The International Spillover of Fiscal and Technology Shocks before the Crisis: The case of the UK and Italy

Saeidinezhad, Elham

Institute for New Economic Thinking, Columbia University

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Elham Saeidinezhad
Institute for New Economic Thinking,
300 Park Avenue South,
New York, NY 10010,
United States

Abstract

In this paper we attempt to shed new light on the dynamic impacts of government spending and technology shocks on the real exchange rate for the Euro area. The main idea under this identification scheme is to let the data speak about the behaviour of the interested variables. Moreover, this paper investigates the impacts of fiscal policy and technology shock jointly in contrast to most of the literature which just focuses on one shock only. Our investigation suggest that the real exchange rate appreciates (falls) following an expansionary fiscal shock. It appreciates in response to a positive technology shock as well however after an on impact depreciation (increase) which lasts for 8 quarters.

1 Introduction

What is the behaviour of the real exchange rate following fiscal policies and technology shocks? It is crucial to have a clear-cut answer to the main question in this paper to understand the mechanism behind the exchange rate fluctuations. Real exchange rate[1] across OECD countries show significant and systematic inconsistencies from standard theories. For instance, during 1980's, in the late 1990s and also more recently in 2002 significant deviation in the United States producer-price based real exchange rate occurred[2].

Overall, the existing evidence appears to fail satisfying the predictions of both Mundell-Fleming type and intertemporal business cycle models under standard calibrations. According to benchmark theories, relative prices of domestic goods goes up following an expansionary government expenditure shocks. This happens since these shocks lead to the higher total demand for domestic goods. On the other hand, productivity gains[3] bring on lower relative prices as a result of higher supply of domestic goods.

[1] Both the real exchange rate or the terms of trade are the measure of the international relative prices.

[2] Andrew Atkeson and Ariel Burstein(2008), for instance, show that during 1980's in the United States, manufactured goods prices changed by approximately 40 percent compared to a weighted average of the prices of manufactured goods made in the US chief trading partners.

[3] We consider productivity gains as "technology shock".

Economists recently provide numerical estimates of the effects of an expansionary government expenditure on exchange rate and other main economic indicators mainly for the Unites States. These estimates are pivotal for policy making since they throw some light on determining the appropriate size and timing of countercyclical fiscal policy measures. Nonetheless, the empirical investigations on this central issue seem to deliver conflicting answers up to this time. Furthermore, most studies related to the impact of fiscal policy as well as technology shock on exchange rate are done for the U.S. and Euro Area seems to be neglected in this regard.

Agreeing with the textbook theories, an expansionary fiscal policy should worsen the current account and consequently appreciates the real exchange rate. The main empirical finding which shows this impact is on the United States during the first half of the 1980s and in the 2000s while the U.S was experiencing twin deficits. In contrast, more recent empirical studies such as those of Kim and Roubini (2008), Monacelli and Perotti (2006), and Ravn et al.(2007), among others, show that government spending depreciates the real exchange rate.[4] Following the productivity gains, as well, the direction and the size of the responses of main economic indices such as hours worked, employment and exchange rate are controversial.[5]

These controversies seem to root in the Real Business Cycle (RBC) model. As presented in the seminal paper by Kydland and Prescott (1982), the main assumptions of the DSGE models which are based on RBC theory, is that prices are flexible and firms are optimizing agents. In the standard RBC framework, theretofore, technology shocks changes demand for labour and raise both per capita hours worked and output and consequently lowers the relative price of domestic goods. When confronted with the data, these predictions have found little support. For example, recent empirical investigation by Corsetti et al. (2008b), Kim and Lee (2008), and Enders and Muller (2009) find that real exchange rates appreciate following a technology shock, captured by the terms of trade or the relative price of consumption across countries.

The objective of this paper is to re-investigate the dynamic behaviour of exchange rate using a new identification approach proposed by Enders et al. (2011)[6] to identify fiscal shocks and productivity gains simultaneously within an estimated VAR model. Crucially, they employ quantitative general equilibrium model in order to determine the sign and also the time horizons of the identification restrictions.[7] The plausibility of these identification assumptions is largely related to the theoretical framework that one has chosen. Having said that, employing a fully specified DSGE model lead to choose both the sign restrictions and the periods that we have to impose those restrictions. While the model is richly identified and endures robust predictions of the reaction of several key variables, it leaves exchange rate behavior unrestricted following an expansionary government ex-

[4]Studies about the effects of fiscal shocks on the real exchange rate for Australia, Canada, the U.K. and the U.S. gives somewhat mixed results, see, for example, Corsetti and Muller (2006) or Monacelli and Perotti (2008).

[5]Regarding technology shocks, proof for an appreciation is built in for U.S. data. Corsetti et al. (2008b) find an appreciation in Japan likewise. However Kim and Lee (2008) show a depreciation for the Euro area and Japan

[6]Sign restriction approach is put forward initially by Uhlig (2005) and developed later in many respects; see e.g Uhlig and Mountford (2009) and Enders et all (2011).

[7]Enders et al (2011) argue that this methodology is complementary to Corsetti et al. (2009a) study in which they use sign restrictions to identify demand and productivity gains in the manufacturing sector and investigate their impact on the real exchange rate. In their study, instead of employing a fully specified general equilibrium model, the authors exercise sector-specific data in order to achieve identification.

penditure and productivity gain. Furthermore, we re-examine this controversy for the Euro Area since the impacts of these two shocks is less empirically investigated in the EU compared to the U.S.[8]

We estimate our VAR model on quarterly frequencies for the Euro Area relative to the US for post-Bretton-Woods period but before the current financial crisis. The model includes data for consumption, output, investment, government spending, government budget balance, inflation, the short term interest rate and exchange rate. Our results suggest that exchange rate appreciates (falls) after an expansionary fiscal policy in the EU. Following a positive technology shock, however, after an on impact depreciation (increase), exchange rate appreciates for the whole period. In overall, even though we use an identification approach which is not often used in the recent literature, our empirical findings are relatively align with the existing studies concerning the impacts of technology shocks and fiscal shocks on exchange rate. More importantly, it is in line with benchmark theories regarding to the impact of these two sets of shocks on exchange rate. It seems that the facts about the exchange rate dynamics that are widely used across different identification schemes are in particular appropriate to examine theories of the international transmission mechanism.

The remainder of this paper is organized as follows. In section 2 we review the literature. In Section 3 we show our identification scheme and explain a quantitative business cycle model from which we determine sign restrictions. In Section 4 we illustrate our VAR specification and results. Section 5 concludes.

2 Literature review

Most controversies in international macroeconomics concern the real exchange rate dynamics for its fluctuations are more significant and long-lasting relative to other real variables. However, most models are unable to explain the behaviour of exchange rate. Furthermore, international financial market assumed to be complete in most benchmark models even though there is a well-documented lack of a consumption risk-sharing across countries. As a means of clarifying this important aspect of the real exchange rate and the dynamics of cross-country consumption, macro-economists turn to apply new generation of models recognized as new open Economy macroeconomics (NOEM). These models extended the literature by taking into account nominal rigidities as a feature of asset market or alternative features.[9]

The real exchange rate is characterized as the ratio of price levels between two countries. Assuming that all prices[10] are sticky, economists can explain real exchange rate fluctuations, as shown by Benigno (2004). In models which assume markets are perfect, the real exchange rate is identical to the ratio of the marginal utility of consumption across countries. These models are subject to perform poorly, even when they allow for other nominal or real rigidities. One way to solve this issue is to presume that agents cannot have access to complete markets in order to secure their assets against country-specific shocks. Chari, Kehoe, and McGrattan (2002) investigate the fluctuation and prolonged behavior of the real exchange rate by constructing a model with sticky prices.

[8]This is indeed a clear-cut difference of this paper with the very similar studies by Corsetti et al. (2009a) and Enders et al. (2011).

[9]Some examples include Benigno (2009), Lane (2001) and Obstfeld and Rogoff (2000).

[10]Including domestically produced as well as imported goods.

Their finding suggest that monetary shocks and nominal anomalies account largely for real exchange rate volatility.

This view, however, has been challenged by studies which emphasize the significant role of fiscal shocks in explaining the fluctuations of exchange rates. Taking the empirical perspective, the impacts of fiscal shocks on real economic variables, have been characterized in different models with forward-looking agents and finite horizons. In particular, Frenkel and Razin (1986) focus on the impacts of tax cuts on the world interest rates, consumption as well as the current account in a two country economy model. Daniel (1993a,b), for instance, investigates the consequence of tax cut in a country in which the time of a future tax increase to balance the budget is unknown. Kawai and Maccini (1995) study the impacts of fiscal deficits on a small open economy when there is a floating exchange rates regime. Governments sell bonds in order to finance its fiscal deficit and is predicted to be financed in the future by either seignorage or tax increases or other combination of these two.

