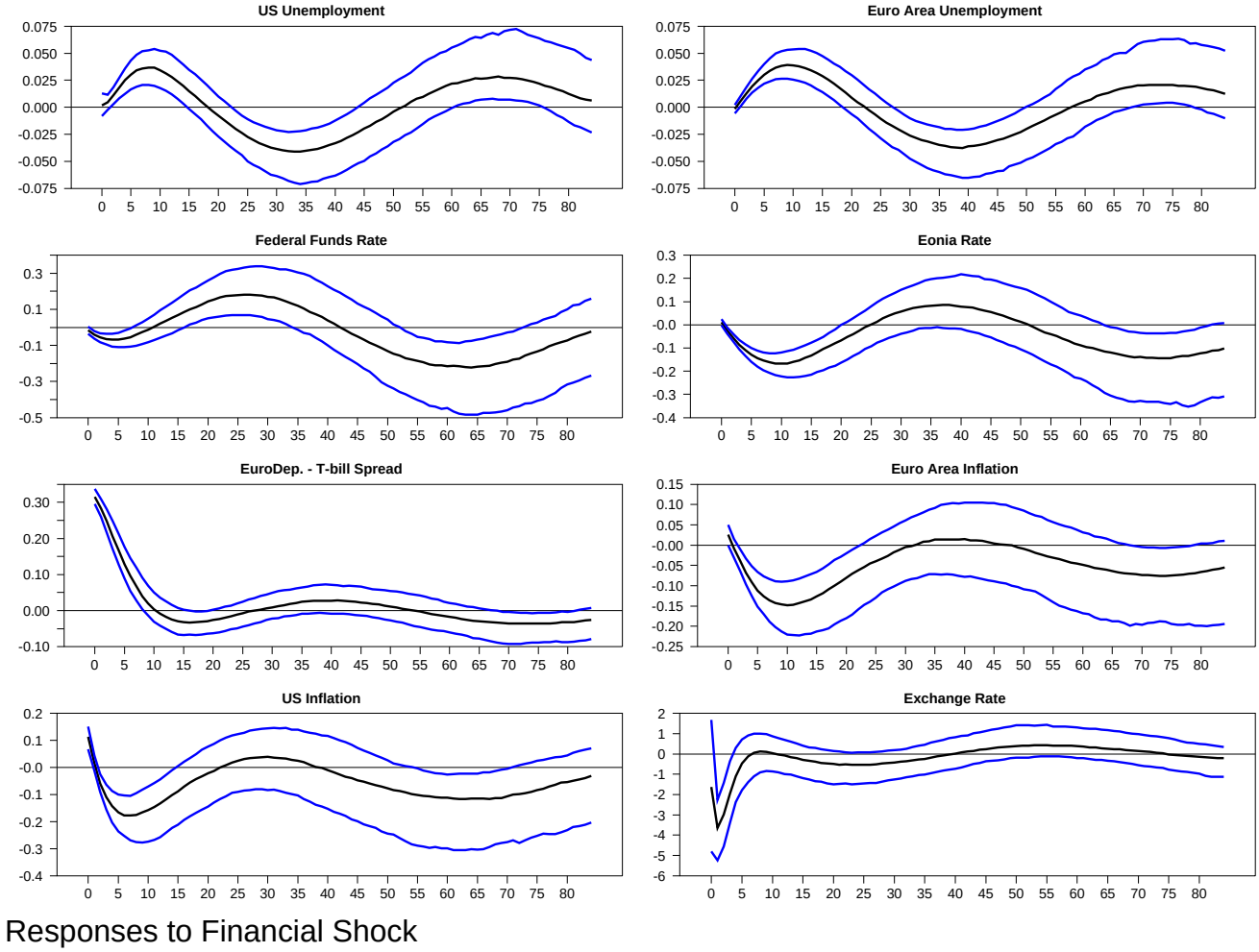


FIGURE 3. Dynamic responses of the macroeconomic variables included in the estimated VAR to the US financial shock orderer third.

