

The transmission mechanism in a changing world*

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October 24, 2002

PRELIMINARY

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Abstract

This paper aims at improving the understanding of the transmission of shocks between different economies and how this transmission may have changed. By employing a model that presents changing transmission mechanism, we show that the transmission of shocks from the US to European countries may change depending on transition variables that characterize changes in financial prices, international capital flows, trade links and monetary policy instruments. We show that the transmission mechanisms estimated with the proposed models for Italy and for Spain have good performance in describing the 2001 downturn compared with VARs.

1 Introduction

The research agenda to which this paper is addressed has been shaped in an important way by the experience of the last downturn in the US. Two aspects of that experience in particular stand out. First, despite some anticipations to the contrary, it appeared that the European economy was strongly affected by the downturn in the US. Second, this cyclical sympathy broke a pattern of desynchronization between the US and the European countries that had held sway for the previous two decades. These points are usefully discussed in International Monetary Fund (IMF) (2001). Between them, these observations point to a need better to understand what links the reactions to shocks in different economies and how these links may have changed through time.

The set-up of the paper reflects these concerns. The central methodological tool of the paper is a trivariate VAR, which focusses on output growth in the US, Germany and one other

*Most of the work for this paper has been done while A. B. Galvão was a Jean Monnet Fellow at the EUI. I am grateful for the hospitality that the EUI had provided me with. We are also grateful to Luisine Lusinyan for compiling most of the database.

European economy (in turn, France, Italy, the UK and Spain). The focus on two poles - the US and Germany - reflects an understanding that for the countries in which we are interested here, these are the two “anchor” economies to which other European economies are likely to display an “affiliation” (see Artis and Zhang (1997)). The goal of the estimation is, first, to define and summarise the impulse response functions to shocks, which are variously defined as “common shocks”, as “purely idiosyncratic shocks” or as “idiosyncratic shocks with contemporaneous spillover”: precisely how these definitions can be enforced, through the concept of the generalized impulse response function due to Koop et al. (1996) is explained below.

Having identified these responses, the second phase of the work is to identify how they have changed over time. The way in which we have chosen to go about this is to focus on changes in the value of variables that may be thought to shape the response of the economy to the initial shock - so-called “transition variables”. For example, it is traditional to assume that trade patterns help to govern the effect of a shock to an external economy on the domestic economy. Frankel and Rose (1998) have documented a positive correlation between measures of bilateral trade intensity and cross correlations of business cycle deviations. So a measure of how trade patterns have changed may help to account for the way in which the impulse response function of the economy with respect to external shocks has changed. In a similar fashion, it has been argued that the nature of the financial system has a bearing on the speed of pass-through of a shock to the economy: so changes in the financial system may have a bearing on changes in the impulse response function. There has been a certain amount of work in this area (e.g.. Andreou et al. (2000)) which (especially for financial variables) has emphasized the potential importance of non-linearities in the responses; accordingly we also take explicit account of possible non-linear features in the present paper.

The agenda of this paper is relatively ambitious. We start with the simplest, wholly linear, set-up, with a view to explicating the shock-identification scheme we are using. In section 3 we then move on to a discussion of a method to select transition variables that are able to characterize changing transmission mechanisms. In the same section, we present the results of the procedure to select transition variables including generalized impulse responses that represent different responses for different regimes. The changing regime models with the chosen transition variables are then employed to predict the response of the economies to a possible external and common shock in 2001 in section 4.

2 The linear transmission mechanism

In this section we analyze the transmission of shocks across countries using a standard VAR based methodology, with several alternative definitions of shocks and related generalized impulse response functions, aimed at discriminating among transmission channels. The first subsection briefly reviews the econometric methodology and defines the shocks. The second subsection presents and discusses results.

2.1 Shocks and responses

The time profile of the effect of a shock on the behavior of the output growth from each country is observed using impulse response functions derived from a VAR that is able to characterize dynamic interdependencies on countries' growth. For example, a VAR built for, the output growth of Germany, the US and another European country, for example, Spain, can be employed to verify how shocks outside Europe affect the economic growth of Spain taking into account the Spanish dependence of Germany. The analysis of the responses to shocks depends on the type of shock, including the composition effects of the impact, the history of the system before the shock hits it and the shocks that are assumed to hit from $t + 1$ to $t + N$, where N is the maximum horizon taken into account. In this paper we employ the concept of generalized impulse response proposed by Koop et al. (1996). This approach allows us to build the time profile of shocks conditional on a specific set of history and a type of shock and it assumes that "normal shocks" (i.e., the average of future and past shocks) keep hitting the system over horizons. When one would like to observe indirect effects of causality relations, this is the approach to use, as suggested by Dufour and Renault (1998).

Formally, we estimate a VAR with autoregressive order p for the k dimension vector of time series $y_t = (y_{1t}, \dots, y_{kt})$. Using the estimated autoregressive parameters and constants, we calculate the transmission of a $k \times ns$ matrix of shocks v compared to the dynamic of the system when only "normal shocks" hit the system. Thus, the generalized response of the series in y_t to the shocks v_t at horizon n conditional on the history W_{t-1} is defined as:

$$GI_Y(n, v_i, W_{t-1}) = E[y_{t+n}|v_i, W_{t-1}] - E[y_{t+n}|W_{t-1}]. \quad (1)$$

In the case of a linear VAR, the GI is independent of W_{t-1} but it is dependent on the composition of shocks defined in v (Pesaran and Shin, 1998). Although the conditional means of (1) could be calculated analytically for linear models, we employed a simulation procedure as proposed by Koop et al. (1996), which is also employed later on for models in which the response may depend on the history W_{t-1} . The procedure is described in the appendix. Because the GIs are computed based on an estimated model, a 95% confidence interval is computed using bootstrap, which is also described in the appendix.

Specifically to the the problem addressed in this paper, we suppose that y_t is always tri-dimensional and includes the output growths of the US $y_{US,t}$, representing the rest of the world (or a large country), and of Germany $y_{ger,t}$, representing the largest economy in Europe, and another European country from the following set {France, Italy, Spain and UK}. This VAR representation aims to provide an account in which the economies of the US and Germany are taken as the leading "anchor" economies which may provide a focal point or attractor for the set of European economies we have in view. There is some evidence for our period that most European economies can be thought of as moving from a US sphere to a German one - though the UK is a traditional exception (see Artis and Zhang (1997)) for this claim.

Based on this arrangement, we consider three types of shocks to the US or the German GDP growth. Pure idiosyncratic shocks (PIS) have no contemporaneous effects on other countries. For example, when the source of the shock is the US, a PIS is defined as the vector $(0,0,1)$. Idiosyncratic shocks with spillovers (SIS) originate in a single country but can have contemporaneous effects on the other countries, as measured by the covariance matrix of the VAR residuals. For example, in the case of a shock from the US, the SIS is defined by the vector $(\sigma_{13}/\sqrt{\sigma_{11}\sqrt{\sigma_{33}}, \sigma_{23}/\sqrt{\sigma_{22}\sqrt{\sigma_{33}}, 1})$, where σ_{ij} is the element in the i^{th} row and j^{th} column of the covariance matrix of the residuals in the proper VAR. Finally, a common shock (COS) is represented by a one-standard-deviation shock in each of the countries under analysis with no contemporaneous effects across countries. In particular, a COS is defined in vector notation as $(\sqrt{\sigma_{11}}/\sqrt{\sigma_{33}}, \sqrt{\sigma_{22}}/\sqrt{\sigma_{33}}, 1)$.

The response of the systems to these three types of shocks can provide useful information for understanding the transmission mechanism across countries. In particular, if the effects of PIS and SIS are very similar, then the contemporaneous spillovers across countries are very limited. This is what would be expected with the traditional trade-related explanations of the transmission mechanism. If, instead, the transmission passes to a considerable extent through financial markets, then contemporaneous substantial spillovers can be expected. The comparison with COS is important, for example, to evaluate whether the recent decline in GDP growth that affected both the US and the European countries can be explained by spillover effects from the US or whether it is more likely due to the fact that the shock was to a large extent common across the US and Europe. It is the former assumption that has awakened interest in the possibility that the channels of transmission have changed (as suggested by the International Monetary Fund (IMF) (2001)) because the trade channel seems incapable of producing such a large and speedy effect. To the extent that the shock was more common than often assumed, this puzzle largely disappears.

2.2 Results

Let us start by comparing the effects of a PIS and SIS shock to the US on European countries. The relevant responses are reported in the first row of Tables 3, 4, 5, for, respectively, $h = 1, 4, 8$, namely, after one quarter, one year and two years.

A first important finding is that for virtually all countries and horizons the responses are larger when contemporaneous spillovers are allowed for. Yet, in most cases the difference between the effects of a PIS and SIS shock is not statistically significant, in the sense that the response to a SIS shock falls within the 95% band around the estimated response to a PIS shock.

In the presence of spillovers, the ranking of the countries in terms of the size of the effects partly depends on the horizon. After one quarter, i.e. $h = 1$, these are largest for the UK (0.54), with Germany ranked second (0.43), and smallest for Italy (0.08). Yet, the shock is

substantially amplified in the case of Italy: one year after the shock the cumulated response is 0.67 (2.7 percentage points in the annual GDP growth), as large as the one for the UK, while for France the corresponding figure is 0.36 only. The effects are basically exhausted after one year, indeed the figures for $h = 8$ are very close to those for $h = 4$, compare Tables 4 and 5.

When the shocks are common, the reaction of the European countries after one quarter happens to be equal or larger than the size of the US shock, with values in the range of about 1 for France and Spain, to about 1.3 (5.3 percentage points in the annual GDP growth) for Italy and the Germany (1.22 for the UK). As in the spillover case, the shock has increasing effects in the case of Italy, with a value of 2.08 for $h = 4$ and 1.86 for $h = 8$. A similar pattern is observed for Spain, while the propagation in Germany and the UK dies out faster, the figures for $h = 4, 8$ are, respectively, 1.61 and 1.64 for the UK and 1.42 and 1.43 for Germany, and even faster for France with values of 1.07 for $h = 4, 8$. It is worth mentioning that in most cases the standard errors are large, so that few differences in the responses across countries are statistically significant.

