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Abstract

This dissertation consists of three essays on applied macroeconometrics. The first chapter studies the effect of fiscal policy on the US economy in a time varying Factor Augmented Vector Autoreggessive (FAVAR) framework. It tries to cure the problem of non-fundamentalness of the shocks that arises as a result of "fiscal foresight" using large dataset in a FAVAR model and accounts for instability of the effects over time by letting the model to be time varying. The second chapter investigates the effects of oil price shocks on output growth and inflation in oil exporting countries. It identifies different oil shocks with the use of sign restrictions in a time varying VAR model and analyses the effects of these identified shocks on oil exporting economies. The third chapter employs a LSTAR (Logistic Smooth Transition Autoregressive) model to study the relationship between the fiscal fundamentals and long term sovereign bond spread in European countries. The system is estimated with the Seemingly Unrelated Regression (SUR) method to account for the correlations between the disturbances in different equations and it is found that when the debt to GDP ratio goes beyond a certain threshold, the fiscal fundamentals become relevant in explaining the sovereign bond spread.

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Chapter 1

Analysing the Effect of Fiscal Policy Shock Using Time Varying Factor Augmented VAR Method

Abstract

Despite decades of academic research, there is no consensus on the effect of fiscal policy shocks on key macro variables. Empirical models give opposing results based on the identification of shocks. Even in the same models, the effects are not stable through time. This paper tries to investigate the effect of government spending shocks on key variables in the economy using Time Varying Factor Augmented Vector Autoregressive (TV-FAVAR) model. The large amount of information in the factor model framework, helps to solve the problem of non-fundamentalness of the shocks that arises as a result of "fiscal foresight". I also account for instability of the effects through time by letting both coefficients and variance of the innovation to be time variant. The reduced form results strongly confirms the time varying nature of the data that should be taken into account. Also, structural analysis shows that there is no significant change in consumption as a result of fiscal policy, which results in GDP multiplier less than one. Finally, I find that fiscal policy becomes more effective in decreasing unemployment during recessions.[1]

JEL classification: E26, C11, C38

Keywords: Government Spending Shock, Fiscal Foresight, Time Varying FAVAR

[1]I gratefully acknowledge the financial support from "Fondazione CARIPLO Mobility Grant" for presenting this paper in the 9th International Student Conference, Izmir, Turkey

1.1 Introduction

How does discretionary fiscal policy action affect key macroeconomic variables? During the last decade, many studies have tried to answer to this question (Ramey and Shapiro (1998), Blanchard and Perotti (2002), Fatás and Mihov (2001)) as it has relevant policy implications for designing and implementing stimulus packages. The issue becomes even more relevant following the recent recession, in order to help policy makers to stimulate the economy by conducting better fiscal policy actions. Despite the importance, there is little consensus among economists on how fiscal policy shocks would affect the economy, and in particular, the private consumption and real wages.

From a theoretical aspect, there are two classes of models that predict opposing results. Namely, while neoclassical models predict a decrease in private consumption and real wages as a result of a positive shock to government expenditure (Baxter and King(993),Christiano and Eichenbaum (1992), and Fatás and Mihov (2001)), the New Keynesian models suggest an increase in these variables following the same shock (Corsetti, Meier and Muller(2009), Ravn, Schmitt-Grohe and Uribe (2006) , Galí, López-Salido and Vallés (2007)).

From the empirical perspectives, researchers find empirical evidence supporting both of the views above. There are two strands of the literature that study fiscal policy and their results differ depending on how fiscal policy shocks are identified. The first approach is to study the effect of fiscal policy on the economy using structural vector autoregressive (SVAR) methods in which the identification of the shocks are based on some institutional assumptions on the effects of the shocks or sign restrictions (see e.g. Blanchard and Perotti (2002), Mountford and Uhlig (2009), Pappa (2005), Caldara and Kamps (2006), Galí, López-Salido, and Vallés (2007), Perotti (2007)). The other approach, known as the "narrative" approach identifies the exogenous shocks in military expenditure through dummy variables, and studies the effect of shocks to the dummies on the economy (see e.g. Ramey and Shapiro (1998), Edelberg, Eichenbaum, and Fisher (1999), Burnside, Eichenbaum, and Fisher (2000), Cavallo (2005), Romer and Romer (2007)).

In an important contribution, Ramey (2009) argues that these two empirical approaches give different results because of timing. She claims that VAR shocks fail to get the correct timing of the news. Arguing this, she shows that what is called fiscal shock in SVAR approach is in fact anticipated and being Granger-caused by Ramey-Shapiro dates.

This anticipation comes from the fact that passing and implementing of every policy actions take time, so agents naturally posses information about future changes in government expenditure, which are not reflected yet in the variables typically included in the VAR. This phenomenon is called “fiscal foresight” and makes econometric analysis of fiscal policy problematic.

Leeper, Walker and Yang (2008) build a simple model to show that fiscal foresight will cause the moving average representation of the data to have roots inside the unit circle and would result in non-invertibility or non-fundamentalness of the moving average representation. In this case it is not possible to recover the true fiscal policy shock through VAR estimation.

Forni, Giannone, Lippi and Reichlin (2009) argue that the use of large factor models can help econometricians to overcome the problem of non-funamentalness. The main idea behind their work is that using large number of economic time series might alleviate the gap between econometricians' information set and the agents' one.

Bernanke, Boivin and Eliasz (2005) study the effects of monetary policy in a model that embeds factor model in the standard structural VAR in order to incorporate a broad range of conditioning information. Their results suggest that factor-augmented VAR (FAVAR) model can successfully extract related information from a large data set of macroeconomic variables. This framework has also been used by Forni and Gambetti (2010) in the context of fiscal policy.

I use FAVAR framework in the same context, allowing for time variation in the parameters of the model. I believe this can be a relevant extension, since existing literature has already shown that the effect of government spending has changed over time (Blanchard and Perotti (2002), Perotti (2005), Pereira (2009) and Kirchner, Cimadomo and Hauptmeier (2010)). Therefore, departing from time constant FAVAR analysis, I account for instability of the model in different subsamples by allowing the coefficients of the model to be time varying.

The rest of the paper is organized as follows. Section 2 describes the model which I want to use. Section 3 discusses identification issues. Section 4 explains estimation of the model. Section 5 presents the results and section 6 concludes.

1.2 Model

My model is based on FAVAR model as described in Bernanke *et al* (2005). However, in order to make the model more flexible in capturing the behavior of the economy, I introduce time varying dynamics into the model allowing coefficients and covariance matrix of the error term in transition equation to change over time. Note that one can introduce other forms of time variation in the model. A simple alternative example is allowing factor loadings to be time variant, However, this makes the estimations more computationally burdensome. Also, increasing the number of time varying unobserved components involves serious identification problems.

Let X_t be a N×1 vector of large number of economic variables at time t, where t=1,...,T is the time index, and G_t denotes the amount of government spending in period t and it is assumed to be perfectly observable and has pervasive effects throughout the economy.

So the model can be written as

$$
\begin{aligned}
X_{i,t} &= \Lambda\ F_t + \lambda\ G_t + \xi_{i,t} && (1.1a)\\
\begin{pmatrix} F_t \\ G_t \end{pmatrix} &= \Phi_t(L)\begin{pmatrix} F_{t-1} \\ G_{t-1} \end{pmatrix} + \upsilon_t && (1.1b)
\end{aligned}
$$

in which

$E(\xi_{i,t}^{'}\xi_{i,t}) = R$
$E(\upsilon_t^{'}\upsilon_t) = \Omega_t$
$E(\xi_{i,t}^{'}\upsilon_t) = 0$

In the above notation, Λ and λ denote the factor loadings of the unobservable factors, F and observable factor, G, respectively.

In this framework I could decompose a n-dimensional vector of variables X_t into a vector of unobservable F_t whit a dimension of k which is much smaller than n and n-dimensional vector ξ_t of the idiosyncratic shock. Then I assume that the joint dynamics of $(F_t^{'}, G_t^{'})$ can be expressed by the standard VAR model.

Therefore, I can write the transition equation of the above system (1.1b) as

$$
y_t = \sum_{l=1}^{L} \phi_{l,t} y_{t-1} + \upsilon_t \tag{1.2}
$$

where $y_t = \binom{F_t}{G_t}$

For the variation in covariance matrix of innovation υ_t, following Primiceri (2005), I postulate triangular reduction of Ω_t as:

$$
A_t \Omega_t A_t^{'} = \Sigma_t \Sigma_t^{'} \tag{1.3}
$$

Where $\Sigma_t = diag(\sigma_{1,t}, ..., \sigma_{k+2,t})$ and A_t is lower triangular matrix with ones on the main diagonal as below

$$
A_t = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ a_{21,t} & 1 & \ddots & 0 \\ \vdots & \ddots & \ddots & 0 \\ a_{(k+2)1,t} & \cdots & a_{(k+2)(k+1),t} & 1 \end{bmatrix} \tag{1.4}
$$

Then, in line with Primiceri (2005), I assume parameters to follow a random walk, and stochastic volatilities follow a geometric random walk, both without any drift.

$$
\begin{aligned}
\phi_t &= \phi_{t-1} + \tau_t && (1.5a)\\
\log(\sigma_t) &= \log(\sigma_{t-1}) + \eta_t && (1.5b)\\
a_t &= a_{t-1} + \vartheta_t && (1.5c)
\end{aligned}
$$

And finally, all error components in the above equations are assumed to be jointly normally distributed and uncorrelated with each other. so

$$\begin{bmatrix} \xi_t \\ \upsilon_t \\ \tau_t \\ \eta_t \\ \vartheta_t \end{bmatrix} \sim N(0, V), \text{where } V = \begin{bmatrix} R & 0 & 0 & 0 & 0 \\ 0 & \Omega_t & 0 & 0 & 0 \\ 0 & 0 & Q & 0 & 0 \\ 0 & 0 & 0 & S & 0 \\ 0 & 0 & 0 & 0 & G \end{bmatrix} \tag{1.6}$$

It should be noted that the assumption of the diagonality of the matrix V is important as unrestricted covariance matrix would increase the number of parameters and make the estimation too complicated.

1.3 Identification

In FAVAR model, as the rest of factor models, one important step is to identify the factors against rotational and scale indeterminacy. As different rotations which result in different models are observationally equivalent, depending on the characteristics of the model, some assumptions should be imposed in order to reach the identification.

Three different approaches have been used in the literature for the identification in factor models. One way is to restrict the upper K×K (where K is the number of factors) block of the factor loadings matrix to be lower triangular as in Geweke and Zhou(1996). Alternatively, Bernanke, Boivin and Eliasz (2005) set the same block equal to identity matrix. Although this is an over-identified restriction, no further restrictions are needed for the scale and sign determinacy and this make it convenient for various application. Some other researchers identify each factor separately by grouping the data into different blocks and extract the related factor exclusively from the specified block. These factors could refer to different economic concepts such as economic activity or inflation (Belviso and Milani (2006)) or different geographical aggregate (Del Negro and Otrok (2004), Mumtaz, Surico and Simonelly(2009)).

In this paper I employ the second approach as I am interested in the common component of variables as opposed to each single factor. Since in the observation equation I have one observable variable in addition to unobservable factors, I have to normalize factors in order to avoid rotational indeterminacy. In particular, the linear combination of the following form should be ruled out

$$F_t^* = AF_t - BG_t \tag{1.7}$$

Where A is a $K \times K$ non singular matrix and B is a matrix of dimension $K \times M$.

As I do not intend to restrict the VAR dynamic, restrictions are only imposed on the observation equation. I substitute F_t^* into 1.1a to obtain

$$X = \Lambda\ A^{-1}F_t^* + (\lambda + A^{-1}B\ \Lambda)\ G_t + \upsilon_t \tag{1.8}$$

Therefore, for identification, it is required that:

$$A^{-1}\Lambda = \Lambda \text{ and } (\lambda + A^{-1}B\ \Lambda)\ = \lambda$$

Bernanke *et al* (2005) have pointed out that for normalization it is sufficient to set upper $K \times K$ block of Λ to an identity matrix and the upper $K \times M$ block of λ to zero. The basic idea for the identification here is to restrict the contemporaneous impact of G on the first K elements of X, so variables which are less likely to respond contemporaneously to innovations in G should be chosen for this block.

But the main identification issue is to identify structural shocks. Despite Blanchard-Protti approach for shock identification which results in unique shock and impulse response function, I employ "sign restriction" (Canova and De Nicolo (2002), Uhlig (2005)) which imposes impulse responses to have a certain sign at particular periods and results in a distribution of shocks and related impulse response function. Using sign restriction as a way to reach identification requires restricting the shock in order to have certain effects on specified variables. These effects should be defined in such a way that most theoretical models and scholars agree upon them, and it makes identification issue less controversial.

To be more specific, following Forni and Gambetti (2010), I identify the expansionary fiscal shock by restricting it to have positive effects on government expenditure, output, prices (CPI and the GDP deflator), prime rate, government primary deficit and tax receipts.

1.4 Estimation

I estimate the model described above using Bayesian methods, and obtain approximate of the posterior distribution by means of Gibbs sampling algorithm.

In particular, I take first 5 principal components of the data and their loadings as the starting values for F and Λ. The number of factors is chosen according to IC_{p2} criterion of Bai and Ng(2002), then I do the normalization using the inverse of first $K \times K$ block of Λ.

Having done this, I can estimate a VAR(1) with time varying coefficients and stochastic volatility.

Then unknown coefficients have been drawn from known conditional posterior distribution as opposed to joint posterior of the whole parameter set. The procedure is as follows:

First, from equations (1a) and (5b), ϕ_t can be sampled from a $N(\phi_{t|t+1}, P_{t|t+1})$ where mean and variance of this normal distribution are obtained by applying Carter and Kohn method.

After having VAR coefficients, a sample for Q can be drawn from Inverse Wishart distribution

In the next step, a sample for A_t can be drawn.

Considering equation (3), equation (2) can be written as below:

$$y_t = \sum_{l=1}^{L} \phi_{l,t} y_{t-1} + A_t^{-1} \Sigma_t \varepsilon_t \tag{1.9}$$

in which $V(\varepsilon_t) = I_n$.

Now stacking all φs in a vector Φ, the system can be written as:

$$\begin{aligned} A_t(y_t - X'\Phi) &= A_t \widehat{y_t} = \Sigma_t \varepsilon_t \\ X' &= I_n \otimes [1, y'_{t-1}, ..., y'_{t-L}] \end{aligned} \tag{1.10}$$

$\widehat{y_t}$ is observable conditional on ϕ_t. Since A_t is lower triangular with ones on the main diagonal, following Primiceri (2005), I can define matrix Z_t as:

$$Z_t = \begin{bmatrix} 0 & \cdots & \cdots & 0 \\ -\widehat{y}_{1,t} & 0 & \ddots & 0 \\ 0 & -\widehat{y}_{[1,2],t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & -\widehat{y}_{[1,\ldots,L-1],t} \end{bmatrix}$$

Where $\widehat{y}_{[1,\ldots i],t}$ is a row vector $[\widehat{y}_{1,t}, \widehat{y}_{2,t}, \ldots \widehat{y}_{i,t}]$ and rewrite (7) as below

$$\widehat{y_t} = Z_t a_t + \Sigma_t \varepsilon_t \tag{1.11}$$

Knowing that G is block diagonal and triangular structure of Z_t, Carter and Kohn method can be used to sample A_t .

