CHAPTER 5: THE TRANSMISSION MECHANISM IN A CHANGING WORLD

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. Three 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. Third, this increase in syncronization may be temporary and a result of common shocks affecting these economies. These points are usefully discussed in International Monetary Fund (IMF) (2001) and Doyle and Faust (2002). 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 recurrently have changed through time.

Previous papers that tried to understand the transmission of international shocks have employed calibrated multi-country models (Canova and Marriman, 1998) and SVAR models with specific identification to extract worldwide shocks and country-specific shocks (Kwark, 1999). In some SVAR identification schemes, the transmission of external shocks in the domestic economic passes through a measure of proportion of trade with the external country (Dassel, 2002; Abeysinghe and Forbes, 2001). In this paper we propose a model that allows different transmission of external shocks (worldwide and country-specific) depending on the characteristics of the economy being affected by the shocks. Therefore, we can characterize recurrently changes in the transmission of shocks between European economies and US without the need of defining changing trade weights, given that the transmission may change as a result of structural characteristics of the economies being affected by the shock, of international financial flows, of behavior of financial markets and of differentials of monetary policy with respect to other countries.

The starting methodological tool of the paper is a trivariate VAR, which focuses on output growth in the US, Germany and one other 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 to define and summarize the impulse response functions to shocks, which are variously defined as "common shocks", i.e. shocks that take place contemporaneously in all countries, as "purely idiosyncratic shocks", i.e. shocks that take place in one country with no contemporaneous effects on other countries, or as "idiosyncratic shocks with contemporaneous spillover", where contemporaneous shock transmission is allowed for. 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. This rather common linear VAR methodology will suggest that common shocks are required to obtain sizable effects on the European economy of a shock originating in the US.

The next phase of the work is to evaluate whether and how the responses to shocks have changed over time, and whether a time-varying transmission mechanism can change the results from the linear VARs. The way in which we have chosen to evaluate these issues 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.(e.g.. Andreou et al. (2000)). Hence, financial variables represent a significant proportion of the transition variables we consider.

Due to the rather limited sample size, we focus on a particular class of nonlinear VARs whose parameters can change abruptly depending on the values of a transition variable. This results in a classification of transition variables into two regimes, one where the values are below a certain threshold, the other where they are above that threshold. The results of allowing for this "abrupt transition" process are interesting and differ from what we find with strictly linear models. In particular, idiosyncratic US shocks with contemporaneous spillovers already have sizable effects on the European economies. As far as the transition variables are concerned, we find that the currency market has an important influence in explaining the transmission of shocks, with stronger effects when large fluctuations in the exchange rate have occurred in the recent past. Moreover, the monetary policy stance can matter, with some differences across European countries in the effects of other financial variables such as stock market conditions. Finally, other results are more country specific, such as the greater importance of US rather than German shocks for Italy or the greater relevance now than in the past of external shocks for the UK.

Our final contribution is to apply the changing regime models to predict the response of the economies to an external or common negative shock in 2001, to evaluate whether we can replicate the slowdown in Europe that ensued in that year. It turns out that the effects of the US shock, once evaluated in a context which allows for threshold effects in transition variables, are sufficient to explain the reduced performance of Germany and Italy. For the UK, a linear model is satisfactory in any case whilst for Spain, there is not much effect. However, it is only in the case of France that the strength of the downturn seems to require us to invoke either the idea that the initial shock "must have been common" or that the relevant transition variables could be different from those of the other European economies.

The organization of the paper is as follows. We start in section 2 with the simplest linear set-up, with a view to explicating the shock-identification scheme we are using. In section 3 we then move on to the "abrupt transition" models, with a discussion of a method for selecting transition variables that are able to characterize changing transmission mechanisms. In the same section, we discuss the results of the procedure for selecting transition variables and present generalized impulse responses that allow for different responses to shocks in different regimes. In section 4 we apply the models to analyze the source and transmission of shocks in the 2001 slowdown. Finally, in section 5 we summarize and conclude. The technical details are gathered in the Appendix.

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 output growth is computed using impulse response functions derived from a VAR that is able to characterize dynamic interdependencies among countries' growth rates. 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 emanating from outside Europe affect the economic growth of Spain taking into account the Spanish dependence on Germany.

More specifically we consider tri-dimensional VARs that include the output growth of the US $y_{US,t}$, representing the rest of the world (or a large country), of Germany $y_{ger,t}$, representing the largest economy in Europe, and of another European country from the following set {France, Italy, Spain and UK}. In this VAR representation the economies of the US and Germany are taken as the leading "anchor" economies which may provide a focal point or attractor for the other European economies under analysis. 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 e.g. Artis and Zhang (1997)).

The analysis of the responses to shocks depends on the definition of shock, 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 construct the time profile of shocks conditional on a specific set of history and type of shock, and it assumes that "normal shocks" (i.e., the average of past shocks) keep hitting the system over future horizons.

Formally, we estimate a VAR of autoregressive order p for the k-dimensional vector of time series $y_t = (y_{1t}, ..., y_{kt})$, where $k = 3$ and p is selected by the Schwarz information criterion. Using the estimated parameters, we calculate the transmission of shocks v as the difference in the expected value of y with and without the shocks. Thus, the generalized response (GI) of the series in y_t to the shocks v_t at horizon h conditional on the history W_{t-1} is defined as:

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

In the case of a linear VAR, the GI is independent of W_{t-1} but it is dependent on the definition of the shocks in v (Pesaran and Shin, 1998). Although the conditional means in (1) could be calculated analytically for linear models, we employed a simulation procedure as proposed by Koop et al. (1996), which is also employed below for the abrupt transition models, where the response may also depend on the regime of the transition variable, incorporated in W_{t-1} The simulation procedure is described in the Appendix A, together with a bootstrap method to compute confidence intervals around the point estimates.