When Germany is the source of the shock, again the effects are systematically larger when spillovers are taken into consideration. Focusing on the PIS shock, the effects are smaller than in the case of a US shock for the UK and Spain and of comparable size for France and Italy. A common feature across countries is that the response dies out quicker than in the case of a US shock. The reaction of the US to a German shock is always smaller than that of Germany to a US shock, but positive and significant.

In summary, four interesting patterns emerge from this analysis. First, spillovers are important but common shocks are required to generate larger changes in GDP growth. Second, the cumulated responses to shocks are typically concave, with most of the effects taking place within one year. Third, there emerge some differences across countries in the responses, with Italy reacting most and France least. Finally, for the UK shocks originating in the US are more important than German ones, but also for the other countries German shocks are not more important than US ones. In the next section we evaluate whether these results remain valid when more complicated models are fitted to the data. In particular, in these models the responses can vary over time and depend on the sign and magnitude of the shocks.

3 The changing regime transmission mechanism

One of the puzzles posed by the apparent near-synchronicity in the down turn of the US and Europe in the most recent experience is that the traditional channel for transmission of a shock or cyclical phase from the US to Europe, that of trade, seems to be incapable of rendering such a fast or large transmission. This suggests therefore that (to the extent to which the common shock element is absent), the spotlight must move to alternative channels of transmission. As detailed below, it is possible to conceive of a number of variables, important to the transmission of shocks, that might have changed over time, so as to assume greater significance in recent

times (especially if accompanied by a non-linearity in response).

In this section we first describe a set of variables whose evolution could affect the propagation of shocks across countries. Then we discuss how their role can be formally evaluated within an econometric framework. In the third subsection we present the results of this analysis.

3.1 Transition variables

The variables possibly affecting the shape and speed of shock transmission are listed in Table 1. The variables are taken as the standardized value of the transition variable of the first country in the VAR, with exception of the monetary policy variables that are expressed as the difference between the standardized value of the chosen country and the corresponding variable for Germany.

It is convenient to divide the transition variables into 8 groups. The first group contains short term interest rates and money supply, as proxies for monetary policy instruments. This is justified by the convergence in interest rates that characterized the path towards the monetary union. The second group contains financial variables such as exchange rates, share prices, and long term interest rates. These variables can capture both the substantial liberalization that took place in financial markets and the expectations of market participants. The third group focuses on financial market structure and tries to capture differences between bank based and market based financial systems. It includes variables such as the ratios of stock market capitalization or activity to GDP, and deposit or private bank credit to GDP. The fourth group is also related to financial integration but looking at financial flows. Hence, there are variables such as net international deposits to GDP, and the external assets to liabilities ratios for German and US banks. The fifth group focuses on trade integration and includes trade and terms of trade. The sixth group captures differences in the structure of the economies and contains proportions of different sectors' value added. The seventh group looks at structural natural characteristics of the economies and in particular at the availability of energy. Hence, it includes variables such as oil imports to GDP and net mineral fuel to GDP. Finally, we have included the unemployment rate, as a crude proxy of differences in the labor markets.

Though this list of variables is not exhaustive, it provides quite an extensive range, definitely larger than anything evaluated in the literature so far, to the best of our knowledge.¹

The transition variables we have chosen come in at least two basic forms. The canonical transition variable is one that describes the “structure” of the economy - these are things like measures of the goods and labour markets and the financial markets. Economists have recently articulated arguments about why flexible labour markets lead to less unemployment persistence and less persistence of output loss: these same arguments suggest that a measure

¹A forthcoming paper by Barrios et al. (2002), exploits a somewhat similar approach, though drawing on a more limited range of possible variables; the objective in the Barrios et al paper however is to explain differences among cyclical cross correlations over a period of time between UK regions and some EMU countries rather than to examine any differences that might be time-varying.

of labour market flexibility or rigidity is directly of interest to us, because it will bear directly on the propagation mechanism that attaches to an initial shock. (Unfortunately we have not obtained a proper measure of labour market rigidity/flexibility but have had to fall back on unemployment for the moment). Similarly, economists have argued that the structure of the financial markets - whether “bank-based” or “market-based” - may have implications for the propagation mechanism of shocks: e.g., market-based systems are generally supposed to pass through interest rate shocks more rapidly from the short to long end of the market than bank-based systems; and bank-based systems are often associated with the idea that they “nurse” firms through bad times - which sounds as though it may have implications for the shape of the propagation mechanism. When it comes to goods markets it is common to find reference being made to measures of industrial diversification, relative reliance on services or the relative importance of energy sources; they should perhaps be considered in association with measures of trade intensity which pertain to the geographical direction of trade. Between them, these measures seem more likely to tell us about the differential impact of shocks arising from different points overseas than to carry implications for the propagation mechanism for an undifferentiated shock. Indeed in the analysis that follows structural variables do not determine any regime changing behaviour in the transmission mechanism, the reason being that lack of information created by short time series data availability.

Not all the variables we have selected to consider as transition variables have this “structural” characteristics: market-based variables and conjunctural policy variables (i.e., interest rates, exchange rates, monetary aggregates, stock market prices) may also be relevant to the speed with which a given shock works through the economy. The question here is that such variables are likely to be endogenous to the output growth rates we model: we ignore this in the modelling treating transition variables as exogenous variables. Figure 2 shows the chosen transition variables and they do not seem to characterize business cycle behaviour, so the cost of this restriction to model changes in the transmission of international business cycle shocks is rather small.

3.2 A formalization

Given an exogenous transition variable z , the covariance structure of the vector y_t changes over time given the values of the function $F_t(z_{t-d})$, where d is the delay. The values of the function are between 0 and 1 and the transition between regimes could be abrupt or smooth. In this type of VAR model, the transmission of shocks depends on initial conditions.

Formally, an observed transition VAR (OT-VAR) is written as:

$$y_t = [c_1 + A_{1,1}y_{t-1} + \dots + A_{1,p}y_{t-p}](1 - F_t(z_{t-d})) + [c_2 + A_{2,1}y_{t-1} + \dots + A_{2,p}y_{t-p}]F_t(z_{t-d}) + \varepsilon_t, \quad (2)$$

where $A_{s,j}$ is the $k \times k$ matrix of autoregressive coefficients of regime s and lag j , c_s is a $k \times 1$ vector of constants of regime s , $F_t(z_{t-d})$ is a $k \times 1$ vector of values of a transition

function that depends on a different set of parameters in each equation of the system, so $F_t(z_{t-d}) = (F_{1,t}(z_{t-d_1}), \dots, F_{k,t}(z_{t-d_k}))$. The transition function $F_t(z_{t-d})$ can be a logistic or an indicator function, characterizing smooth or abrupt transitions across regimes. The logistic function is $F_{i,t}(z_{t-d_i}) = G_{i,t}(z_{t-d_i}; \gamma, r) = \frac{1}{1 + \exp(-\gamma(z_{t-d_i} - r)/\sigma_{z_{t-d_i}})}$, where γ is the smoothness parameter, r is the threshold and $\sigma_{z_{t-d_i}}$ is included to make γ scale free. The indicator function is $F_{i,t}(z_{t-d_i}) = I_{i,t}(z_{t-d_i}; r) = 1(z_{t-d} \geq r)$, which is equal to one when the inequality is true and equal to zero otherwise.

For the purpose of modelling dynamic changes of the interdependence of economic fluctuations across countries, the restriction that each equation of the system has the same transition function $F_{1,t}(z_{t-d_1}) = \dots = F_{k,t}(z_{t-d_k})$ is imposed in the general model described in equation (2). Then all equations of the system have their dynamic changing at the same regime aiming at reproducing changes of the transmission of shocks across countries without taking into account shifts of only a particular country.

Although smooth transitions have the appeal of modelling slowly shifts between regimes, we decide to estimate only threshold VAR models. The reason is that it is difficult to estimate the parameters of smooth transitions with short samples as the ones of this paper (116 observations and even less) because there is not many observations in the neighborhood of the threshold. This problem is solved with threshold models allowing a minimum number of observations in each regime. In addition, threshold VARs allow the variances of shocks to change between regimes which is an advantage when one wants to characterize changes in the generalized impulse response functions across regimes.

Assuming that one knows p and z , the procedure to estimate models with abrupt transition (OAT-VAR) are described in the appendix B. The determination of autoregressive order and the delay is also described in appendix B.

3.3 Selection of Transition Variables

Given the set of transition variables described in section 3.1, the procedure to choose the appropriate transition variable is described in Appendix C. The procedure has three steps: (1) a test that resembles the linearity test described in Teräsvirta (1998), (2) a selection of transition variables that specify OAT-VARs with smallest information criteria, (3) the choice of the transition variables that generate statistically different responses between regimes based on generalized impulse responses, conditional on the history of each regime.

In Table 2, we present the selected transition variables in the second step. Both classes of possible transition variables that characterize the structure of the economy has not been chosen in this step because these variables have a shorter data availability (around 80 observations) which is not informative enough to obtain any significant changes in the transmission mechanisms due to the changes in the economic structure. Three main points are raised from the analysis in Table 2. The first one regards similarities in the choice among the available classes of transition

variables for Italy and for Spain in contrast to those for the UK and for France. In the case of the former countries, variables related with trade and labour market were chosen, while in the latter countries' variables that measure need of oil imports were selected. Second, at least one measure of monetary policy differential was selected for each country analyzed. Finally, the choice of the financial variables indicate two important markets for the transmission of shocks: currency and stocks.