Providing a draw for A_t will allow me to sample G from Inverse Wishart distribution. Consider the system of equation

$$A_t(y_t - X'\Phi) = y_t^* = \Sigma_t \varepsilon_t \tag{1.12}$$

Conditional on A and Φ, y_t^* is observable. Even though this system is nonlinear, squaring and taking logarithms of its element would make it linear. So the approximation of the system would be as follows:

$$y_t^{**} = 2h_t + e_t \quad (1.13)$$

$$h_t = h_{t-1} + \eta_t \quad (1.14)$$

$e_t = \log(\varepsilon_t^2)$, $h_t = \log(\sigma_t)$ and $y_t^{**} = \log[(y_t^*)^2 + .001^2]$.

The above system is a linear non-Gaussian state space system, since the innovations in the measurement equation are distributed as $\log \chi^2(1)$. Noticing that εs have an identity variance-covariance matrix, the variance covariance matrix of es will be diagonal as well. This would justify the use of independent mixture of normal distributions as an approximation for any element of e. Following Kim, Shephard and Chibb (1998), to transform the system into a Gaussian one, I use a mixture of seven normal densities with component probability q_j, mean $m_j - 1.2704$ and variance ν_j^2, where $\{q_j, m_j, \nu_j^2\}$ are chosen in order to match the moment of $\log \chi^2(1)$ distribution. The values of these constants are

j	q_j	m_j	ν_j^2
1	0·00730	-10·12999	5·79596
2	0·10556	-3·97281	2·61369
3	0·00002	-8·56686	5·17950
4	0·04395	2·77786	0·16735
5	0·34001	0·61942	0·64009
6	0·24566	1·79518	0·34023
7	0·25750	-1·08819	1·26261

Given a draw for Σ_t, I can sample elements of S from Inverse Gamma distribution.

To obtain a draw for the factor loadings (Λ and λ), considering equation 1.1a, it is straightforward to use the results of normal linear regression models to sample factor loadings from normal distribution, provided that F_t and G_t are known. Then covariance matrix (R) can be sampled from inverse gamma distribution.

Under relatively weak regularity conditions, iterations on these steps would give me a realization from the joint posterior distribution. I generate 50000 draws from the Gibbs sampler and skip 45000 burn in draws, in order to be able to find the posterior distribution of the unknown parameters.

[2] This constant should be added to make the more robust estimation (Primiceri(2005))

1.4.1 Prior Specification

In setting the priors for parameters and hyperparameters of the state equation, I closely follow Primiceri (2005). The calibration of the priors for the estimation has been done by estimating a constant FAVAR model using a training sample on the initial 5 years of the data which is a standard practice. For the priors of parameters in the transition equation (factor loadings and the variance of the shocks[3]) I use normal and inverse gamma which is the natural conjugate prior for the linear regression model. So

$$\Lambda_i \sim N(0, I)$$

$$R_{i,i} \sim IG(\frac{.01}{2}, \frac{.01}{2})$$

and I employ equation by equation OLS to obtain the unknowns.

1.5 Empirical Evidence

1.5.1 Data

The dataset consists of 108 US macroeconomic time series with quarterly frequency spanning from 1959:I to 2007:IV taken from FRED Database, Federal Reserve Bank of St. Louis used in Forni and Gambetti (2010)[4]. It includes all complementary categories such as fiscal variables, industrial production indices, GDP and components, labor market variables, stock market variables, leading indicators, price indices and deflators, money and credit aggregates, and finally long- and short-term interest rates. Since I need stationary variables for the analysis, each series is transformed to reach stationarity. In order to extract the principal components from this panel of data, I also standardize all variables following Belviso and Milani (2005), which makes the estimated factors unitless.

A brief description of the series in the dataset and the corresponding transformations are provided in the appendix.

1.5.2 Reduced Form Evidence

Model Fit

In the first step, to examine how well the methodology can represent the data, I assess the model fit to the data by checking the R^2 statistics of regressing each series onto the factors. In table 1, I report the results for some selected series. As can be seen, the R^2

[3]The errors are mutually orthogonal in this equation, so the covariances are zero by construction.

[4]I should thank Mario Forni for providing the dataset

measure for goodness of fit is relatively high and it can be concluded that the factors are quite capable of explaining the common variations in the data. Hence omitted variable bias in the VAR equation should not be a concern. As a robustness check, I increase the number of factors, however there is no significant change observed in the model fit following this.

Description	**R^2**
RGDP	0.99
Real Federal Current Tax Revenues	0.97
Real Federal Consumption Expenditures and Gross Investment	0.93
GDP Deflator inflation	0.93
Civilian Unemployment Rate	0.97
Real Private Fixed Investment,	0.99
Vacancies	0.77
ISM Manufacturing Index	0.83

Table 1: R-squared statistics from regressions of specified series on factors

Time Variation of Coefficients

In figure 1, I provide some evidence on time variation in the coefficients of the state equation. This figure, plots the median of the posterior distribution for each coefficient and its 68% confidence interval versus their corresponding estimations of the time invariant model. Although few parameters do not change much, most of the coefficients of the model demonstrate substantial time variations.

Learning models predict that the drift of reduced form parameters should be in a structured way (Sargent (1999)), considering the restrictions related to optimization and foresight. This can be checked in this model by looking at the principal components of matrix Q which is the variance-covariance matrix of innovations in the transition equation of the VAR coefficients. The results reveal that the first PC of this matrix can explain above 99 percent of total variance. So the time variation in the parameters is consistent with the prediction of learning models.

Evolution of Uncertainty

Figure 2 plots the total prediction variance which is a measure of total amount of uncertainty entering the system at each point in time. This can be calculated as $\ln(|\Omega_t|)$. The figure clearly shows that the size of the shocks hitting the US economy have changed substantially over time, justifying the use of stochastic volatility in the analysis. Moreover there is an obvious coincident between the upward spikes in the size of the shocks and NBER recessions.

1.5.3 Structural Analysis

In this section I present empirical results for responses of some variables of interest to a government spending shock obtained from the TV-FAVAR model. This methodology allows to study the evolution of the response of each variable to government expenditure shock over time. Shock has been normalized in order to make initial increase in the level of spending of size 1% of GDP, so the responses can be interpreted as the multipliers.

Before reporting the time varying results, to make my study comparable with the results from constant FAVAR model, I calculate the mean of the impulse response function for selected variables over all quarters in the sample and plot them in figures 3 and 4. The shape of the responses fairly resemble the results of Forni and Gambetti(2010) although the magnitude of responses for GDP and consumption in this study are fairly smaller.

Figure 5 displays the response of real GDP to a shock in government expenditure. In the left panel, I report the posterior mean impulse response function while the right panel is the contour plot of the left one. As can be seen from the figure, after a shock in government expenditure, the output rises with the multiplier which is less than one at the impact, and then increases for some quarters to reach its maximum. To give a better sense of this reaction, the impact multiplier and the maximum multiplier have been plotted in figure 6. I find that while there is a sign of increase in the impact GDP multiplier during the recessions in early eighties and early two thousand, such an effect could not be seen in other recessions as well as for maximum multiplier. Figure 6 also shows a very low degree of persistence in the responses of GDP in different time periods.

I report the impulse response function of private consumption in figure 7. The size and pattern of the responses have changed over time, although the response is statistically insignificant almost everywhere. During the recessions of early eighties and early two thousand, the response of private consumption is decreasing over time, while it increases in mid and late eighties. As the decreasing pattern does not happen in other recessions, some other factors rather than state of the business cycle might have influenced on it.

figure 8 plots the impact response of unemployment rate in different time periods. From the figure, it is evident that when the economy is in the recession, fiscal policy becomes more effective in reducing the unemployment rate.

The overall results suggest that macroeconomic impact of government spending shock has changed through time. Although the effect does vary in the sample period, there is no evidence confirming the existence of a clear trend in effectiveness of fiscal policy in stabilizing the economy[5].

[5]Perotti (2005) argues that the effect of government spending shock has become substantially weaker over time.

1.6 Conclusion

In this paper, I investigate the effects of fiscal policy shock and its evolution in a time varying factor augmented VAR framework, identified via sign restriction. I extract 5 static factors from the data as the driving force of the whole economy and let them interact with the government expenditure in a VAR in which the coefficients and variance-covariance matrix of the shocks are time varying. Estimation of the model has been done using Bayesian method.

The reduced form results of the model confirm that the amount of uncertainty entering the US economy varies substantially over time, being bigger when the economy is in the recession. The mean of the posterior distribution of the VAR coefficients are also changing over the sample period. Accordingly, the time varying model is most likely to provide better understanding of the effects of fiscal policy on the US economy.

Having a time varying model, I also provide pieces of evidence that suggest the effectiveness of fiscal policy has changed over time. They also weakly support the hypothesis that the effect of fiscal shocks increases during the recessions, but the evidence on this issue are not clear-cut and the conclusion should be made with caution. Hence, while the state of the economy in the business cycle might be one important variable in determining the effectiveness of fiscal policy, there seem to be other parameters that influence it. Identifying the sources of time variation in transmission mechanisms of the fiscal policy is a topic that deserves further investigation.

Bibliography

[1] Auerbach, A.J. and Y. Gorodnichenko (2010). Measuring the Output Responses to Fiscal Policy, NBER Working Papers 16311

[2] Baxter, M. and R. G. King (1993). Fiscal Policy in General Equilibrium, American Economic Review, American Economic Association, vol. 83(3), 315-334

[3] Bernanke, B. S., J. Boivin and P. Eliasz (2005). Measuring Monetary Policy: A Factor Augmented Autoregressive (FAVAR) Approach, The Quarterly Journal of Economics 120, 387-422.

[4] Blanchard, O.J. and R. Perotti (2002). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output, The Quarterly Journal of Economics: 1329-1368.

[5] Carter, C. K. and R. Kohn (1994), On Gibbs Sampling for State Space Models, Biometrika, 81, 541–553.

[6] Cavallo, M. (2005). Government Employment Expenditure and the Effects of Fiscal Policy Shocks, Federal Reserve Bank of San Francisco, Working Paper No. 16.

[7] Christiano, L. J. and M. Eichenbaum (1992). Current Real-Business-Cycle Theories and Aggregate Labor-Market Fluctuations, American Economic Review, American Economic Association, vol. 82(3), 430-450

[8] Corsetti, G., A. Meier and G. Müller (2009). Fiscal Stimulus with spending reversals, CEPR Discussion Papers 7302

[9] Del Negro, M. and C. Otrok (2008). Dynamic factor models with time-varying parameters: measuring changes in international business cycles, Staff Reports 326, Federal Reserve Bank of New York

[10] Fatas, A. and I. Mihov (2001). The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence, CEPR Discussion Papers 2760

[11] Eedelberg, W., M. Eichenbaum and J. D. M. Fisher (1999), Understanding the Effects of a Shock to Government Purchases, Review of Economic Dynamics, 166-206

[12] Forni, M., and L. Gambetti (2010), Fiscal Foresight and the Effects of Goverment Spending, CEPR Discussion Papers 7840

[13] Forni, M., D. Giannone, M. Lippi and L. Reichlin (2009). Opening the Black Box: Structural Factor Models with Large Cross-Sections, Econometric Theory 25, 1319-1347.

[14] Gali, J. D. Lopez-Salido and J. Vallés (2007), Understanding the Effects of Government Spending on Consumption, Journal of the European Economic Association, 5, 227-270.

[15] Kim, C. and C. R. Nelson (1999) State-Space Models with Regime Switching (Cambridge, MA: MIT Press).

[16] Kirchner M., J. Cimadomo and S. Hauptmeier (2010). Transmission of Government Spending Shocks in the Euro Area: Time Variation and Driving Forces, Working Paper Series 1219, European Central Bank

[17] Leeper, E.M., Walker, T.B. and S.S. Yang (2008). Fiscal Foresight: Analytics and Econometrics, NBER Working Paper No. 14028.

[18] Mountford, A. and H. Uhlig (2008). What are the Effects of Fiscal Policy Shocks?, NBER Working Paper No. 14551

[19] Mumtaz, H. (2010). Evolving UK macroeconomic dynamics: a time-varying factor augmented VAR, Bank of England working papers 386

[20] Pappa, E. (2005). New-Keynesian or RBC Transmission? The Effects of Fiscal Policy in Labor Markets, CEPR Discussion Paper No. 5313

[21] Pereira, M. (2009). Empirical evidence on the stabilizing role of fiscal and monetary policy in the US. MPRA Paper 19675, University Library of Munich.

[22] Perotti, R. (2005). Estimating the effects of fiscal policy in OECD countries, Proceedings, Federal Reserve Bank of San Francisco

[23] Perotti, R. (2007). In Search of the Transmission Mechanism of Fiscal Policy. NBER Macroeconomics Annual.

[24] Primiceri, G. (2005), Time varying structural vector autoregressions and monetary policy, The Review of Economic Studies, Vol. 72, No. 3, 821–852.

[25] Ramey, V.A. (2009). Identifying Government Spending Shocks: It's All in the Timing, NBER Working Papers No. 15464.

[26] Ravn, M., S, Schmitt-Grohe and M. Uribe (2006). Deep Habits, Review of Economic Studies, Wiley Blackwell, vol. 73(1), 195-218

[27] Mertens, K. and Ravn, M.O. (2009). Measuring the Impact of Fiscal Policy in the Face of Anticipation: A Structural VAR Approach, Economic Journal, CEPR Discussion Papers 7423

[28] Romer, C. and D. Romer (2007). The macroeconomic effects of tax changes, NBER working paper 13264

[29] Stock, J.H. and M.W. Watson (2005). Implications of Dynamic Factor Models for VAR Analysis, NBER Working Papers No. 11467.