Based on this arrangement, we consider three types of shock to the US and to 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 $(0, 0, 1)$. This notation means that this quarter the US grows, say, at a 4% quarterly rate rather than 3%, while the other countries are unaffected.

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, we define the SIS as 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, and the division by $\sqrt{\sigma_{33}}$ is used to make the size of the shocks comparable across countries. Notice that in practice this definition implies that the size of the spillover is equal to the cross-country correlation of the estimated VAR residuals. Other definitions are possible, for example σ_{13}/σ_{33} would be equivalent to the coefficient in a linear regression of country one residual on the US residual, while the shock defined as

$$\left(2^{nd} \text{ row of } \begin{pmatrix} \sigma_{22} & \sigma_{23} \\ \sigma_{32} & \sigma_{33} \end{pmatrix}^{-1} \begin{pmatrix} \sigma_{12} \\ \sigma_{13} \end{pmatrix}, \frac{\sigma_{23}}{\sigma_{33}}, 1 \right),$$

would correspond to a Choleski ordering US-Germany-other country. It is not clear which definition is preferable, but all of them would be equal if $\sigma_{13} = 0$, $\sigma_{23} = 0$. In this case there would be no spillovers and the effects of the SIS would be equal to those of the PIS (and, viceversa, equal effects from PIS and SIS imply $\sigma_{13} = 0$, $\sigma_{23} = 0$). Since in the empirical application with the linear VARs we find that the effects of the SIS are *never* statistically different from those of the PIS, at least in the case of US shocks, we can conclude that $\sigma_{13} = 0$, $\sigma_{23} = 0$ so that the choice of the best definition is probably not very critical.

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 $(\sqrt{\sigma_{11}}/\sqrt{\sigma_{33}},\sqrt{\sigma_{22}}/\sqrt{\sigma_{33}},1)$, where the standardization by $\sqrt{\sigma_{33}}$ is again used to make the size of the shocks comparable across countries.

The response of the systems to these three types of shocks can provide useful information for understanding the transmission mechanism across countries. In particular, as mentioned, 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 more substantial contemporaneous spillovers might 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, as anticipated, in all 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, and viceversa.

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 (which corresponds to 2.7 percentage points in annual GDP growth), as large as the one for the UK, while for France the corresponding figure is 0.36 only. This large and slowly response of Italy to US shocks is also present in the global model of Pesaran et al. (2003). 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. The point that US shocks have only short-horizon effect has also being shown by Ballabriga et al. (1999).

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 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 and, moreover, the spillovers are generally significant in this case. This is perhaps a difference to be expected and can indicate the stronger integration of the European economies with Germany than with the US.

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.

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 deal with the selection of the most relevant transition variables. Finally, we present the results of the analysis of the time-varying transmission mechanism.

3.1 Transition variables

The variables possibly affecting the shape and speed of shock transmission are listed in Table 1, with more details in Appendix D. 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, expressed as differences with respect to the corresponding German variables. This is justified by the convergence in interest rates that characterized the path towards 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 the 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 and natural resource characteristics of the economies and in particular at the availability of energy. Hence, it includes variables such as the ratio of oil imports to GDP and of net mineral fuel imports to GDP. Finally, we have included the unemployment rate, as a crude proxy for 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 use of other indicators is made difficult by their non-availability for all countries with comparable definitions for a long enough period of time.

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 labor markets and the financial markets. Economists have recently articulated arguments about why flexible labor markets lead to less unemployment persistence and less persistence of output loss: these same arguments suggest that a measure

[1] A 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 labor 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 labor 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. Unfortunately, in the following analysis structural variables do not determine any regime changing behavior in the transmission mechanism, the reason being the lack of sufficient variability due to the short time series available for this type of data.

Not all the variables we have selected to consider as transition variables have these "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 problem here is that such variables could be endogenous to the output growth rates we model, but we have to ignore this in the modelling because of the substantial computational complications it would introduce that could be hardly addressed with the rather short sample available (quarterly data for 1970:1-2001:4). Moreover, the results presented in section 3.3 show that the definition of the regimes has no clear resemblance to business cycle behavior, so that the cost of imposing this exogeneity restriction to model changes in the transmission of international 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 also on initial conditions.

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

$$\begin{aligned} y_t &= [c_1 + A_{1,1}y_{t-1} + ... + A_{1,p}y_{t-p}](1 - F_t(z_{t-d})) + \\ &\quad [c_2 + A_{2,1}y_{t-1} + ... + A_{2,p}y_{t-p}]F_t(z_{t-d}) + \varepsilon_t, \end{aligned} \tag{2}$$

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 $F_t(z_{t-d}) = (F_{1,t}(z_{t-d_1}), ..., F_{k,t}(z_{t-d_k}))$. 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. Note that z is the standardized value of one of the transition variables listed in Table 1, $j = RST, ..., UNEM$ for country X, which is the first country in the trivariate VAR, so $z \in z_X^j$.

For the purpose of modelling dynamic changes in the interdependence of economic fluctuations across countries, the restriction that each equation of the system has the same transition function $F_{1,t}(z_{t-d_1}) = ... = F_{k,t}(z_{t-d_k})$ is imposed in the general model described in equation (2) because of the small number of degrees of freedom. Moreover, this restriction is in line with our interest in estimating a model able to characterize changes in the transmission of shocks from abroad to a given country depending on characteristics of the country suffering the shock.

Although smooth transitions have the appeal of modelling slow shifts between regimes, we decided to report results only for threshold VAR models. This is so for three main reasons. First, it is difficult to estimate the parameters of the smooth transition functions when there are few observations around the threshold, a larger problem in a short sample. The second advantage of VARs with abrupt transition is that they are more able to reproduce correctly the dynamic behavior of the variables in the presence of structural breaks (Carrasco, 2002), which is one of our main concerns. Finally, abrupt transition VARs allow the variances of shocks to shift between regimes, which is an advantage when one wants to produce responses that can be different across regimes.