3.4 Results

The responses to US and German shocks from the OAT-VARs with transition variables chosen in the second step are reported in Tables 3, 4, 5, for, respectively, $n = 1, 4, 8$. Compared to the point estimates and the 95% confidence intervals of the linear models, the majority of the OAT-VARs estimated with the chosen transition variables have a significantly different response in one regime or another, depending on the type of shock. However, in the case of few models the transmission mechanism of both regimes is statistically different. The shaded variables in Tables 3, 4 and 5 represent variables in which the responses are asymmetric across regimes based only on the confidence intervals of the SIS - US shocks because of the long time of computation required to calculate the confidence intervals by bootstrap (see appendix A).

We do not find evidence of any changing behavior in the transmission mechanism when France and Germany respond to external shocks for all the horizons.

For Italy, there is an evidence of changing transmission mechanism for four variables when $n = 1$ and for two variables when $n = 8$. The first two variables are changes in the real effective exchange rates (DREER) and in the stock prices (DSPI1) that characterize currency and stock market conditions. When the real effective exchange rate of the Italian currency was increasing six quarters previously, the response to SIS - US is quite muted at $h = 1$ but it increases fast up to $h = 4$, by contrast when the opposite occurs, the response is two times larger at $h = 1$ but it is equal at $h = 8$. The responses of the same type of shock with origin in Germany have different behavior. Analyzing the results using DSPI1 as transition variable indicates that when the stock prices had decreased seven quarters previously, the economy is now more susceptible to common shocks but not to shocks with origin only in Germany or the US.

Figure 2 presents the plot of transition variables and transition functions against time chosen for Italy. The proportion of the GDP net international bank deposits (BIN) and the proportion of Italian trade with the other European countries in the sample (TRADE) are transition variables that imply transition functions that show slower changes in the economy than DREER and DSPI1. When Italy is a net exporter of bank assets two years ago, the effect of shocks today is significantly larger. This suggests that Italy is more vulnerable to shocks when it has invested abroad. In contrast, larger proportions in trade with Europe decreases the vulnerability of Italy.

For Spain, two variables were chosen across all horizons: the DREER and the DSPI1,

similar to Italy. When DREER is employed as transition variable, the asymmetries across regime differ depending on the type of shock: a common one or a SIS. In the latter case, large positive increases in the real effective exchange rate one year ago makes the Spanish economy today more vulnerable to a German or a US shock but much less vulnerable to a common shock. When DSPI is the transition variable, the responses in the upper regime depend on the type of shock. The response of the US shocks is relatively small compared to the response of a German or common shocks.

For the UK, the chosen transition variable shows an interesting monetary policy behavior: when the UK interest rate is too low compared with the one in Germany one year ago, the economy today is more fragile with strong responses to shocks. As argued in section 2.1, a possible problem of this transition variable is that short-term interest rate is treated as exogenous while it could also be responding to business cycle shocks, given that it is a monetary policy instrument. However, the figure 3 shows that the last change in regime was in 1991, illustrating that the transition function is not taking into account normal monetary policy changes. Observing the same figure, our results seem to suggest that the UK is being more susceptible to external shocks today than at the end of the 1980's.

In summary, the chosen transition variables characterize changes in the transmission of external shocks depending on transition variables that represent financial prices, international financial flows, trade integration and dissimilarities in monetary policy.

4 Using the estimated changing transmission mechanisms to analyze the 2001 downturn

The previous section presented some evidence of regime changing behavior in the transmission mechanism of external shocks to Italy, Spain and UK. In this section, we present predictions based on some chosen models of the changes in GDP growth in Italy, Spain, UK, France and Germany as response to a US shock with contemporaneous spillovers and a common shock.

In Table 6, we analyze whether the downturn that occurred in 2001 in the majority of the European economies can be characterized by either US shock or a common shock. We present the annualized growth rate at 2000:4 in the first column and the actual annual growth rate of 2001 in the last column for the corresponding countries. To measure the effect of a US shock with contemporaneous spillover (SIS - US), we employ multipliers based on Tables 3, 4 and 5 that are based on a 1% shock on quarterly basis, so we need some simple calculations to get the response to a 2% shock on annual basis. Similarly, we can use the results of Tables 3, 4 and 5 to get responses to a 2% common shock normalized by the US shock. Supposing that if there is no shock, the economy will be growing at the same rate as 2000:4, we calculate the predicted growth rate for 2001 after the shock as the response at $n = 4$ plus the growth rate at 2000:4.

The expected responses for a common shock are able to characterize the downturns in France, Italy and Spain, but they over-estimate the response for Germany and the UK. The

main weakness of the presented results is the spectacular over-estimation in the response of the UK economy to a shock with the OAT-VAR that employs the short-term interest rate spread with Germany as transition variable. The reason for that is in the estimation period, low UK interest rate in respect to the German interest rate was a sign of weak UK economy, responding strongly to external shocks. This is not the case of the actual period however. In contrast, the OAT-VAR for Spain and Italy present estimates that imply weaker responses to shocks compared with the linear VAR that characterizes better the response of Spain and Italy to shocks in 2001.

Based on our estimated VARs, we concluded that the 2001 downturn of European economies is better characterized by a common shock than by a shock with origin in the US.

5 Conclusion

By employing a model that presents changing transmission mechanism, we show that the transmission of shocks from the US to European countries may change depending on transition variables that characterize changes in financial prices, international capital flows, trade links and monetary policy instruments. We show that the transmission mechanisms estimated with the proposed models for Italy and for Spain have good performance in describing the 2001 downturn compared with VARs.

Future research could exploit the OT-VARs proposed in this paper to account for changes due to monetary policy in the monetary transmission mechanism. In addition, different econometric techniques could be useful for exploiting better the information content of the variables that characterize economic and financial structure, given that their limited availability constrained their application in a VAR context.

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A Generalized Impulse Responses

The generalized impulse responses (GI) are computed based on an estimated VAR or OT-VAR (equation 2). The past values of the vector of endogenous variables y_t and of the transition variable z_t are written as $W_{t-1} = (y_{t-1}, \dots, y_{t-p})$ and $Z_{t-1} = (z_{t-1}, \dots, z_{t-d_{\max}})$ and are used to build a matrix of histories $\Omega_{t-1} = ((W_{t-1}, \dots, W_{T-1})', (Z_{t-1}, \dots, Z_{T-1})')$. This matrix of histories is partitioned to obtain GIs conditional on the regime when calculating GIs for the OT-VARs. In that case, the first partition Ω_{t-1}^1 has the rows of Ω_{t-1} such that $F_t(z_{t-d}) = 0$ and the second partition Ω_{t-1}^2 has the rows of Ω_{t-1} such that $F_t(z_{t-d}) = 1$.

GIs are computed to five types of shocks, then the $5 \times k$ matrix of shocks is $v = (v_1, \dots, v_5)'$, where v_1 and v_2 are PIS and SIS with origin in the US; v_3 and v_4 are the same type of shocks with origin in Germany; and v_5 is COS, standardized by the US values. We build GIs conditional on each of these 5 combinations of type and origin of shock. Because the determination of the regimes depends upon an exogenous variable, we do not expect size or sign effects given that the shock does not influence the regime changing mechanism.

The responses from the OT-VAR for horizons larger than $t + d$ depend on predictions of z_t . Thus we use data simulated from an AR(p) of z_t to obtain a sequence of values of the transition variables z_t, \dots, z_{t+n} . The autoregressive order of an AR for the full sample is obtained by minimization of the SIC including a drift. The residuals η_t of the AR(p) of z_t are saved to be used in the calculation of the conditional means of the GIs.

The algorithm employed to obtain $GI_Y(n, v_i, \Omega_{t-1}^j)$, which is the GI at horizon n conditional on a type of shock in v and one subset of histories of Ω_{t-1} , is:

- (1) Pick one row of shocks from the matrix v_i and pick one of the subsets Ω_i^j of the matrix Ω_{t-1} .

- (2) Pick one of the rows of Ω_i^j .
- (3) Use these vectors to compute $y_t^{s,m} = f(\Omega_{t-1}, \theta) + v_i$, where θ is a vector with all the estimated parameters of the model. This calculates the impact of the shock.
- (4) Draw a sub-sample ϵ^* of size $N + 1$ by bootstrapping from the residuals ϵ . When calculating GIs for the OT-VAR, draw also a sub-sample η^* of size $N + 1$ by bootstrapping from η , which are the residuals of the AR(p) of z_t .
- (5) Use η^* to get a sequence z_{t+0}, \dots, z_{t+N} given the estimated AR(p) conditional on Z_{t-1} . Use ϵ^* , the sequence z_{t+0}, \dots, z_{t+N} , and the estimated VAR to get $y_t^{ns,m}, \dots, y_{t+N}^{ns,m}$. This calculates a sequence that describes the dynamic of the system when there is not a shock.
- (6) Use z_{t+0}, \dots, z_{t+N} , $y_t^{s,m}$, the first N observations of ϵ^* and the estimated VAR to get $y_{t+1}^{s,m}, \dots, y_{t+N}^{s,m}$. This computes the dynamic effect of the shock. .
- (7) Repeat steps 3 to 6 M times (800 in our tables). Thus, obtain $E[y_{t+n}|\Omega_i^j, v_i] = \frac{1}{M} \sum_{m=1}^M y_{t+n}^{s,m}$ and $E[y_{t+n}|\Omega_i^j] = \frac{1}{M} \sum_{m=1}^M y_{t+n}^{ns,m}$. In this way, steps 3 to 6 are aimed at calculating the conditional expectations. Note that this could be calculated analytically for the linear VAR but not for the OT-VAR. We use the same algorithm for both cases.
- (8) Pick another row of Ω_{t-1}^j and repeat the procedure from 3 to 7 until all rows are considered.
- (9) Average the conditional means over stories to get $E[y_{t+n}|\Omega_{t-1}^j, v_i]$ and $E[y_{t+n}|\Omega_{t-1}^j]$, so $GI_Y(n, v_i, \Omega_{t-1}^j) = E[y_{t+n}|\Omega_{t-1}^j, v_i] - E[y_{t+n}|\Omega_{t-1}^j]$.
- (10) Select another combination of shock in v_i and subset of histories Ω_i^j and repeat steps 2 to 9 until all possibilities are exhausted. This will generate a set of different GIs conditional on the shock and the set of histories.