[30] Uhlig, H. (2005). What are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure, Journal of Monetary Economics, 381-419

1.7 Appendix :

Transformations: 1=levels, 2= first differences of the original series, 5= first differences of logs of the original series

no.series	Transf.	Mnemonic	Long Label
1	5	OPHNFB	Nonfarm Business Sector: Output Per Hour of All Persons
2	5	UNLPNBS	Nonfarm Business Sector: Unit Nonlabor Payments
3	5	ULCNFB	Nonfarm Business Sector: Unit Labor Cost
4	5	WASCUR/CPI	Compensation of Employees: Wages and Salary Accruals/CPI
5	5	COMPRNFB	Nonfarm Business Sector: Real Compensation Per Hour
6	5	GDPC1	Real Gross Domestic Product, 1 Decimal
7	5	GNPC96	Real Gross National Product
8	5	NICUR/GDPDEF	National Income/GDPDEF
9	5	DPIC96	Real Disposable Personal Income
10	5	OUTNFB	Nonfarm Business Sector: Output
11	5	FINSLC1	Real Final Sales of Domestic Product, 1 Decimal
12	5	FPIC1	Real Private Fixed Investment, 1 Decimal
13	5	PRFIC1	Real Private Residential Fixed Investment, 1 Decimal
14	5	PNFIC1	Real Private Nonresidential Fixed Investment, 1 Decimal
15	5	GPDIC1	Real Gross Private Domestic Investment, 1 Decimal
16	5	PCECC96	Real Personal Consumption Expenditures
17	5	PCNDGC96	Real Personal Consumption Expenditures: Nondurable Goods
18	5	PCDGCC96	Real Personal Consumption Expenditures: Durable Goods
19	5	PCESVC96	Real Personal Consumption Expenditures: Services
20	5	GPSAVE/GDPDEF	Gross Private Saving/GDP Deflator
21	5	FGCEC1	Real Fed. Cons. Exp. and Gross Investment, 1 Decimal
22	5	FGEXPND/GDPDEF	Federal Government: Current Expenditures/ GDP deflator
23	5	FGRECPT/GDPDEF	Federal Government Current Receipts/ GDP deflator
24	2	FGDEF	Federal Real Expend-Real Receipts
25	1	CBIC1	Real Change in Private Inventories, 1 Decimal
26	5	EXPGSC1	Real Exports of Goods and Services, 1 Decimal
27	5	IMPGSC1	Real Imports of Goods and Services, 1 Decimal
28	5	CP/GDPDEF	Corporate Profits After Tax/GDP deflator
29	5	NFCPATAX/GDPDEF	Nonfin. Corporate Business: Profits After Tax/GDP deflator
30	5	CNCF/GDPDEF	Corporate Net Cash Flow/GDP deflator
31	5	DIVIDEND/GDPDEF	Net Corporate Dividends/GDP deflator

no.series	Transf.	Mnemonic	Long Label
32	5	HOANBS	Nonfarm Business Sector: Hours of All Persons
33	6	COMPNFB	Nonfarm Business Sector: Compensation Per Hour
34	6	GDPCTPI	Gross Domestic Product: Chain-type Price Index
35	6	GNPCTPI	Gross National Product: Chain-type Price Index
36	6	GDPDEF	Gross Domestic Product: Implicit Price Deflator
37	6	GNPDEF	Gross National Product: Implicit Price Deflator
38	5	INDPRO	Industrial Production Index
39	5	IPBUSEQ	Industrial Production: Business Equipment
40	5	IPCONGD	Industrial Production: Consumer Goods
41	5	IPDCONGD	Industrial Production: Durable Consumer Goods
42	5	IPFINAL	Industrial Production: Final Products (Market Group)
43	5	IPMAT	Industrial Production: Materials
44	5	IPNCONGD	Industrial Production: Nondurable Consumer Goods
45	2	AWHMAN	Average Weekly Hours: Manufacturing
46	2	AWOTMAN	Average Weekly Hours: Overtime: Manufacturing
47	2	CIVPART	Civilian Participation Rate
48	5	CLF16OV	Civilian Labor Force
49	5	CE16OV	Civilian Employment
50	5	USPRIV	All Employees: Total Private Industries
51	5	USGOOD	All Employees: Goods-Producing Industries
52	5	SRVPRD	All Employees: Service-Providing Industries
53	5	UNEMPLOY	Unemployed
54	5	UEMPMEAN	Average (Mean) Duration of Unemployment
55	2	UNRATE	Civilian Unemployment Rate
56	5	HOUST	Housing Starts: Total: New Privately Owned Housing Units Started
57	2	FEDFUNDS	Effective Federal Funds Rate
58	2	TB3MS	3-Month Treasury Bill: Secondary Market Rate
59	2	GS1	1-Year Treasury Constant Maturity Rate
60	2	GS10	10-Year Treasury Constant Maturity Rate
61	2	AAA	Moody's Seasoned Aaa Corporate Bond Yield
62	2	BAA	Moody's Seasoned Baa Corporate Bond Yield
63	2	MPRIME	Bank Prime Loan Rate
64	6	BOGNONBR	Non-Borrowed Reserves of Depository Institutions
65	6	TRARR	Board of Governors Total Reserves, Adjusted for Changes in Reserve
66	6	BOGAMBSL	Board of Governors Monetary Base, Adjusted for Changes in Reserve
67	6	M1SL	M1 Money Stock
68	6	M2MSL	M2 Minus
69	6	M2SL	M2 Money Stock

no.series	Transf.	Mnemonic	Long Label
70	6	BUSLOANS	Commercial and Industrial Loans at All Commercial Banks
71	6	CONSUMER	Consumer (Individual) Loans at All Commercial Banks
72	6	LOANINV	Total Loans and Investments at All Commercial Banks
73	6	REALLN	Real Estate Loans at All Commercial Banks
74	6	TOTALSL	Total Consumer Credit Outstanding
75	6	CPIAUCSL	CPI For All Urban Consumers: All Items
76	6	CPIULFSL	CPI for All Urban Consumers: All Items Less Food
77	6	CPILEGSL	CPI for All Urban Consumers: All Items Less Energy
78	6	CPILFESL	CPI for All Urban Consumers: All Items Less Food and Energy
79	6	CPIENGSL	CPI for All Urban Consumers: Energy
80	6	CPIUFDSL	CPI for All Urban Consumers: Food
81	6	PPICPE	Producer Price Index Finished Goods: Capital Equipment
82	6	PPICRM	Producer Price Index: Crude Materials for Further Processing
83	6	PPIFCG	Producer Price Index: Finished Consumer Goods
84	6	PPIFGS	Producer Price Index: Finished Goods
85	6	OILPRICE	Spot Oil Price: West Texas Intermediate
86	5	USSHRPRCF	US Dow Jones Industrials Share Price Index (EP) NADJ
87	5	US500STK	US Standard and Poor's Index of 500 Common Stocks
88	5	USI62...F	US Share Price Index NADJ
89	5	USNOIDN.D	US Mfg New Orders For Nondefense Capital Goods(BCI 27)
90	5	USCNORCGD	US New Orders Of Consumer Goods and Materials (Bci 8)
91	1	USNAPMNO	US ISM Manufacturers Survey: New Orders Index SADJ
92	5	USVACTOTO	US Index of Help Wanted Advertising VOLA
93	5	USCYLEAD	US The Conference Board Leading Econ. Indicators Index
94	5	USECRIWLH	US Econ. Cycle Research Institute Weekly Leading Index
95	2	GS10-FEDFUNDS	
96	2	GS1-FEDFUNDS	
97	2	BAA-FEDFUNDS	
98	5	GEXPND/GDPDEF	Government Current Expenditures/ GDP deflator
99	5	GRECPT/GDPDEF	Government Current Receipts/ GDP deflator
100	2	GDEF	Governnent Real Expend-Real Receipts
101	5		Real Fed. Cons. Exp. and Gross Investment National Defense
102	2		Federal primary deficit
103	5		Real Federal Current Tax Revenues
104	5		Real Government Current Tax Revenues
105	2		Government primary deficit
106	5	GCEC1	Real Government Cons. Exp. and Gross Investment

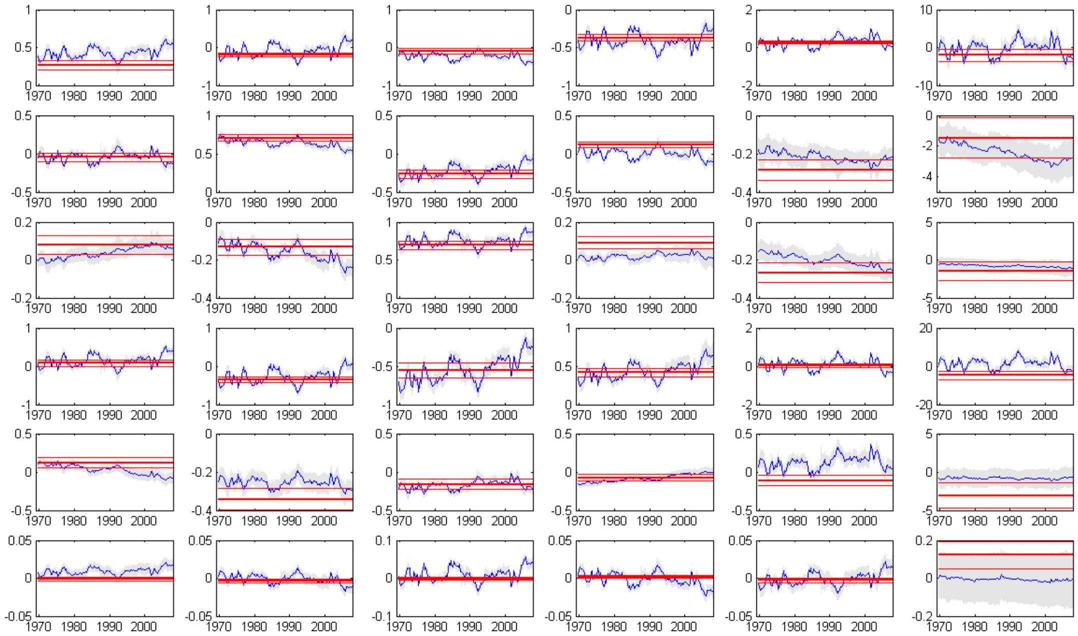

Figure 1.1: Posterior median of coefficients from the time varying FAVAR model versus the constant one .

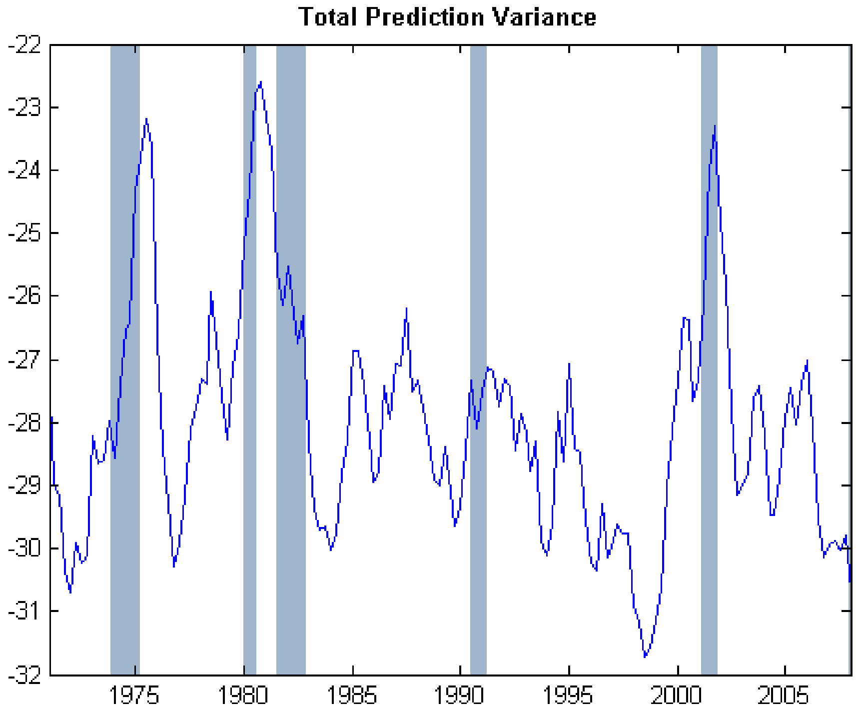

Figure 1.2: Total prediction Variance

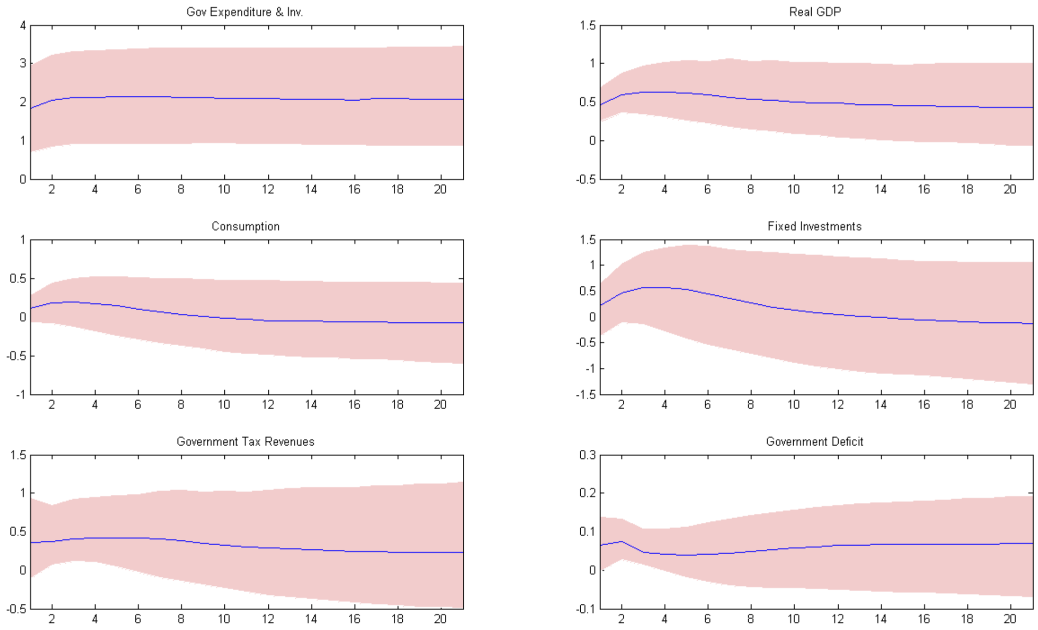

Figure 1.3: Impulse response function of selected variables (median and 16%, 84% quantiles of posterior distribution) to a expansionary fiscal policy shock, averaged over all time periods