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

3.3 Selection of Transition Variables

Given the set of potential transition variables in section 3.1, the procedure for choosing the most appropriate variables is described in detail in Appendix C. The procedure has two main steps: (1) the computation of a statistic that resembles the linearity test in Teräsvirta (1998) to verify whether nonlinearity matters, (2) a selection of transition variables that specify OAT-VARs with smallest information criteria. A third step could be added where only transition variables that generate statistically different responses between regimes based on generalized impulse responses, conditional on the history of each regime, are retained.[2]

In Table 2, the transition variables selected by the two step procedure are presented. The two classes of variables "Financial market structure" and "Economic structure" have not been considered at this step. The reason is that these variables have a shorter data availability (around 80 observations) which is not informative enough to evaluate their statistical significance.

Three main points can be made on the basis of Table 2. First, at least one measure of monetary policy differential was selected for each country analyzed. Second, the choice of the financial variables indicates two important markets for the transmission of shocks: currency and stocks. Finally, there are similarities in some transition variables for Italy and Spain in contrast to those for the UK and France. For the former countries variables related to trade and labor market were chosen, while for the latter countries variables that measure the need of oil imports were selected.

3.4 Results

The responses to US and German shocks from the OAT-VARs for the selected transition variables are reported in Tables 3, 4, 5, for, respectively, $h = 1, 4, 8$. 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 statistically different response in one regime or another, possibly depending on the type of shock (light shaded areas). However, only a few models have transmission mechanisms that are statistically different across regimes (dark shaded areas).

A general result of interest is that the currency market is an important channel to explain changes in the transmission of shocks because OAT-VARs with an exchange rate are chosen for each country. Analyzing the responses together with the results of Table 2 and Figures 1, 2, 3 and 4, we can conclude that the economies are more fragile when strong fluctuations of the exchange rate have occurred. This could be due to the impact of the exchange rate changes on corporate balance sheets that would reinforce the financial acceleration mechanism.

For France, there is some weak evidence of asymmetries across regimes in the transmission mechanism. Observing the OAT-VARs for RST (difference between French and German real short-term interest rates) and for DM2SA (difference between French and German changes in

[2] The transition variable for the VAR with country X, Germany and US is $z^j_{X,t-d}$ 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 $X =$Germany, which is a VAR of $y_{GER,t}$, $y_{UK,t}$, $y_{US,t}$ with transition variables from the German data and the UK as the reference country for monetary policy. Notice that in principle groups of transition variables could be considered, but the sample available would make parameter estimation quite unreliable.

M2), we can infer that the transmission mechanism of German shocks depends on the divergence of the French monetary policy with respect to Germany: when interest rates are too high or when money supply is increasing at high rates, France is more susceptible to German shocks. In the occurrence of these events the accommodating potential of French monetary policy would be more limited.

Similarly, the ST transition variable for the UK shows an interesting monetary policy behavior: when the interest rate is too low compared with the one in Germany one year previously, 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, Figure 1 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. A possible reason for such a finding is the increasing integration in both financial and trade terms of the UK in the global economy.

Observing Figure 2 together with the Tables, we can suggest regimes in which the Italian economy is more susceptible to shocks from the US: (a) when there is a strong valuation of the exchange rate (DREER); (b) when stock prices are increasing (DSPI); (c) during 70's bank assets outflow (BIN); (d) when there is a low proportion of trade with European countries (TRADE); (e) when the unemployment rates are increasing. Regarding German shocks, we can identify three characteristics of the Italian economy that can tight the transmission mechanism: (a) devaluation of the exchange rate (DREER); (b) during 70's bank assets outflow (BIN); (c) when the unemployment rates are increasing. The choice of these variables imply that the financial market is a strong channel for the transmission of shocks, that intra-European trade is an insurance against shocks from outside Europe and that high unemployment makes the economy fragile.

The results for Spain show that there is no interesting asymmetry when German shocks are considered, but when US shocks are taken into account, the results show that the transmission of shocks from the US to the Spanish economy is weaker when (a) the real exchange rates are stable (DREER); (b) when the stock market is booming (DSPI1); (c) before 1987 when there is no large proportion of trade with European countries (TRADE). Explanations of these findings are similar to what we mentioned before, namely, with stable exchange rates monetary policy can be more flexible, when the domestic economy is in good conditions as reflected by the stock market external shocks are less problematic and, finally, increasing trade integration implies a greater exposure to foreign shocks.

The response of the German economy to shocks emanating from the US also illustrates a sensitivity to a financial channel. The exchange rate is of some importance at all horizons and international capital flows are significant at the longer ones. These sensitivities stand out more for the German economy than for the others. They might be held to confirm two well-known features of the German economy. First, that its currency, the DM, was the only currency of world significance compared to the US dollar; second, that the real economy was (and remains) highly export-oriented.

In summary, the transmission of external shocks appears to depend on transition variables that represent exchange rate movements, financial prices, international financial flows, trade integration and dissimilarities in monetary policy.

4 How big were the effects on Europe of the recent US slowdown?

The previous section presented evidence of regime changing behavior in the transmission mechanism of external shocks. In this section, we exploit some of the non-linear models to derive the expected effects of a rather large and negative US shock on GDP growth in Italy, Spain, UK, France and Germany.

We characterize the US downturn as generated from a -3% shock in the annual growth rate at 2000:4. Shocks of this size and sign had occurred in the past, and they are associated with dated US recessions. To measure the effects of this shock we rescale the responses in Tables 3 and 4 that are based on a 1% shock on a quarterly basis. Notice that, notwithstanding the overall nonlinearity of the OAT-VAR, the effects of the shock are proportional to its sign and size because the shock does not affect the regime changing probabilities. The latter do depend on the history at the time of the shock, which defines which mechanism will regulate the shock transmission.