Canzoneri et al. (2001b) argue that it is essential to have strict fiscal discipline in common currency areas where national governments enjoy less autonomy in following their goals. They differentiate between Ricardian and non-Ricardian regimes. In the first one, the nominal anchor is determined by monetary policy and moreover the exchange rate is defined by the standard theories. In non-Ricardian regime, however, fiscal policy is being used as the nominal anchor and appoints the exchange rate.

Looking further in the literature, one can see that even though closed-economy RBC models[11] have been successful to some extant in explaining the U.S. macroeconomic data, open-economy versions of these models that have integrated international relationships[12] have been less productive in replicating basic determinents of macroeconomic time series. The closed-economy versions come from the fact that countries play a role in international markets. However they dismiss the evidence that open economies have the privilege of sharing nation-specific volatilities with other economies through the exchange of goods and financial assets.

For instance, the extension of the Kydland-Prescott model to a two-country framework by Backus et al.(1994) lead to a riskier investment than is shown in the industrialized countries. Open-economy models, as well, lead to mixed results in replicating main characteristics of international data. Countries which participate in international trade can affect their economies' behavior by shattering the tie between its production and its spending on consumption and investment. This allows an economy to experience smoother consumption during the time compared to a closed economy. They also have larger response of investment to movements in expected rates of return. This is why models which are featured by shocks to technology show[13] larger changes in relative prices in open-economy models relative to the corresponding closed-economy versions. This also clarifies why technology shocks induce significant movements in the balance of trade and exchange rate in those models. Yet, previous models comes from the fact that nearly half of a country's output is made of non-traded goods. This evidence is possibly an important missing factor of existing RBC since it helps reconstruct the link between a country's output and its spending. As a result of all these controversies in the literature, this paper aims to study the implications of fiscal policy in the determination of the real

[11]See Kydland, F., E. and Prescott, E., C., (1982) and Prescott, (1986).

[12]See Enrique G. Mendoza, (1991); David K. Backus et al., (1992); Marianne Baxter and Mario J. Crucini, (1993) for more details.

[13]Here the assumption is that technology shocks create changes in the expected return to investment.

exchange together the impacts of technology shock on this key economic variable.

3 Identifying government expenditure and technology shocks

3.1 Sign restrictions

Several studies concerning to the study of macroeconomic shocks turn to employ VAR in order to identify those shocks empirically. The identification in their model is either based on long-run or short-run restrictions. Howeverin this paper, we use an alternative technique of identification since the standard schemes tend to produce results which are in conflict with the prediction of the RBC models.

Estimation of the reduced-form VAR [14]widely agreed in the literature[15]:

$$\begin{aligned} Y_t &= \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + ... + \Phi_p Y_{t-p} + \epsilon_t & (1) \\ &= \Theta(L) Y_t + \epsilon_t & (2) \end{aligned}$$

where Y_t is a $n \times 1$ vector of data at time t, $\Theta(L)$ is a polynomial in the lag operator L of order p and ϵ_t is the reduced form one-step ahead prediction error. Identification of economically meaningful shocks requires a sufficient number of restriction on the underlying structural model. Let $u_t = A^{-1}\epsilon_t$ is a $n \times 1$ vector of independent structural shocks such that:

$$E(uu') = \Sigma_u = I_n$$

where I_n is an identity matrix of order n and A is an $n \times n$ matrix. Identification of u_t requires the researcher to impose $n(n-1)/2$ restrictions on matrix A. In the VAR literature this was done by a recursive ordering of variables:

$$\begin{aligned} \Sigma_\epsilon &= E(\epsilon_t, \epsilon_t') & (3) \\ &= AA' \end{aligned}$$

where A is the Cholesky factor of Σ_ϵ.[16]

Instead of imposing a priori restriction to matrix A, in line with Uhlig (2005) and Mountford et al. (2009), we achieve the identification of the VAR model by applying sign restrictions on the impulse responses of a group of variables for a certain period $k = k_1, ..., k_n$ after the shock.It is shown in their paper that any impulse vector $a \subseteq R^n$ can be restored if there exists an $n-$dimensional vector q of unit length such that that $a = \tilde{A}q$ where $\Sigma_\epsilon = AA' = \tilde{A}\tilde{A}'$, and $\tilde{A}$ is the lower triangular Cholesky factor of the covariates matrix, Σ_ϵ. Note that $\widetilde{A} = AQ$ where Q is an $n \times n$ orthogonal matrix.

As we are going to show later, we developed our sign restrictions using real business cycle model. Assume that n is the number of structural shocks that we are going to

[14]Here, we have used a Bayesian procedure, following almost all the literature which produce error bands for impulse responses, For further details relevant to this paper, see appendix B in Uhlig (2005)

[15]We do not use a constant as well as a trend term here in line with practically the entire literature. They are easily included, see the appendix in Uhlig (1994) for details.

[16]Recursive identification impose short-run restriction based on ad-hoc ordering. This method was used by Sims (1986). Blanchard and Sims (1986) also achieved identification by imposing short-run restrictions. Alternatively, Blachard and Quah (1989) identified structural shocks by imposing $n(n-1)/2$ long-run restrictions on $C(1) = [I - \Phi(1)]^{-1}$.

identify. Uhlig (2005) and Uhlig and Mountford (2009) show that identifying n shocks is similar to identifying a rank n impulse response matrix. This is a sub-matrix of matrix A if and only if $AA^{'} = \Sigma^{'}$. Impulse responses can therefore be written as:

$$[a^{(1)}, ..., a^{(n)}] = \hat{A}Q \tag{4}$$

$\hat{A}$ is the lower triangular Cholesky factor of $\Sigma^{'}$. Q is equal to $[q^1, ..., q^n]$ which is an $n \times \zeta$ matrix made of orthonormal rows q^s such that $QQ^{'} = I_n$.

We can show that the impulse responses can be written as linear combinations of impulse responses which are produced under Cholesky decomposition of $\Sigma^{'}$. Assume that $C_{ji}(k)$ is the impulse response of the *jth* variable at time period k to the *ith* shock in the cholesky decomposition of $\Sigma^{'}$. Now let's define $c_i(k) = \mathbb{R}'$ as the vector of response. Therefore the impulse response of $r_a^{(s)}(k)$ to the impulse vector of $a^{(s)}$ is given by

$$r_a^{(s)}(k) = \sum_{i=1}^{\zeta} q_i^{(s)} c_i(k) \tag{5}$$

The restrictions that we use in order to obtain the identification for shock s are $(r_a^{(s)}(k))_j \geq 0$ if $j \epsilon \zeta_+$ and $(r_a^{(s)}(k))_j \leq 0$ if $j \epsilon \zeta_-$ for some subsets of the variables ζ_- and ζ_+. We employ Bayesian approach for the actual estimation of our model.[17] To see what we did in a glance, we take a draw from normal-wishart posterior for (β, Σ) and make a standard normal matrix called M. Afterwards, we construct orthonormal matrix Q applying QR decomposition of matrix M while we have to make sure that $QQ^{'} = I$ and also $QR = M$. Finally in this part we make matrix α to calculate impulse responses.

In this identification scheme orthogonal structural shocks could lead to tight identifying sign restrictions in the way that lots of draws from the Normal-Wishart posterior for the VAR parameters (β, Σ) are not accepted since they do not allow any impulse matrices that fits the sign restrictions. As a result, many draws receive zero prior weight, even if only few of the restrictions are mildly not met. This issue becomes more problematic if the number of orthogonal shocks as well as the number of variables included in the VAR model increases. To find a solution for this complication, we let for small deviations ε from the sign restrictions.[18]

3.2 Business cycle model

Here we go through the business cycle model from which we draw our sign restrictions. The model we are using here is widely used in this literature and it features two-country specific model in which some frictions exist.[19] We employ Gali(1999) model in which there is some degree of sticky prices that will alter the transmission of real shocks. Additionally, one of the assumptions is that each country is specialized in producing a particular type of good. Consumers, on the other hand, in both countries consume both goods however in different extent. Moreover, the extension of their consumption in each country will determine relative prices which consequently derives real exchange rate fluctuations. We

[17]Specifically, we apply a flat Normal-Wishart prior (see Uhlig (1994) for a detailed discussion of the properties), while the numerical implementation follows Rubio-Ramirez et al. (2005)

[18]For more detailed use of literature see Enders et al.(2011)

[19]See, e.g., Chari et al. (2002) and Kollmann (2002)

followed Engel (1999), Chari et al. (2002) and Enders et al. (2011) and did not take non-traded goods into account for the US.

Before describing our sign restrictions we briefly explain the structure of the model. The world consists of two different countries called "home" and "foreign" country.