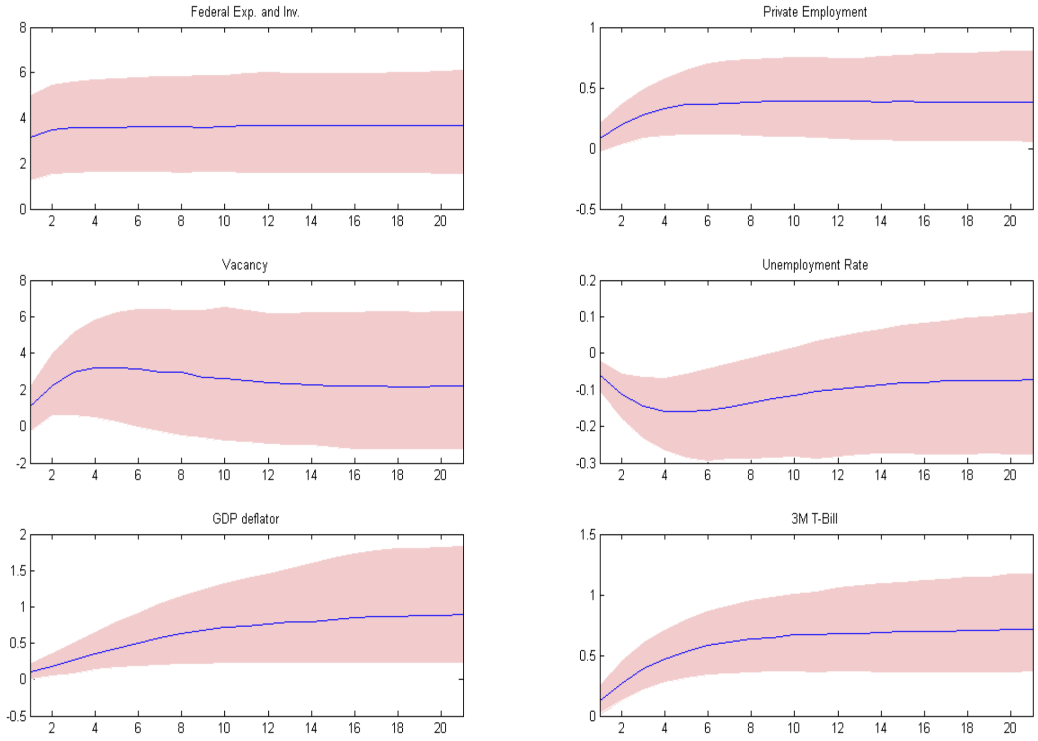

Figure 1.4: Impulse response function of selected variables (median and 16%, 84% quantiles of posterior distribution) to a expansionary fiscal policy shock, averaged over all time periods

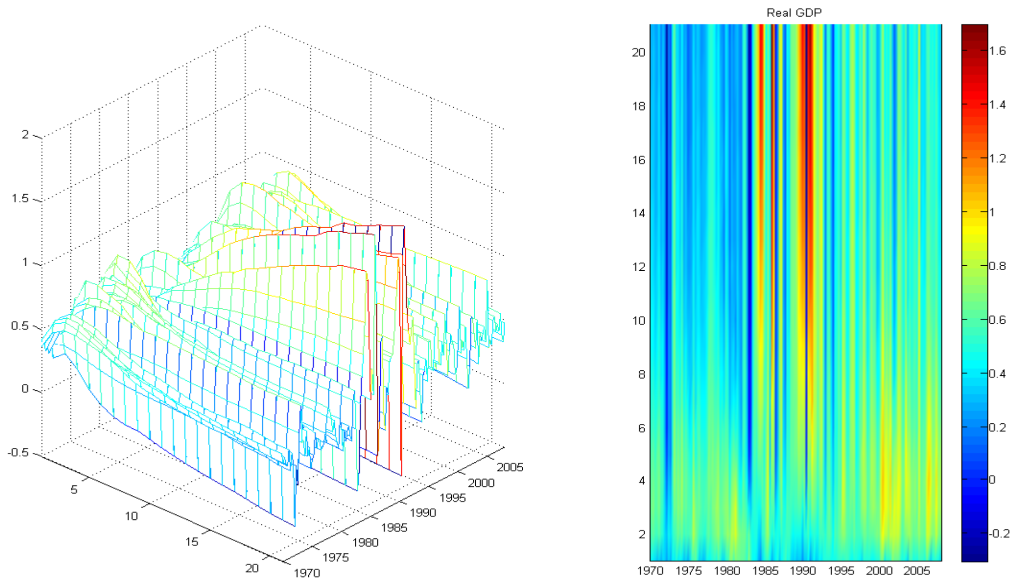

Figure 1.5: Median of posterior distribution of impulse response function of real GDP to a expansionary fiscal policy shock

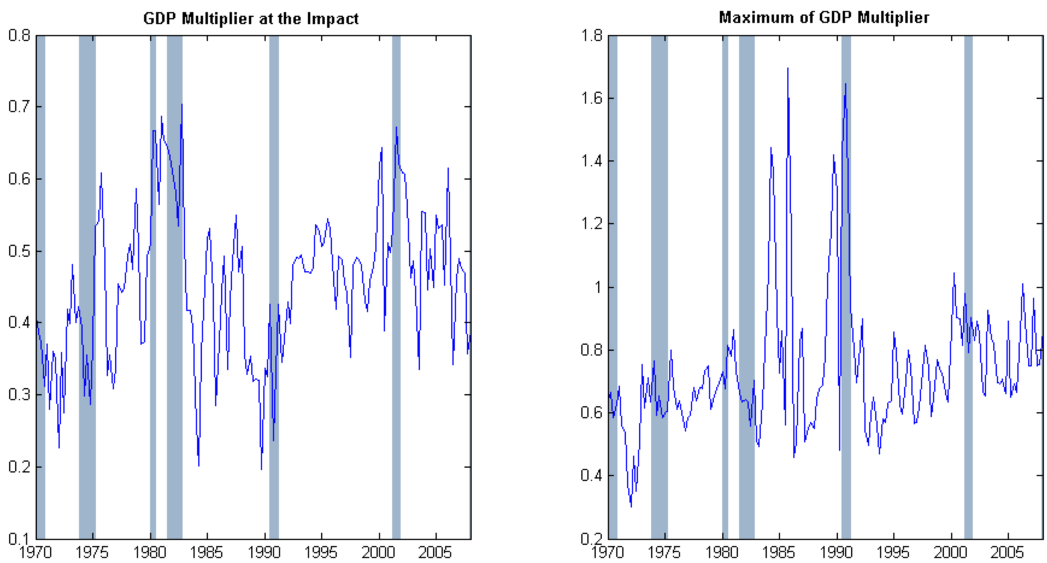

Figure 1.6: The impact and maximum GDP multiplier

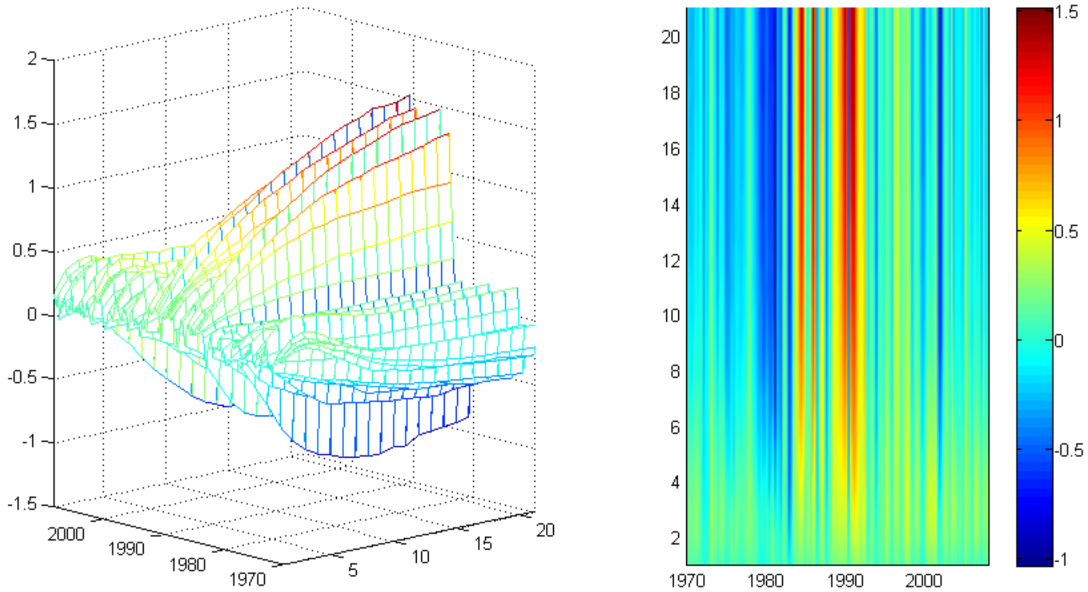

Figure 1.7: Median of posterior distribution of impulse response function of private consumption to a expansionary fiscal policy shock

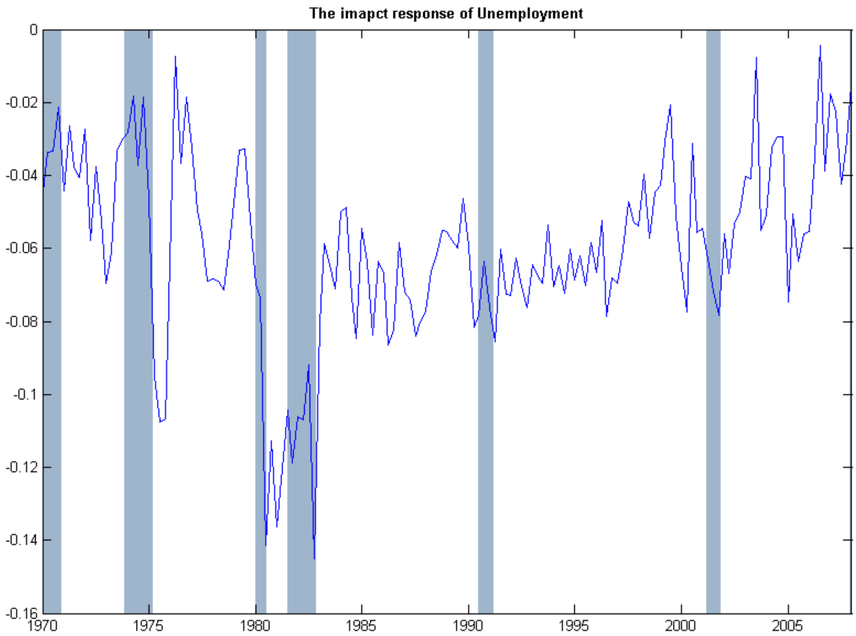

Figure 1.8: The impact response of unemployment to a expansionary fiscal policy shock

Chapter 2

The effects of supply-driven and demand-driven oil price shocks on macroeconomic aggregates in oil exporting countries, a time varying approach

Abstract

This study tries to investigate the effects of different oil price shocks (supply, aggregate demand and oil specific demand shocks) on macroeconomic variables in selected oil exporting countries. For this purpose, I distinguishe between supply-driven and demand-driven shocks to the oil price by imposing two different types of restrictions on the parameters of the model. Employing a structural VAR model, I impose bounds on the elasticity of oil supply and also use sign restrictions on the responses generated by the model to identify oil shocks. Moreover, the model uses time varying coefficients which allows the slopes of short-run oil supply and demand to change over time. Having done that, it examines the effects of the identified oil shocks on key macro variables of selected oil exporting countries (namely Iran, Saudi Arabia, Qatar and United Arab Emirates). The results suggest that the increase in GDP growth and inflation after the oil shock in oil exporting countries, which is documented in the literature, could be mainly attributed to the component that reflects the increase in the aggregate demand.

Keywords: Oil Price Shocks, Time Variation, Sign Restrictions

2.1 Introduction

Oil revenue is the most important component of government's total revenue in many oil exporting developing countries. It accounts for about 50 and 90 percent of governement's total revenue in Iran and Saudi Arabia, respectively. The price of crude oil has shown large variations in the last several years. It has changed from values of around 25$ per barrel in August 2003 to over 130$ in mid-2008 and then collapsed dramatically during the Great Recession of 2008. These fluctuations create uncertainty and result in economical instability for both oil-importing and oil-exporting countries. Particularly, oil dependent countries have experienced high volatility of exports and hence government revenues. Considering the structure of these economies, oil price fluctuations can have strong effects on government budget as well as other macroeconomic and financial variables. Therefore, understanding the macroeconomic implication of oil price shocks is of great importance for policy makers of such countries.

As Kilian (2009) argues, the implication of oil price increases might be quite different on real GDP and CPI inflation depending on the underlying cause of the price increase. So, distinguishing different oil shocks (e.g. supply, aggregate demand and oil specific demand) and analyzing their effects on key macro variables can be a step forward in understanding the consequences of oil price fluctuations in oil-exporting economies. Moreover, even the response of macroeconomic variables to a specific type of oil price shock might not be constant over time. Some studies provide pieces of evidence suggesting the economy's structure have changed and thus the dynamic effects of the oil price shocks are now different from what we have seen in the past (Blanchard and Gali (2007), Baumeister and Peersman (2009)).

I will use a time varying structure to identify oil shocks allowing the supply and demand for oil to change over time. Then using these identified shocks, I examine their effects on macroeconomic aggregates of selected oil exporting countries.

2.2 Literature Review

The study of the effect of oil price shocks on macroeconomic performance has been a central issue in energy economics literature for a few decades. In a seminal contribution, Hamilton (1983) asserts that prior to 1972, oil shocks have been a significant contributing factor of recessions in the US. Kilian (2009) differentiates between supply and demand shocks in oil price as they have different dynamic effects on the economy and uses the cholesky identification scheme to recover structural shocks. Baumeister and Peersman (2009) impose sign restrictions on the implied responses of different shocks and observed that over time, the volatility of oil production decreased while the volatility of price increased. They explain these facts based on the declines in the supply and demand elasticities. Kilian and Murphy (2010) show that imposing sign restrictions are not sufficient to determine the relative importance of different supply and demand shocks as they illustrate different shocks satisfying sign restrictions while having contradictory implications. They argue that we still need to impose a bound on the magnitude of the price elasticity of oil supply in order to narrow down the range of admissible models. In their work, the underlying VAR structure is assumed to be stable, implying that the slope of supply and demand for oil is fixed over time.

While most papers that study the relationship between oil price shocks and macroeconomic variables in the literature have focused on oil importing countries (Hooker (1996), Mork et al (1994), Blanchard and Gali (2007), Holmes and Wang (2003), Kilian (2009), Baumeister and Peersman (2009)), very few of them have explored oil exporting developing countries.

Eltony and Al-Awadi (2001) provide evidence on importance of symmetric oil price shocks explaining fluctuations in macroeconomic variables in Kuwait. Their results reveal that oil price shocks significantly affect government expenditures, which are the major determinant of the level of economic activity in Kuwait.

Berumet and Ceylan (2005) study the effects of symmetric oil price shocks on industrial production for a group of Middle East and North African countries. Their results suggest that the effects of oil price shocks on output are positive and statistically significant in Algeria, Iran, Iraq, Jordan, Kuwait, Oman, Qatar, Syria, Tunisia, and UAE. On the contrary, for Bahrain, Egypt, Lebanon, Morocco and Yemen no significant impact is found .

Farzanegan and Markwardt (2009) investigate the dynamic relationship between oil price shocks and macro variables in the Iranian economy using the VAR approach and find a positive relation between positive oil price changes and both output growth and inflation.

My analysis aims to investigate the effects of different types of oil shocks on GDP growth and inflation in selected oil exporting countries, after having identified each one of them in a time varying setting.