We assume that if there had been no shock the economies would have grown during 2001 at the rates predicted by the IMF in October 2000 (*The World Economic Outlook*, October 2000). For example, the predicted GDP growth rate for the US was 3.2%, while the actual was 0% (as reported in (*The World Economic Outlook*, October 2002) This also justifies our choice of a -3% shock for the US. The last column of Table 6 reports the corresponding forecast errors for the European countries, which are substantially larger for France and Germany than for Italy, Spain and the UK.

We consider three transition variables for the OAT-VARs, that are both sensible from an economic point of view and relevant from the previous statistical analysis. First, DREER, that measures real exchange rate disequilibrium. Second, TRADE, that measures the proportion of trade of one country with other European countries, so that large values for this variable can insulate from negative trade effects with the US. Third, ST, the deviation of the short term interest rate with respect to the German one (or of the UK one in the case of Germany). Though this variable has a limited variability in the recent period because of the monetary union, it varied substantially in the past and was found to be relevant for the shock transmission, likely because it is a proxy for the overall status of the economy of a country. Basically, all countries are in a regime characterized by limited exchange rate disequilibrium, high intensity of European trade and small deviations in interest rates. Thus, we would expect the economies to be relatively resilient to a US shock. Notice that all countries in part of the sample under analysis (1970-2001) were also in regimes of exchange rate disequilibrium, low trade and high interest rate differentials, so that the OAT-VARs are important to determine the proper coefficients to be used in the computation of the shock responses.

The results are summarized in Table 6, with details on the models and transition functions available upon request. The predicted responses depend substantially on the chosen transition variable, but it is difficult to indicate the most appropriate variable on statistical or economic grounds. A safer alternative can be to consider an average of the three responses, which can be considered as a pooled forecast. Then, a first interesting characteristic is that very similar responses are obtained for all the European countries, in the range -1.9% to -1.5%. Thus, about 50%-60% of the US shock is trasnmitted to Europe. These values are also rather close to the figures from simple linear VARs. A second interesting feature is that the actual response for Italy and Spain is overall in line with the average prediction of the models, the actual response of the UK is smaller than predicted, and the one of France and Germany is much larger. This suggests that either a positive idiosyncratic shock has taken place in the UK contemporaneously to the negative US one, with an additional negative shock in France and Germany, or that additional shock absorber / amplifier mechanisms are at work, and the institutional reforms in the goods, financial and labour markets implemented in the UK and partly in Italy and Spain could be candidate explanations.

5 Conclusion

In this paper, we propose a class of nonlinear VARs to model the possibly time-varying relationships among GDP growth rates for the major economies. Using these models, we show that the transmission of shocks from the US to European countries may change depending on transition variables that represent changes in exchange rates, financial prices, international capital flows, trade links and monetary policy instruments. Moreover, there are gains in allowing for a changing transmission mechanism when analyzing the strong effect of the recent US recession on some European economies. Specifically, while linear VARs, as well as large scale macroeconometric models, cannot explain the fast and substantial shock transmission from the US to Europe, this can be achieved by our OAT-VARs.

Future research could exploit the OT-VARs proposed in this paper to examine the monetary transmission mechanism or the impact of fiscal shocks on the economy. In addition, different econometric techniques could be developed to better exploit the informational content of the variables that characterize economic and financial structure, given that their limited variability constrained their application in the OAT-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 $W_{t-1} = (y_{t-1}, ..., y_{t-p})$ and $Z_{t-1} = (z_{t-1}, ..., z_{t-d_{\max}})$ and are used to build a matrix of histories $\Omega_{t-1} = ((W_{t-1}, ..., W_{T-1})', (Z_{t-1}, ..., Z_{T-1})')$. 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^1_{t-1} has the rows of Ω_{t-1}such that $F_t(z_{t-d}) = 0$ and the second partition Ω^2_{t-1} has the rows of Ω_{t-1} such that $F_t(z_{t-d}) = 1$.

GIs are computed for five types of shocks, so that the $5 \times k$ matrix of shocks is $v = (v_1, ..., v_5)'$, 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 $z_t, ..., z_{t+n}$. 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 $GI_Y(n, v_i, \Omega^j_{t-1})$, 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^j_i of the matrix Ω_{t-1}.

(2) Pick one of the rows of Ω^j_i.

(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 $\boldsymbol{\eta}^*$ of size $N+1$ by bootstrapping from $\boldsymbol{\eta}$, which are the residuals of the AR(p) of z_t.

(5) Use $\boldsymbol{\eta}^*$ to get a sequence $z_{t+0}, ..., z_{t+N}$ given the estimated AR(p) conditional on Z_{t-1}. Use ϵ^*, the sequence $z_{t+0}, ..., z_{t+N}$, and the estimated VAR to get $y_t^{ns,m}, ..., y_{t+N}^{ns,m}$. This calculates a sequence that describes the dynamic of the system when there is not a shock.

(6) Use $z_{t+0}, ..., z_{t+N}$, $y_t^{s,m}$, the first N observations of ϵ^* and the estimated VAR to get $y_{t+1}^{s,m}, ..., y_{t+N}^{s,m}$. 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: $y_t = [c_1 + A_{1,1}y_{t-1} + ... + A_{1,p}y_{t-p} + \varepsilon_t^{*1}](1 - F_t(z_{t-d})) + [c_2 + A_{2,1}y_{t-1} + ... + A_{2,p}y_{t-p} + \varepsilon_t^{*2}]F_t(z_{t-d})$, where ε_t^{*1} and ε_t^{*2} are bootstrapped from $\boldsymbol{\epsilon}$, conditional on the regime. This means that information on the regime dependent covariance matrices are employed in the computation of the GIs.