3.2.1 Households

In each country the representative household allocate some of its resources to consume some goods and also supply labour. There is also an endogenous discount factor in this model which means that leisure and consumption is higher than its steady state if thee discount factor is higher. Labour and capital are not mobile internationally. Household in each country rent the capital they own to intermediate firm. It is also costly to adjust the level of investment. The law of motion for capital is given by

$$k_{it+1} = (1-\sigma)k_{it} + [1 - \Psi(I_{it}/I_{it-1})]I_{it} \tag{6}$$

Where σ denotes the depreciation rate. Across countries, trade is in the form of bonds denominated in the currency of each country. Each representative household in each country has a budget constraint. Also in each country consumers maximize their preference function subject to law of motion of capital, their budget constraint as well as a non-ponzi scheme condition.

3.2.2 Final good firms

We assume that investment and consumption are composite goods that households buy from final good firms. These firms are in perfect competition market and purchase their inputs from monopolistic competitive firms. One of the other important assumptions here is that we assume that the law of one price holds for the firms and therefore we have:

$$P^B_{It}(j) = S_t P^B_{2t}(j); P^A_{1t}(j) = S_t P^A_{2t}(j) \tag{7}$$

let $A_{it}(j)$ and $B_{it}(j)$ denote the amount of good j which respectively is made in country *1* and *2* and used in country i to assemble the relevant final goods. These are produced under a technology level which depends on the elasticity of substitution between foreign and home goods and the elasticity of substitution between goods manufactured within the same country. It also depends on the home bias in the composition of final goods.

The problem of this firm is to minimize expenditures in combining intermediate goods subject to the technology that it is using. Furthermore, assuming that we are in the home country, we define the real exchange rate as follows:

$$RX_t = S_t P_{2t}/P_{1t} \tag{8}$$

therefore an increase corresponds to a depreciation. [20]

[20] The terms of trade are defined as the price of imports relative to the price of exports: P^B_{it}/P^A_{it}

3.2.3 Fiscal Policy

For fiscal policy we assume that government spending consists of the basket of intermediate goods. More importantly we assume that government goods are made with the same technology that final good firms uses except that merely goods which are manufactured domestically enter the consumption bundle of the government. This evidence is put forward by Corsetti and Muller (2006). They argue that the import goods as part of government expenditure is in general less than half the import content in private spending. Government consumption evolves as follows:

$$G_{it} = (i - \rho_g)G_i + \rho_g G^1_{it} + \varphi_y(Y_{it} - Y_i) - \varphi_d(D_{it} - D_i) + \varepsilon^g_{it} \tag{9}$$

letters without time subscript refer to steady-state values; ρ_g shows persistence and φ_y and φ_d demonstrate the extent in which government expenditure reacts to the deviation of output and debt from their steady-state values. ε^g_{it}, is an i.i.d. shock to current government spending, which may have been robustly predicted n periods in advance because, say, of institutional features of the legislative process. We also assume that tax rates adjust to the level of debts. The government budget constrain in country i is as follows:

$$D_{it} + P^G_{it}G_{it} = \tau_{it}(W_{it}H_{it} + R^{it}_k K_{it} + \Upsilon_{it}) + D_{it} + R^{-1}_{it} \tag{10}$$

P^G_{it} is the price index of government consumption.

3.3 Generating sign restrictions

Since our VAR model is estimated on time series data for the European Union relative to the U.S, we mainly focus on evidence for the European Union.

In this paper we try to derive plausible sign restrictions which meets the parametrization of all kind of standard models through the following procedure. First we assume that confidence intervals are specified and we have uniform and independent distribution. Afterwards, we draw a entire of 100,000 realizations of the parameter vector. We have to then calculate impulse responses to a government expenditure and a productivity gain for each realization. In addition, we compute confidence bounds including 99 percent of the impulse responses and eventually discover which variables react unambiguously no matter positively or negatively after an specific shock for a k periods following that shock. We follow Enders et al.(2011) in this paper who argue that "Computing the impulse responses for a large number of realizations of the parameter vector ensures the robustness of our sign restrictions. Assuming a uniform distribution over the specified interval, we consider the entire range of parameter values, while dismissing all values outside the interval as implausible on a priori grounds. In order to dismiss very unlikely implications of realizations of the parameter vector, we consider 99 percent coverage bands."

We employ range of parameter values in order to simulate the model in hand.[21]

[21] For detailed explanation of how to compute these parameter values, see Enders et al.(2011) paper. In their seminal paper they explain how they determine sign restrictions from model responses to positive technology innovation and fiscal expansions under various parameterizations in detail. Table 1 in their paper summarizes the whole procedure of parametrization.

4 New evidence on the behavior of Euro Area real exchange rates

4.1 Data and baseline specification

We estimate the VAR model (1) on time series data for the Euro Area relative to the U.S. We include a constant and 4 lags of endogenous variables in the VAR model. The vector of endogenous variables consists of, in logs and real terms, private consumption, GDP, private investment, government spending as well as the primary budget balance scaled by GDP, inflation (measured using the GDP deflator), the nominal short-term interest rate and the log of the real exchange rate. Data for real output, private consumption, government spending, the GDP deflator, and private fixed investment are taken from the OECD Economic Outlook database. Government spending consists of government spending on goods and services (government consumption), however it does not include investment and transfers.[22] The data ranges from 1975Q1 to 2007Q4. We dismiss the first two troublesome years after the collapse of the Bretton-Woods system.[23]

For all the variables we used the data for Euro Area relative to the U.S. However exchange rate is an exception.[24]

We use our baseline specification and identify a shock in government spending together with productivity gains while the backbone of our identification procedure is the sign restrictions summarized in Table 1.

Table 1: Expansionary Innovations in Euro Area

Variables	Government Spending	Technology Shock
Consumption	unrestricted	+8
Output	+2	+8
Investment	-4	+4
Gov.Spending	+4	unrestricted
Gov.Budget	-4	+0
Interest Rate	+4	-4
Inflation	+0	-0
Exchange Rate	Unrestricted	unrestricted

[22] Additionally, we use the same source of data to achieve the short-term interest rate, the government balance (measured in percent of GDP), exports of goods and services (value, local currency), imports of goods and services (value, local currency), and GDP (market prices) for the U.S. Net exports, as a fraction of GDP, are computed on the basis of these series. For the Euro area we obtain several series from the ECB's AWM database. For more details of where to get relevant data, see Fagan et al.(2001) and Enders et al.(2011). We take the CPI-based real effective exchange rate for the U.S. from the Main Economic Indicators of the OECD.

[23] Euro area growth rates consists of West-Germany for just before 1990Q4, and unified Germany from 1991Q1 afterwards.

[24] We apply the short-term interest rate (STN), the deflator of exports of goods and services (XTD), the deflator of imports of goods and services (MTD), and the government primary surplus (GPN-YEN). In case OECD data is used, similar adjustments have been applied in constructing the AWM database. Weights are based on PPP adjusted values for the year 2000, as reported in the World Economic Outlook database (2007) of the IMF.

4.2 Empirical results

Figs. 1 to 16 shows the impulse responses to the shocks in government spending and technology given the estimated VAR model. We can see in all the figures the median and also the 16% and 84% quantiles of the posterior distribution of impulse responses. Crucially the results are considered as “significant” whenever both quantiles are either above or below zero at a specific point in time. The horizontal axis shows periods (in quarters) after each shock while the vertical axis, on the other hand, represents the percentage that the responses depart from its baseline values. We show the periods in which we impose sign restriction as shaded area in the figures.

Figures 1 to 8 shows the impulse responses of the variables in the model to an expansionary shock in government expenditure. The impulse responses of all variables display the response of relative variables to a domestic innovations[25] however the only exception is real exchange rate which shows the reaction of the domestic variable. Relative government expenditure increases persistently for almost 12 quarters. However it is likely to decrease in later periods. Enders et al. (2011) argue that this happens as a result of systematic cut in response to higher public debt. GDP rises for nearly three quarters on impact however it also falls afterwards. Succeeding the evidence reported by Perotti (2005) for a post-1980 data and also by Mountford and Uhlig (2009) and Enders et al.(2011) for the U.S, this paper shows a very temporary expansion in output as a result of government spending shocks this time for Euro Area. Indeed, GDP increases just for the period that its respond is restricted to be non-negative. In contrast to the case of US, however, GDP keeps falling for all the periods following a fiscal shock. The government budget deteriorates for at least 14 quarters. Private consumption, in the same manner, decreases for the most period of the study however after an initial rapid increase which lasts for 8 months. Gali et al. (2007) suggest that private consumption rises after an increase in government expenditure only if there is either a labor market friction or when the majority of individuals consume disposable rather than permanent income. Our results document that government spending crowds out private investment for the whole period and reduces inflation after it increases initially for roughly 5 quarters. Therefore, investment decline, while inflation rises slightly for 5 quarter and then declines. Interest rates, in turn, increase initially as long as they are restricted to respond non-negatively, but falls constantly thereafter. The reaction of real exchange rate after the shock is that it appreciates (falls) continually. The size of these exchange rate dynamics, however, is not considerable. Under standard assumptions, exchange rate appreciates following an expansionary government spending in business cycle models as well as textbook modifications of the Mundell-Fleming model. As discussed in methodology section, we do not restrict exchange rate impulse responses and as a result, we find interesting evidences: align with standard models of exchange rate behavior, an expansionary government spending appreciates (decreases) the real exchange rate. Furthermore, this finding is in contrast with the number of studies which investigate the same issue using different identification schemes. Blanchard and Perotti (2002) identify their model assuming that government spending is predetermined. Kim and Roubini (2008) as well as Monacelli and Perotti (2006) analyze U.S. data and Australia, the U.S., the U.K and Canada respectively. They find evidence that government spending shocks depreciate the real exchange rate. Canada, however,

[25]This means that variables are the difference between the reaction of a domestic variable (here European Union) and its foreign partner (United States). We used relative variables in this paper since we focus on the behavior of the real exchange rate, which is defined by these relative variables.

was an exception[26].