Specifically for OAT-VARs, we generate data based on the following formulation: $y_t = [c_1 + A_{1,1}y_{t-1} + \dots + A_{1,p}y_{t-p} + \epsilon_t^{*1}](1 - F_t(z_{t-d})) + [c_2 + A_{2,1}y_{t-1} + \dots + A_{2,p}y_{t-p} + \epsilon_t^{*2}]F_t(z_{t-d})$, where ϵ_t^{*1} and ϵ_t^{*2} are bootstrapped from ϵ , conditional on the regime. This means that information of the regime dependent covariance matrices are employed to the computation of the GIs.

Because of parameter uncertainty, inference on the GIs for each horizon is based on confidence intervals. We employ bootstrap to get the extreme values of an empirical 95% confidence interval. The distribution of the GI values for each horizon, conditional on the same set of histories and type of shock, is built by simulating R samples of size T using the estimated parameters and bootstraps from the residuals. Then these samples are employed to re-estimate the model and to re-calculate the GIs using the described algorithm. Because this procedure is heavily computer intensive, we use $R = 200$ and $M = 400$.

B Estimating OT-VAR

The estimation of the observed transition VAR depends on the assumption of the functional form of the transition function. In general the minimization of the sum of squared residuals and maximization of the likelihood can be written as the minimization of the determinant of

the covariance matrix given a set of parameters θ to be estimated:

$$\hat{\theta} = \arg \min_{\theta \in \Theta} \det(\hat{\Sigma}(\theta)),$$

where $\hat{\Sigma}(\theta)$ is calculated as $1/T \sum_{i=1}^T \epsilon_i \epsilon_i'$. Note that we assume that the transition variable (including the delay) and the autoregressive order is known. Conditional on knowing also the threshold r , the problem can be solved by OLS. Using this information the covariance matrix is minimized changing at each step only the value of r , given that the autoregressive parameters and constants just follow these values. We define a set of possible values for the threshold, trimming 10% of the observations in each tail of the ordered distribution of the threshold variable. Then we calculate a model for each value and the estimated threshold is the one that minimizes the determinant of the covariance matrix.

The autoregressive order is chosen by comparing Schwarz Information criteria (SIC) of OT-VARs estimated with different p . Note that the penalty for one more lag is of $2*3*3*p$. The delay is calculated by a search aiming at minimizing the determinant of the covariance matrix jointly with the threshold.

C Procedure to Choose Transition Variables

We collect data on the transition variables for the two benchmark countries - the US and Germany - and also for France, Italy, Spain and the UK. The characteristics of the data and the sources are described in Appendix D. The transition variable for the VAR with X , Germany and US is $z_{X,t-d}^j$ and its value is calculated using the standardized value of each transition variable j , except for $j = RST, ST, DM2SA$ where the transition variable is the difference of the standardized value of country X with relation to Germany. Delays from 1 to 8 are considered. We also use a VAR for the case that $X = \text{Germany}$, which is a VAR of $y_{GER,t}, y_{UK,t}, y_{US,t}$ with transition variables from the German data and when monetary policy values in reference to the UK.

For each one of four combinations of endogenous variables in the system of $y_{X,t}, y_{GER,t}$, and $y_{US,t}$, where $X = \{FR, IT, SP, UK\}$, we use a three-step procedure to choose the transition variables from the set $\Xi_X = \{z_{X,t}^{RST}, \dots, z_{X,t}^{UNEM}\}$, with all j s as described in Table 1².

- (1) A test statistic is calculated for each delay and transition variable similar to the one described by Teräsvirta (1998) to test linearity. The variable addition type of test uses an auxiliary VAR, which is a regression of y_t on constants, W_{t-1} and $W_{t-1}z_{t-d}$. The determinant of the covariance matrix of this auxiliary VAR is compared with the determinant of the covariance matrix of the VAR under the null using a LR type of test with p-values form a chi-squared distribution. The transition variable in Ξ_X is set chosen when the null hypothesis is rejected at 10% for at least one of the delays considered.

²This procedure is also employed to the VAR of $y_{GER,t}, y_{UK,t}, y_{US,t}$.

- (2) Transition Variables from Ξ_X that have been chosen in the previous step are employed to estimate an OAT-VAR with the same transition function in each equation of the system and with a delay jointly estimated with the threshold by grid search. Then the OAT-VARs are ranked by their fit measured by the Schwarz information criteria ($n \log\left(\left|\hat{\Sigma}\right| + \log(n)k\right)$ with k being the total number of estimated parameters). The transition variables of the 50% best ranked OAT-VARs are chosen for the next step.
- (3) In this step, we use the 95% confidence intervals and the point estimates of the generalized impulse responses to verify whether the responses conditional on the history and residual variances of each regime are statistically different. The transition variables are chosen when the transmission mechanisms of the regimes are statistically different. Transition variables selected in the last step with OAT-VARs that show evidence of non-stationarity when bootstrap is employed to obtain the confidence intervals are also excluded.

D Description of Data Set³

The endogenous variables in the systems are always the quarterly growth of real GDP, that is, 100 times the first difference of log-level of real GDP. The series French GDP is computed using nominal GDP and GDP deflator from the OECD dataset (1970:Q1-2001:Q2). The series for Italy, US and UK are the constant price series (base 1995) presented by the OECD and have the same length as the French one. The series of output growth of Germany is computed using the current price series from OECD. The series is not seasonally adjusted before 1991:Q2 and we do the adjustment using X12. We avoid the jump due to the unification using the GDP growth for West Germany until 1991:Q1 and for unified Germany from 1991:Q2. For Spain, we use growth rates of the IMF GDP volume index until 1980:Q1, and then the OECD constant price series is available with the same base as the one in previous countries.

D.1 Transition Variables

D.1.1 Monetary Policy Instruments

RST: Short-Term Real Interest Rate

Calculation: $\ln(1+(ST-((CPI/(\text{lag}(CPI,4)))-1)*100)/100)$, where CPI is the Consumer Price Index (base 1995=100) and $\text{lag}(CPI,4)$ is the CPI lagged 4 periods

Sample period: France, Germany, UK, US: 1970Q1-2001Q4; Italy: 1971Q1-2001Q4; Spain: 1974Q1-2001Q4

Source: IFS (2002)

³All final data are quarterly. If the original frequency of the data is annual, the frequency transformation method is described.

ST: Short-Term Interest Rate

Description: France, UK, US: Treasury Bill Rate; Germany, Italy, Spain: Money Market Rate, percent per annum, end of period

Sample period: France, Germany, UK, US: 1970Q1-2001Q4; Italy: 1971Q1-2001Q4; Spain: 1974Q1-2001Q4

Source: IFS (2002)

DM2SA: Broad Money M2

Description: sum of Money (IFS, line 34=lines 14a+14d+14e+14f+14g+24) and Quasi-Money, (IFS, line 35=lines 15+25) billions of national currency; break in 1999q1 for Euro area countries due to the change to a Euro area-wide definition of residency; starting in 1999q1, data are converted using the Euro conversion rate

Transformation: 100*1st log difference of seasonally adjusted series (with X12)

Sample period: 1970Q1-2001Q4

Source: IFS (2002)

D.1.2 Financial Variables**DREER: Real Effective Exchange Rate**

Description: index number (base 1995=100), for IFS: REER based on relative consumer prices

Transformation: 100*1st log difference

Sample period: France, Germany, Italy, Spain, US: 1970q1-2001q4; UK: 1972Q1-2001Q4

Sources: OECD (2002): 1970Q1-2001Q2, IFS (2002): 2001Q3

D_ERE: Exchange Rate

Description: units of national currency per US Dollar, end of period; starting in 1999q1, D_ERE for Euro area countries is based on Euro-US Dollar exchange rate and the Euro conversion rates

Transformation: 100*1st log difference

Sample period: 1970Q1-2001Q4

Source: IFS (2002)

RLT: Long-Term Real Interest Rate

Calculation: $\ln(1+(LT-((CPI/(\text{lag}(CPI,4)))-1)*100)/100$, where CPI is the Consumer Price Index with (base 1995=100) and $\text{lag}(CPI,4)$ is the CPI lagged 4 periods

Sample period: France, Germany, Italy, UK, US: 1970q1-2001q4; Spain: 1978q2-2001q4

Source: IFS (2002)

LT: Long-Term Interest Rate

Description: Government Bond Yield, percent per annum, end of period

Sample period: France, Germany, Italy, UK, US: 1970Q1-2001Q4; Spain: 1978Q2-2001Q4

Source: IFS (2002)

DSPI: Share Prices

Description: index number (base 1995=100), UK, US: Share Prices Industrial
 Transformation: 100*1st log difference
 Sample period: France, Germany, Italy, Spain, US: 1970q1-2001q4; UK: 1970Q1-1999Q1
 Source: IFS (2002)

D.1.3 Financial Market Structure

STRA: Stock Market Activity

Description: ratio of Stock Market Total Value Traded to GDP, defined as total shares traded on the stock market exchange divided by GDP
 Transformation: linear interpolation assuming that the obs. of Q4 is the annual value
 Original frequency: annual
 Sample period: 1975-1997
 Source: World Bank (2001)

SCAP: Stock Market Size

Description: ratio of Stock Market Capitalization to GDP, defined as total value of listed shares divided by GDP
 Transformation: linear interpolation assuming that the obs. of Q4 is the annual value
 Original frequency: annual
 Sample period: 1976-1997
 Source: World Bank (2001)