2.3 Empirical methodology

2.3.1 A time-varying VAR with stochastic volatility

To account for change in oil price volatility, I use a VAR framework with time-varying coefficients and stochastic volatility following Primiceri (2005), Cogley and Sargent (2005), and Benati and Mumtaz (2007).

Considering structural VAR model of the form

$$Y_t = C_t + \sum_{1}^{p} B_{i,t} Y_{t-1} + u_t$$

In which Y_t is a vector that contains global crude oil production, world industrial production and real price of oil. $B_{i,t}$ are 3 by 3 matrices of time varying coefficients of the lag of endogenous variables. u_t are reduced form innovations that are assumed to have time varying covariance matrix Ω_t and zero mean. This time varying covariance matrix allows the shocks to have time variation in their magnitude as well as their contemporaneous impacts. Having time varying coefficients will also enable the propagation mechanism of the shocks to change over time. The model is estimated using Gibbs sampling algorithm presented in Primiceri (2005) . More details regarding the model setup are provided in the Appendix.

2.3.2 Identification

Sign restrictions have mainly been employed to identify different shocks of the crude oil market in recent years (Baumeister and Peersman (2009), Kilian and Murphy (2010)). This identification strategy allows to avoid restricting the magnitude of the contemporaneous impact of the shocks, and this can be considered as a clear advantage over recursive identification schemes.

With the use of sign restrictions, I identify three underlying structural shocks, which are shock to the world production of crude oil ("oil supply shock"), shock to the demand for crude oil and other industrial commodities as a result of global business cycle ("aggregate demand shock") and oil specific demand shock that can also be considered as the shock to the demand for crude oil but orthogonal to the previous shock. The latter shock reflects particularly the fluctuations in demand for oil that can be considered as sector specific, such as fears about shortage of oil supplies in the future.

Table 1 below summarizes the identification restrictions.

	Q_{oil}	P_{oil}	Y_{world}
Oil supply shock	$\leqslant 0$	$\geqslant 0$	$\leqslant 0$
Global demand shock	$\geqslant 0$	$\geqslant 0$	> 0
Oil-specific demand shock	$\geqslant 0$	$\geqslant 0$	$\leqslant 0$

Table 1. Identification Restrictions

In addition to these restrictions, I also limit the price elasticity of oil supply in order to restrict the model from replicating dynamics which are unlikely to happen, as in Kilian and Murphy (2010). The logic behind the imposition of this restriction is as follows.

In the VAR model, by construction, the relation between reduced form and structural shocks are

$$\begin{bmatrix} e_t^{prod} \\ e_t^{worldIP} \\ e_t^{Oil\ price} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{pmatrix} \varepsilon^{Oil\ supply\ shock} \\ \varepsilon^{Aggregate\ demand\ shock} \\ \varepsilon^{Oil-specific\ demand\ shock} \end{pmatrix}$$

The ratio of $\frac{a_{13}}{a_{33}}$ is the short run elasticity of oil supply and we knew from the literature that it should be close to zero. Therefore I abandon all models that have a large value for this ratio. The upper bound that I put on this ratio has been obtained by considering the period of Persian Gulf War on august 1990 as a well-defined exogenous oil price shock. At the time, the price of oil increased by 44 percent while the production of crude oil from all producers except Iraq and Kuwait increased by just 1.17 percent, suggesting a ratio of .025 ($\frac{1.17}{44}$) that can be regarded as an upper bound for this elasticity following Kilian and Murphy (2010).

2.3.3 Regression model for understanding the effects of oil price shocks on oil-exporting economies

Having identified different types of shocks, an interesting question is how these structural shocks affect macroeconomic aggregates such as inflation and real GDP growth in oil exporting countries. Assuming that there is no feedback from inflation and output growth of these countries to oil shocks within a quarter, I can treat these structural shocks as predetermined regressors and examine their effects on inflation and GDP growth of these countries. This assumption could be justified considering the following argument. None of these countries are large enough to affect neither aggregate demand nor oil specific demand. The share of crude oil production of these countries is not large enough (the highest share is for Saudi Arabia with about 10 percent of global oil production), moreover, oil supply can not significantly change within a quarter due to technical restrictions.

One of the main challenges in dealing with this regression model is the frequency mismatch as I have the shocks at monthly frequency but GDP growth becomes available quarterly. By averaging structural shocks in each quarter, a measure of quarterly shock has been constructed as below:

$$\hat{\mu}_{jt} = \frac{1}{3} \sum \hat{\varepsilon}_{j,t,i} \qquad \text{for j=1,2,3}$$

where subscript t represents the quarter and subscript i represents the month in each quarter.

Then I regress output growth and inflation on these new measures of oil shocks as follows

$$\Delta Y_t = \alpha_j + \sum \psi_{ji} \hat{\mu}_{jt-1} + u_{jt}$$

$$\pi_t = \gamma_j + \sum \phi_{ji} \hat{\mu}_{jt-1} + \nu_{jt}$$

In which ψ_{ji} and ϕ_{ji} can be interpreted as impulse response functions of GDP growth and inflation, respectively. In the above regressions, as u_{jt} and ν_{jt} potentially have serial correlation, block bootstrapping should be used to provide reliable inferences.

2.4 Empirical Result

In the first step, I estimate a time-varying VAR with stochastic volatility based on monthly data for the vector Y which contains the percent change in global crude oil production, the log of world industrial production and the log of the real oil price . The data are collected for the sample period starting from January 1974 to December 2007. In order to calibrate the priors for estimation, I used first 6 years of data as a training sample.

Figure 1 displays the annual average of different oil shocks as implied by the model. By looking at this figure, we can conclude that at each period of time, which component of oil shock was the main driver of price change. For example, a big drop in oil price between 1985 and 1986 can be imputed to the shock in aggregate demand, while the price increase in 1990 can be driven by the negative supply shock related to Persian Gulf War.

The elasticity of oil demand has been shown in figure 2. It can be seen that from early 90's, this elasticity no longer exceeds from -0.5 implying the demand has become less sensitive to the recent price changes. This result is in line with Baumeister and Peersman's finding of substantial decline of both demand and supply elasticities over time.

Figure 3-6 depict the median response of GDP and price level to different types of shocks together with the 16th and 84th percentile error band in the countries under investigation. Briefly looking at the response of output to oil shocks, it becomes clear that the part of the shock related to increase in aggregate demand is mainly responsible for the increase in real GDP in these oil exporting countries.

Oil supply shock reduces real GDP in these countries. Considering the fact that almost all episodes of supply fall occured during the political unrest in the region, and the theory of investment under uncertainty (Henry, 1974), would justify this decrease since uncertainty about the future makes investment as a part of aggregate output to fall. This could also explain the decrease in the price level. Particularly, Iran, which has a larger and more diversified economy and therefore less dependent on oil, suffers less relative to others.

The shock to aggregate demand results in what we would have expected from an oil shock in oil exporting countries, as it increases the real GDP and also the price level. This makes more sense referring to earlier pieces of evidence documented by Kilian (2009), that much of the recent increase in crude oil prices has been driven by global aggregate demand shocks.

Finally, the oil-specific demand shock causes a significant decrease in the price level in all countries except for UAE where the response is still negative but insignificant. This shock has a positive and insignificant effect on output in Iran and Qatar but negatively affects GDP of Saudi Arabia and UAE. This decrease in the GDP of the latter countries could be explained by the standard Dutch disease effect.

2.5 Conclusion

This study aims at disentangling different oil shocks in a time-varying setting, and exploring their effects on output growth and inflation in selected oil-exporting countries. In this regards, I firstly run a VAR on global oil production, world industrial production and real oil prices allowing the coefficients and variance-covariance matrix of the shocks to be time varying. Three types of oil shocks have been identified with the use of sign restrictions and limiting the price elasticity of supply (as in Kilian and Murphy(2010)). I observed substantial declines in the price elasticity of demand for crude oil which confirms the previous results on volatility puzzle.

Then, assuming no feedback from GDP growth and inflation to oil shocks within a quarter, I find the aggregate demand components of the oil shocks as the most relevant factor influencing GDP and inflation of oil-exporting countries. These findings are in line with the evidences documented in the literature.

Bibliography

[1] Baumeister, C., and G. Peersman (2009), Sources of the Volatility Puzzle in the Crude Oil Market, mimeo, Ghent University.

[2] Benati, L. and H. Mumtaz (2007), U.S. Evolving Macroeconomic Dynamics: A Structural Investigation, ECB Working Paper 476.

[3] Berument, H., and Ceylan, N.B. (2005). The impact of oil price shocks on the economic growth of selected MENA countries. Working Paper, Bilkent University.

[4] Blanchard, O.J., and Gali, J. (2007). The macroeconomic effects of oil price shocks: why are the 2000s so different from the 1970s? MIT Department of Economics, Working Paper

[5] Cogley, T. and T.J. Sargent (2005), Drift and Volatilities: Monetary Policies and Outcomes in the Post WWII U.S., Review of Economic Dynamics, 8 , p 262-302.

[6] Eltony, M.N., Al-Awadi, M. (2001), Oil price fluctuations and their impact on the macroeconomic variables of Kuwait: a case study using a VAR model. International Journal of Energy Research 25, 939–959.

[7] Farzanegan, M.R.,Markwardt,G. (2009), The effects of oil price shocks on the Iranian economy. Energy Economics 31,134–151.

[8] Hamilton, J.D.(1983), Oil and the marcoeconomy since World War II. The Journal of Political Economy 91, 228–248.

[9] Hamilton, J.D. (2003), What is an oil shock? Journal of Econometrics 113, 363–398

[10] Henry, C. (1974), Investment decisions under uncertainty : their reversibility effect . American Economic Review 64, 1006–1012.

[11] Hooker, M.A., 1996. What happened to the oil price–macroeconomy relationship? Journal of Monetary Economics 38, 195–213.

[12] Kilian, L. (2009), Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market, American Economic Review, 99(3), p 1053-1069.

[13] Kilian, L., Murphy, D.P. (2010). Why agnostic sign restrictions are not enough: understanding the dynamics of oil market VAR models. CEPR Discussion Paper

[14] Mehrara, M.,Oskoui,K.N. (2007), The sources of macroeconomic fluctuations in oil exporting countries : a comparative study .Economic Modelling 24,365–379.

[15] Mork, K.A., Oslen, O., and Mysen, H.T. (1994). Macroeconomic responses to oil price increases and decreases in seven OECD countries. Energy Journal, 15, 19-35.

[16] Primiceri, G.E. (2005), Time Varying Structural Vector Autoregressions and Monetary Policy, Review of Economic Studies, 72, p 821-852.

2.6 Appendix 1

Model setup. This model is time varying VAR model, so we can write it in the state space representation. the measurement equation can be written as

$$Y_t = B_t X_{t-1} + u_t$$

where X_t is a vector of lags (p=...) of all dependent variables as well as a constant term and B_t includes time-varying coefficients. As we also have stochastic volatility in the model, u_t are heteroskedastic error terms with variance-covariance matrix Ω_t that can be decomposed as $\Omega_t = A_t^{-1} H_t (A_t^{-1})'$.

H_t is a diagonal matrix that contains stochastic volatilities and A_t is a lower triangular matrix of the contemporaneous interactions among variables:

$$H_t = \begin{bmatrix} h_{1,t} & 0 & 0 \\ 0 & h_{2,t} & 0 \\ 0 & 0 & h_{3,t} \end{bmatrix} \qquad A_t = \begin{bmatrix} 1 & 0 & 0 \\ a_{21,t} & 1 & 0 \\ a_{31,t} & a_{32,t} & 1 \end{bmatrix}$$

For the evolution of these parameters, I assume the following processes in line with Primiceri (2005):

$$\begin{aligned} B_t &= B_{t-1} + \tau_t \\ \log(h_t) &= \log(h_{t-1}) + \eta_t \\ a_t &= a_{t-1} + \vartheta_t \end{aligned}$$

And error components are assumed to be normally distributed and uncorrelated with each others.

$$\begin{bmatrix} u_t \\ \tau_t \\ \eta_t \\ \vartheta_t \end{bmatrix} \sim N(0, V), \text{where } V = \begin{bmatrix} R & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & G \end{bmatrix}$$

