INTERNATIONAL TRANSMISSION OF SHOCKS AND POLICIES WITHIN THE EU: THE SPANISH CASE.

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Abstract

In this paper I try to evaluate empirically the Spanish economic dependence on its EU neighbors during the last two decades. A Bayesian VAR is estimated to identify the links between their key macromagnitudes.

I explore further the possibility that the relationships found were similar responses to common shocks with a number of reduced VARs. Evidence is found supporting the "locomotive" role of Germany with respect to France and to a lesser extent to Spain, due to a faster response to common shocks like shocks to oil prices, US gdp, and US short-term interest rates.

1 INTRODUCTION

In the last two decades the Spanish economy has lived an intensive modernisation process. A necessary element for that transformation has been the opening up of the Spanish economy to the world economy. Trade in goods and services was rapidly liberalised, financial assets trade later on (capital controls did not fully disappear until 1991), foreign investment was greatly encouraged by government policies. By this opening up process the Spanish economy has made itself more and more interdependent with the rest of the world. Particularly with the EC members (Spain joined the EC in June 1986 and the EMS in June 1989).

An immediate question comes to mind: *which has been the impact during these two last decades, if any, of the foreign economies on the key Spanish macrovariables?*. Section 2 of the paper presents the estimation of two VAR on the main Spanish macrovariables and a selection of foreign ones to account for those interdependencies. One taking Germany as the foreign country and the other taking France. The methodology -Bayesian VAR (BVAR)- is briefly introduced and results summarised.

Section 3 explores the different responses of the three countries' variables to common shocks. Reduced VARs are estimated to explore wether the interdependencies found in the previous VAR are due to a similar response to those common external shocks. Section 4 concludes.

2 MEASURING INTERDEPENDENCIES: A VAR APPROACH

In this section I present a global VAR model to get an insight of the size and characteristics of the Spanish economy dependence on the rest of the world.

The natural "rest of the world" for Spain in the last two decades is clearly the EC. I have thus taken its two biggest members, France and Germany, to represent the "foreign" country in each of the two models estimated. Moreover, if one takes a look at the composition of the Spanish trade in the last years it is easily seen that France and Germany are

by far the two main Spanish trade partners. Altogether, France and Germany represent 26.8% of total Spanish trade from 1973 to 1992. And this share increases to 31.27% in the subperiod after 1986, when Spain joined the EC.[1]

I have selected a subset of macrovariables that would represent the main aspects of an open economy, but would certainly not fully describe its dynamics:

- output : real GDP (y),
- prices : CPI annualised rate of change (p),
- labor market: total employment (n),
- money market: nominal short term interest rate -call money rate- (r),
- fiscal policy: real government expenditure (g),
- exchange rate: real bilateral exchange rate (e),
- foreign variables: real GDP (y*), CPI inflation (p*), short term nominal IR (r*).

The series are quarterly from the OECD Main Economic Indicators series. I transformed all them in logs, except for the interest rates. The period analysed is 1973.2 to 1993:2 (the maximum available).

2.1 THE VAR METHODOLOGY AND THE BVAR

A Vector Autorregression model is a stochastic difference equation of the form

$$X_t = CW_t + A(L)X_{t-1} + u_t \tag{1}$$

If X_t is covariance stationary, the system can also be represented in Moving Average representation (MAR) form

$$X_t = DW_t + B(L)u_t \tag{2}$$

where X_t is the vector of endogenous variables, C and D are matrices of coefficients, A(L) and B(L) are polynomials in the lag operator L, W_t is a matrix of deterministic variables and u_t is the innovations vector, which follows a white noise process with mean zero and variance-covariance matrix VCV_u.

VAR models are weakly restricted models and therefore useful to analyze sample evidence without conditioning on controversial assumptions on the workings of the economy.

[1]Source: own calculations from OECD Foreign Trade Series

They permit to explore the dynamic interdependencies between the set of endogenous variables in a number of ways. F-tests can be computed on the significance of lags of any variable on the contemporary value of another; the correlation structure of innovations can also provide interesting information.

VAR models permit also to describe the in-sample effect of a shock on the rest of the system through (i) *Variance Decomposition*: percentage of the variance of the jth variable forecast error at t+k explained by a shock in the ith variable at time t, and (ii) *Impulse Response function*: response over time of the jth variable to a shock at t in the ith variable. For these computations the system is expressed in MAR form and the variance-covariance matrix of the residuals VCV_u typically orthogonalised, usually through Cholesky decomposition, to obtain contemporaneously uncorrelated innovations whose shocks can be associated to a single variable.

I have estimated two different VARs: one with German variables as the foreign variables and another with France as the foreign country. Both estimate a system of nine variables as described above, with four lags of each of them given that they are quarterly data, and six deterministic variables: four seasonal dummies, a dummy for the period 1980:1-1981:4 (covering the immediate impact of the second oil crisis) and another dummy for the tremendously inflationary and uncertain pre-constitution period in Spain 1977:3-1978:2. Therefore there are 42 coefficients to be estimated in each equation. With only 81 observations there is a serious problem of degrees of freedom.

Overparameterization is a problem that arises very often in the estimation of unrestricted VAR models. It is technically solved by performing a Bayesian estimation of the system.[2]

In the *Bayesian method* a prior distribution of the A(L) coefficients is specified as a function of a small number of parameters. The prior is modified using the sample information to yield a posterior distribution, which provides the estimates of the A(L) coefficients.

In this case I assume the prior distributions on the lags of the endogenous variables independent Normal. The means and standard errors of the prior distributions are specified as follows.

[2]All computations have been done with RATS 4 0

A previous non-bayesian estimation suggested that, in general, the selected variables were mainly explained by themselves, especially by the first lag. Therefore, a zero mean is assumed for all coefficients but for the first lag of the dependent variable. Augmented Dickey-Fuller tests suggested all nine variables to be integrated of order 1. Instead of imposing stationarity in the VAR differencing the series, I set the mean of the prior for the first lag of the dependent variable in each equation to be one. This way I allow sample data to confirm or not the unit root and give space for cointegration relationships to arise. The standard deviation of the prior distribution for variable j in equation i is the following

$$s(i,j) = \gamma f(i,j)[s_i/s_j] \tag{3}$$

where:

- s_i is the standard error of a univariate autorregression on equation i.
- γ is the standard deviation on the own lags. I set it equal to 0.1.[3]
- *f(i,j)* is the tightness on variable j in equation i relative to variable i. I set it equal to 1 if i=j, .5 otherwise. The later being less than 1, it assumes a higher tightness for other variables lags in each equation But pushing it too close to zero would yield a system of univariate autoregressions, eliminating possible interdependencies.