BDA: Bank Domestic Assets/GDP

Description: ratio of Deposit Money Bank (Domestic) Assets to GDP, where the nominator= (IFS, lines 22a+22b+22c+22d, billions of national currency) and the denominator =GDP nominal, seasonally adjusted (IFS, line 99b, billions of national currency); break in 1999q1 for Euro area countries due to the change to a Euro area-wide definition of residency; starting in 1999q1, data are converted using the Euro conversion rates
 Transformation: missing values filled with interpolation
 Sample period: France: 1970Q1-2001Q3 missing 1998Q3-Q4; Italy: 1974Q4-2001Q1; Spain: 1986Q1-2001Q3; Germany, UK, US: 1970Q1-2001Q3
 Source: IFS (2002)

BCP: Private Bank Credit/GDP

Description: ratio of Deposit Money Bank Claims on (Credit to Domestic) Private Sector to GDP, where the nominator=(IFS, line 22d, billions of national currency) and the denominator=GDP nominal, seasonally adjusted (IFS, line 99b, billions of national currency); break in 1999q1 for Euro area countries due to the change to a Euro area-wide definition of residency; starting in 1999q1, data are converted using the Euro conversion rates

Transformation: missing values filled with interpolation

Sample period: France: 1970Q1-2001Q3 missing 1998Q3-Q4; Italy: 1970Q1-2001Q1; Spain: 1986Q1-2001Q3; Germany, UK, US: 1970Q1-2001Q3

Source: IFS (2002)

BS1: Bank Assets to GDP/Stock Market Size

Description: ratio of Deposit Money Bank Assets to GDP to Stock Market Capitalization to GDP

Transformation: linear interpolation assuming that the obs. of Q4 is the annual value

Original frequency: annual

Sample period: 1976-1997

Source: World Bank (2001)

BS2: Private Bank Credit to GDP/Stock Market activity

Description: ratio of Private Credit by Deposit Money Banks to GDP and Stock Market Total Value Traded to GDP

Transformation: linear interpolation assuming that the obs. of Q4 is the annual value

Original frequency: annual

Sample period: 1975-1997

Source: World Bank (2001)

D.1.4 International Capital Flows

BIN: Net Banks International Assets over Liabilities/GDP

Description: ratio of Deposit Money Banks International Assets to GDP, where the nominator=(IFS, line .7a., billions of US Dollars) and the denominator=GDP nominal,seasonally adjusted (IFS, line 99b, billions of national currency) divided by the period average exchange rate;break in 1999q1 for Euro area countries due to the change to a Euro area-wide definition of residency

Transformation:

Sample period: France, Germany, Italy, Spain: 1970q1-2001q4; France: missing 1998q3-q4; UK, US: 1970q1-2001q3

Source: IFS (2002)

TNET: Total Net Flows/GDP

Description: ratio of Total Net International Capital Flows (sum of net FDI, net portfolio and net other investments) to GDP, where the nominator=(IFS, lines 78bd+78be+78bf+78bg+78bh+78bi, billions of US Dollars) and the denominator=GDP nominal, seasonally adjusted (IFS, line 99b, billions of national currency) divided by the period average exchange rate

Transformation:

Sample period: France: 1975Q1-2001Q3; Gemany: 1971Q1-2001Q3;
Italy: 1970Q1-2001Q1; Spain: 1975Q1-2001Q3; UK: 1970Q1-2001Q3
US: 1973Q1-2001Q3

Source: IFS (2002)

BDBAL: External Assets/Liabilities of German Banks

Description: ratio of External Assets to External Liabilities of German Banks (vis-à-vis a given chosen country, both in millions of Euro)

Transformation:

Sample period: France, Italy, UK, US: 1975Q4-2001Q4; Spain: 1982Q2-2001Q3

Source: Datastream, Bundesbank Data

USBCL: External Claims/Liabilities of US Banks

Description: ratio of Total Claims on Foreigners to Total Liabilities to Foreigners Reported by Banks in the US (both in millions US dollar)

Transformation:

Sample period: 1978Q2-2001Q4

Source: US Treasury

USBGR: US Bond Purchase from Country X/Total Europe

Description: ratio of Gross Purchases by US Residents of Foreign Bonds from country X to Gross Purchases by US Residents of Foreign Bonds from Total Europe (in millions US dollar)

Transformation:

Sample period: 1977Q1-2001Q4

Source: US Treasury (2002)

USSTGR: US Stock Sales to Country X/Total Europe

Description: ratio of Gross Sales by US Residents of US Corporate Stocks to country X to Gross Sales by US Residents of US Corporate Stocks to Total Europe (both in millions US dollar)

Transformation:

Sample period: 1977Q1-2001Q4

Source: US Treasury (2002)

D.1.5 Trade

TOT: Terms of Trade

Description: ratio of Export Price Index (base 1995=100) to Import Price Index (base 1995=100)

Sample period: France: 1970q1-2001q2; Germany, Italy: 1970q1-2001q1;
Spain, UK: 1970Q1-2001Q3; US: 1970Q1-2001Q4

Source: IFS (2002)

TRADE: Trade with Chosen Countries/Total Trade

Description: Trade (exports plus imports) with the Chosen
Countries in percent to Total Trade

Original frequency: monthly

Transformation: seasonally adjusted with X12. quarterly data obtained by
averaging monthly data over quarters.

Sample period: 1970:Q1-2001:Q3

Source: OECD (2002)

D.1.6 Economic Structure

MANVA: Value Added Manufacturing/Value Added Total Industries

Description: Share of Value Added in Manufacturing in that of the Total Industries, value added at
1990 market prices; Spain: no data; Germany: data for Western Germany before
1990 including data for total Germany after 1990

Transformation: linear interpolation assuming that the obs. of Q4 is the annual value

Original frequency: annual

Sample period: France, Germany, Italy: 1970-1997; UK, US: 1970-1996

Source: OECD (2002) (General Economic Problems / International Sectoral Data Base)

RETVA: Value Added Retail/Value Added Total Industries

Description: Share of Value Added in Wholesale and Retail Trade, Restaurants and Hotels in that of
the Total Industries, value added at 1990 market prices; Spain: no data; Germany:
data for Western Germany before 1990 including, data for total Germany (extrapolated)
after 1990;

Transformation: linear interpolation assuming that the obs. of Q4 is the annual value.
for 1991-1997 data only on Wholesale and Retail Trade are
available. The data on Restaurants and Hotels for 1991-1997
are extrapolated from the series of 1970-1990 using a 3rd-order
polynomial and added to Wholesale and Retail Trade data.

Original frequency: annual

Sample period: France, Germany, Italy: 1970-1997; UK, US: 1970-1996

Source: OECD (2002) (General Economic Problems / International
Sectoral Data Base)

AGRVA: Value Added Agriculture/Value Added Total Industries

Description: Share of Value Added in Agriculture in that of the Total Industries, value added at 1990 market prices; Spain: no data; Germany: data for Western Germany before 1990 including, data for total Germany after 1990;

Transformation: linear interpolation assuming that the obs. of Q4 is the annual value

Original frequency: annual

Sample period: France, Germany, Italy: 1970-1997; UK, US: 1970-1996

Source: OECD (2002) (General Economic Problems / International Sectoral Data Base)

FNSVA: Value Added Financial Sector/Value Added Total Industries

Description: Share of Value Added in Financial Institutions and Insurance in that of the Total Industries, value added at 1990 market prices; Spain: no data; Germany: data for Western Germany before 1990 incl., data for total Germany after 1990;

Transformation: linear interpolation assuming that the obs. of Q4 is the annual value

Original frequency: annual

Sample period: France, Germany, Italy: 1970-1997; UK, US: 1970-1996

Source: OECD (2002) (General Economic Problems / International Sectoral Data Base)

MNF: Manufacturing Industrial Production/GDP

Description: Share of GDP Contributed by Total Manufacturing, defined as the value added contributed by manufacturing sector as a percentage of value added for the total economy Germany: data only for Western Germany

Transformation: linear interpolation assuming that the obs. of Q4 is the annual value

Original frequency: annual

Sample period: 1980-1997

Source: OECD (2002) (Industry, Science and Technology / Main Industrial Indicators / Industrial Composition)

D.1.7 Natural Resources**OLIMP: Oil Imports/GDP**

Description: ratio of Net Oil Imports to GDP, toe per thousand 1995
US dollars

Transformation: linear interpolation assuming that the obs. of Q4 is the annual value

Original frequency: annual

Sample period: 1970-1999

Source: OECD (2002) (Energy, International Energy Agency / OECD Energy Balances / Indicators / Flow)

NETIMP: Net Imports of Mineral Fuels/GDP

Description: Net Imports (imports minus exports) of Mineral Fuels, Lubricants and Related Materials (SITC Section 3), millions of US dollars to GDP

Transformation: 100*

Sample period: 1970Q1-2000Q2, Spain: data not included

Source: OECD (2002) (Foreign Trade / Monthly Foreign Trade Statistics / Trade by Standard International Trade Classification (SITC) Sections)

D.1.8 Labour Market

UNEM: Unemployment Rate

Description: unemployment as percentage of total labour force, seasonally adjusted

Transformation:

Sample period: 1970:Q1-2001:Q2. Spain: 1972:Q2-2001:Q2

Source: OECD

Table 1
List of Possible Transition Variables

1 – Monetary Policy Instruments
a- RST: short-term real interest rate
b- ST: short-term interest rate
c- DM2SA: Broad Money M2
2 – Financial Variables
a- DREER: real effective exchange rate (US\$)
b- D_ERE: exchange rate
c- RLT: long-term real interest rates
d- LT: long-term interest rate
e- DSPI1(2): share prices
3 – Financial Market structure
a- STRA: stock market activity/ GDP
b- SCAP: stock market capitalization/GDP
c- BDA: bank domestic assets/GDP
d- BCP: bank private credit/ GDP
e- BS1: bank assets to GDP/stock market size
f- BS2: private bank credit/value traded
4 – International financial flows
a- BIN: net bank international deposits/ GDP
b- TNET: total net international flows/ GDP
c- BDBAL: external assets/liabilities of German Banks
d- USBCL: external assets/liabilities of US Banks
e- USBGR: US bonds purchase from country X/ total Europe
f- USSTGR: US corporate purchase from country X/total Europe
5 – Trade
a- TOT: terms of trade
b- TRADE: trade with the chosen countries as percentage of total trade
6 – Economic Structure
a- MANVA: value added manufacturing/ value added total industry
b- RETVA: value added retail/ value added total industry
c- AGRVA: value added agriculture/ value added total industry
d- FNSVA: value added financial sector/ value added total industry
e- MNF: manufacturing industrial production/GDP
7 – Natural resources
a- OLIMP: oil imports/ GDP
b- NETIMP: net mineral fuels/GDP
8 – Labour Market
a- UNEM: unemployment rate

Note: More details on these transition variables are available in the appendix D.