2.7 Appendix 2

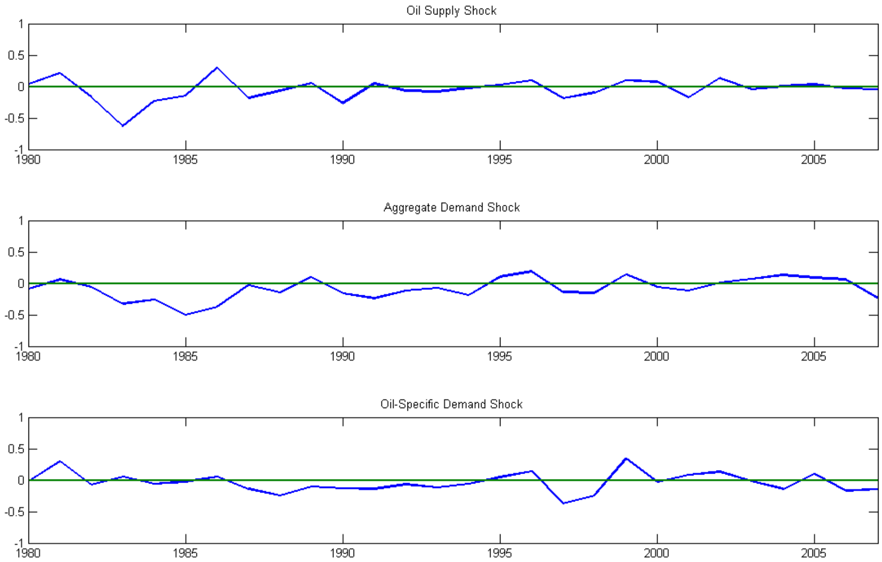

Figure 2.1: Evolution of different oil shocks

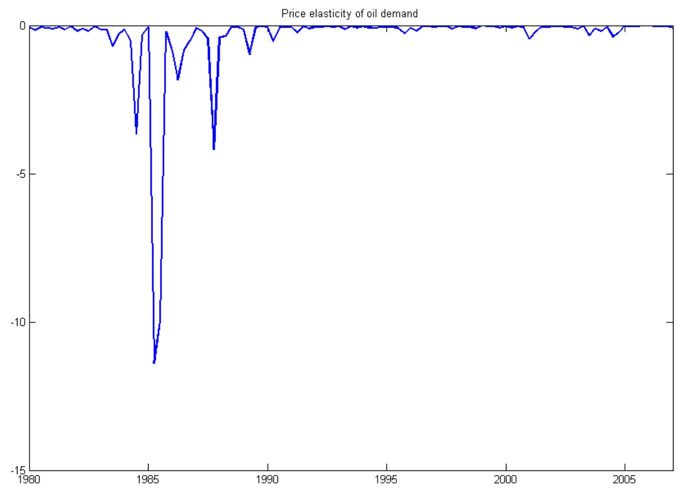

Figure 2.2: Price Elasticity of demand for oil

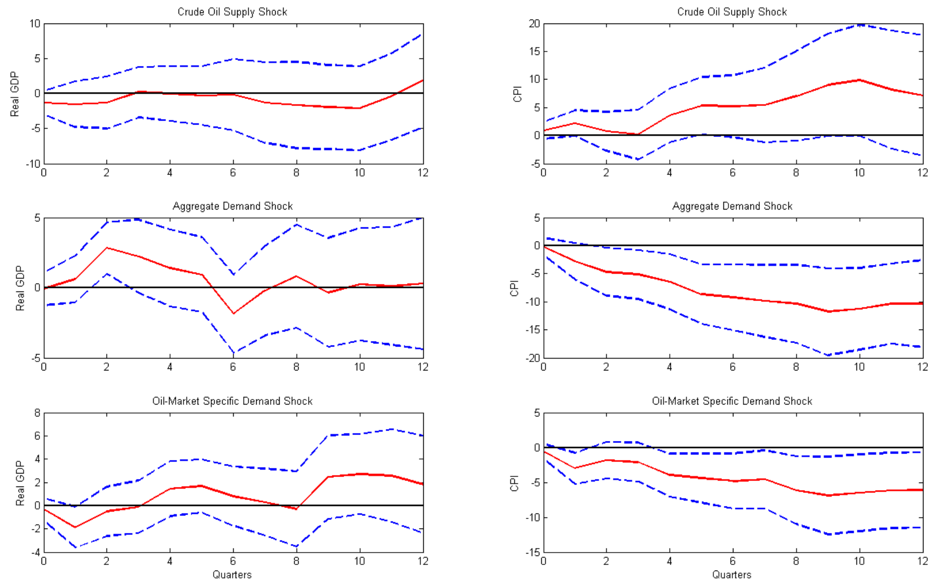

Figure 2.3: Response of Real GDP and Price Level to different oil shocks in Iran

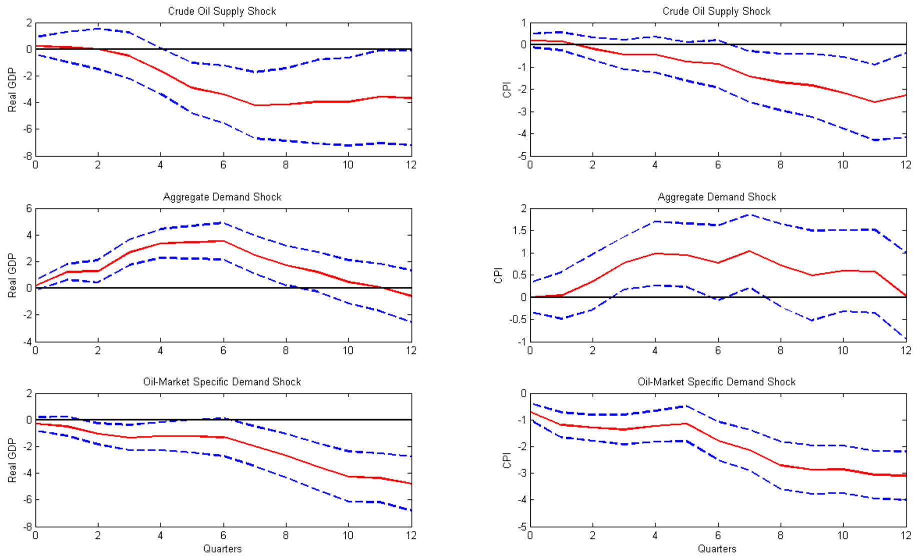

Figure 2.4: Response of Real GDP and Price Level to different oil shocks in Saudi Arabia

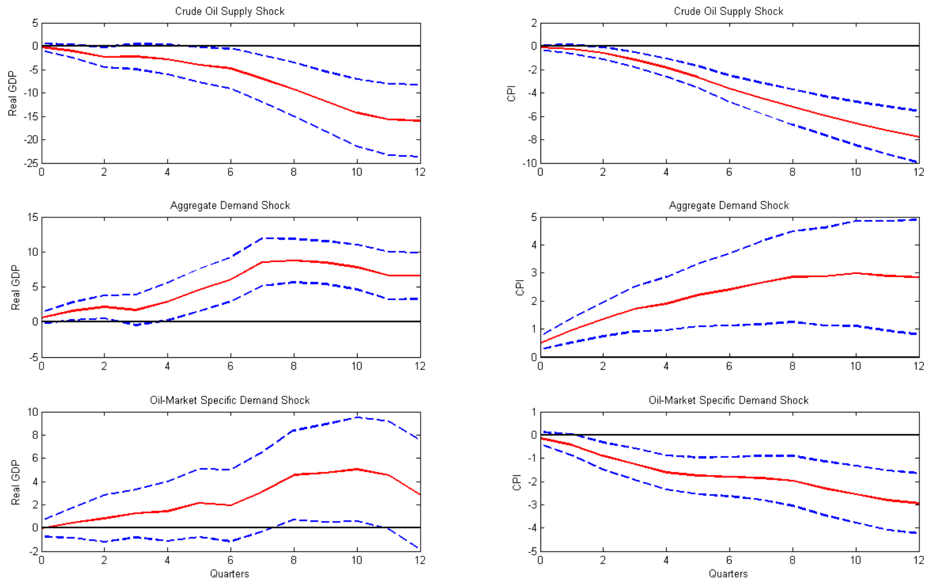

Figure 2.5: Response of Real GDP and Price Level to different oil shocks in Qatar

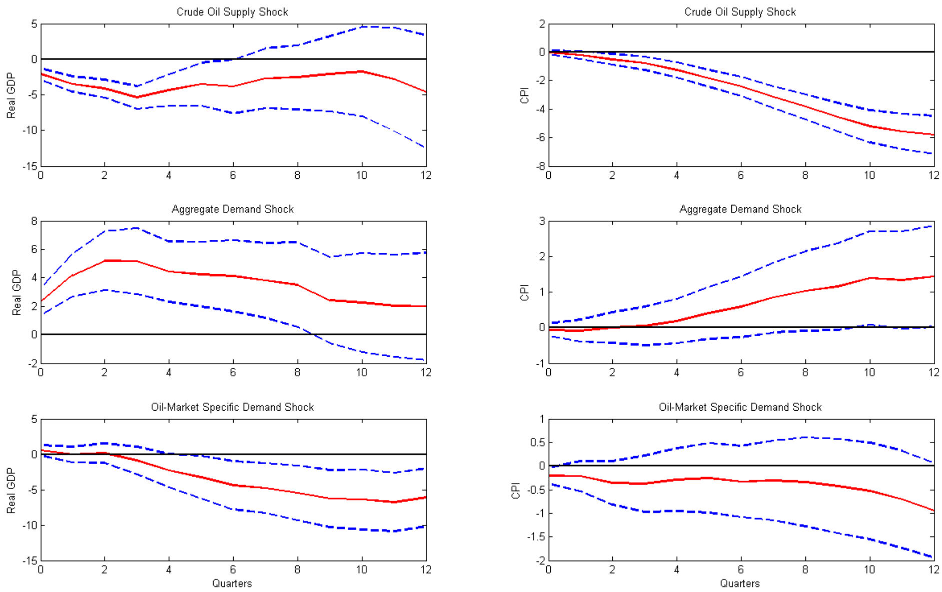

Figure 2.6: Response of Real GDP and Price Level to different oil shocks in UAE

Chapter 3

Sovereign Bond Spread in EMU Countries

Abstract

This paper studies the behavior of sovereign bond yield spread over Bund across 10 EMU countries for the time period between 2002 and 2013 using Logistic Smooth Transition Autoregressive (LSTAR) model. The results suggest a threshold value of 123 percent for future debt over GDP, such that if forecasts for a country's debt exceed this value, market will treat its sovereign bond differently with respect to the period before it. In fact, when future debt of a country is not too high and the market is confident about its solvency, the behavior of the spread seems to be unrelated to fiscal stance as its main driver is the global spread and the coefficients of the fiscal fundamentals are not significant. As the future debt goes beyond this threshold, concerns about its ability to repay the accumulated debt rises and the fiscal fundamentals become relevant in the spread determination.

Keywords: Sovereign Bond Spread, Euro Area, LSTAR Model

3.1 Introduction

By the start of Economic and Monetary Union (EMU) sovereign bond yields spreads of the member countries had largely converged, which seemed quite natural considering the same monetary policy regime. However, during recent financial crisis, substantial increase in the yield spread between German Bund and euro area government bonds has been observed.

This increase in the spread would cause the funding cost of the government to rise. Noting that those countries with higher spread are already experiencing trouble time in meeting their financial obligations, the increase in spread would make their fiscal stance even worse and raise concerns about sustainability of these governments.

There is a large volume of studies trying to investigate the driving forces of sovereign bond yield differential within the euro area (Codogno et al. (2003), Geyer et al. (2004), Gomez-Puig (2006), Bernoth et al. (2006), Hallerberg and Wolff (2008)). In general, they have found default risk, liquidity risk and changes in investors' preferences (risk aversion) as three main determinants of the yield spreads in euro area, in which the first two are country specific while the third one is global wide.

Recent sovereign debt crisis in Europe and surge of bond yield in certain European states make it difficult to impute this sharp increase in the spread to changes in macroeconomic fundamentals, as for example the spread on Greek sovereign bond grew eightfold during the period between September 2008 and August 2010 while macroeconomic variables in Greece have experienced milder change in the same period. The story is fairly similar in some other countries like Portugal and Ireland. Some researchers argue that simple linear regression models may have failed to explain the relationship between bond spreads and different types of risk because of change in pricing behavior of financial markets toward various risk components. So, the reaction of the markets to various sources of risk has become stronger.

This paper studies the determinants of the sovereign bond yield spread in the euro area and in particular, trying to identify the presence of any structural break in the market pricing of different types of risks. To this end, a nonlinear LSTAR model is developed which allows the response of the spread to change when the forecast of the government debt over GDP exceeds a certain threshold value and the corresponding value is endogenously determined.

Moreover, it is found that when the market is calm and concerns about solvency of the government are not so strong, the behavior of the spread seems to be a random walk process as its main driver is the global spread and coefficients of fiscal fundamentals are not significant. In the other case, when the expectation of the future debt exceeds a certain threshold, market becomes suspicious about the ability of the government to repay its debt. In this situation, while the global spread remains significant, fiscal fundamentals come to play a role as their coefficients become significant.

Moreover, by estimating the threshold for the expected government debt to GDP, I find when future debt exceeds 123 percent of GDP, concerns about sustainability of the government intensify. This number is highly significant and robust in different specifications.

The rest of the paper has the following structure. Section 2 reviews the related literature. Section 3 provides a descriptive analysis of the data and the model is presented in section 4. Section 5 shows results and section 6 concludes.

3.2 Literature Review

In recent years, a considerable amount of literature has been published on the determinants of government bond spreads in the euro area. These studies suggest several sources of risk that could be thought as the main drivers of the spread.

First, credit risk or the risk of default can be considered as one explanation for difference in sovereign bond yields for which countries' fiscal position seems to be a good proxy for that.

In an early contribution, Alesina et al. (1992) look at the spread between sovereign and corporate bond yield in 12 OECD countries over the period 1974-89 and find that the spread is positively related to the debt over GDP in the highly indebted countries of the sample. Bernoth et al. (2004) analyze European bond market before and after the start of EMU in 1999 and find debt, deficit and debt service as measures of fiscal imbalance that have positive impact on government bond spread. By including levels and quadratic terms of the fiscal variables, they also provide evidence on non-linearity of the relation between debt service and spread. The fact that the government's debt and deficit are significant drivers of sovereign bond spread, has also been found in some other studies like Hallerberg and Wolff (2008), Schuknecht et al. (2010) and Gerlach et al. (2010).

Second, liquidity risk is another potential determinant of the spread since illiquidity of the asset will impose its holder more transaction cost. However, empirical evidence for the effect of this type of risk on bond spread is not so robust. On one side of the spectrum, Gomez-Puig (2006), Barrios et al. (2009) and Gerlach et al. (2010) find liquidity risk as an important factor in explaining bond yield spread in euro area. Bernoth et al. (2004) conclude that liquidity risk premia has faded out after the introduction of EMU. Favero et al. (2010) find that liquidity risk matters only for some euro area bonds and Baber et al. (2009) argue that liquidity plays a role only when market uncertainty increases. Lastly, Schuknecht et al. (2010) could not find a significant estimate for the effect of liquidity on bond spread.

Third, market attitude toward risk has been examined as a significant determinant of sovereign bond spread in many studies. Codogno et al. (2003), find that global risk factor, proxied by the spread between US corporate and government bond of the same maturity, has significant effect on yield spreads across EMU countries. This conclusion is also confirmed by Geyer et al. (2004). Sgherri and Zoli (2009) and Favero et al. (2010) find that euro area sovereign bond spreads are mostly driven by a common time-varying factor that represents the investors' risk aversion.

Moreover, recent pieces of evidence show that the reaction of financial markets to these factors has also been changed during the crisis. Thus, the way that government bond yield is affected by the variables proxying the aforementioned factors seems to be different during the crisis comparing pre-crisis period. Haugh et al. (2009), Schuknecht et al.

(2010) find that the crisis leads to stronger response of bond spread to fiscal imbalances. Aßmann and Boysen-Hogrefe (2010) conclude that while crisis raise the importance of both credit risk and liquidity risk in explaining bond spreads, appreciation of the latter is more remarkable. However, their results might be bias as they do not control for the international risk aversion.

3.3 Descriptive Analysis

The variable which is used here is the long term sovereign bond spread over German Bund that is analyzed for 10 different European countries (Belgium, Ireland, Greece, Spain, Italy, France, Netherlands, Austria, Portugal and Finland).

Figure 1 shows bond spread of the sample countries over German Bund. What is immediately clear from the figure is that after September 2008, the sovereign bond spread of the countries in the sample substantially increased. This suggests that there might be a regime shift in bond spread determination which could not be explained by simple linear regression model. While the maximum bond spread of the sample countries was 77 basis points by September 2008, it started to diverge since then and reached to 2700 basis points in February 2012, both of these two numbers are for Greece.

Moreover, the unconditional correlation between spreads in the sample is calculated and has been reported in table 1. We can distinguish two blocks of countries, namely the countries with high yield (Greece, Portugal, Ireland, Italy and Spain) and low yield (Netherlands, France, Finland, Austria and Belgium). Note that the correlation between the spread of countries in each block is high while the correlation of spread between countries from different block is relatively low. This observation suggests to employ the GVAR modelling approach which considers the interdependencies between countries as presented by Pesaran et al (2004). It is worthy to note that what probably matters here is similarities in fiscal stances and not the value of trade as used by Pesaran et al (2004).