2.2 ESTIMATION RESULTS

The system is too complex to assign specific economic content to all estimated regression coefficients. Still though, it appears that for almost all variables, the more significant regressors are their own lags, which confirms the prior imposed. In the Spain-Germany VAR Real GDPs are significant for each other (interdependence), Spanish inflation for Spanish interest rate (r reflects the anti-inflationary monetary policy) and Spanish GDP for employment (as expected).

The estimated *cross-correlation matrix of the residuals* provides important insight about the interdependence between the variables, it shows which variables would immediately react to a shock in any variable. Table 1 displays these correlation coefficients for

[3]It is what practice has shown the lower bound of the reasonable values for the overall tightness, that is, a relatively "tight" one which favours the prior with respect to higher values of γ without imposing it "too much"

the Spain-Germany case and Table 2 for the Spain-France one. Newey-West consistent S.E. (Newey and West (1987)) are displayed under the estimated correlation coefficient.

Table 1: Cross-correlation of innovations: Spain-Germany

	g	r*	y*	p*	r	p	e	n	y
g	1								
	0								
r*	.07	1							
	.07	0							
y*	-.02	.19	1						
	.07	.06	0						
p*	.03	.18	-.11	1					
	.08	.07	.08	0					
r	-.19	-.22	-.01	.02	1				
	.05	.06	.05	.05	0				
p	-.15	-.01	.08	.001	.11	1			
	.07	.07	.07	.07	.07	0			
e	-.37	-.33	-.12	-.03	.15	.30	1		
	.08	.06	.07	.08	.08	.07	0		
n	.05	.04	.07	-.03	.02	.05	-.04	1	
	.09	.09	.09	.09	.09	.09	.09	0	
y	-.18	-.07	.21	-.04	.29	-.07	.03	.28	1
	.10	.10	.11	.10	.10	.10	.10	.09	1

It is interesting to note the significant positive correlation between national and foreign real GDPs and national and foreign short-term nominal interest rates. The rest of Spanish innovations are correlated with national disturbances rather than foreign ones, suggesting the important role of interest rates in the transmission of shocks across countries. French innovations are correlated to different Spanish innovations; it is not the case of German residuals. This suggests a more unilateral dependence of the Spanish

economy with respect to Germany than to France.

Table 2: Cross-correlation of innovations: Spain-France

	g	r*	y*	p*	r	p	e	n	y
g	1								
	0								
r*	-.04	1							
	.05	0							
y*	-.08	.19	1						
	.09	.09	0						
p*	.17	.25	.06	1					
	.09	.08	.09	0					
r	-.18	.10	.18	.17	1				
	.05	.05	.04	.04	0				
p	- 15	.03	.07	.11	.11	1			
	.08	.08	.08	.08	.08	0			
e	-.23	-.26	-.03	.08	.25	.20	1		
	.06	.06	.05	.06	.05	.06	0		
n	.04	.16	.10	.13	.006	.07	-.04	1	
	.11	.11	.10	.11	.11	.11	.11	0	
y	-.16	.15	.42	.23	.20	.01	-.03	.35	1
	.13	.13	.11	.13	.13	.14	.14	.10	1

To get an idea of the longer run responses of the variables to shocks one can either look at the *Variance Decomposition* of the series or at the *Impulse Response functions*. Given the high interrelation among residuals it is hard to identify a shock to the residual of a certain equation with a shock to a single variable. For this reason the residuals are transformed to an uncorrelated form by orthogonalysing their estimated variance-covariance matrix. I have used the Cholesky decomposition.[4]

[4]The Cholesky decomposition has the inconvenient that a shock to a variable affects contemporanously

The impulse responses for the Spain-Germany VAR are displayed in Figure 6. Figure 7 displays those of the Spain-France VAR. The vertical axis represents the reaction of the variable as percentage of its forecast error S.D. to a one forecast error's S.D. shock to another variable. The horizontal one is the number of periods after the shock. It is worth to emphasize two points:

(i) there is a higher response of Spanish variables to foreign shocks than German or French responses to Spanish shocks (which look more like a lagged and reduced response to Spanish GDP reaction). However, French variables show more intensive reactions than German ones to shocks in the Spanish macrovariables. This fits into a more general result as in Ballabriga, Sebastián and Vallés (1993), that Spain appears to be more open to EC shocks than Germany or France.

(ii) Spanish variables respond more to national shocks than to foreign ones (above 100% response of Spanish real GDP in a year to CPI inflation or employment shocks). This difference is more exaggerated in the Spain-Germany case than in the Spain-France one.

Summarizing, two main observations stand out regarding the interdependencies Spain-EC:

- There is a significant positive contemporaneous correlation between Spanish and foreign shocks,
- There is a higher reaction of Spanish variables to foreign shocks than the other way around, especially with respect to Germany.

3 ASYMMETRIC RESPONSE TO COMMON SHOCKS?

Put together, the two last observations emphasized in the previous section suggest the possibility that all countries may react to the same common shocks but that there is some *asymmetry* in the reaction so that Germany or France react first and transmit those shocks to Spain. This would be, in a sense, the "locomotive" role found in Ballabriga,

only those variables that follow in the X_t vector, not those that preceed the shocked variable Therefore it is important that the variables thought to be more exogenous come first in the ordering of the X_t vector

Sebastián and Vallés (1993) for the German economy with respect to the rest of Europe and particularly to Spain.

In the whole literature developed around the European Monetary Union it has been emphasized the unsustainability of such a fixed exchange rates system if member countries respond in an asymmetric way to economic shocks. And this refers not only to the existence of different country-specific shocks not fully transmitted to the other countries[5] but also asymmetric impact of common external shocks across countries.

I have estimated several VARs to obtain evidence about the symmetries or asymmetries in the responses of Spanish, German and French variables to common external shocks. The variables are those included in the global BVAR estimated in the previous section: real GDPs, CPI inflations and nominal short-term interest rates. The common external shocks are represented by shocks to:

- oil price: petroleum price index, US PPI (source: OECD Main Economic Indicators),
- US real GDP (source: OECD Main Economic Indicators),
- US short-term nominal interest rate (source: OECD Main Economic Indicators).

I estimated 12 four-variable VARs. Each of them includes the same macrovariable for the three countries -Spain, France and Germany- and one external variable. This way I can study the diverse responses of each country to that specific common shock, in timing and magnitude, study the existence or not of *asymmetric responses to common shocks.*

There are several points that can be checked with the *Impulse Response functions* of these VARs:

(i) The diverse response of each country to common shocks in general, so as to see which country is more open to external shocks, i.e. responds faster or more intensively.