Figs 9-16 reveals how our variables reacts to a technology shock, i.e., productivity gain. Government spending decreases initially for nearly 6 quarters however rises for 20 quarters afterwards. The budget does not decrease on impact and indeed increases for the whole period. Enders et al. (2011) generate the same result for the US and argue that it is likely to be the byproduct of the fact that tax revenues are procyclical. The response of consumption is positive for the whole period. GDP increases for the intial 12 quarters howevers it falls sharply afterwards. Private investment responses increases for 16 quarters before its start to fall. Nominal interest rate, as the model imposes, falls for 6 quarters however it starts to increase afterwards for nearly 10 quarters before it starts to fall sharply again. Inflation after a technology shock follows the pattern of nominal interest rate.

Real exchange rate after a technology shock, similar to that of fiscal policy, appreciates (falls) for most of the periods however after an initial depreciation which lasts for 9 quarters. One of the exceptions of the standard collaboration of the RBC model is called the Balassa-Samuelson effect. The Balassa-Samuelson effect argues that exchange rate may appreciate following an improvement in the technology of the production of traded goods. This happens through the impact of these technology shocks on the price of non-traded goods. 0ur results, in line with Balassa-Samuelson effect, document that exchange rates appreciate (fall) considerably in most quarters after a productivity gain however after an on impact depreciation which lasts for 10 quarters. These movements of exchange rate, on the other hand, contrasts evidences obtained from the rest of the litrature which use long-run restrictions to identify technology shocks. The exchange rate medium-term movements in this paper shows that exchange rate depreciates (increases) just for the several initial quarters. Subsequently, the exchange rate falls beyond its steady-state level before the shock happens. The same medium-term patterns for the exchange rate is also confirmed in the study of Enders et al. (2011) for the US.

4.3 Our Results and *further* issues in the literature

This paper investigates the dynamic response of a series of euro area macroeconomic variables to fiscal policy and technology shocks employing structural VAR models. The similar studies for the euro area, however, mostly concentrate on monetary policy rather than fiscal policy. For instance, Peersman and Smets (2001) merely analyze monetary policy shocks, and Peersman and Straub (2004) estimate both monetary and technology shocks using model-based sign restrictions. In contrast to those papers, we identify fiscal policy shocks as well as technology shock simultaneously by imposing theoretically-consistent restrictions in line with Enders et al.(2011).

The identification of impulse responses that built on structural VAR models aims not just at calculating the properties of the data. It also tends to determine the set of shocks that should be integrated in dynamic general equilibrium models. A controversial debate in the literature is to understand the impacts of positive technology shocks on

[26]Beetsma et al. (2008) employed a methogology suggested by Ramey and Shapiro (1998) to identify shocks in the Euro Area. Their results suggest that the real exchange rate appreciates after an expansionary government expenditure in this area. This methodology according to the litrature is a well-documented substitution to the Blanchard-Perotti method. Monacelli and Perotti (2006) used the same identification approach and report that government spending decreases, while the real exchange rate depreciates. They argue that this happens as a result of the Carter-Reagan military build-up.

main economic indicators such as hours worked under different specifications.[27]

Sousa et al. (2012) investigate the impacts of a one-standard deviation positive technology shock and argue that it induce a steady increase in the output. Furthermore, wages, consumption and investment also react positively to a technology shock. These results has been confirmed in most benchmark theories. The difference between their study and ours, however, is that they study the impact of monetary policy together with technology shock while our focus is on the effects of fiscal policy and technology shock. We also find a continuing development in private consumption after a technology shock however GDP and private investment merely increases for initial 12 and 16 quarters respectively following the shock and then they start to fall till the very end of the period. Both studies affirm each other on the reaction of inflation to a technology shock. Inflation's reaction is mainly contemporaneous and the largest response happens on impact. Besides, this reaction is not statistically important and it is not different from zero[28]. They finally conclude that positive technology shocks create a permanent drop in the number of labor input employed in the economy. Sousa et al. (2012) finally suggest that hours worked are procyclical which calls into question the reliability of the RBC paradigm. Indeed, if productivity gains were the major drivers of business cycles in the economy then their VAR results would show a negative relationship of hours worked and output growth and not the positive one evidenced in their study, (Enders et al. (2011))[29]. Christiano et al.(2003), as well, show that a technology shocks induce an increase in consumption, investment and output. Hours per capital's reaction, however, is in a sharp contrast with the evidences reported in a large body of literature in which per capita hours worked decreases following a positive technology shock. These papers utilize a reduced form time series models employing minimal identifying assumptions to estimate a technology sock's impact on the economy. Their results are significant since they cast doubt upon the basic properties of many structural business cycle models which imply that per capita hours worked increase after a permanent shock to technology. Concurrently, they imply that permanent technology shocks does not have any significant role in explaining business cycle fluctuations. After all, technology might produce quantitatively significant impacts if one accepts the traditional growth models theories. Dedola and Neri (2007), furthermore, examine U.S time series data for the postwar period and argue that a positive technology shock push U.S. hours worked per capita after one year. Contrary to Christiano et al.(2003), their results confirm the significant role of a technology shock in determining output dynamics and are in line with the predictions of standard RBC models. One of the main differences between DeDola and Neri (2007) and Christiano et al.(2003) is that the former use sign-restriction approach in identifying the technology shock.

In the fiscal policy literature, we investigate the impacts of the changes in government expenditure on key economic indicators such as private consumption. This is a crucial issue since fiscal policy is believed by policy makers to have an important impact on individuals' welfare given that private consumption is the largest portion of the aggregate

[27]Several studies have been done in this regard, namely Basu and Kimball (2004) and Gali (2004). Also see Erceg, Guerrieri and Gust (2005) for a compehensive study of the reliability of identifying technology shocks using long-run restrictions on a VARs.

[28]In their model however, they also include per capita hours and show that it seems to fall permanently which is similar to the one reported by Gali (2004) for the euro area.

[29]Their results from VARs model which are based on restrictions are in line with the conclusions reported in Christiano, Eichenbaum and Vigfusson (2004), the response of hours to a technology shock would also change substantially if hours worked were found to be stationary.

demand. Macroeconomic theories, in contrast, do not have a universal opinion about the welfare implications of the fiscal shocks. According to the textbook Keynesian theories, private consumption increases following a positive shock in government spending. It is however argued that the impact of a fiscal policy shock on aggregate output depends on the changes in investment. Additionally, investment broadly relies on the monetary policy determination of the interest rate. This model assumes that economic agents maximize their utility function and finance their consumption out of their present income. Most modern-day macroeconomic models, on the other hand, follow the neoclassical theories and assume that consumers are infinitely lived consumption-smoothing agents. These models predict a fall in consumption following an increase in government expenditure through negative wealth effect. This effect comes from the fact that economic agents predict an increase in tax rates in future by governments in order to finance their current fiscal expansions. The empirical literature, however, provide conflicting answer to the question of the impact of fiscal policy on consumption.

Gali et al. (2007) and Erceg et al. (2006) suggest that their results confirm the presence of the “hand-to-mouth” consumers who their consumption behavior leads to the crowding in of the private investment. A study by Rossi et al. (2004), however, could not find enough support for the Gali et al. (2007) findings after replicating their results by assuming that individuals are rule-of-thumb consumers if taxation is distortionary instead of being lump-sum. Our results in this paper, in contrast, shows that consumption falls following an on impact increase of this variable which merely lasts for 8 quarters after an expansionary government expenditure. Coenen et al. (2007a) also shows an increase in consumption following an expansionary fiscal shock which is negligible. Horvath (2009), align with this paper, notice that an increase in private consumption after a rise in government expenditure is not generally an character of the economy under optimal stabilization. This holds even when one’s definition of the consumer behavior is different from conventional macroeconomic theories. Indeed, he argues that a “crowding-in” effect of consumption following a government expansion merely happens in situations that might be hard to reconcile with realities in advanced countries.