Because of parameter uncertainty and finite sample size, inference on the GIs for each horizon is based on a 95% bootstrap 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 the OT-VAR

The estimation of the observed transition VAR depends on the assumption on 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 of the residuals given a set of parameters θ to be estimated:

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

where $\hat{\Sigma}(\boldsymbol{\theta})$ is calculated as $1/T\sum_{i=1}^{T} \epsilon_t\epsilon_t'$. 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 p 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 d 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 $z^{j}_{X,t-d}$ 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 $X =$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 VAR we use a three-step procedure to choose the transition variables from the set $\Xi_X = \{z^{RST}_{X,t}, ..., z^{UNEM}_{X,t}\}$, with all js as described in Table 1

(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 chosen when the null hypothesis is rejected at 10% for at least one of the delays considered.

(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 ($n \log(\left|\hat{\Sigma}\right| + \log(n)m$ with m 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.

D Description of Data Set[3]

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 lenght 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.

All transition variables are quarterly and are described below. If the original frequency of the data is annual, the frequency transformation method is also described below.

D.1 Transition Variables

D.1.1 Monetary Policy Instruments

RST-: Short-Term Real Interest Rate

Calculation:	ln(1+(ST-((CPI/(lag(CPI,4)))-1)*100)/100,where CPI is the Consumer Price Index (base 1995=100) and 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)

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)

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

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/(lag(CPI,4)))-1)*100)/100, where CPI is the Consumer Price Index with (base 1995=100) and 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)

DSPI1: 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 montly 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 precentage 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 b- D_ERE: exchange rate (US$) 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	*d,* *r*	SIC (T)	Transition Variable	*d,* *r*	SIC (T)	Transition Variable	*d,* *r*	SIC (T)	Transition Variable	*d,* *r*	SIC *(T)*
1: Monetary Policy Instruments (3)	RST DM2SA	1, 0.381 3, 0.549	-97.34 (116) -95.08 (116)	ST	4, -0.483	-73.59 (113)	DM2SA	1, -0.506	-112,97 (116)	RST ST	1, -0.700 4, 0.651	-20.59 (117) -21.70 (117)
2: Financial Variables (5)	D_ERE DSPI1	8, 0.179 8, -0.522	-93.90 (116) -95.87 (116)	DREER DSPI1	6, -0.544 7, 0.006	-76.93 (116) -78.55 (116)	DREER DSPI1	6, 0.780 1, -0.467	-112.97 (116) -121.14 (116)	DREER	2, 0.650	-38.84 (108)
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 TRADE	4, -0.398 4, 0.561	-110.24 (116) -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; T: 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		1		0.04		0.32	
	(0.018 0.3)	(0.018 0.3)	(0.103 0.5)	(0.10 0.45)	(0.72 1.2)	(0.72 1.21)	(-0.1 0.2)	(-0.10 0.20)	(0.147 0.5)	(0.15 0.49)
RST	0.23	0.07	0.22	0.47	0.77	1.41	-0.03	0.29	0.26	0.74
	(-0.02 0.36)	(-0.05 0.37)	(-0.11 0.53)	(0.02 0.78)	(0.57 1.23)	(0.75 1.55)	(-0.11 0.25)	(-0.10 0.26)	(0.05 0.61)	(0.15 0.78)