Table 2
Chosen Transition Variables for systems with y_X , y_{GER} and y_{US}

X	France			Italy			Spain			UK		
	Transition Variable	<i>d</i> , <i>r</i>	SIC (<i>n</i>)	Transition Variable	<i>d</i> , <i>r</i>	SIC (<i>n</i>)	Transition Variable	<i>D</i> , <i>r</i>	SIC (<i>n</i>)	Transition Variable	<i>d</i> , <i>r</i>	SIC (<i>n</i>)
1: Monetary Policy Instruments (3)	RST	1, 0.381	-97.34 (116)	ST	4, -0.483	-73.59 (113)	DM2SA	1, -0.506	-112.97 (116)	RST	1, -0.700	-20.59 (117)
	DM2SA	3, 0.549	-95.08 (116)							ST	4, 0.651	-21.70 (117)
2: Financial Variables (5)	D_ERE	8, 0.179	-93.90 (116)	DREER	6, -0.544	-76.93 (116)	DREER	6, 0.780	-112.97 (116)	DREER	2, 0.650	-38.84 (108)
	DSPI1	8, -0.522	-95.87 (116)	DSPI1	7, 0.006	-78.55 (116)	DSPI1	1, -0.467	-121.14 (116)			
3: Financial Market Structure (6)												
4: International Financial Flows (6)				BIN	4, 0.899	-74.75 (116)	BIN	4, 0.060	-122.09 (116)	USBCL	3, 0.617	-114.20 (84)
5: Trade (2)				TRADE	8, 1.124	-76.58 (116)	TOT	4, -0.398	-110.24 (116)			
							TRADE	4, 0.561	-110.46 (116)			
6: Economic Structure (5)												
7: Natural Resources (2):	NETIMP	8, 0.726	-93.88 (116)							NETIMP	6, 0.693	-11.59 (117)
8: Labour Market (1):				UNEM	6, 1.092	-73.42 (116)	UNEM	1, 0.255	-111.03 (116)			

Note: The selection of the transition variable presented in this table is the result of the step 2 of the procedure described in appendix C.

Legend: d: delay; r: threshold; SIC: Bayesian information criteria; n: number of observations employed in the estimation.

Table 3
Comparing Cumulative Responses at $n = 1$

	PIS - US		SIS - US		COS		PIS - Ger		SIS - Ger	
	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg
France										
linear	0.19		0.29		0.99		0.04		0.32	
RST	0.23	0.07	0.22	0.47	0.77	1.41	-0.03	0.29	0.26	0.74
D_ERE	0.23	0.21	0.30	0.60	1.03	1.08	0.04	0.05	0.43	0.48
DSPI	0.17	0.19	0.46	0.39	0.82	1.18	0.07	0.05	0.47	0.43
DM2SA	0.14	0.21	0.39	0.24	1.15	0.74	0.06	0.10	0.44	0.49
NETIMP	0.28	0.18	0.45	0.18	1.28	0.93	0.02	0.11	0.42	0.52
Italy										
linear	0.08		0.09		1.32		0.04		0.26	
DREER	0.25	0.17	0.60	0.21	1.44	1.27	-0.13	0.00	-0.52	0.45
DSPI	0.03	0.14	-0.38	0.40	1.86	1.13	0.08	0.03	0.37	0.52
BIN	0.15	0.13	0.24	-0.42	1.13	1.21	0.03	-0.06	0.38	-0.24
TRADE	0.03	-0.32	0.05	-0.51	1.29	1.06	0.28	-0.09	0.60	0.54
ST	0.13	-0.20	0.17	-0.83	1.53	0.26	0.06	-0.37	0.28	0.27
UNEM	0.19	0.10	-0.15	0.19	1.65	1.04	0.00	0.03	-0.13	0.35
Spain										
linear	0.10		0.19		0.95		-0.04		0.13	
DREER	0.12	0.19	0.25	1.10	0.90	0.65	-0.08	-0.14	0.23	0.38
DSPI	0.05	0.05	1.37	0.16	0.70	1.17	-0.02	-0.02	0.29	0.37
DM2SA	0.12	0.14	0.11	0.40	1.60	0.89	-0.05	0.02	0.20	0.23
TOT	0.00	0.22	0.00	0.39	0.35	1.22	-0.29	0.06	-0.25	0.39
BIN	-0.01	0.19	0.14	0.59	0.86	1.12	0.16	-0.19	0.33	0.25
TRADE	0.05	0.18	-0.40	0.43	0.32	1.15	-0.19	-0.05	0.30	0.20
UNEM	0.01	-0.01	0.22	0.13	0.84	1.06	0.17	-0.30	0.37	-0.22
UK										
linear	0.28		0.54		1.22		-0.07		0.33	
RST	0.20	0.13	0.47	0.27	0.95	1.12	-0.06	0.00	0.16	0.36
DREER	0.19	0.18	0.16	0.31	0.78	0.97	-0.15	-0.18	0.39	0.08
USBCL	0.15	0.16	0.33	-0.01	1.21	0.45	-0.13	-0.11	0.11	0.54
ST	0.29	0.22	0.60	0.45	2.12	1.40	0.30	-0.12	0.74	0.28
NETIMP	0.23	-0.31	0.49	0.21	1.34	1.19	-0.06	1.08	0.22	0.87
Germany										
linear	0.14		0.43		1.30					
RST	0.13	0.01	0.33	0.54	1.27	1.03				
D_ERE	0.65	0.36	0.83	0.74	1.04	1.54				
TNET	0.13	0.13	0.54	0.30	1.73	0.96				
USBGR	0.04	-0.11	0.09	0.31	1.07	1.00				
ST	0.01	0.12	0.17	0.85	1.10	1.89				

Note: transition variables description in Table 1 and with details of the corresponding OAT-VARs in Table 2. Legend: PIS: pure idiosyncratic shock; SIS: spillover idiosyncratic shock; COS: common shock; 1st reg: cond. on first regime history; 2nd reg: same for second regime; light shaded areas: responses outside linear CI. Strong shaded areas: statistically different impulse responses between regimes when confidence intervals for SIS - US are employed.

Table 4
Comparing Cumulative Responses at $n = 4$

	PIS - US		SIS -US		COS		PIS -Ger		SIS -Ger	
	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg
France										
linear	0.26		0.36		1.07		0.05		0.35	
RST	0.29	0.07	0.27	0.47	0.90	1.43	0.02	0.26	0.33	0.73
D_ERE	0.29	0.28	0.35	0.67	1.14	1.16	0.05	0.09	0.48	0.52
DSPI	0.42	0.37	0.70	0.62	1.18	1.61	0.24	0.24	0.65	0.66
DM2SA	0.39	0.62	0.62	0.61	1.26	1.08	-0.01	0.02	0.40	0.73
NETIMP	0.38	0.16	0.58	0.15	1.51	0.89	0.05	0.07	0.52	0.48
Italy										
linear	0.61		0.67		2.08		0.27		0.60	
DREER	0.62	0.77	1.38	0.88	3.21	2.20	0.76	0.37	0.46	0.93
DSPI	0.42	0.56	0.20	0.91	2.72	1.89	0.51	0.35	0.88	0.94
BIN	0.32	1.42	0.43	1.46	1.46	3.52	0.07	1.01	0.50	1.56
TRADE	0.24	-0.63	0.37	-0.89	1.76	1.56	0.60	0.03	0.97	0.85
ST	0.55	0.14	0.68	-0.54	2.30	0.93	0.36	-0.06	0.71	0.42
UNEM	1.46	0.29	1.55	0.40	3.39	1.47	0.84	0.09	1.39	0.51
Spain										
linear	0.30		0.44		1.69		-0.11		0.19	
DREER	0.41	0.39	0.57	1.99	1.50	1.20	-0.23	-0.25	0.29	0.63
DSPI	0.28	0.27	2.43	0.48	1.50	2.25	0.09	0.09	0.64	0.79
DM2SA	0.61	0.57	0.59	1.00	3.11	1.80	-0.13	0.01	0.34	0.47
TOT	0.01	0.73	0.06	0.94	0.66	2.12	-0.31	-0.08	-0.25	0.59
BIN	0.09	0.50	0.28	1.23	1.26	2.28	0.08	-0.12	0.38	0.67
TRADE	0.33	0.52	-0.12	0.89	0.62	2.01	-0.18	-0.15	0.45	0.33
UNEM	0.17	-0.46	0.44	-0.27	1.27	1.31	0.13	-0.24	0.47	-0.13
UK										
linear	0.39		0.67		1.61		-0.06		0.38	
RST	0.49	0.15	0.66	0.27	1.01	1.05	-0.26	-0.11	0.14	0.27
DREER	0.74	0.73	0.61	0.79	1.36	1.34	-0.42	-0.54	0.41	-0.06
USBCL	0.87	0.00	1.04	-0.81	1.52	0.09	-0.67	-0.87	-0.23	0.44
ST	0.58	0.31	1.18	0.56	3.14	1.59	0.82	-0.12	1.45	0.33
NETIMP	0.83	0.28	1.05	0.56	1.85	1.66	-0.44	0.09	0.11	0.73
Germany										
RST	0.27	0.48	0.48	0.89	1.38	1.25				
D_ERE	0.40	0.50	0.51	0.86	0.86	1.77				
TNET	0.65	0.55	1.08	0.72	2.40	1.42				
USBGR	0.27	0.19	0.31	0.65	1.35	1.38				
ST	0.05	0.41	0.22	1.43	1.21	2.91				

Note: see note of Table 3.