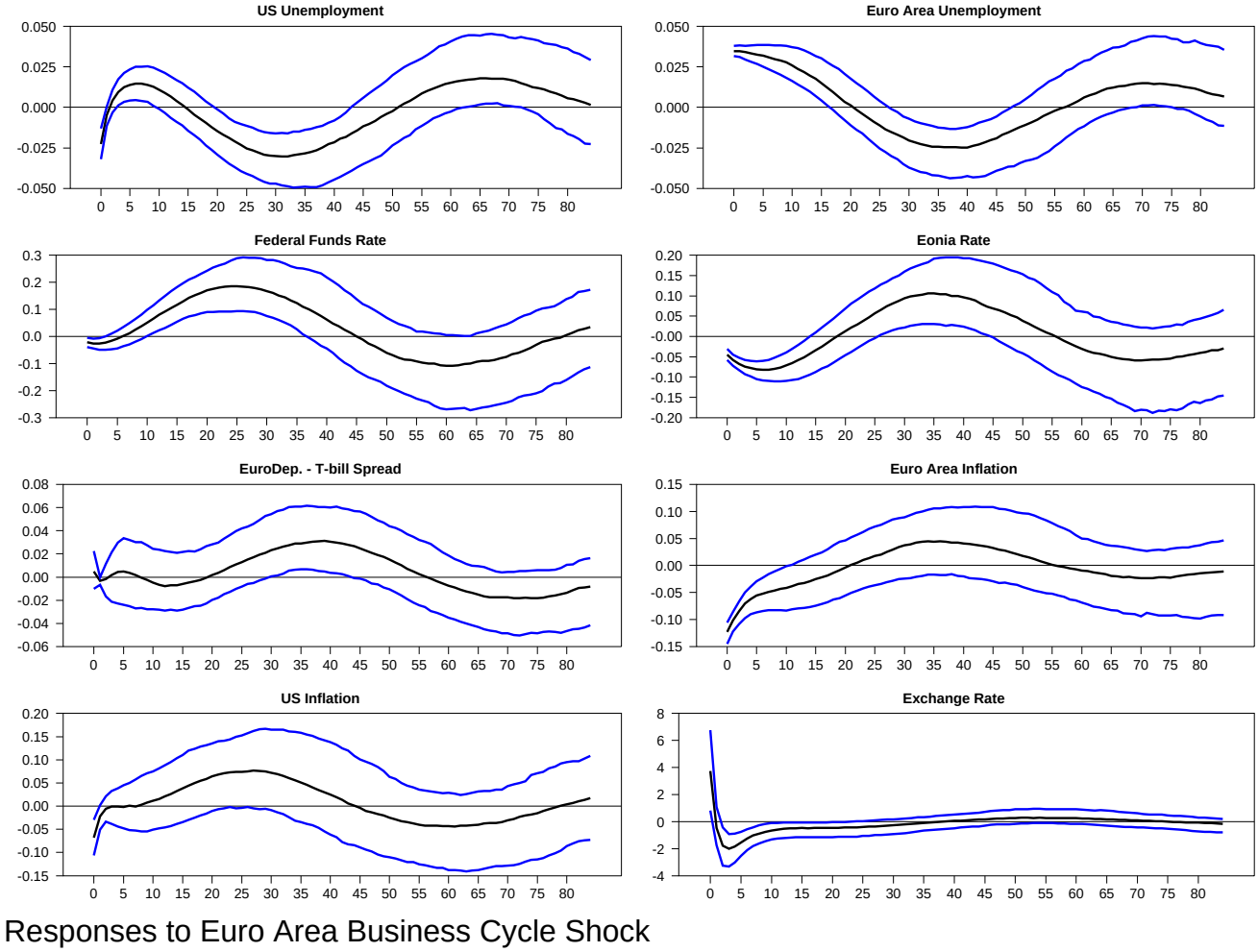


FIGURE 4. Dynamic responses of the macroeconomic variables included in the estimated VAR to the Euro area business cycle shock orderer fourth.