D_ERE	0.23	0.21	0.30	0.60	1.03	1.08	0.04	0.05	0.43	0.48
	(0.00 0.40)	(0.00 0.40)	(-0.02 0.62)	(0.22 0.85)	(0.73 1.35)	(0.76 1.44)	(-0.16 0.22)	(-0.16 0.20)	(0.15 0.68)	(0.19 0.70)
DSPI	0.17	0.19	0.46	0.39	0.82	1.18	0.07	0.05	0.47	0.43
	(0.07 0.36)	(0.05 0.35)	(0.12 0.79)	(0.14 0.65)	(0.59 1.14)	(0.89 1.54)	(-0.11 0.20)	(-0.11 0.18)	(0.01 0.72)	(0.12 0.65)
DM2SA	0.14	0.21	0.39	0.24	1.15	0.74	0.06	0.10	0.44	0.49
	(-0.01 0.27)	(-0.03 0.28)	(0.10 0.63)	-0.83 1.04)	(0.86 1.48)	(0.29 1.88)	(-0.14 0.26)	(-0.16 0.29)	(0.20 0.66)	(-0.84 1.06)
NETIMP	0.28	0.18	0.45	0.18	1.28	0.93	0.02	0.11	0.42	0.52
	(0.02 0.49)	(0.01 0.59)	(0.07 0.75)	-0.25 0.88)	(0.78 1.79)	(0.62 1.70)	(-0.22 0.21)	(-0.23 0.26)	(-0.03 0.71)	(0.04 1.00)
Italy										
linear	0.08		0.09		1.32		0.04		0.26	
	(-0.06 0.26)	(-0.06 0.26)	(-0.10 0.36)	-0.10 0.36)	(1.08 1.74)	(1.08 1.74)	(-0.14 0.18)	(-0.14 0.18)	(-0.01 0.46)	(-0.01 0.46)
DREER	0.25	0.17	0.60	0.21	1.44	1.27	-0.13	0.00	-0.52	0.45
	(0.01 0.36)	(-0.02 0.34)	(-0.69 1.14)	-0.14 0.47)	(0.59 3.27)	(0.85 1.66)	(-0.21 0.12)	(-0.21 0.13)	(-1.10 0.31)	(0.15 0.65)
DSPI	0.03	0.14	-0.38	0.40	1.86	1.13	0.08	0.03	0.37	0.52
	(-0.13 0.29)	(-0.08 0.29)	(-0.67 0.08)	-0.02 0.73)	(1.33 2.51)	(0.69 1.63)	(-0.12 0.22)	(-0.13 0.24)	(-0.08 0.66)	(0.13 0.82)
BIN	0.15	0.13	0.24	-0.42	1.13	1.21	0.03	-0.06	0.38	-0.24
	(-0.12 0.35)	(-0.36 0.53)	(-0.10 0.53)	-1.04 1.12)	(0.79 1.82)	(0.37 2.23)	(-0.16 0.26)	(-0.41 0.42)	(0.09 0.68)	(-1.01 0.88)
TRADE	0.03	-0.32	0.05	-0.51	1.29	1.06	0.28	-0.09	0.60	0.54
	(-0.31 0.25)	(-0.36 0.23)	(-0.50 0.34)	(-1.11 1.13)	(0.73 1.58)	(0.55 2.89)	(-0.05 0.41)	(-0.09 0.42)	(0.02 0.84)	(-0.55 1.42)
ST	0.13	-0.20	0.17	-0.83	1.53	0.26	0.06	-0.37	0.28	0.27
	(-0.47 0.39)	(-0.42 0.46)	(-0.58 0.57)	-1.42 1.42)	(0.54 2.09)	(0.09 5.27)	(-0.88 0.39)	(-0.44 0.39)	(-0.43 0.63)	(-1.33 1.32)
UNEM	0.19	0.10	-0.15	0.19	1.65	1.04	0.00	0.03	-0.13	0.35
	(-0.39 1.16)	(-0.17 0.35)	(-0.96 1.34)	-0.46 0.63)	(0.45 3.05)	(0.51 1.62)	(-0.71 0.60)	(-0.20 0.26)	(-0.92 1.37)	(-0.09 0.80)
Spain										
linear	0.10		0.19		0.95		-0.04		0.13	
	(-0.06 0.25)	(-0.06 0.25)	(0.00 0.35)	(0.00 0.35)	(0.66 1.29)	(0.66 1.29)	(-0.16 0.08)	(-0.16 0.08)	(-0.07 0.29)	(-0.07 0.29)
DREER	0.12	0.19	0.25	1.10	0.90	0.65	-0.08	-0.14	0.23	0.38
	(-0.03 0.27)	(-0.07 0.27)	(-0.02 0.48)	(0.09 1.32)	(0.65 1.18)	(0.33 1.23)	(-0.2 0.02)	(-0.25 0.03)	-0.04 0.43)	(-0.84 1.17)
DSPI	0.05	0.05	1.37	0.16	0.70	1.17	-0.02	-0.02	0.29	0.37
	(-0.10 0.22)	(-0.09 0.23)	(-1.31 1.52)	-0.13 0.44)	(0.13 1.79)	(0.80 1.53)	(-0.2 0.12)	(-0.19 0.13)	(-1.39 1.32)	(0.02 0.68)
DM2SA	0.12	0.14	0.11	0.40	1.60	0.89	-0.05	0.02	0.20	0.23
	(-0.03 0.25)	(-0.01 0.25)	(-0.56 0.79)	(0.09 0.71)	(0.65 2.93)	(0.61 1.11)	(-0.1 0.09)	(-0.13 0.08)	(-0.58 0.89)	(-0.18 0.59)
TOT	0.00	0.22	0.00	0.39	0.35	1.22	-0.29	0.06	-0.25	0.39
	(-0.07 0.39)	(-0.03 0.36)	(-0.41 0.94)	-0.22 0.79)	(0.23 1.60)	(0.59 1.69)	(-0.26 0.23)	(-0.26 0.20)	(-0.54 0.83)	(-0.29 0.69)
BIN	-0.01	0.19	0.14	0.59	0.86	1.12	0.16	-0.19	0.33	0.25
	(-0.14 0.29)	(-0.13 0.29)	(-0.30 0.63)	-0.15 0.84)	(0.48 1.29)	(0.66 1.61)	(-0.18 0.18)	(-0.18 0.18)	(-0.35 0.70)	(-0.29 0.78)
TRADE	0.05	0.18	-0.40	0.43	0.32	1.15	-0.19	-0.05	0.30	0.20
	(-0.15 0.57)	(-0.15 0.53)	(-0.97 1.09)	(-0.3 1.35)	(0.20 2.03)	(0.43 1.83)	(-0.4 0.20)	(-0.32 0.22)	(-0.52 1.10)	(-0.73 1.03)
UNEM	0.01	-0.01	0.22	0.13	0.84	1.06	0.17	-0.30	0.37	-0.22
	(-0.27 0.37)	(-0.44 0.39)	(-0.30 0.67)	(-0.57 0.75)	(0.30 1.30)	(0.25 2.01)	(-0.16 0.29)	(-0.46 0.25)	(-0.28 0.76)	(-0.56 0.70)