Considering table 1, the standard deviation of bond spread is calculated separately for all, high yield and low yield countries before and after the crisis(Figure 2-3). In these figures, we can observe that even after the start of financial crisis, there is not a big divergence in bond spread of countries with good financial conditions, on the contrary, most of the standard deviation is related to countries with weak fiscal stances. This observation supports the idea that although the crisis affects sovereign bond spread of all countries, but this effect is more pronounced in some countries while not so strong in the others.

The correlation between bond spread with debt and deficit over GDP has been showed in figure 4 and 5. These two figures suggest a positive relationship between these fiscal variables and the spread in EMU countries, justifying the inclusion of the variables in the empirical model. The values in these figures are average over the whole sample period. Of course one might argue that this positive correlation is the result of deterioration of fiscal stances in some countries after the debt crisis, but the calculation for different subsamples before and after the crisis confirms this positive correlation.

3.4 Model

The preliminary data analysis performed in the previous section has shown that although fiscal variables in addition to a measure of global risk could be thought as main determinants of sovereign bond spread, the relationship between spread and these factors are not constant through time, and there is somehow a regime shift in the model of bond spread determination. It should be noted that as we can see in figures 2 and 3, countries like Netherlands or Finland seem to be in a same regime and global financial crisis has not changed the relationship between their bond spreads and fundamentals so much.

To model this non-linearity in the response of the spread to different factors, a LSTAR model is employed which belongs to the broader category of threshold models. Using this kind of model allows the relationship between spread and its determinants to become different when the specific variable, namely the forecast of debt to GDP, exceeds a certain threshold. Moreover, since the shift does not take place abruptly, I allow the transition between two regimes to be gradual. The following specification is adopted for a system of ten equations for the bond spread of countries in the sample over German Bund.

$$\begin{aligned} Y_i \;=\; & \beta_1 * i + \beta_2 * Gl\_Spread_i + \beta_3 * Gl\_Spread_i(-1) + (\beta_4 + \beta_5 * X_i)(1 - G(debt_i, C)) \\ & + (\beta_6 + \beta_7 * X_i) G(debt_i, C) \end{aligned} \tag{3.1}$$

In which Y_i is the bond spread of country i over Bund, i is the interest rate in the Euro area and X is a vector consisting of lagged value of the spread, forecast of debt over GDP minus the same ratio for Germany, forecast of deficit over GDP minus the same ratio for Germany and an index for international risk aversion[1]. The European Commission publishes the European economic forecasts report twice a year which is used for the forecast of fiscal measures.

G is the logistic function as below

$G(debt_i, C) = \frac{1}{1+\exp[-\lambda(debt_i - C)]}$

This form of function, whose behaviour in illustrated in figure 6, allows the model to switch smoothly between two regimes depending on whether the forecast of debt/GDP is above a certain threshold or not.

[1] Despite some studies in the literature, I could not find any significant effect for liquidity of the bond in explaining the spread.

Gl_spread is a weighted average of spreads of all other countries where weights are calculated in such a way that the more similar the countries are in terms of fiscal fundamentals, the higher is the weight. The idea behind this way of weighting relies on the assumption that similarities in fiscal fundamentals between two specific countries make the financial market to consider sovereign bonds of these countries of similar quality. Hence the increase in the spread of Portuguese bond might not have any effect on sovereign bond of Finland, but it is likely to affect Irish bond. So $Gl\_Spread_i = \sum_{j \neq i} w_{ij} Y_j$ and weights can be calculated as below:

$$dist_{ij} = 0.5 * E_t(b_i - b_{Ger})/60 + 0.5 * E_t(d_i - d_{Ger})/3$$

$$w^*_{ij} = \frac{1}{dist_{ij}} \quad \text{if} \;\; dist_{ij} < 1, \;\; \text{otherwise} \;\; w^*_{ij} = 0$$

$$w_{ij} = \frac{w^*_{ij}}{\sum_{j \neq i} w^*_{ij}}$$

This term is constructed to represent country-specific trends for the spreads, and deliver a factor that contains the level of spread of all other countries weighted by their similarities in fiscal fundamentals. Favero and Missale first created this term considering the construction of global variables in the GVAR modeling approach (Pesaran, Schuermann, Weiner (2004) and Dees, di Mauro, Pesaran, Smith (2007), where trade weights have been used in construction of global macro variables for each countries.

3.5 Empirics

3.5.1 Estimation results

For estimating the aforementioned model, the data of 10 European countries (Austria, Belgium, France, Finland, Greece, Italy, Ireland, Spain, Netherlands and Portugal) is used.

Spread is the difference between 10 year sovereign bond yield for each country in the sample and yield on 10 year German Bund. Moreover, as European Commission's reports provide the forecast of the variables of interest in two successive years, the average for a 2-year period of the expected budget balance and debt ratio over GDP are used. The expected variables are the European Commission Forecasts released on a semi-annual basis, so the same value has been used after each release until the next one becomes available. Indeed, the difference between each country's forecast and the forecast of the same variables for Germany are included.

As a measure for international risk aversion, either spread between yields on US Baa and Aaa corporate bonds or spread between yields on Baa corporate bond and 10 years government bond could be used and both of them can be computed based on FRED database of the Federal Reserve of St.Louis. These two variables are often used in empirical studies to describe the market attitude toward risk. Here, the latter is employed although the results are robust using the other one.

Before going to system estimation, the model for each country in the sample is estimated separately. As table 2 shows, the two terms related to the global variable are significant with the opposite sign, meaning that what matters for the spread is the first difference of this global spread. The estimated values for the threshold are highly significant and in line with what we would expect for high yield and low yield countries. The auto regressive term is significant for both regimes. If we look at the coefficients for forecast of debt and deficit and also international risk aversion, we observe the coefficients are not with the expected sign and also insignificant in many cases. This might be due to lack of observation for each country, considering the fact that forecasts have been released only twice a year.

Then the system of 10 equations is estimated with the use of seemingly unrelated regression (SUR) method over the sample from Jan 2002 to September 2013 to see what is the threshold in the whole sample and whether the coefficients of different types of risks have been changed or not. In SUR approach, the correlations between the disturbances in the equations are taken into account which results in a more efficient estimation. Results are presented in table 3. As can be seen, the threshold for forecast of debt over GDP is 123 percent, meaning that sovereign bond of those countries with the value of debt over GDP above 123 percent are treated by the market differently with respect to others. Notice that the estimate for this threshold is highly significant. Moreover, the coefficients for different risks are insignificant when the debt is below the threshold. So, for those countries that have never been expected to have this amount of debt, the prediction of the model is that their bond spread is mainly affected by the global spread variable which is the weighted average of the spread in similar countries. Thus, we can conclude that the situation of their fiscal fundamentals is not a serious concern for their bond spread as long as they have relatively low debt. However, when expected future debt increases and exceeds the threshold value, effects of different type of risk become significant with the expected sign. This implies that for those countries that have accumulated a huge amount of debt, the response of the market for their bond to changes in future debt and deficit is considerable.

Having estimated the model, we can obtain Generalized Impulse Response Functions (GIRF) for this nonlinear model as proposed by Koop, Pesaran, and Potter (1996) to investigate the effect of increase in future debt of one country on bond spread in other countries. The formulation of this type of impulse response function is as follows

$GIRF(h, \delta, \omega_{t-1}) = E(y_{t+h}|\varepsilon_t = \delta, \omega_{t-1}) - E(y_{t+h}|\varepsilon_t = 0, \omega_{t-1})$

where h denotes the horizon and ω_{t-1} represents the history of the process up to the time t. Since there are not analytical solutions for horizons longer than one period, it needs to do numerical analysis or Monte Carlo simulations to estimate the GIRF.

In figure 7, the response of bond spread of the countries in the sample to 1 percent increase in future debt over GDP in Portugal at April 2010 with the horizon of one year is reported. The vertical axis is country's spread reported in basis point.

Here, we can observe that increase in the future debt of Portugal affects bond spread of the other countries with different magnitudes. While this effect is very low for Austria and Netherlands, it is relatively high in Spain and Greece, which their fiscal stances are similar to Portugal. Note that the jump in the responses of Belgium and Finland bond spread is due to the way that the global spread is constructed. Since the weights are not endogenous, its variation might cause a jump in the value of global spread and so for the spread.

3.6 Conclusion

This paper contributes to the literature on sovereign bond spread in the euro area by proposing a threshold model. This modeling approach allows to explain the spread of long term bond of certain countries rise during financial crisis.

For this purpose, the yield spread on government bond in 10 EMU countries between Jan 2002 and September 2013 is analyzed. Moreover, in addition to the variables usually employed to explain the determinants of bond spread, a global variable is constructed according to GVAR literature which is added to the model in order to catch country specific trends for the spread.

Then a LSTAR model is used to identify any regime shift in the response of spread to various factors and the corresponding value of the threshold is estimated.

The results suggest that, this global spread significantly affects bond yield spread, in fact its first difference matters since its lag appears with the same value but different sign. furthermore, a threshold value for the forecast of debt to GDP is estimated to be 123 percent that when a country hits this threshold value, various sources of risk become relevant despite the fact that they were all insignificant in the normal times.

Bibliography

[1] Alesina, A., De Broeck, M., Prati, A., Tabellini, G., 1992. Default risk on government debt in OECD countries. Economic Policy 15, 427-451.

[2] Barrios, S., Iversen, P., Lewandowska, M., Setzer, R., 2009. Determinants of intra-euro-area government bond spreads during the financial crisis. European Commission, Directorate General for Economic and Financial Affairs, Economic Papers No. 388.

[3] Beber, A., Brandt, M-W., Kavajecz, K-A., 2009. Flight-to-Quality or Flight-to-Liquidity? Evidence from the Euro-Area Bond Market. Review of Financial Studies 22, 925-957.

[4] Bernoth, K., J. von Hagen, and Schuknecht, L., 2004. Sovereign Risk Premia in the European Government Bond Market, ECB Working paper, 369.

[5] Codogno, L., Favero, C., Missale, A., 2003. Yield spreads on EMU government bonds. Economic Policy 18, 505-532.

[6] Dees, S., di Mauro, F., Pesaran, M. H. & Smith, L. V. ,2007. Exploring the international linkages of the euro area: a global VAR analysis, Journal of Applied Econometrics, 22(1), 1-38.

[7] Favero, C., Pagano, M., von Thadden, E.-L., 2010. How does liquidity affect government bond yields? Journal of Financial and Quantitative Analysis 45, 107-134.

[8] Favero, C., Missale, A. (2011). Sovereign spreads in the Euro area: Which prospects for a Eurobond? CEPR Discussion Papers 8637.

[9] Gerlach, S., Schulz, A., Wolff, G.B., 2010. Banking and sovereign risk in the euro-area. CEPR Discussion Paper No. 7833.

[10] Geyer, A., Kossmeier, S., Pichler, S. 2004. Measuring systematic risk in EMU government yield spreads. Review of Finance, 8 (2), 171-197.

[11] Gomez-Puig, M., 2006. Size matters for liquidity: Evidence from EMU sovereign yield spreads. Economics Letters 90, 156-162.

[12] Hallerberg, M., Wolff, G.B., 2008. Fiscal institutions, fiscal policy and sovereign risk premia in EMU. Public Choice 136, 379-396,

[13] Haugh, D., Ollivaud, P., Turner, D., 2009. What drives sovereign risk premiums? An analysis of recent evidence from the euro-area. OECD Economics Department Working Papers No. 718.

[14] Koop, G., Pesaran, H., Potter, S.M., 1996. Impulse Response Analysis in Nonlinear Multivariate Models, Journal of Econometrics, 74, 119-147

[15] Pesaran, M. H., Schuermann, T. and Weiner, S. M. ,2004. Modelling Regional Interdependencies using a Global Error-Correcting macro-econometric model, Journal of Business and Economic Statistics 22(2), 129–162.

[16] Schuknecht, L., von Hagen, J., Wolswijk, G., 2010. Government bond risk premiums in the EU revisited: The Impact of the financial crisis. ECB Working Paper Series No. 1152

[17] Sgherri, S., Zoli, E., 2009. euro-area sovereign risk during the crisis. IMF Working Paper No. 09/222.

3.7 Appendix

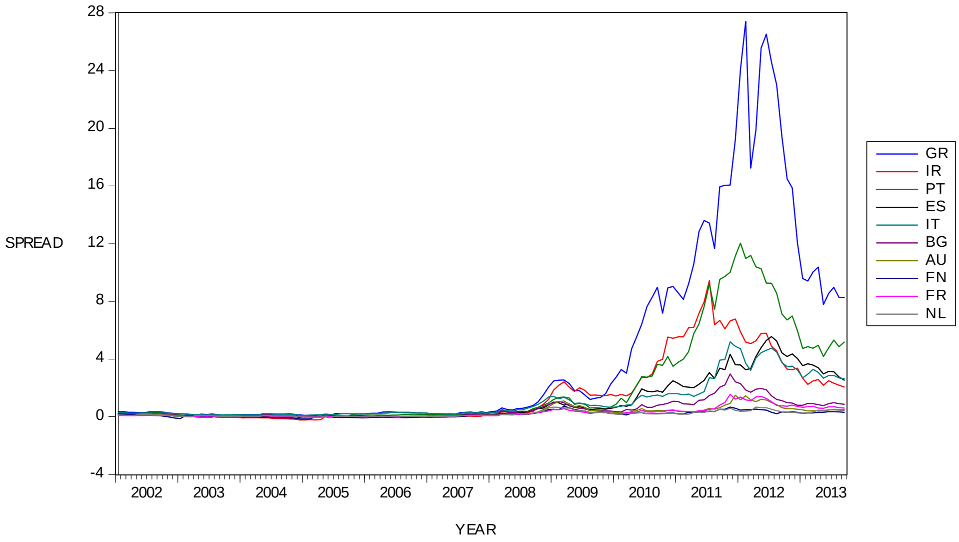

Figure 3.1: Spread on long term sovereign bond of selected countries over Bund

Note: the spread is expressed in basis points

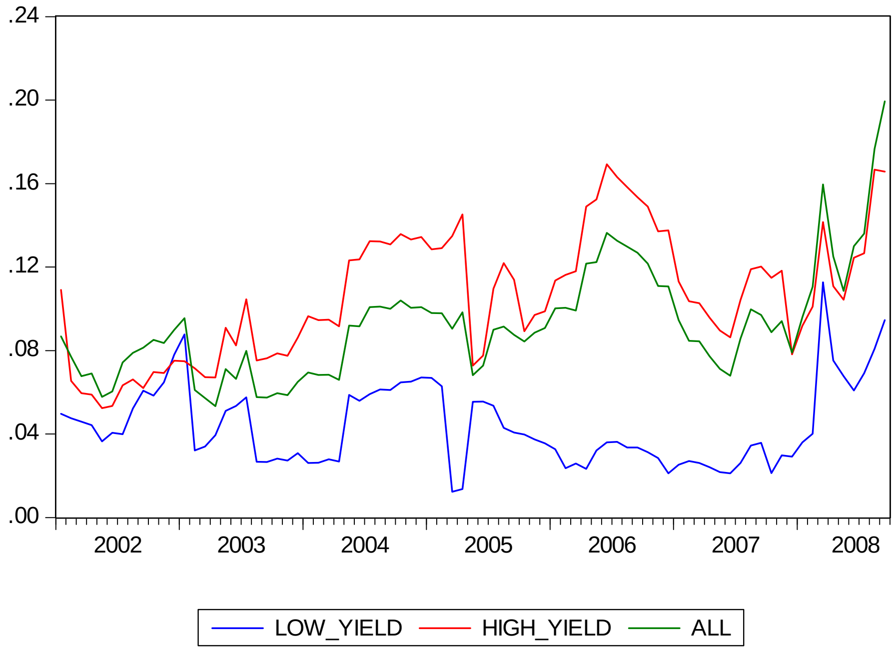

Figure 3.2: Standard deviation of bond spread for countries in the sample before the crisis