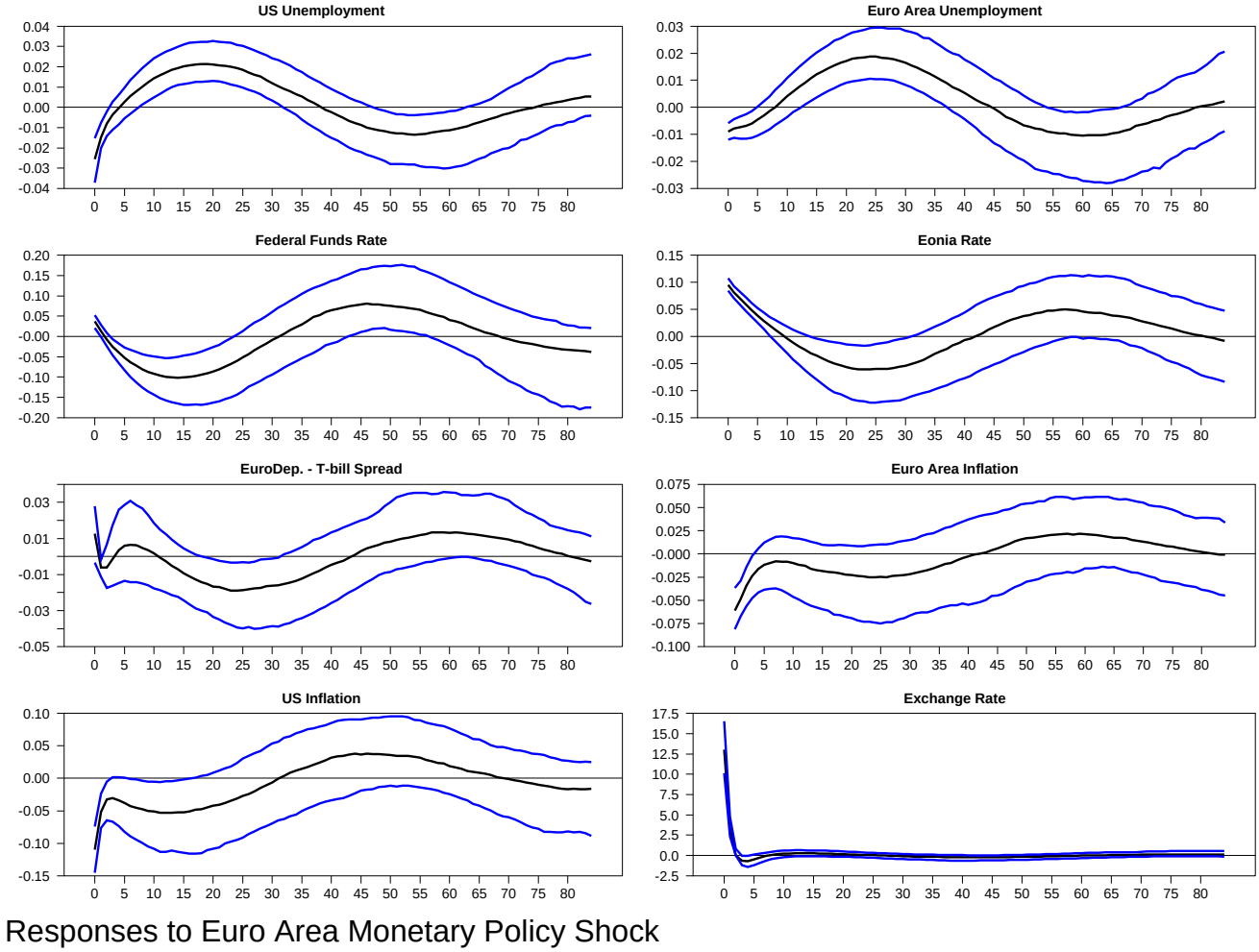