(ii) In case of asymmetric responses, the existence of a sequence in the responses would indicate a certain "locomotive" role for the first country with respect to the "follower" ones. There would be a transmission effect then, from the country reacting first to the "follower".

(iii) If such a transmission effect is suggested, a variable whose response across coun-

[5]This problem is studied in the risk-sharing literature.

tries to the different shocks follows the same pattern than that of GDPs could be considered a possible "transmission mechanism".

The length of the lag polymonial A(L) is also four. The smaller amount of coefficients to be estimated makes unnecessary the use of Bayesian estimation methods. The four equations of the unrestricted VAR are jointly estimated by OLS. Cointegration relationships arised in almost all VARs, so I actually estimated cointegrated VARs. The residuals showed excess kurtosis in many cases but did not suffer from serial correlation.[6]

I estimated first the responses of the three real GDPs to each shock. They are displayed in Fig. 1 and 2. Each plot reports the Impulse response of a variable to a S.D. shock in the orthogonalised[7] residual of one of the common shocks, within its 95% confidence interval (+2 S.E.,-2 S.E.). The consistent Standard Errors for the impulse responses have been computed following Lütkepohl (1991).

Table 3 summarizes the information provided by the plots. It reports the lag of the maximum response (*peak*) measured in quarters, its sign (*sign*), and whether it is significantly different from zero (*signif*).

There is a clear **asymmetric response** of Spanish, French and German GDP to common external shocks. It is particurarly clear when the shock is to the US GDP. German output reacts first, contemporaneously to the shock, then French output and finally the Spanish one, in a more intensive way than the other two. This sequence indicates a "locomotive" role of German output with respect to France, and of both with respect to Spain.

One possible interpretation is that Spain is less open to external shocks that its EC neighbors (so it reacts later) but is very responsive to their reaction (so it responds more intensively). *France and Germany would appear as transmittors of the common external shocks to the Spanish economy.* This agrees with the second observation drawn from the VAR estimated in section 2, that there is a higher reaction of Spanish variables to foreign shocks than the other way around, especially with respect to Germany.

Table 4 summarizes the responses of German, French and Spanish short-term nominal interest rates, displayed in Fig. 2 and 3.

[6] more information on the statistical properties of the residuals in the Appendix

[7] through a Cholesky decomposition of the estimated variance of the residuals, as before

Short-term interest rates react very similar to GDPs to common external shocks. There is an asymmetric response, characterized by a sequence: it is first the German IR which reacts, then the French one and finally the Spanish IR. But here the Spanish variable does not react more intensively. Spanish interest rates were during the last two decades more responsive to other factors than the external shocks or their transmission through German and French rates. A sensible interpretation is that the domestic economic situation, the domestic monetary policy during the last two decades drove the evolution of the short term interest rates offsetting the external shocks effects.

As the GDPs, German, French and Spanish interest rates responded more in the past years to shocks to the US output than to US rates. The "leadership" often attributed to the US seems to have been more clear in the evolution of the real economy than in the monetary aspects. This is almost evident in light of the progressive monetary unification held in the last two decades by Germany, France and Spain.

Table 5 reports the main features of the responses of the annualized CPI rate of change of the three countries to the common external shocks. Their plots are in Fig. 4 and 5.

A similar sequencial, asymmetric response to common external shocks is observed among the three countries inflation rates. But the responses are almost non significant in most of the cases. Inflation rates respond much more to domestic reasons than to external shocks. This is found especially for the Spanish case.

From this exploration some conclusions can be drawn:

• Evidence is found supporting the **asymmetric response** of Germany, France and Spain to common external shocks, especially US real GDP shocks.

• German real GDP reacts first to external shocks, then French output and finally the Spanish one. This sequence indicates a **locomotive role** of German output with respect to France, and of both with respect to Spain.

• Nominal interest rates respond to external shocks in a similar asymmetric way across countries that real output. This suggest an important **role of interest rates in the transmission of output shocks** between Germany, France and Spain.

• But interest rates react less significantly to common shocks. Inflation rates are even less responsive. Therefore, the observed sequence of output reactions has to be linked through **other variables** than just interest rates responses.

References

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[4] Lütkepohl, H. (1991) Introduction to Multiple Time Series Analysis, Berlin: Springer, 1991.

[5] Newey, W.K. and West, K.D. (1987) *'A simple positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix'*, Econometrica, vol.55, No.3.

Table 3: Response of GDPs to common external shocks

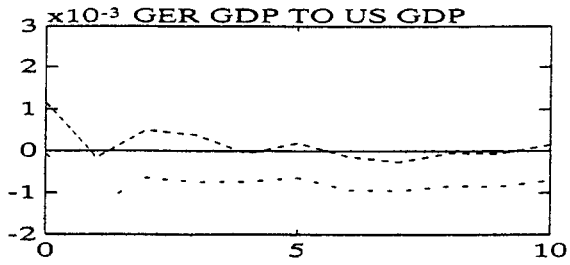
Shock to US GDP			
	peak	sign	signif
German GDP	0	pos	yes
French GDP	5	pos	yes
Spanish GDP	6-7	pos	more
Shock to US IR			
	peak	sign	signif
German GDP	-	neg	not
French GDP	-	neg	not
Spanish GDP	-	neg	not
Shock to OIL prices			
	peak	sign	signif
German GDP	0	neg	not
French GDP	1	neg	not
Spanish GDP	3	neg	yes

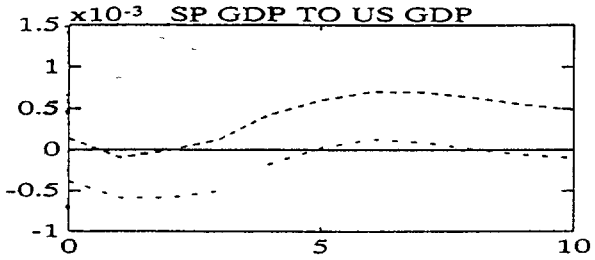
Table 4: Response of IRs to common external shocks

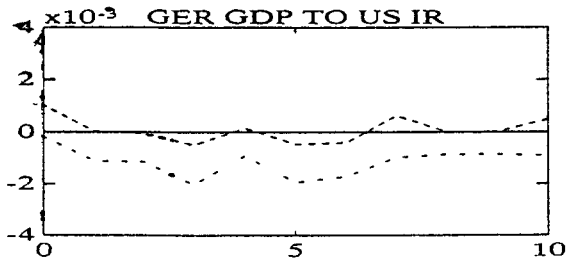
Shock to US GDP			
	peak	sign	signif
German IR	1	pos	yes
French IR	2	pos	yes
Spanish IR	3	neg	not
Shock to US IR			
	peak	sign	signif
German IR	1	pos	not
French IR	2	pos	not
Spanish IR	3	pos	not
Shock to OIL prices			
	peak	sign	signif
German IR	1	pos	not
French IR	1	pos	yes
Spanish IR	-	-	not