5 conclusion

In this paper, we investigate international relative prices and its impact on the behavior of a couple of important economic variables after an expansionary government expenditure and technology shock in Euro Area. More specifically, the center of interest here is on the effects of productivity gains and fiscal shocks on exchange rate. The real exchange rate is an important factor since it contains important information regarding the international transmission mechanism, (Enders et al. (2011)). Furthermore, the role of fiscal shocks and technology shocks altogether in particular had not previously been studied in the case of the Euro Area. The results in this literature to a large extent depend on the estimated VAR models in which identification is obtained either by short-run or long-run restrictions. These models are widely just based on a standard collaborations, which exclusively provides evidences by construction. We employ sign restrictions derived from the DSGE models in this paper in order to identify structural shocks and more specifically technology shock. More importantly, the existing evidence on the reaction of exchange rate following a technology and government spending shocks is controversial and and seems to call into question the predictions of international business cycle models.

We document evidences for 15 countries in the Euro Area using a different identification method which involves Bayesian econometrics and sign restrictions. For obtaining robust sign restrictions, following Enders et al. (2011) we achieve 100,000 simulations of parameters based on a quantitative business cycle. To identify shock simultaneously, several variables have been restricted by our identification scheme while we leave the response of the exchange rates to be determined by the data. Standard models predict that government spending and technology shocks appreciate and depreciate exchange rates respectively. Our results confirm the predictions of the benchmark models about the exchange rate in particular about the impact of fiscal policy. We could not, however, find enough support for the alternative calibrations of these models which assumed a low trade price elasticity.

Assessing a VAR model on time series data for the Euro Area relative to the U.S. economy, the results suggest that expansionary government spending shocks appreciates (decreases) the real exchange rate. Furthermore, the real exchange rate depreciates (increases) after a positive technology shock however just for a short period of time. With regard to the basics, our empirical results to some extent can justify the predictions of standard business cycle models. More importantly, it seems like different parametrization of the model we used does not necessarily lead to different behavior of exchange rate responses to both shocks. Corsetti et al. (2008a) document that robust wealth effects after a technology shocks push the demand for domestic goods further than supply and therefore appreciate the exchange rate.

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Figure 1: Europe's Private Consumption Impulse Response Relative to the US after an Expansionary Fiscal Policy

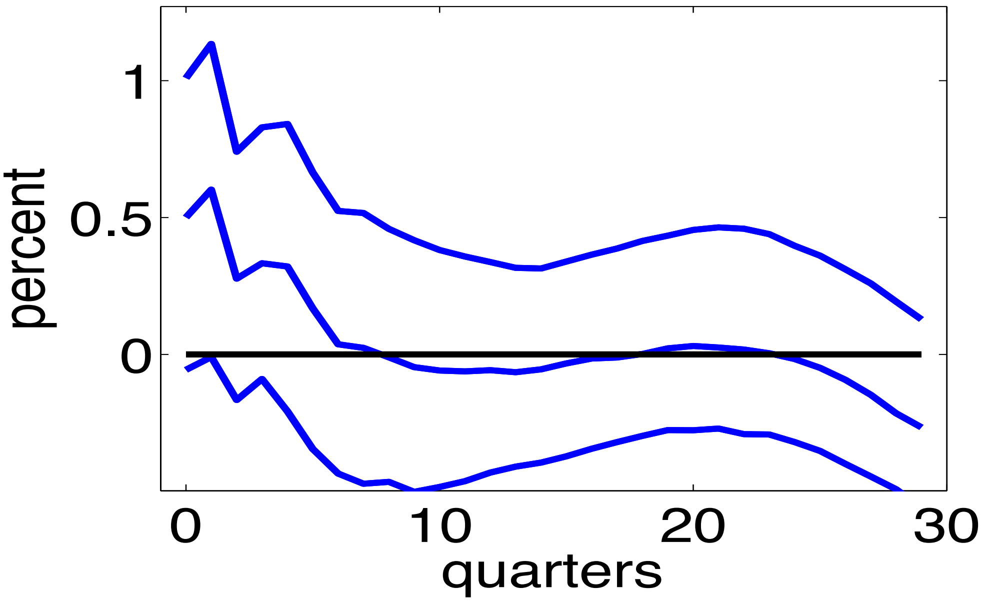

Figure 2: Europe's Exchange Rate Impulse Response Relative to the US after an Expansionary Fiscal Policy

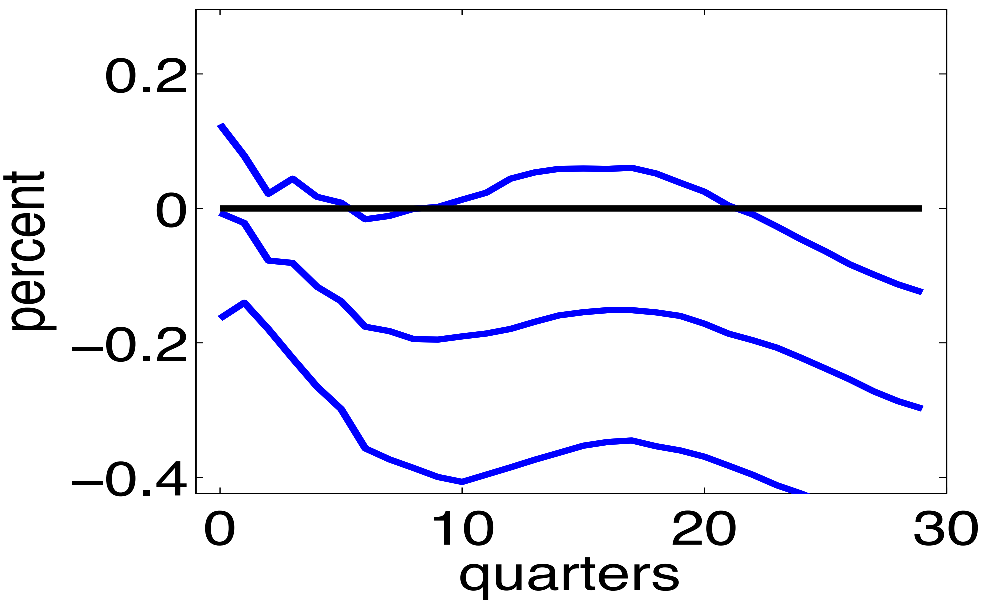

Figure 3: Europe's GDP Impulse Response Relative to the US after an Expansionary Fiscal Policy

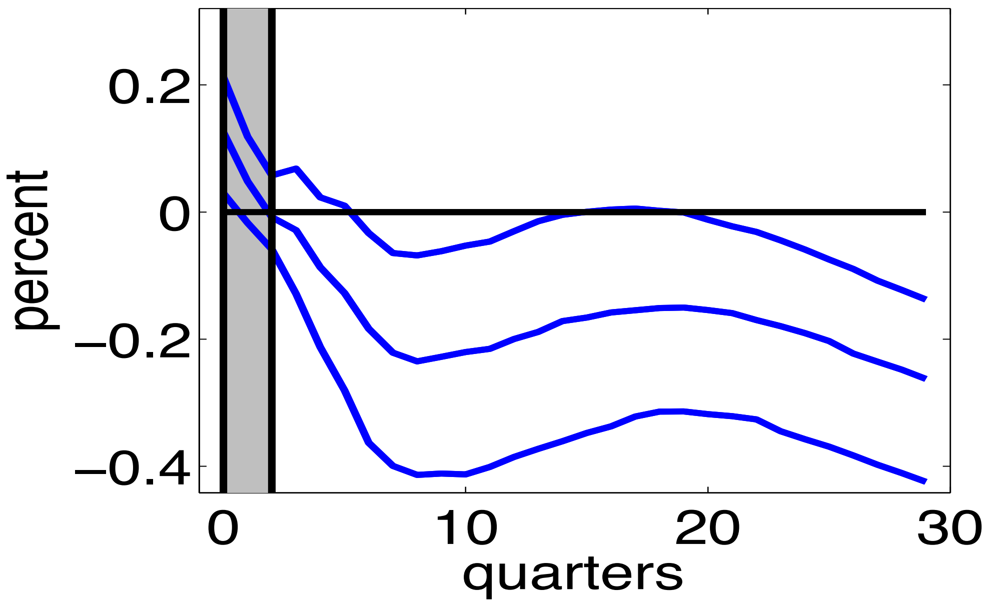

Figure 4: Europe's Government Budget Impulse Response Relative to the US after an Expansionary Fiscal Policy