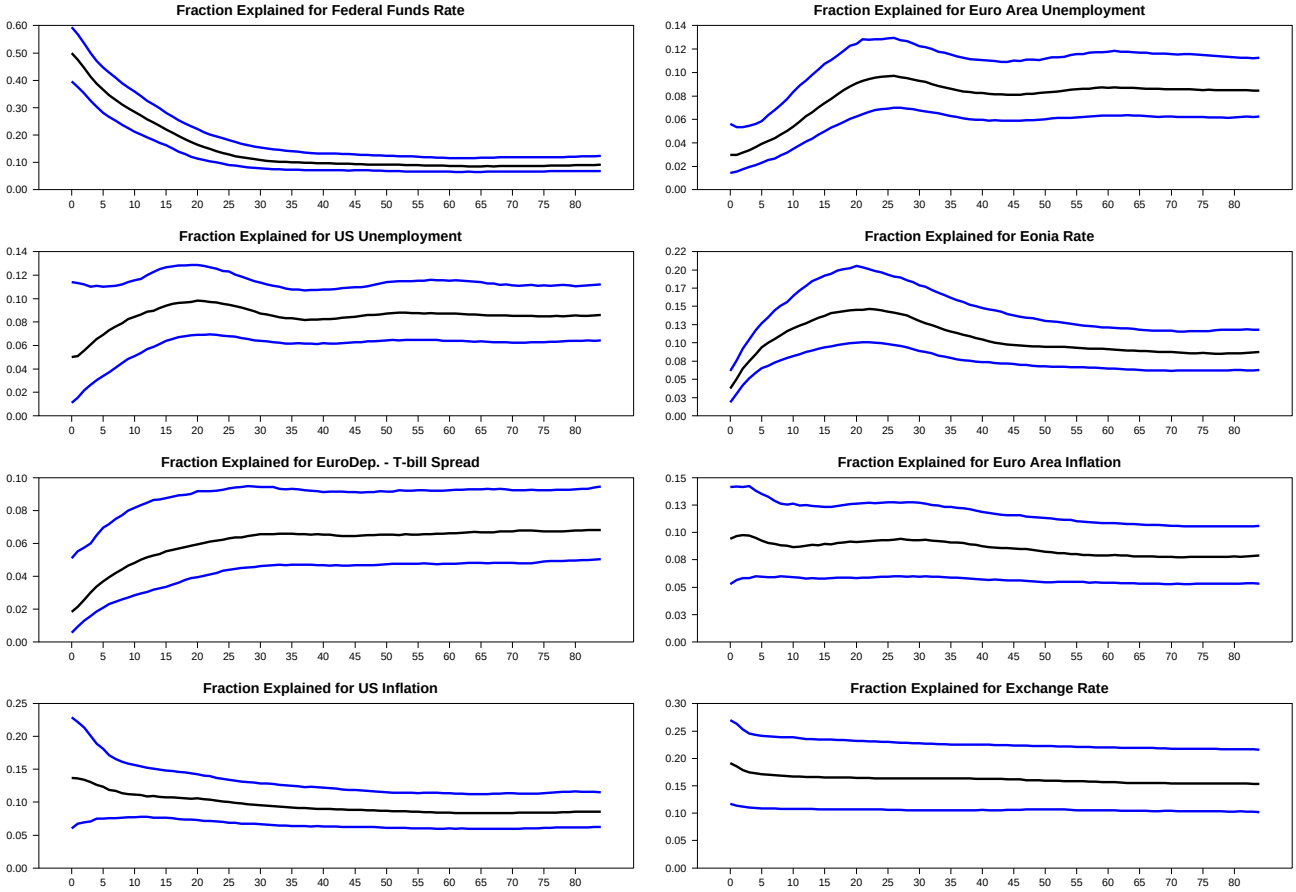