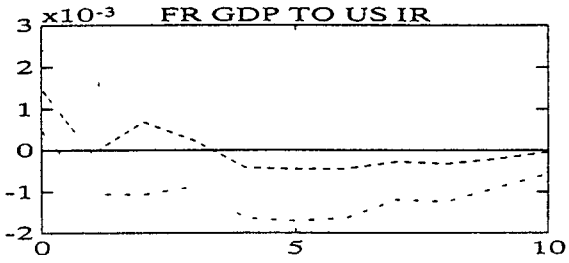
Table 5: Response of IRs to common external shocks

Shock to US GDP			
	peak	sign	signif
German INFL	1	pos	not
French INFL	3	pos	not
Spanish INFL	3	-	not
Shock to US IR			
	peak	sign	signif
German INFL	1	pos	not
French INFL	1	pos	not
Spanish INFL	2	pos	not
Shock to OIL prices			
	peak	sign	signif
German INFL	0	pos	yes
French INFL	0	pos	yes
Spanish INFL	-	-	not









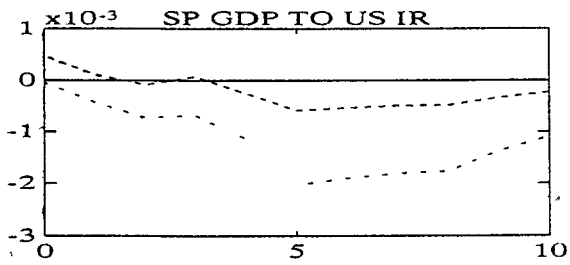