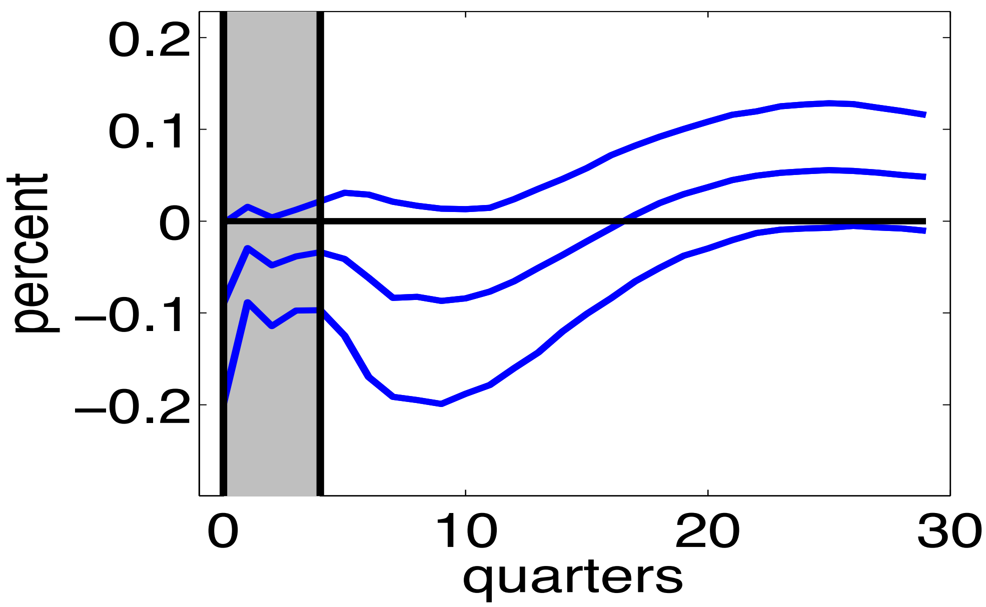

Figure 5: Europe's Government Spending Impulse Response Relative to the US after an Expansionary Fiscal Policy

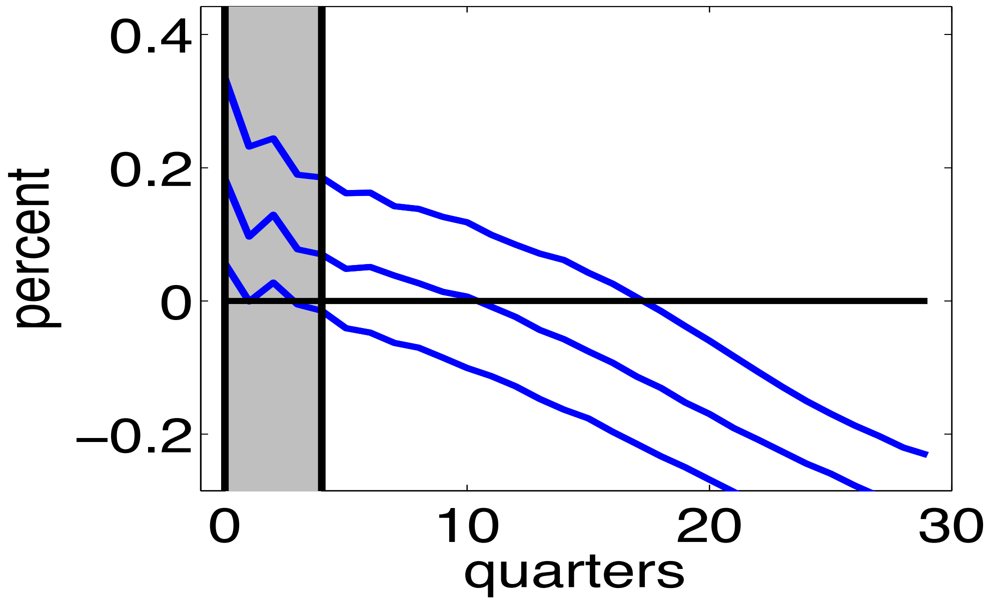

Figure 6: Europe's Inflation Impulse Response Relative to the US after an Expansionary Fiscal Policy

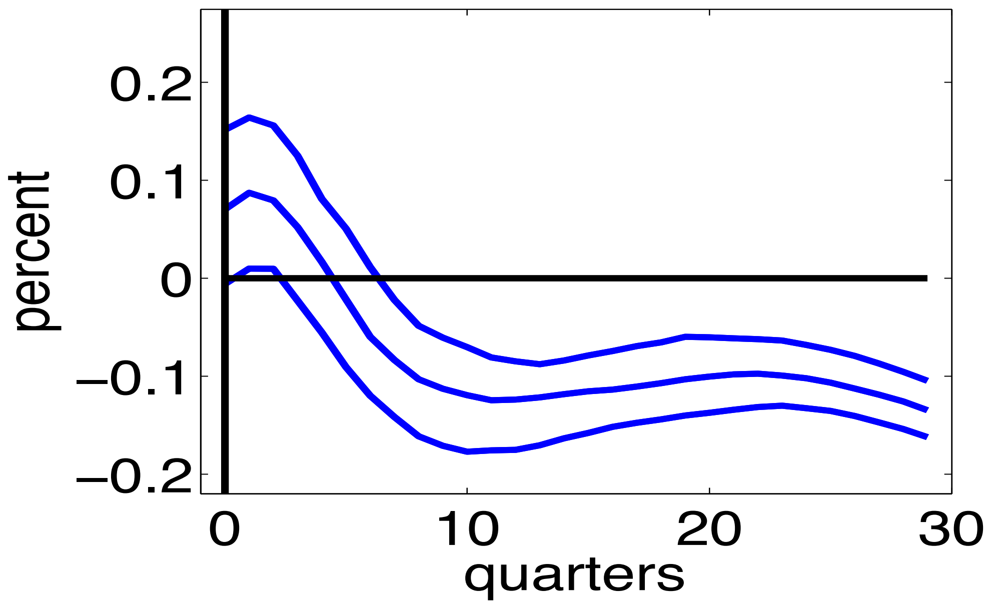

Figure 7: Europe's Interest Rate Impulse Response Relative to the US after an Expansionary Fiscal Policy

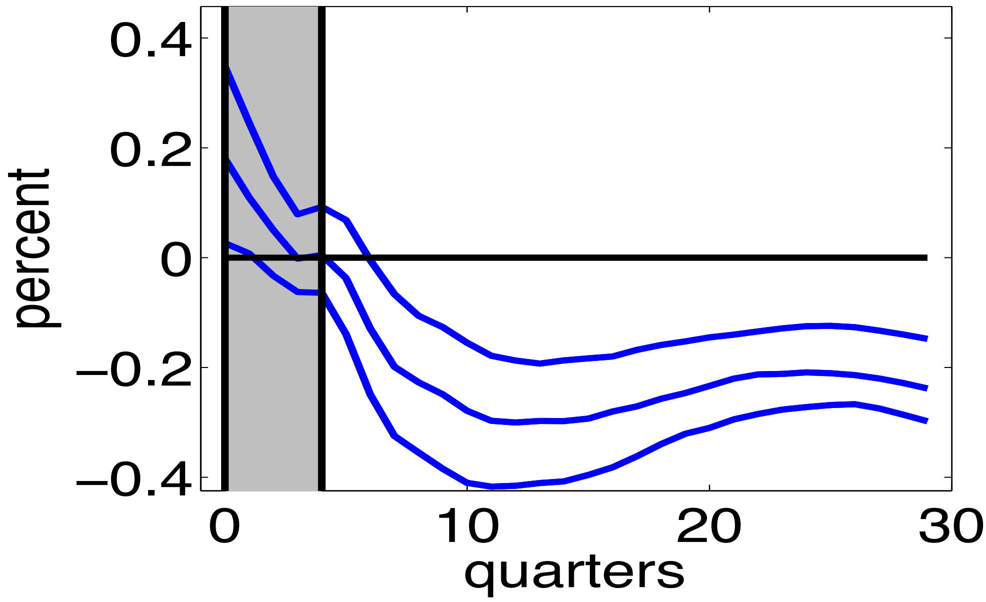

Figure 8: Europe's Private Investment Impulse Response Relative to the US after an Expansionary Fiscal Policy