FIGURE 5. Dynamic responses of the macroeconomic variables included in the estimated VAR to the Euro area monetary policy shock orthogonal to the other four identified structural shocks.

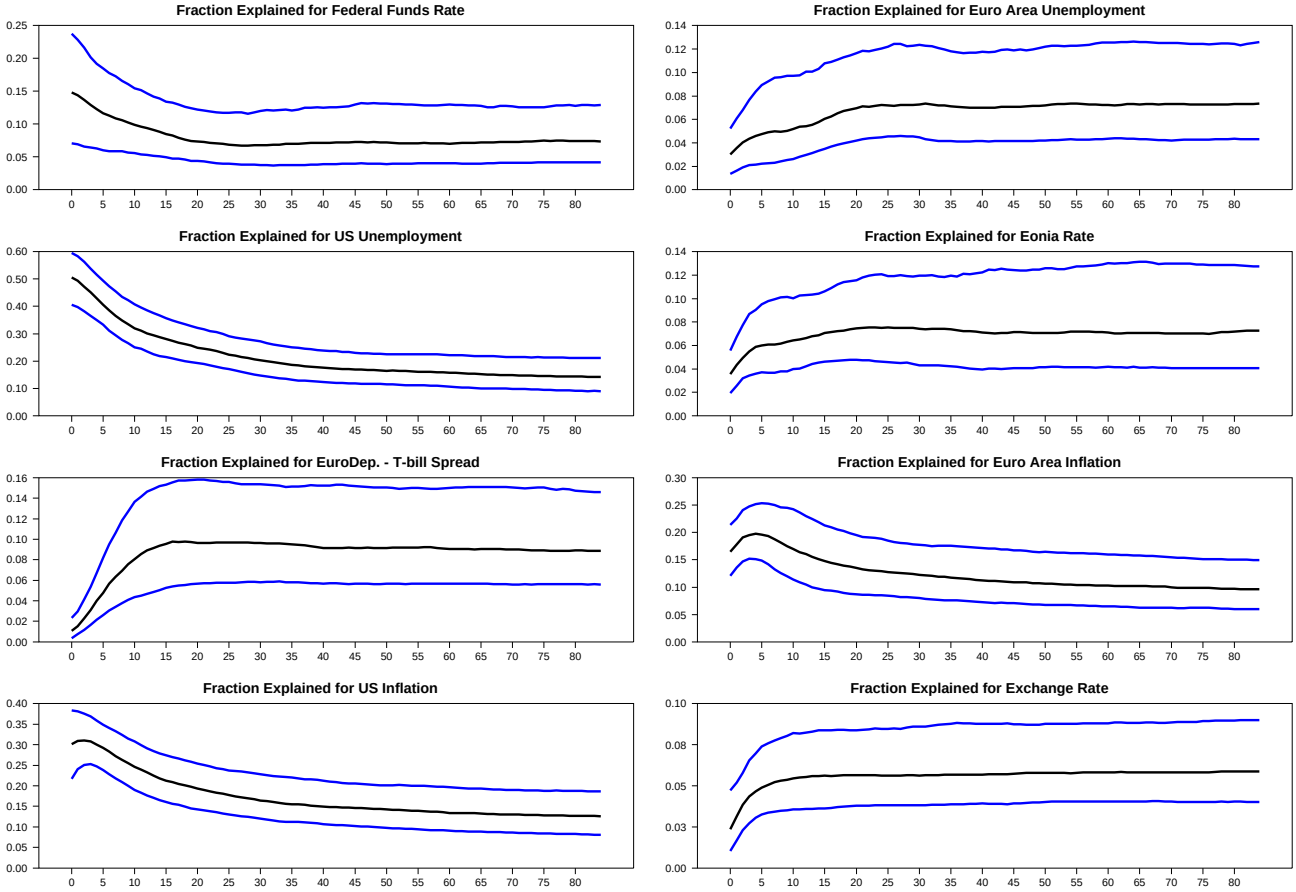
US Monetary Policy Shock



Fraction of Variance Explained

FIGURE 6

US Business Cycle Shock