Figure 1 Plots of responses to common shocks

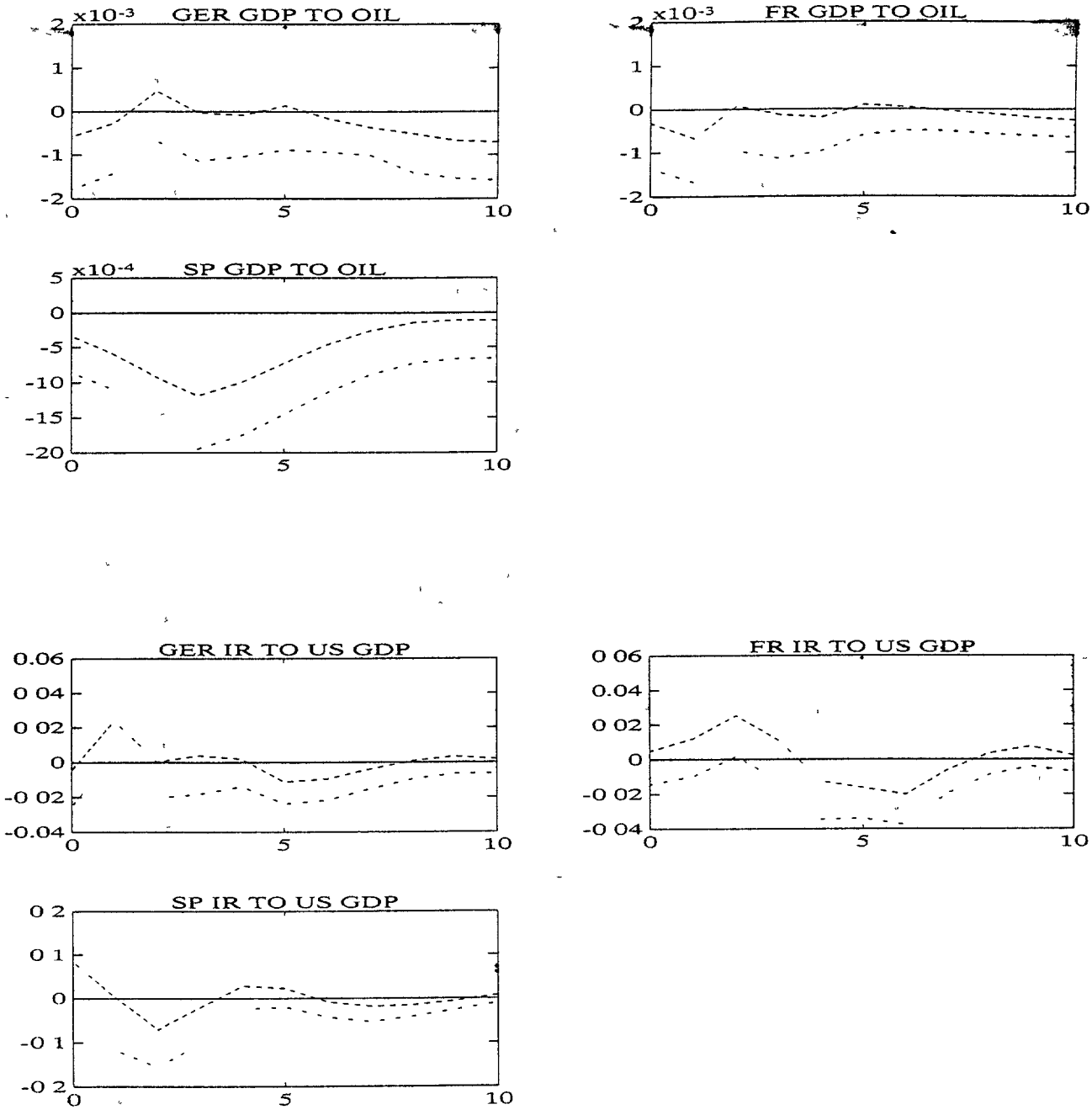


Figure 2 Plots of responses to common shocks

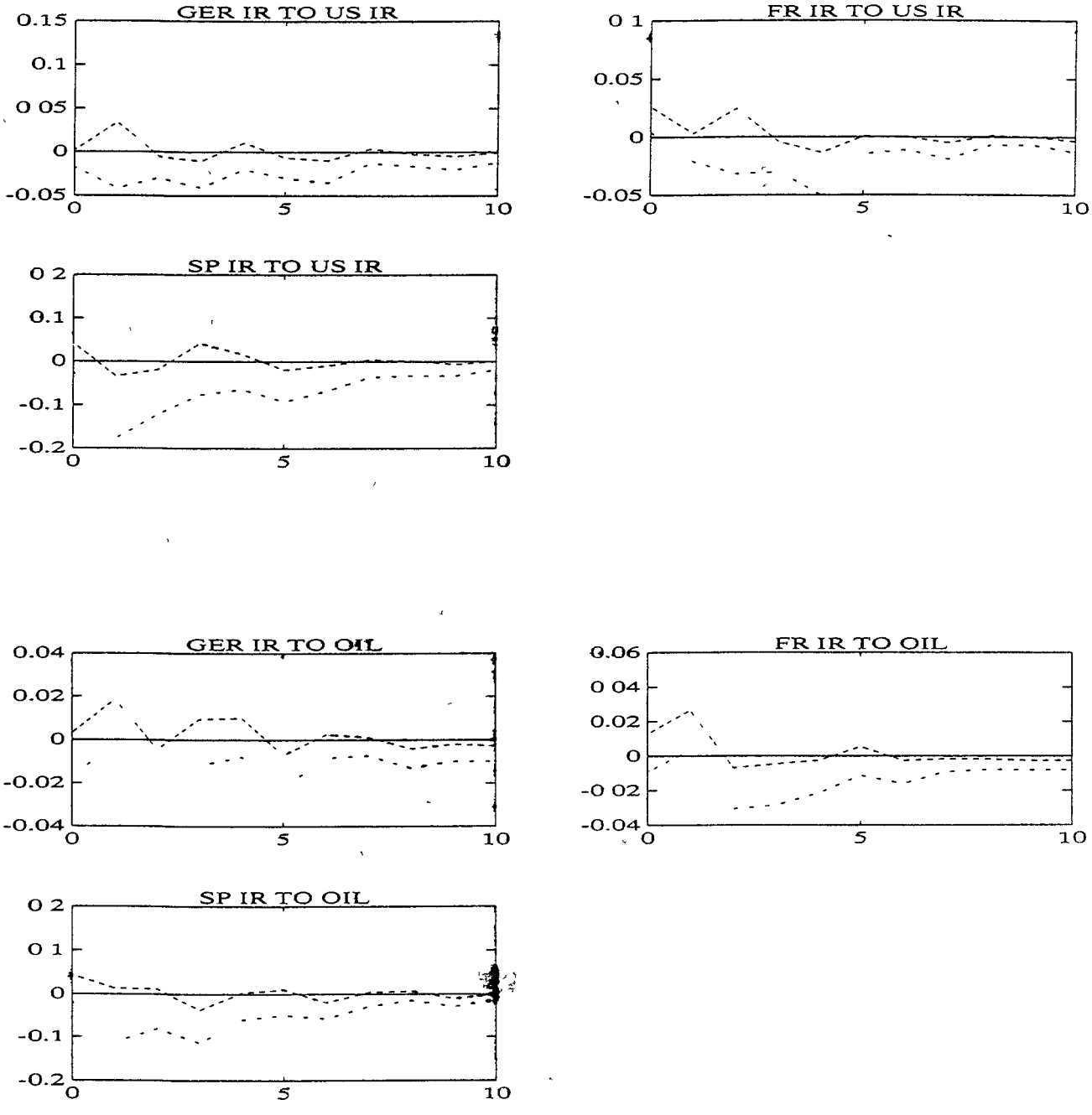
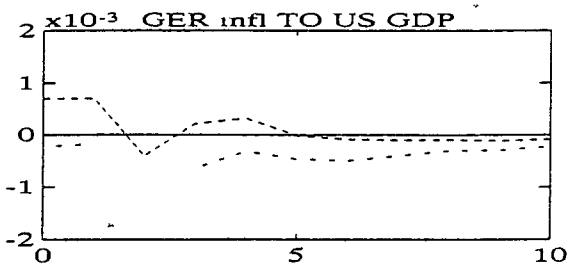
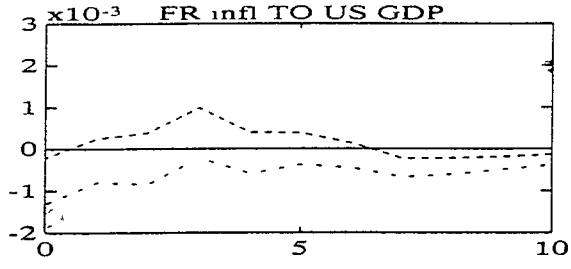
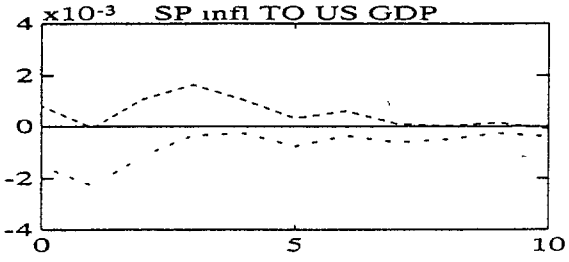
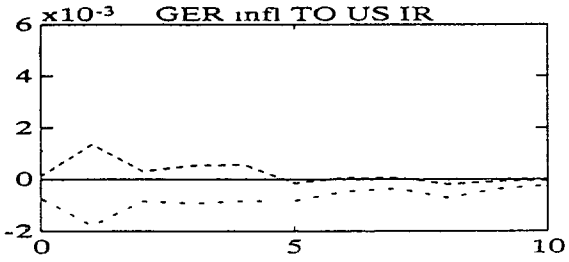


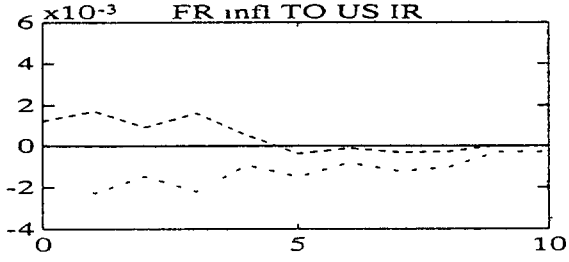
Figure 3 Plots of responses to common shocks