UK										
linear	0.28		0.54		1.22		-0.07		0.33	
	(0.06 0.54)	(0.06 0.54)	(0.24 0.86)	(0.24 0.86)	(0.98 1.84)	(0.98 1.84)	(-0.26 0.14)	(-0.26 0.14)	(0.05 0.60)	(0.05 0.60)
RST	0.20	0.13	0.47	0.27	0.95	1.12	-0.06	0.00	0.16	0.36
	(-0.06 0.45)	(-0.09 0.44)	(-0.12 0.90)	(-0.08 0.65)	(0.53 1.62)	(0.67 1.77)	(-0.27 0.26)	(-0.21 0.21)	(-0.54 0.72)	(0.06 0.65)
DREER	0.19	0.18	0.16	0.31	0.78	0.97	-0.15	-0.18	0.39	0.08
	(-0.09 0.43)	(-0.06 0.40)	(-0.40 0.83)	(-0.08 0.58)	(0.29 1.62)	(0.52 1.39)	(-0.37 -0.02)	(-0.36 -0.02)	(-0.70 0.74)	(-0.24 0.35)
USBCL	0.15	0.16	0.33	-0.01	1.21	0.45	-0.13	-0.11	0.11	0.54
	(-0.70 1.38)	(-0.79 1.35)	(-1.85 1.71)	(-1.17 2.11)	(-0.04 3.72)	(-0.59 3.00)	(-0.56 0.52)	(-0.63 1.18)	(-1.09 1.06)	(-0.81 2.20)
ST	0.29	0.22	0.60	0.45	2.12	1.40	0.30	-0.12	0.74	0.28
	(-0.13 0.58	(-0.12 0.50)	(-0.17 0.88)	(0.03 0.82)	(0.97 2.70)	(0.96 2.19)	(-0.27 0.33)	(-0.31 0.18)	(-0.22 0.87)	(0.06 0.64)
NETIMP	0.23	-0.31	0.49	0.21	1.34	1.19	-0.06	1.08	0.22	0.87
	(-0.45 0.67)	(-1.17 0.73)	(-0.24 1.08)	(-1.52 1.30)	(0.37 2.06)	(-0.31 4.96)	(-0.57 0.40)	(-0.73 0.96)	(-0.64 0.86)	(-1.23 1.45)
Germany										
linear	0.14		0.43		1.30					
	(-0.07 0.34)	(-0.07 0.34)	(0.19 0.65)	(0.19 0.65)	(0.92 1.68)	(0.92 1.68)				
RST	0.13	0.01	0.33	0.54	1.27	1.03				
	(-0.14 0.39)	(-0.16 0.39)	(-0.02 0.63)	(-0.12 0.91)	(0.74 1.76)	(0.45 1.76)				
D_ERE	0.65	0.36	0.83	0.74	1.04	1.54				
	(-0.16 1.20)	(-0.39 0.75)	(-0.89 1.41)	(0.27 1.12)	(0.36 4.41)	(1.01 2.13)				
TNET	0.13	0.13	0.54	0.30	1.73	0.96				
	(-0.12 0.37)	(-0.12 0.36)	(0.14 0.85)	(-0.06 0.58)	(1.07 2.16)	(0.64 1.57)				
USBGR	0.04	-0.11	0.09	0.31	1.07	1.00				
	(-0.53 0.32)	(-0.54 0.38)	(-0.52 0.48)	(-0.20 0.80)	(0.23 1.58)	(0.41 1.92)				
ST	0.01	0.12	0.17	0.85	1.10	1.89				
	(-0.24 0.31)	(-0.25 0.34)	(-0.17 0.58)	(-0.02 0.94)	(0.77 1.80)	(0.66 2.15)				