Table 5
Comparing Cumulative Responses at $n = 8$

	PIS - US		SIS -US		COS - US		PIS -Ger		SIS -Ger	
	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg	1st reg	2nd reg
France										
linear	0.28		0.36		1.07		0.05		0.35	
RST	0.33	0.04	0.32	0.43	0.94	1.39	0.06	0.24	0.38	0.69
D_ERE	0.29	0.28	0.36	0.67	1.14	1.17	0.06	0.08	0.49	0.54
DSPI	0.58	0.55	0.82	0.78	1.27	1.70	0.25	0.28	0.68	0.68
DM2SA	0.40	0.52	0.57	0.47	1.05	0.98	-0.15	-0.08	0.24	0.60
NETIMP	0.39	0.19	0.58	0.17	1.51	0.89	0.04	0.06	0.50	0.48
Italy										
linear	0.73		0.77		1.86		0.20		0.49	
DREER	0.50	0.90	1.00	0.99	2.27	2.00	0.60	0.44	0.46	0.89
DSPI	0.53	0.77	0.32	0.99	2.31	1.67	0.33	0.14	0.68	0.70
BIN	0.38	1.99	0.48	3.08	1.46	3.95	0.07	1.97	0.49	3.17
TRADE	0.34	-0.58	0.46	-0.83	1.69	1.58	0.48	-0.19	0.86	0.64
ST	0.73	0.37	0.80	-0.59	2.18	1.38	0.22	-0.05	0.60	0.55
UNEM	1.63	0.37	2.26	0.48	2.92	1.50	1.41	0.07	2.18	0.49
Spain										
linear	0.42		0.57		2.01		-0.15		0.22	
DREER	0.55	0.51	0.71	2.16	1.66	1.31	-0.26	-0.27	0.30	0.65
DSPI	0.66	0.66	3.19	0.87	2.00	2.94	0.07	0.07	0.78	1.02
DM2SA	1.18	1.02	1.16	1.53	4.19	2.48	0.04	0.16	0.63	0.76
TOT	0.03	1.03	0.07	1.22	0.71	2.38	-0.34	-0.20	-0.28	0.62
BIN	0.13	0.89	0.33	1.74	1.38	2.96	0.08	-0.10	0.40	0.93
TRADE	0.36	0.71	-0.14	1.11	0.64	2.34	-0.19	-0.24	0.52	0.35
UNEM	0.21	-0.50	0.48	-0.32	1.31	1.19	0.12	-0.26	0.48	-0.16
UK										
linear	0.40		0.67		1.64		-0.07		0.37	
RST	0.36	0.09	0.54	0.21	0.90	0.98	-0.34	-0.17	0.04	0.19
DREER	0.93	0.93	0.78	0.93	1.54	1.39	-0.50	-0.76	0.41	-0.19
USBCL	1.00	-0.07	1.14	-1.01	1.27	-0.11	-1.05	-1.09	-0.54	0.29
ST	0.70	0.32	1.42	0.58	3.64	1.63	1.06	-0.12	1.79	0.35
NETIMP	0.99	0.00	1.17	0.51	1.91	1.08	-0.67	1.33	-0.03	0.95
Germany										
linear	0.23		0.52		1.43					
RST	0.24	0.46	0.44	0.90	1.34	1.26				
D_ERE	0.63	0.73	0.50	1.10	1.12	1.98				
TNET	0.95	0.72	1.39	0.87	2.66	1.56				
USBGR	0.42	0.19	0.45	0.62	1.47	1.40				
ST	0.07	0.53	0.24	1.70	1.24	3.38				

Note: see note of Table 3.

Table 6
Effect of a -2%-annual-GDP-growth shock at 2001:1
(based on multipliers of Tables 3, 4 and 5)

PRELIMINARY

	No shock	SIS – US			COS – US			Actual
	2000:4	n=1	n=4	For 2001	n=1	n=4	For 2001	2001
France	2.7%	-0.4%	-0.6%	2.1%	-2%	-2.2%	0.3%	0.2% (R)
Germany	1%	-0.3%	-0.4%	0.6%	-3%	-2.8%	-1.8%	0% (R)
Italy	3.3%	-0.4%	-1.6%	1.7%	-2.4%	-3.2%	0.1%	0.5%
Spain	3.9%	-2%	-3.6%	0.3%	-1.4%	-2.6%	1.3%	2%
UK	1.8%	-1.2%	-2.4%	-0.6%	-4%	-6%	-4.2%	1.5%

Note: The responses are computed using the linear multipliers for France and Germany, the average of the multipliers from the regime defined for 2001:1 of the OAT-VARs with DREER, DSP11, BIN and TRADE for Italy, the average of the multipliers from the regime defined for 2001:1 of the OAT-VARs with DREER and DSP11 for Spain and the average of the multipliers from the regime defined for 2001:1 of the OAT-VARs with ST for UK. (R) denotes that the country had two quarters of negative growth in 2001. The actual values are from OECD.

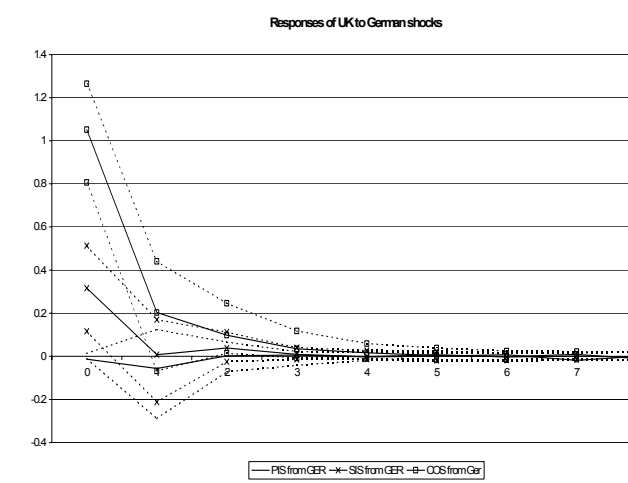
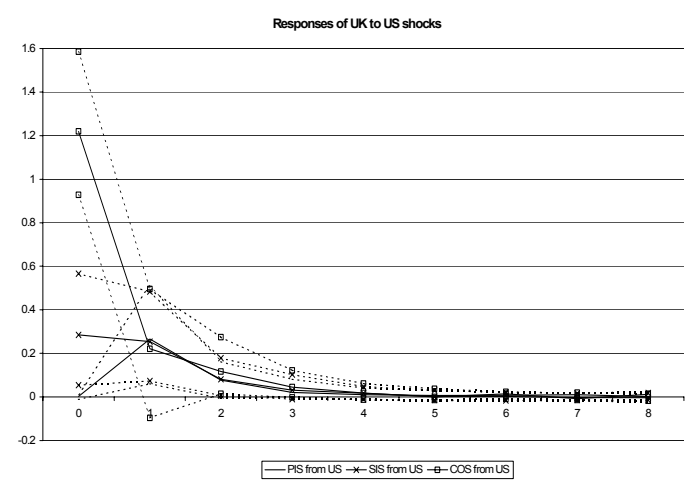
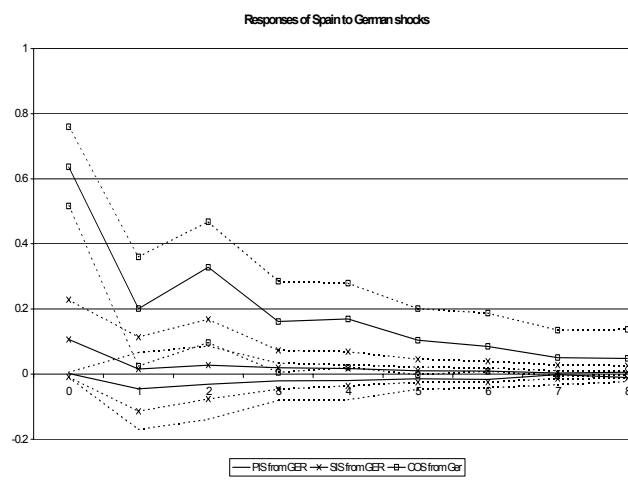
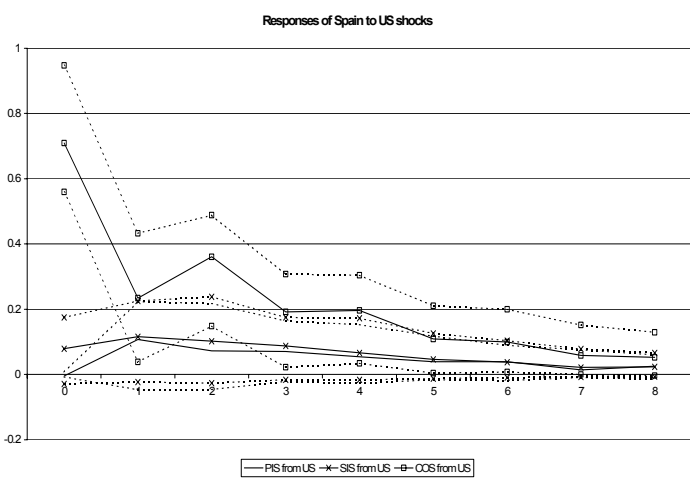
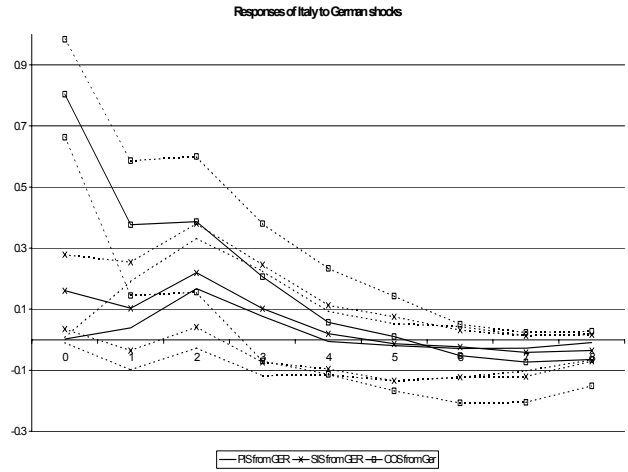
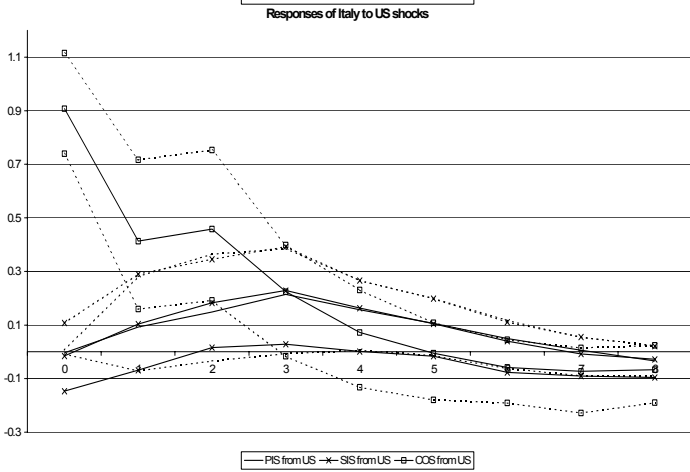
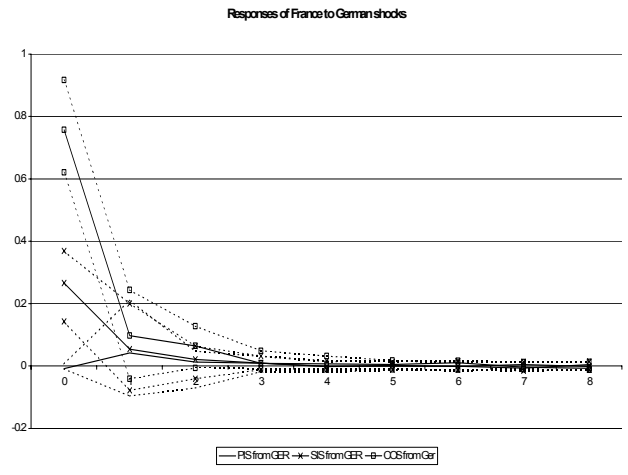
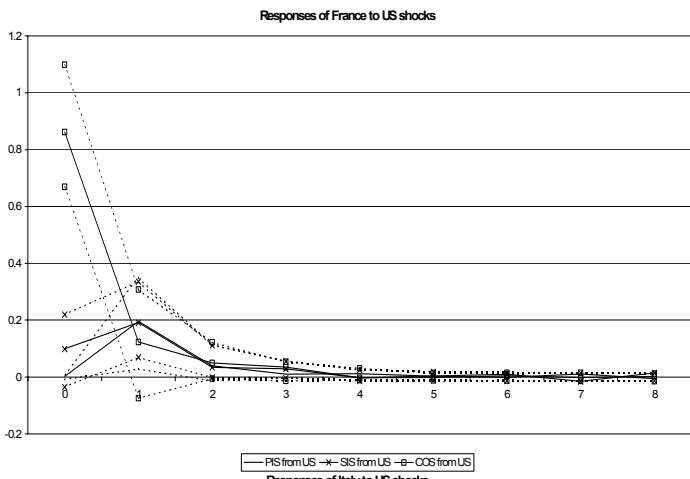