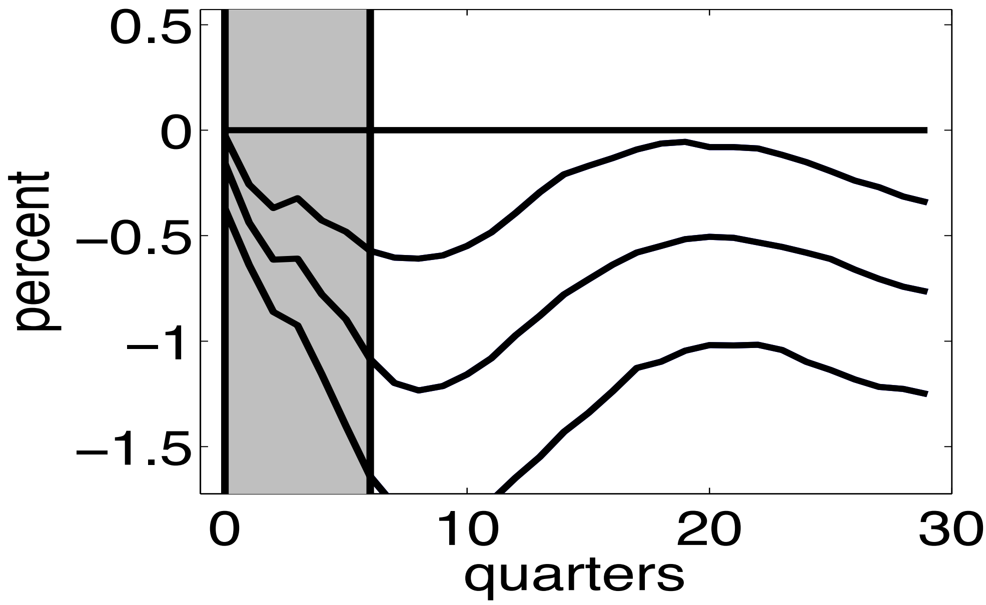

Figure 9: Europe's Private Consumption Impulse Response Relative to the US after a Technology Shock

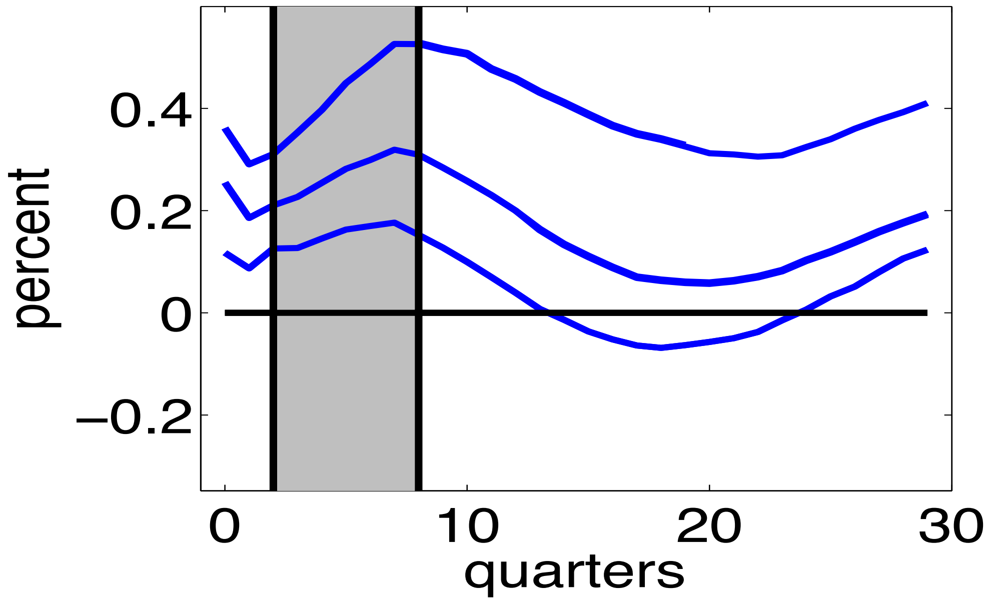

Figure 10: Europe's Exchange Rate Impulse Response Relative to the US after a Technology Shock

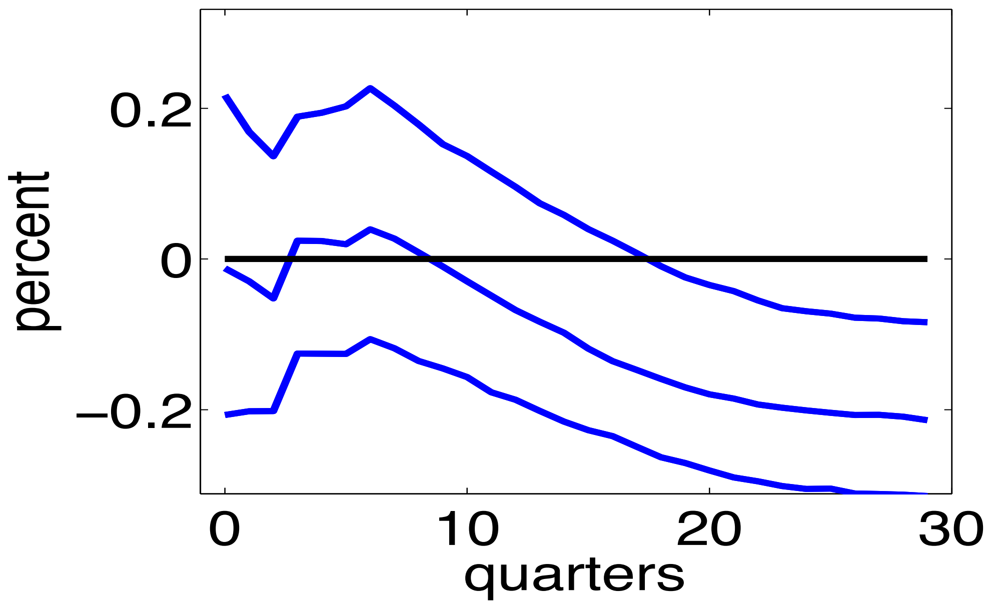

Figure 11: Europe's GDP Impulse Response Relative to the US after a Technology Shock

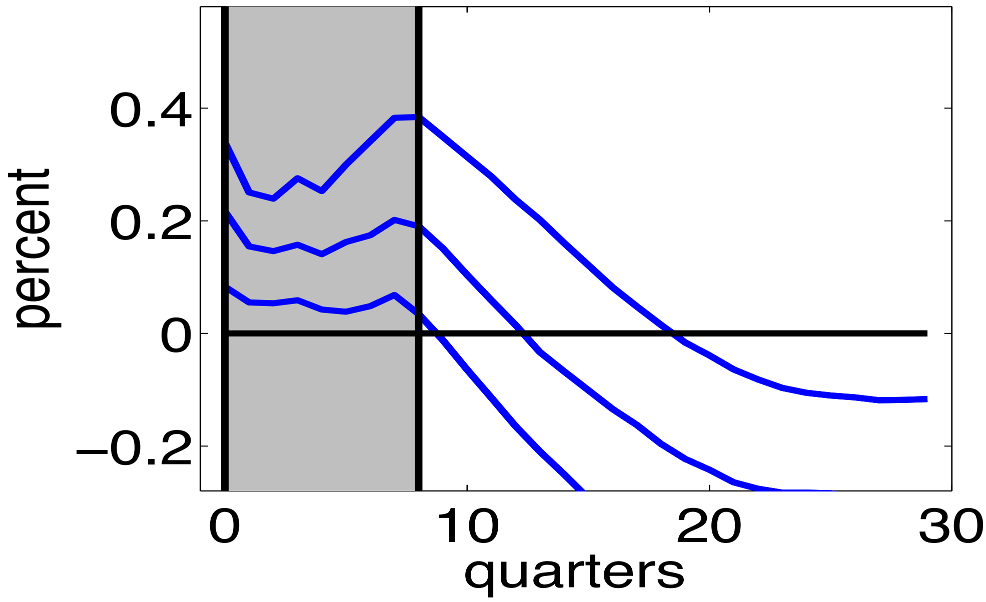

Figure 12: Europe's Government Budget Impulse Response Relative to the US after a Technology Shock

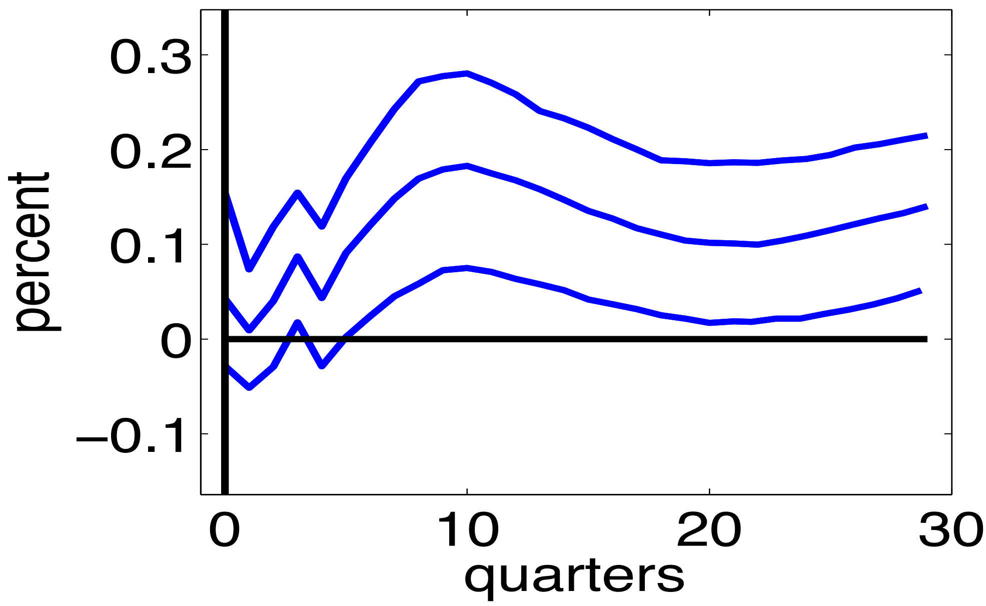

Figure 13: Europe's Government Spending Impulse Response Relative to the US after a Technology Shock