Fraction of Variance Explained

FIGURE 7

Financial Shock

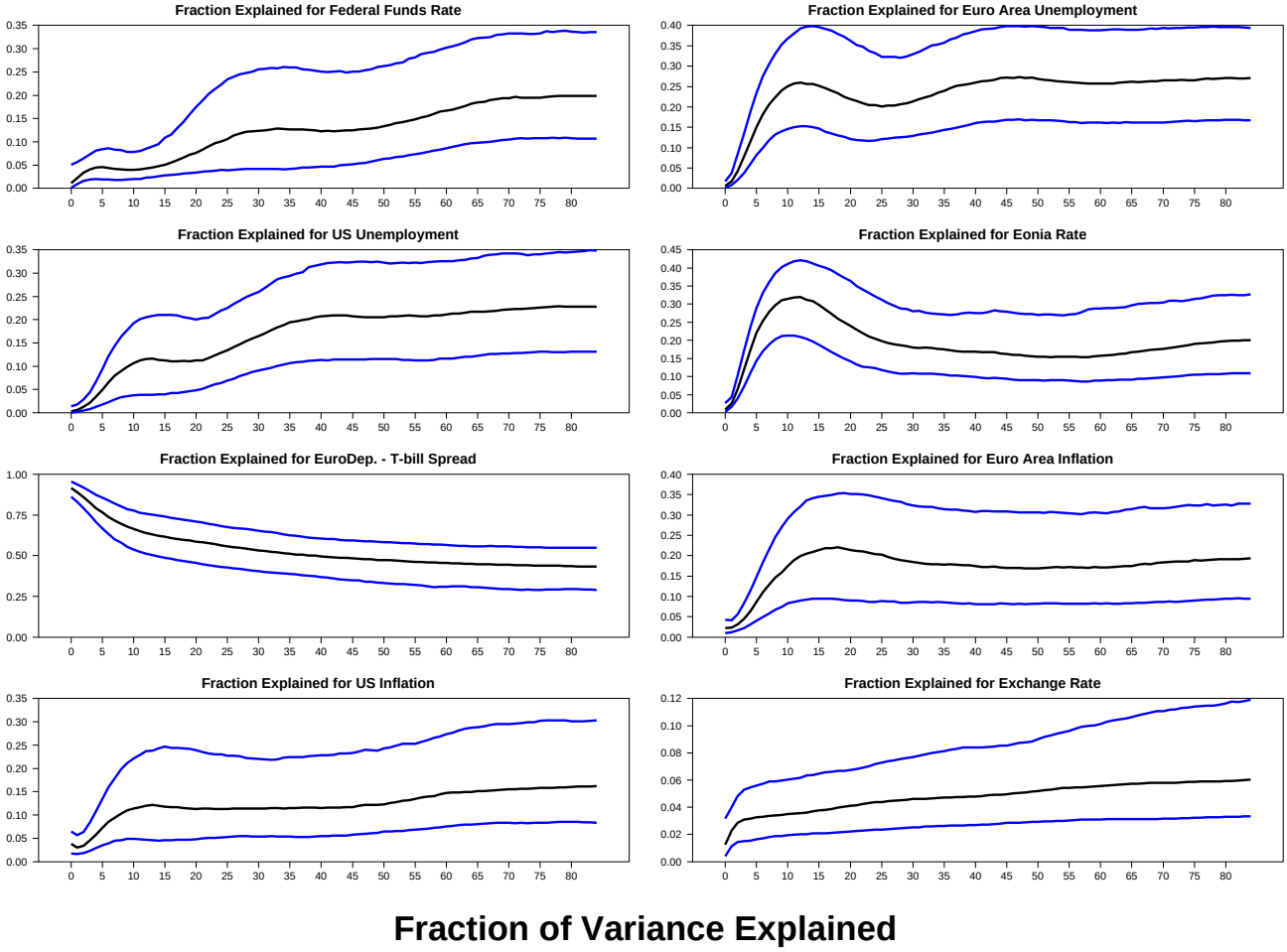
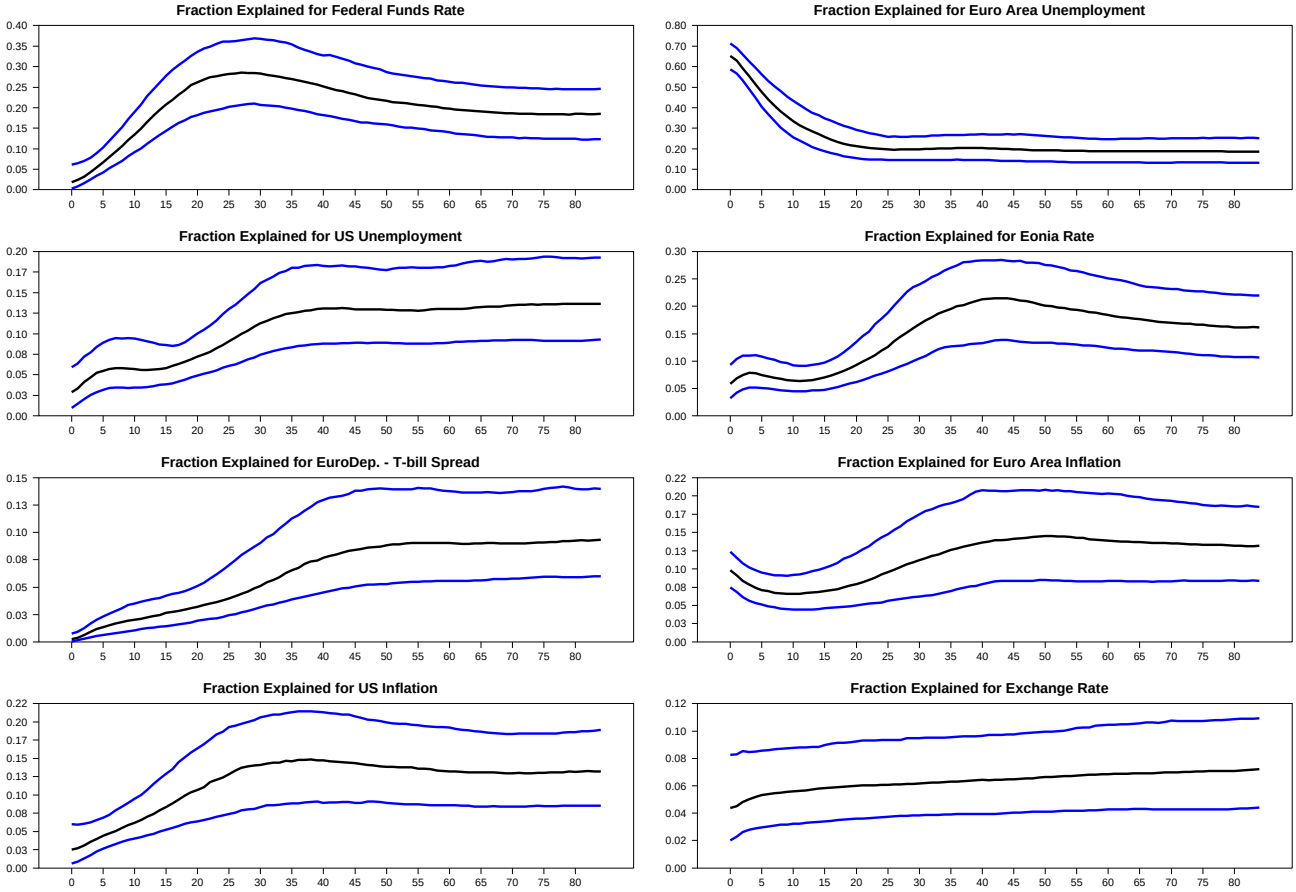