Figure 1: Generalized response of country X of shocks of size PIS, SIS and COS with US and German source using a VAR (dashed lines are 95% CI computed by bootstrap).

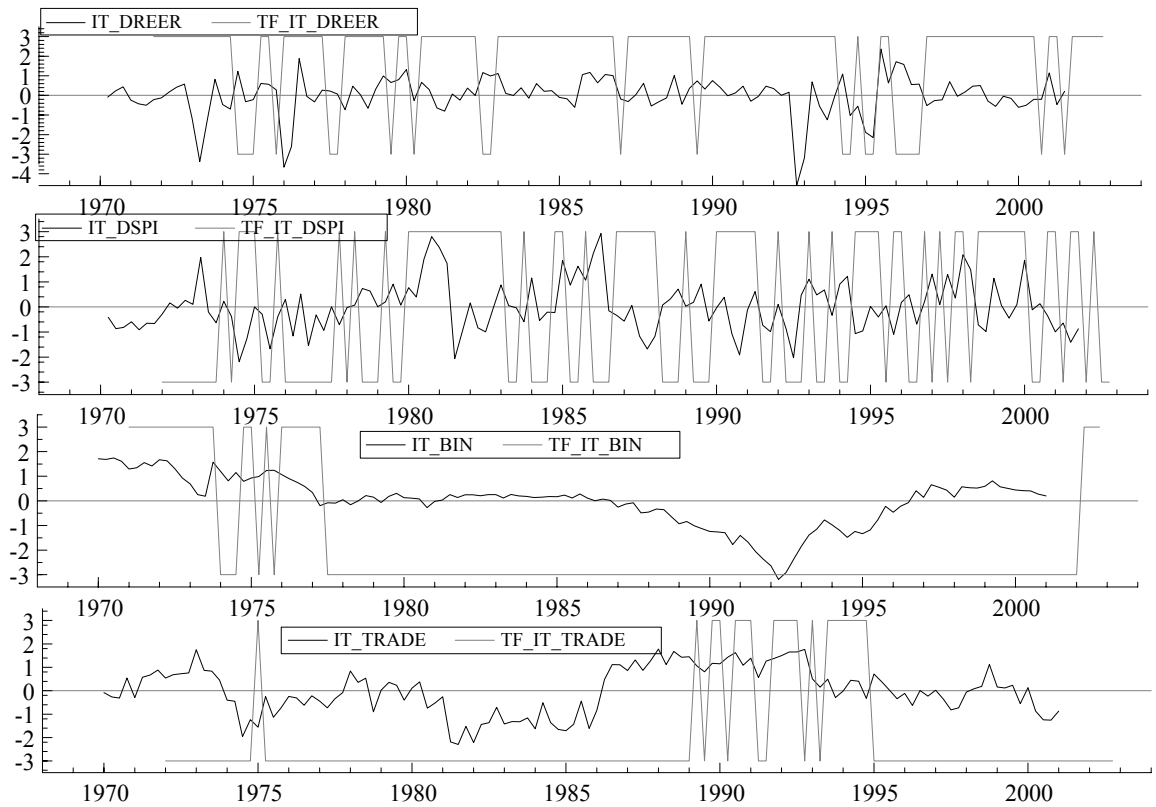


Figure 2: Transition Function and Transition Variables chosen for OAT-VARs for Italy

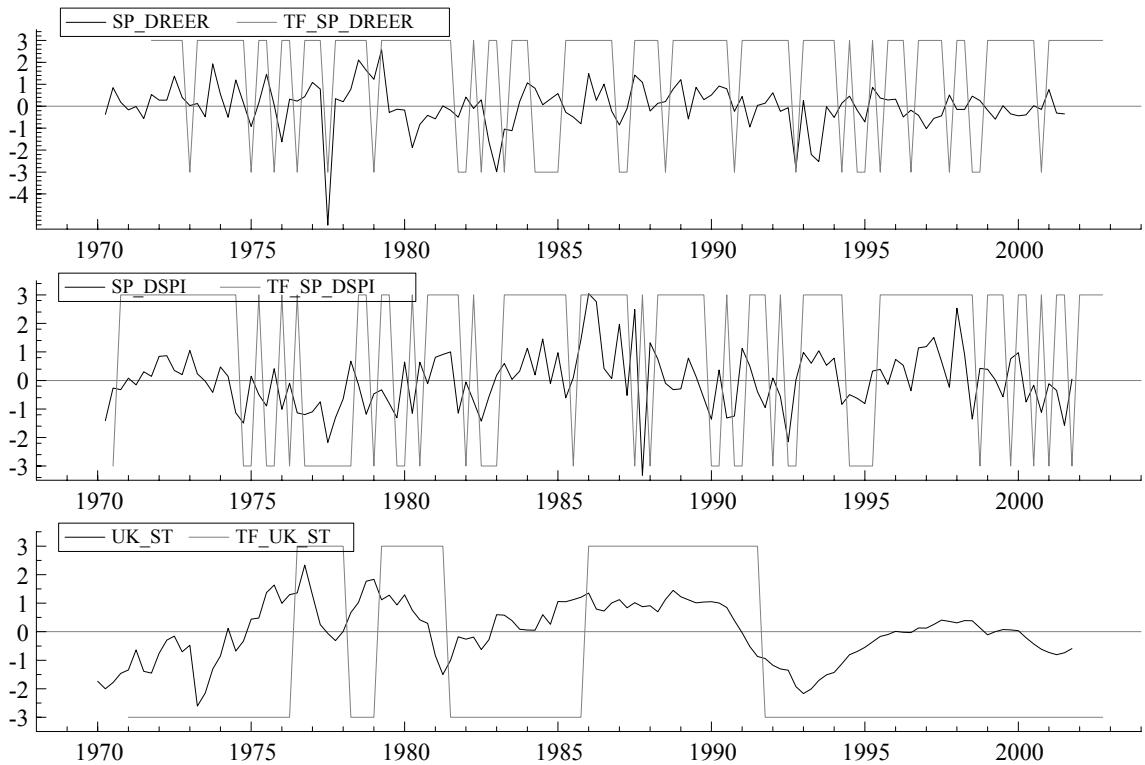


Figure 3 Transition Function and Transition Variables chosen for OAT-VARs for Spain and UK