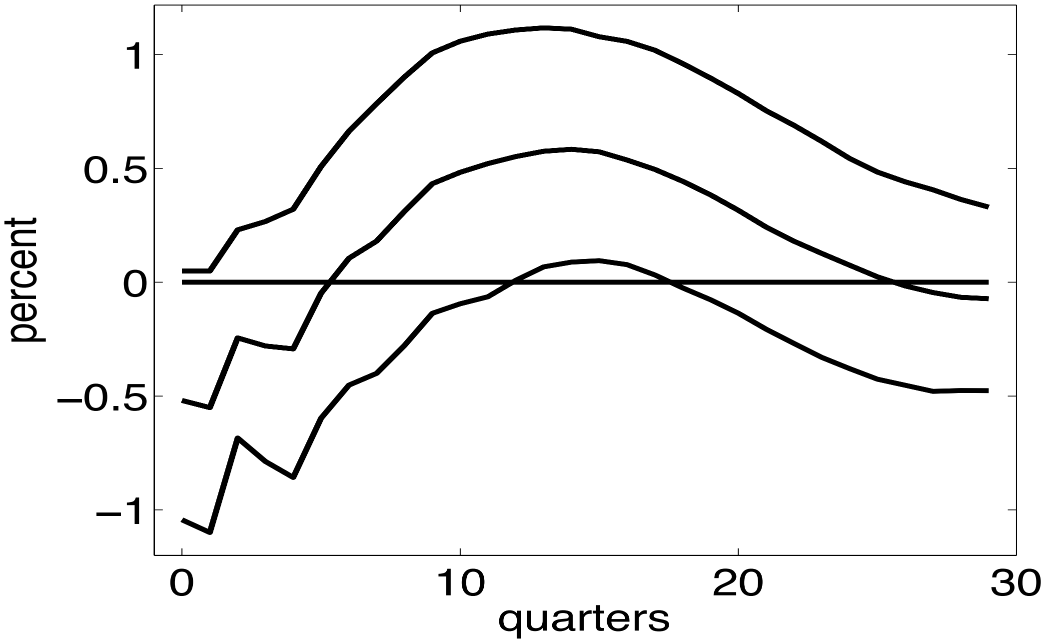

Figure 14: Europe's Inflation Impulse Response Relative to the US after a Technology Shock

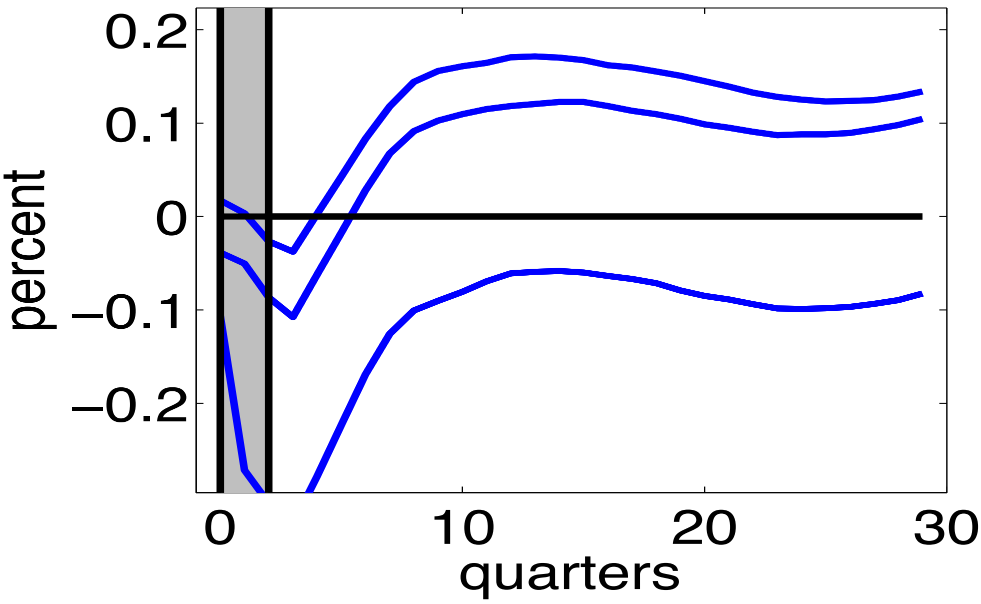

Figure 15: Europe's Interest Rate Impulse Response Relative to the US after a Technology Shock

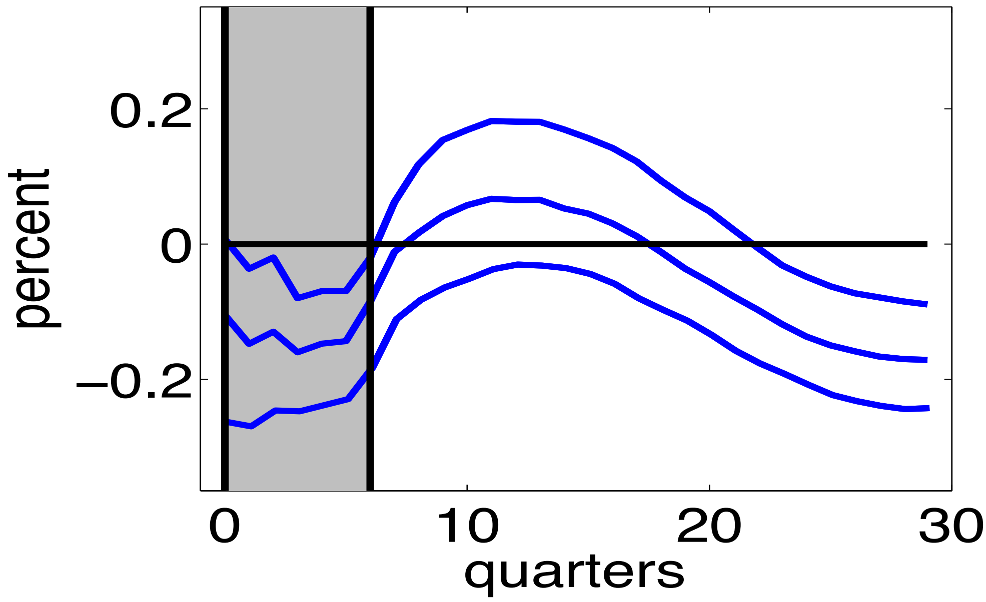

Figure 16: Europe's Private Investment Impulse Response Relative to the US after a Technology Shock

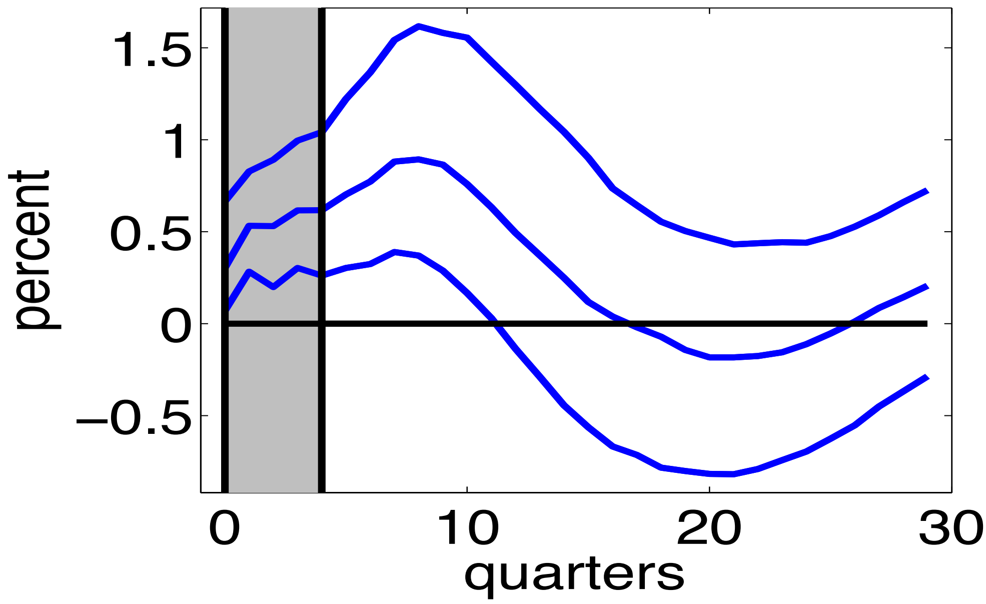

Figure 17: Variance Decomposition of Technology Shock