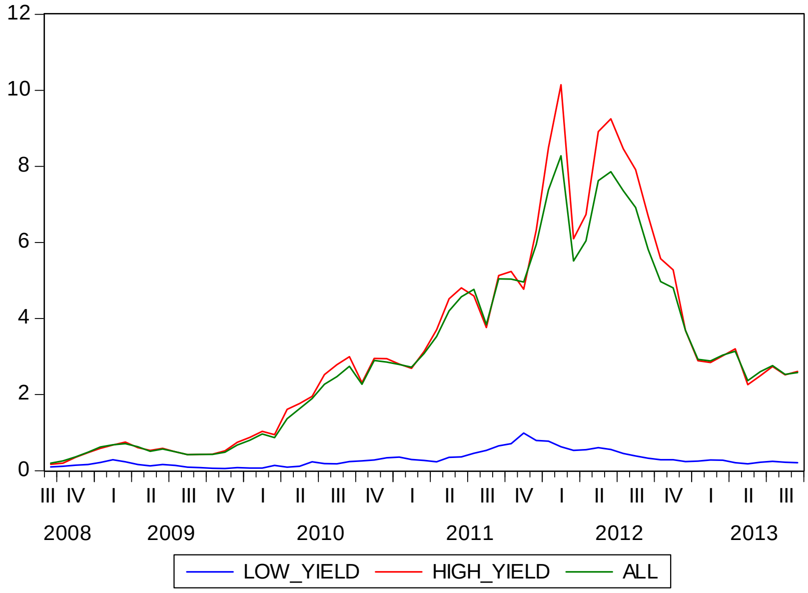

Figure 3.3: Standard deviation of bond spread for countries in the sample after the crisis

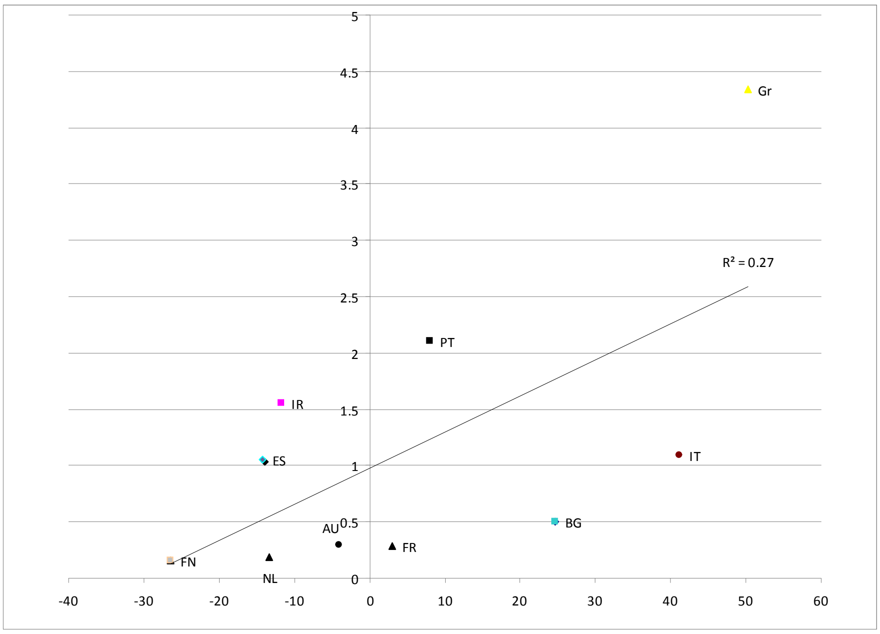

Figure 3.4: Bond spread versus forecast of debt to GDP

	NL	FN	AU	BG	FR	ES	IT	IR	PT	GR
NL	1.00									
FN	0.94	1.00								
AU	0.90	0.91	1.00							
BG	0.83	0.85	0.89	1.00						
FR	0.84	0.82	0.91	0.95	1.00					
ES	0.74	0.70	0.78	0.87	0.92	1.00				
IT	0.78	0.75	0.84	0.93	0.97	0.97	1.00			
IR	0.70	0.74	0.76	0.89	0.80	0.83	0.82	1.00		
PT	0.70	0.71	0.81	0.94	0.93	0.93	0.95	0.90	1.00	
GR	0.68	0.67	0.81	0.89	0.92	0.95	0.95	0.86	0.97	1.00

Table 1. Unconditional correlation of spread in sample countries

		AU	ES	FN	FR	Gr	IR	IT	NL
	Interest	0.007	0.017	0.001	0.020	-0.005	0.025	0.014	0.007
		(0.012)	(0.020)	(0.006)	(0.014)	(0.141)	(0.046)	(0.024)	(0.008)
	GI Spread	0.054	-0.094	-0.051	-0.046	0.105	0.116	-0.301	-0.033
		(0.047)	(0.079)	(0.035)	(0.020)	(0.205)	(0.054)	(0.096)	(0.026)
	GI Spread(-1)	-0.072	0.253	0.067	0.010	-0.271	-0.053	-0.042	0.035
		(0.046)	(0.091)	(0.035)	(0.021)	(0.175)	(0.046)	(0.098)	(0.026)
	intercept	-0.123	-0.008	0.094	-0.063	-0.806	-0.104	0.463	-0.138
		(0.047)	(0.074)	(1.469)	(0.064)	(1.525)	(0.212)	(0.313)	(0.035)
	spread(-1)	0.801	0.886	0.789	0.633	1.012	1.035	0.884	0.648
		(0.101)	(0.043)	(0.305)	(0.404)	(0.114)	(0.102)	(0.052)	(0.101)
Regim 1	forecast of debt	-0.002	-0.001	0.001	0.004	0.019	0.002	-0.017	-0.001
Below Threshold		(0.00331)	(0.0024)	(0.0632)	(0.0058)	(0.031)	(0.007)	(0.008)	(0.0019)
	forecast of deficit	-0.005	0.007	0.027	-0.004	0.028	-0.011	0.000	-0.002
		(0.006)	(0.010)	(0.113)	(0.007)	(0.063)	(0.021)	(0.016)	(0.004)
	international risk	0.109	-0.028	0.078	0.036	0.171	0.076	0.273	0.110
		(0.033)	(0.037)	(0.097)	(0.057)	(0.286)	(0.081)	(0.061)	(0.024)
	intercept	-0.240	3.877	0.057	-0.082	-9.315	-5.713	6.127	-0.007
		(0.094)	(1.872)	(0.036)	(0.056)	(2.508)	(2.658)	(1.806)	(0.043)
	spread(-1)	0.650	-0.120	0.903	0.794	0.477	0.330	0.188	0.714
		(0.078)	(0.163)	(0.054)	(0.047)	(0.070)	(0.117)	(0.205)	(0.092)
Regim 2	forecast of debt	-0.031	0.118	0.000	-0.011	0.024	-0.009	-0.128	-0.006
above Threshold		(0.010)	(0.027)	(0.001)	(0.003)	(0.018)	(0.034)	(0.033)	(0.002)
	forecast of deficit	0.059	-1.022	0.006	0.101	1.017	1.352	0.446	0.030
		(0.023)	(0.275)	(0.003)	(0.020)	(0.360)	(0.275)	(0.209)	(0.009)
	international risk	0.182	5.171	-0.039	-0.004	8.475	-0.251	1.707	-0.028
		(0.076)	(0.900)	(0.024)	(0.025)	(2.553)	(0.669)	(0.676)	(0.035)
	Threshold	70.605	76.579	31.646	67.251	141.194	94.987	119.865	56.998
		(1.804)	(0.466)	(4.184)	(2.392)	(4.396)	(7.487)	(0.474)	(1.355)

Table 2. Estimation results for each country's separate regression

Interest Rate	0.005	
	(0.003)	
gl_spread	0.399**	
	0.015	
gl_spread(-1)	-.0432**	
	(0.015)	
intercept	-0.0296*	-8.39**
	(0.0148)	(1.25)
spread(-1)	0.974**	0.819**
	(0.007)	(0.03)
forecast of debt	-0.00012	0.013*
	(0.00016)	(0.006)
forecast of deficit	0.0017	0.22**
	(0.0011)	(0.05)
international risk aversion	0.009*	2.74
	(0.004)	(0.38)
Threshold	123.727**	
	(3.815)	

Table 3. Estimation of the model for spread on Bund by Seemingly Unrelated Regression model

The number in parentheses is the standard deviation of the coefficient
** indicates significance at 1%, * indicates significance at 5%

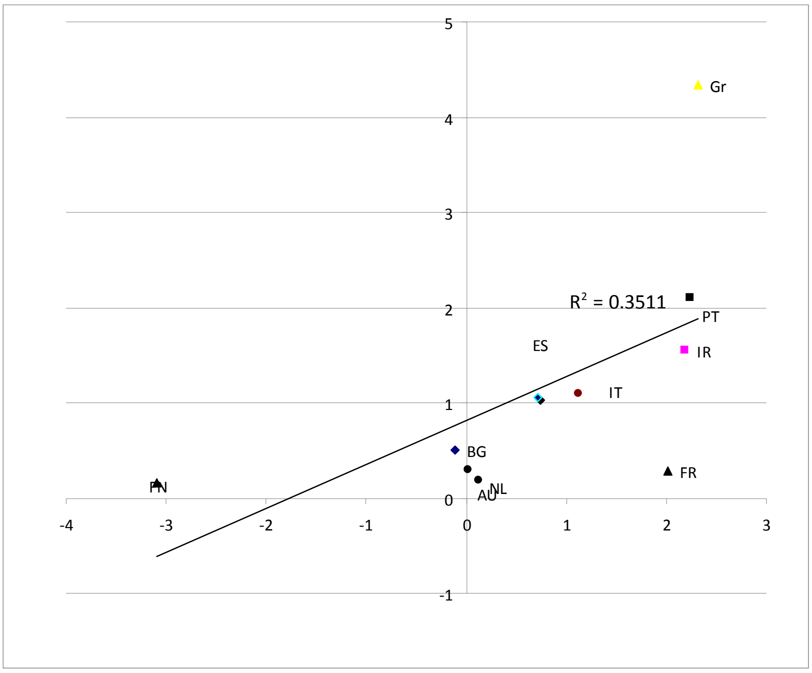

Figure 3.5: Bond spread versus forecast of deficit to GDP

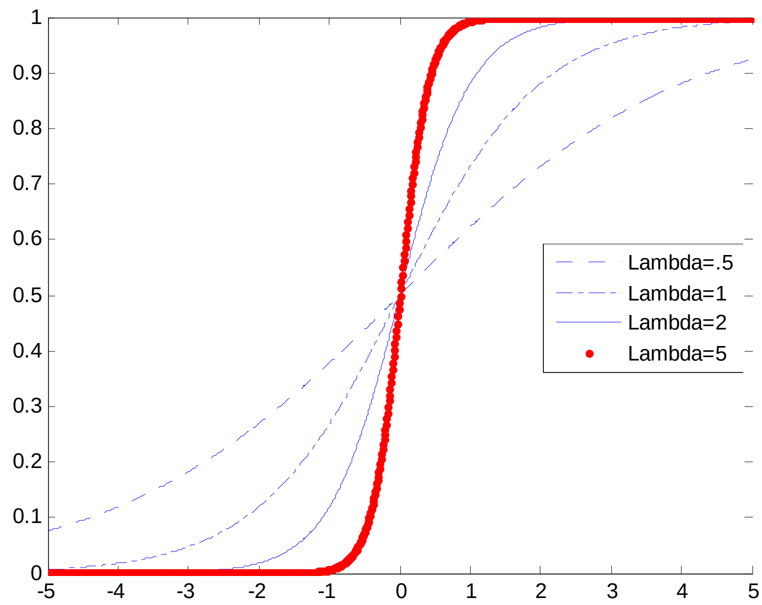

Figure 3.6: Dynamics of Logistic Function

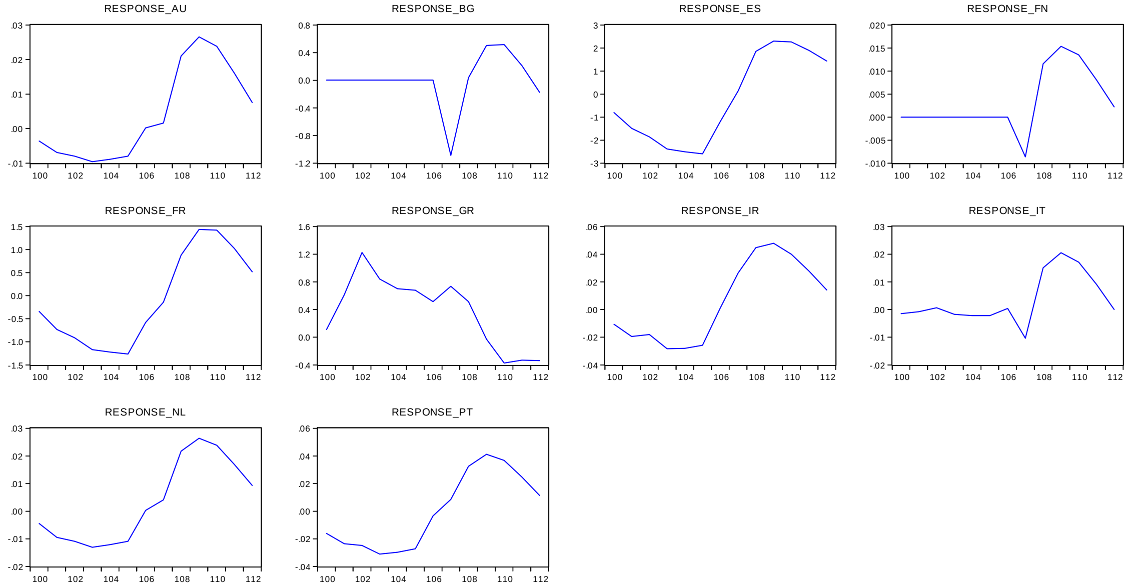

Figure 3.7: Impulse Response of shock to forecast of debt to GDP of Portugal on bond spread of the sample countries