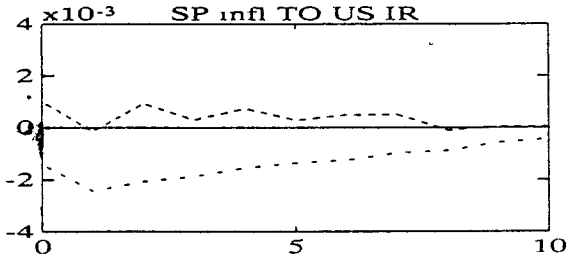


Figure 4 Plots of responses to common shocks

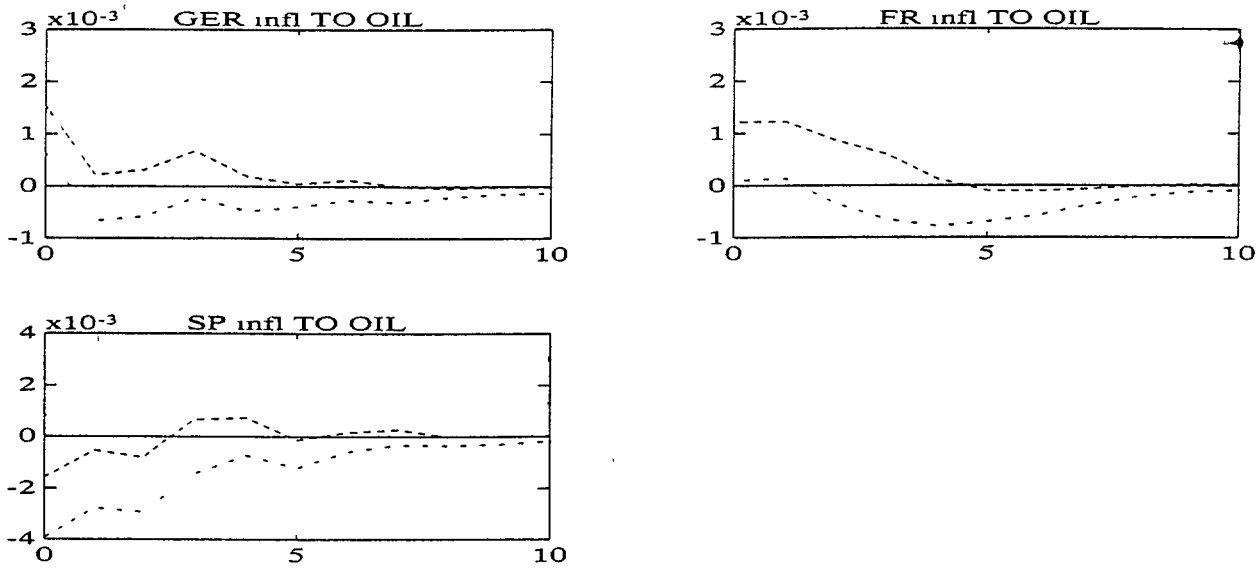


Figure 5 Plots of responses to common shocks

Figure 6a Impulse responses of the BVAR Spain-Germany