FIGURE 8

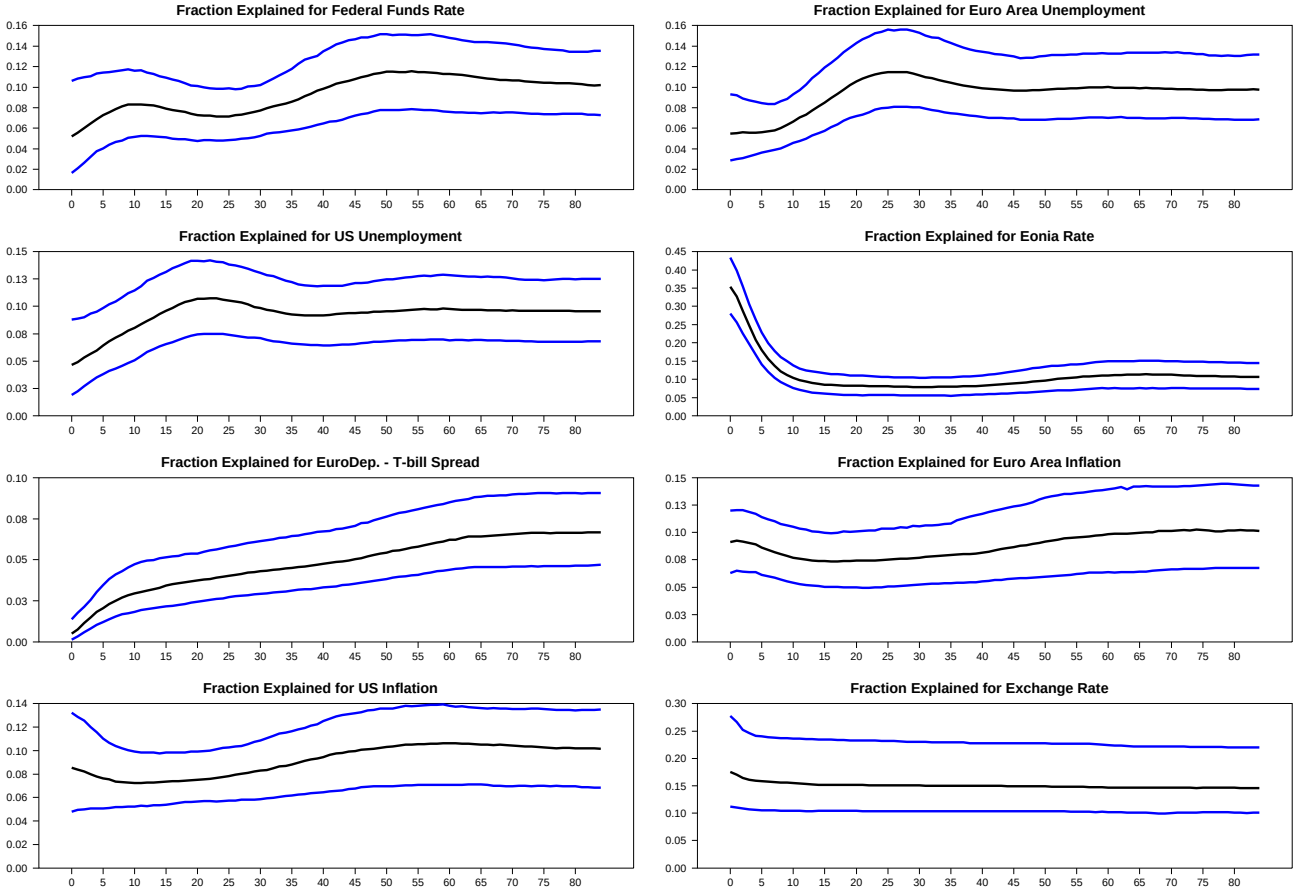
Euro Area Business Cycle Shock



Fraction of Variance Explained

FIGURE 9

Euro Area Monetary Policy Shock



Fraction of Variance Explained

FIGURE 10