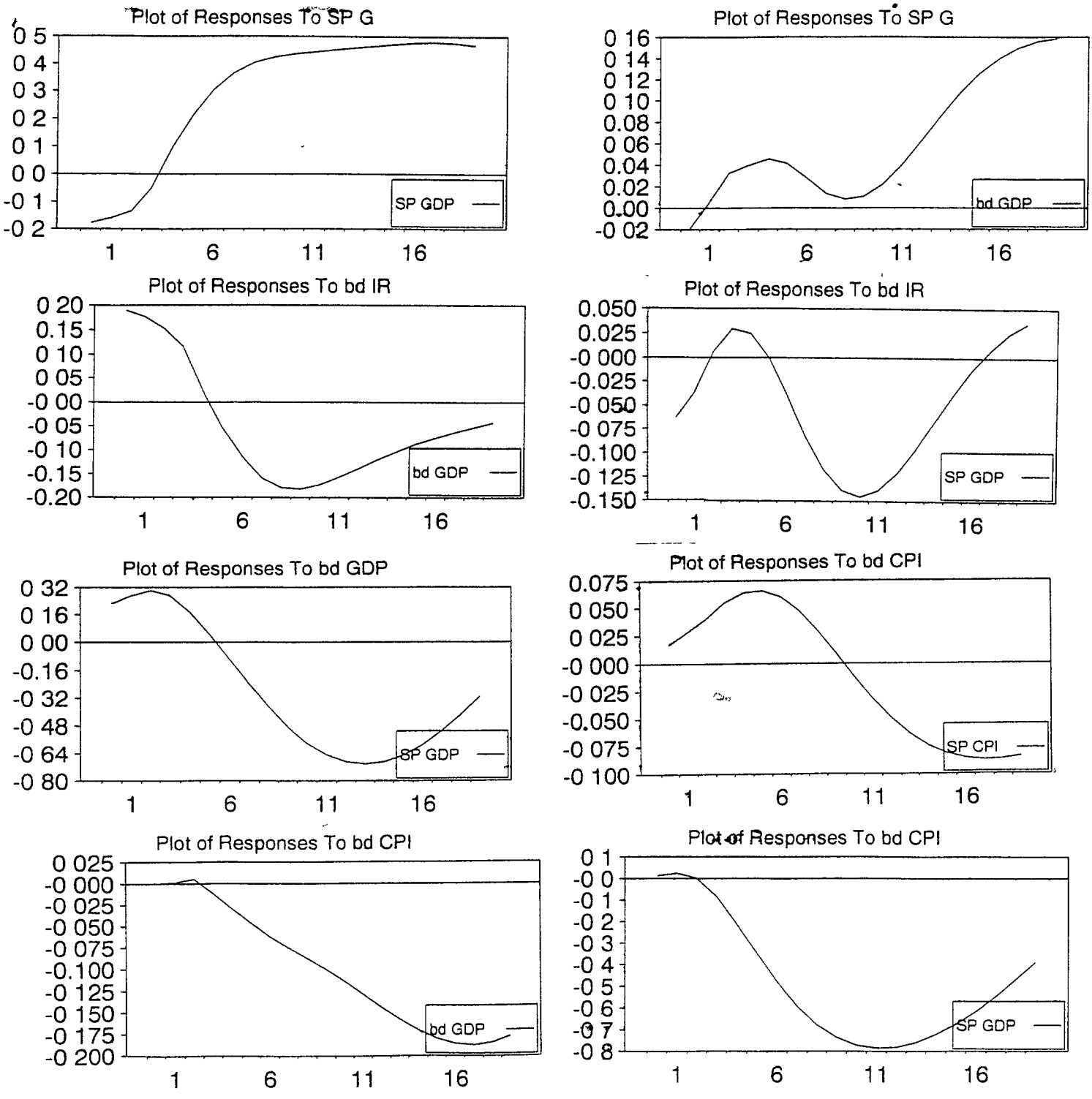
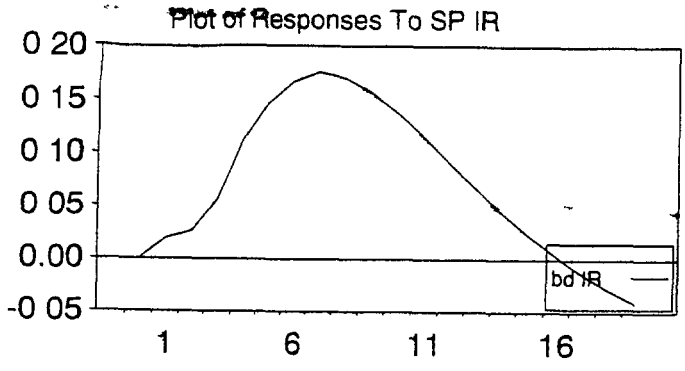
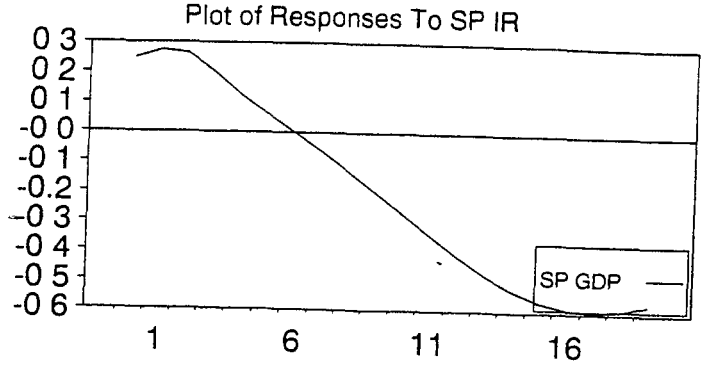
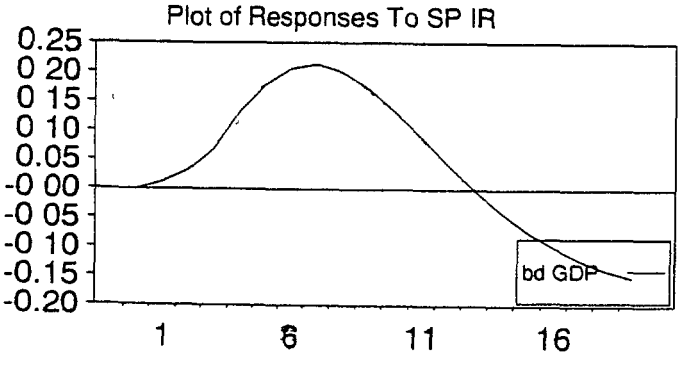
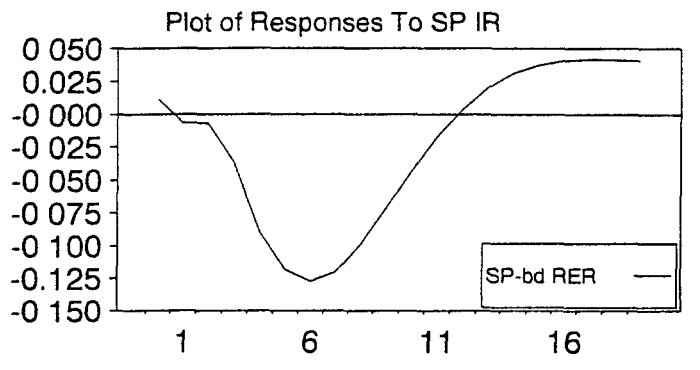


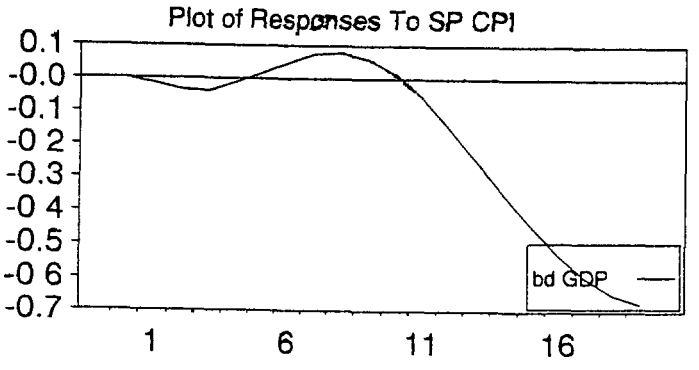
Figure 6b Impulse responses of the BVAR Spain-Germany

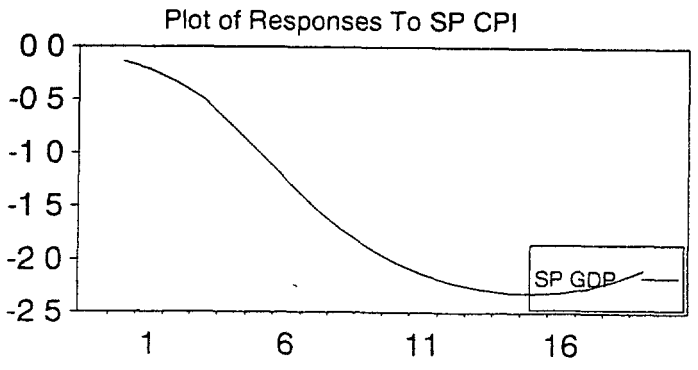


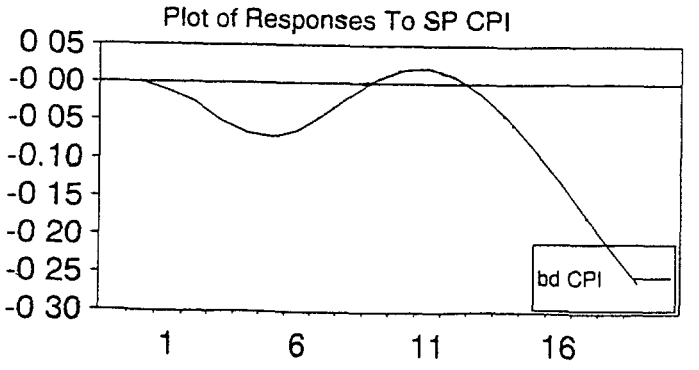












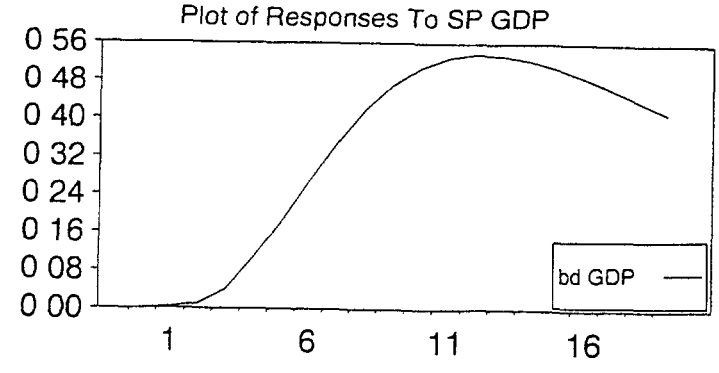
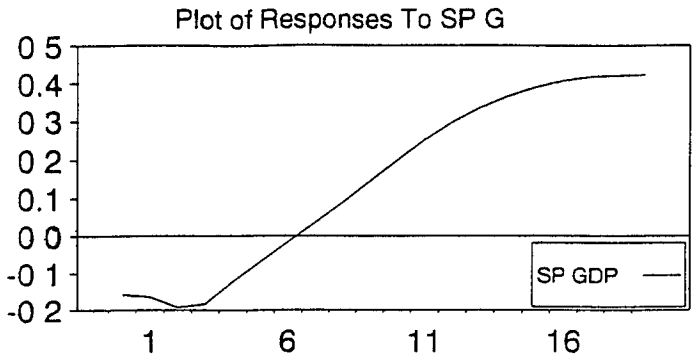
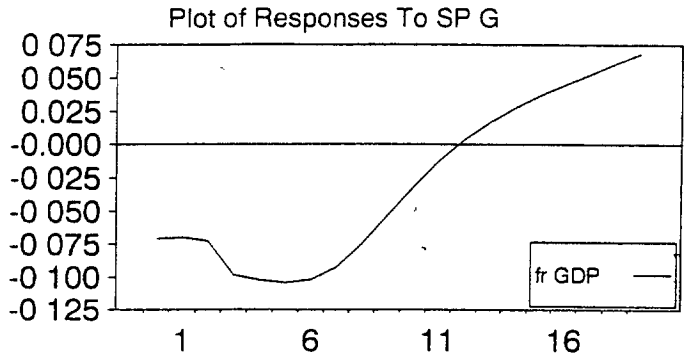
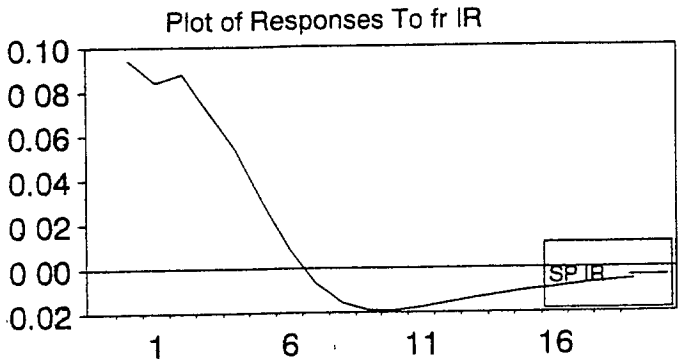
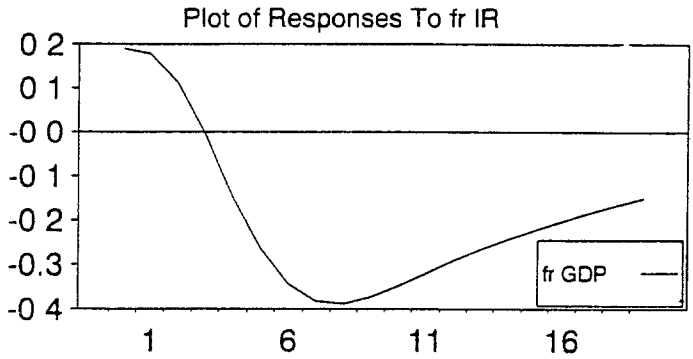


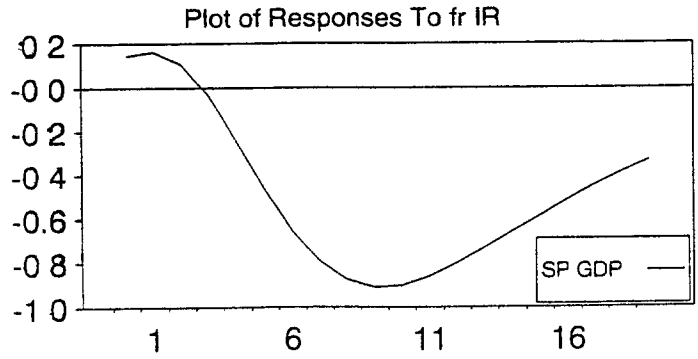
Figure 7a Impulse responses of the BVAR Spain-France

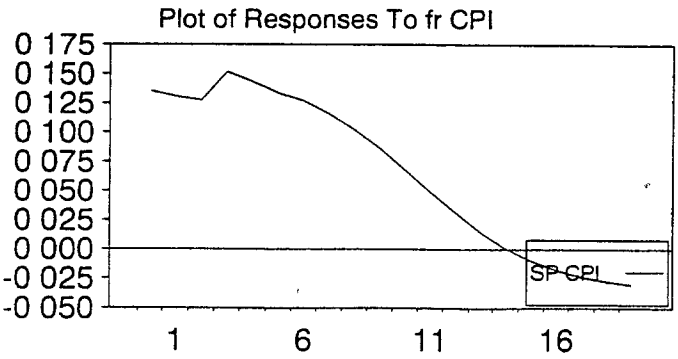


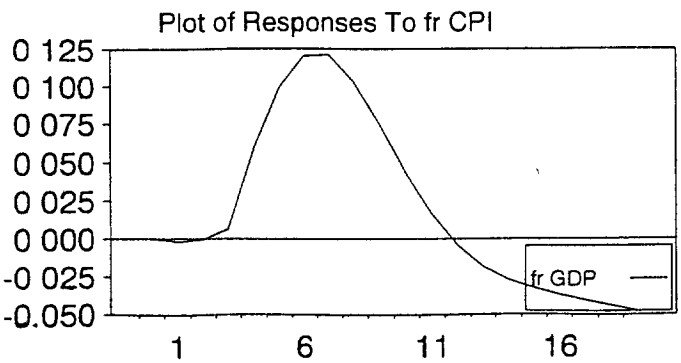












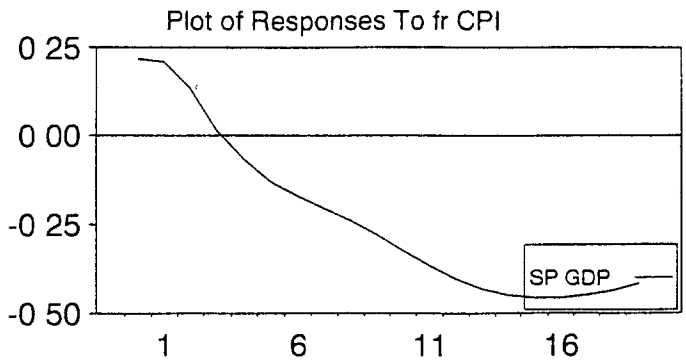


Figure 7b Impulse responses of the BVAR Spain-France