Notes: Responses computed for OAT-VARs estimated with the indicated transition variables and with parameters described on Table 2. The values between parentheses are 95% confidence intervals computed by bootstrap as described in the appendix. Light shaded areas indicate that the response is statistically different from the VAR. Strong shaded areas indicate that the response is statistically different from the other regime.

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	0.3		0.36		1.1		0.05		0.35	
	(0.03 0.46)	(0.03 0.46)	(0.12 0.56)	(0.12 0.56)	(0.78 1.32)	(0.78 1.32)	(-0.07 0.19)	(-0.07 0.19)	(0.19 0.51)	(0.19 0.51)
RST	0.29	0.07	0.27	0.47	0.90	1.43	0.02	0.26	0.33	0.73
	(-0.09 0.49)	(-0.09 0.49)	(-0.18 0.64)	-0.02 0.89)	(0.59 1.40)	(0.83 1.64)	(-0.14 0.32)	(-0.14 0.29)	(0.07 0.67)	(0.19 0.92)
D_ERE	0.29	0.28	0.35	0.67	1.14	1.16	0.05	0.09	0.48	0.52
	(0.00 0.55)	(-0.02 0.54)	(-0.01 0.72)	(0.23 0.98)	(0.77 1.55)	(0.82 1.62)	(-0.12 0.20)	(-0.12 0.19)	(0.16 0.75)	(0.23 0.78)
DSPI	0.42	0.37	0.70	0.62	1.18	1.61	0.24	0.24	0.65	0.66
	(0.12 0.73)	(0.12 0.78)	(0.30 1.13)	(0.29 1.01)	(0.77 1.64)	(1.11 2.01)	(-0.06 0.52)	(-0.04 0.47)	(0.20 1.02)	(0.31 0.96)
DM2SA	0.39	0.62	0.62	0.61	1.26	1.08	-0.01	0.02	0.40	0.73
	(0.14 0.89)	(-0.06 0.77)	(0.27 1.08)	-0.74 1.29)	(0.82 1.67)	(0.48 2.38)	(-0.29 0.29)	(-0.29 0.33)	(0.09 0.71)	-0.42 1.26)
NETIMP	0.38	0.16	0.58	0.15	1.51	0.89	0.05	0.07	0.52	0.48
	(-0.09 0.77)	(-0.12 0.94)	(0.04 1.05)	-0.30 1.17)	(0.69 2.36)	(0.52 2.22)	(-0.31 0.39)	(-0.31 0.37)	(-0.07 1.01)	(0.01 1.12)
Italy										
Linear	0.61		0.67		2.08		0.27		0.60	
	(0.14 1.08)	(0.14 1.08)	(0.04 1.14)	(0.04 1.14)	(1.39 2.89)	(1.39 2.89)	(-0.07 0.67)	(-0.07 0.67)	(0.17 0.91)	(0.17 0.91)
DREER	0.62	0.77	1.38	0.88	3.21	2.20	0.76	0.37	0.46	0.93
	(0.22 1.01)	(0.25 1.05)	(-0.01 1.82)	(0.28 1.22)	(1.30 4.48)	(1.45 2.81)	(-0.14 0.72)	(-0.12 0.67)	(-0.84 0.87)	(0.44 1.31)
DSPI	0.42	0.56	0.20	0.91	2.72	1.89	0.51	0.35	0.88	0.94
	(0.03 0.94)	(0.12 0.92)	(-0.31 0.82)	(0.40 1.45)	(1.95 3.75)	(1.32 2.68)	(0.00 0.80)	(0.02 0.77)	(0.29 1.26)	(0.44 1.46)
BIN	0.32	1.42	0.43	1.46	1.46	3.52	0.07	1.01	0.50	1.56
	(0.03 1.14)	(0.17 2.30)	(0.00 1.44)	(-0.40 2.79)	(1.09 3.43)	(0.99 4.92)	(-0.69 0.63)	(-1.35 1.62)	(0.08 1.29)	-0.97 2.55)
TRADE	0.24	-0.63	0.37	-0.89	1.76	1.56	0.60	0.03	0.97	0.85
	(-1.05 1.19)	(-0.89 0.85)	(-0.83 1.51)	(-1.37 1.71)	(0.61 3.23)	(0.54 4.69)	(-0.14 1.48)	(-0.22 1.08)	(0.21 1.83)	-0.40 1.97)
ST	0.55	0.14	0.68	-0.54	2.30	0.93	0.36	-0.06	0.71	0.42
	(-35.9 1.75)	(-2.37 1.47)	-53.84 1.66)	(-9.41 2.37)	(-85.6 3.78)	-0.52 7.96)	-18.98 2.39)	(-1.36 2.46)	(-12.2 1.3)	-5.26 2.32)
UNEM	1.46	0.29	1.55	0.40	3.39	1.47	0.84	0.09	1.39	0.51
	(-0.15 2.75)	(-0.04 1.19)	(-1.18 3.59)	(-0.49 1.41)	(0.42 7.73)	(0.75 3.11)	(-1.06 2.34)	(-0.28 0.61)	(-1.19 3.14)	-0.04 1.28)
Spain										
Linear	0.30		0.44		1.69		-0.11		0.19	
	(-0.14 0.71)	(-0.14 0.71)	(0.00 0.84)	(0.00 0.84)	(1.10 2.37)	(1.10 2.37)	(-0.38 0.14)	(-0.38 0.14)	(-0.20 0.53)	-0.20 0.53)
DREER	0.41	0.39	0.57	1.99	1.50	1.20	-0.23	-0.25	0.29	0.63
	(-0.01 0.85)	(-0.22 0.83)	(-0.05 1.13)	(0.24 2.45)	(1.01 2.03)	(0.50 2.06)	(-0.5 -.02)	(-0.51 0.03)	(-0.17 0.67)	-1.25 1.97)
DSPI	0.28	0.27	2.43	0.48	1.50	2.25	0.09	0.09	0.64	0.79
	(-0.14 0.72)	(-0.12 0.74)	(-2.04 2.80)	(-0.06 1.07)	(0.45 3.57)	(1.39 2.95)	(-0.52 0.56)	(-0.42 0.54)	(-2.37 2.50)	(0.05 1.42)
DM2SA	0.61	0.57	0.59	1.00	3.11	1.80	-0.13	0.01	0.34	0.47
	(0.00 0.93)	(-0.02 0.94)	(-0.91 1.59)	(0.18 1.60)	(1.23 5.16)	(1.12 2.27)	(-0.43 0.14)	(-0.46 0.14)	(-1.18 1.45)	-0.39 1.06)
TOT	0.01	0.73	0.06	0.94	0.66	2.12	-0.31	-0.08	-0.25	0.59
	(-0.03 1.24)	-0.14 1.24)	(-0.35 1.76)	(-0.21 1.66)	(0.51 2.82)	(0.89 3.26)	(-0.56 0.33)	(-0.54 0.31)	-0.82 1.39)	-0.45 1.18)
BIN	0.09	0.50	0.28	1.23	1.26	2.28	0.08	-0.12	0.38	0.67
	(-0.62 0.80)	-0.42 0.80)	(-0.68 1.08)	(-0.26 1.71)	(0.51 2.20)	(0.78 2.82)	(-0.28 0.26)	(-0.30 0.27)	(-0.45 1.18)	(-0.39 1.39)
TRADE	0.33	0.52	-0.12	0.89	0.62	2.01	-0.18	-0.15	0.45	0.33
	(-0.39 1.79)	-0.36 2.05)	(-1.27 2.70)	(-0.92 2.22)	(0.34 5.32)	(0.88 3.42)	(-1.02 0.47)	(-0.64 0.42)	(-1.27 2.24)	(-1.28 2.05)
UNEM	0.17	-0.46	0.44	-0.27	1.27	1.31	0.13	-0.24	0.47	-0.13
	(-0.75 0.79)	-1.25 0.69)	(-0.60 1.32)	(-0.86 1.23)	(0.17 2.10)	-0.19 2.90)	(-0.41 0.43)	(-0.59 0.36)	(-0.47 1.04)	(-0.79 0.90)

UK										
linear	0.39		0.67		1.61		-0.06		0.38	
	(0.08 0.77)	(0.08 0.77)	(0.32 1.10)	(0.32 1.10)	(1.05 2.18)	(1.05 2.18)	(-0.26 0.16)	(-0.26 0.16)	(0.08 0.68)	(0.08 0.68)
RST	0.49	0.15	0.66	0.27	1.01	1.05	-0.26	-0.11	0.14	0.27
	(-0.06 0.82)	(-0.03 0.67)	(-0.05 1.05)	(0.02 0.91)	(0.37 2.05)	(0.62 1.88)	(-0.55 0.19)	(-0.34 0.23)	(-0.73 0.72)	(-0.01 0.71)
DREER	0.74	0.73	0.61	0.79	1.36	1.34	-0.42	-0.54	0.41	-0.06
	(0.25 1.25)	(0.24 1.19)	-0.38 1.58)	(0.24 1.29)	(0.60 2.41)	(0.75 1.98)	(-0.86 -0.08)	(-0.83 -0.16)	(-1.24 1.12)	(-0.55 0.44)
USBCL	0.87	0.00	1.04	-0.81	1.52	0.09	-0.67	-0.87	-0.23	0.44
	(-16 68)	(-9 85)	(-11 77)	(-4 196)	(-10 97)	(-8 80)	(-17 12)	(-4 14)	(-13 145)	(-6 61)
ST	0.58	0.31	1.18	0.56	3.14	1.59	0.82	-0.12	1.45	0.33
	(-0.17 0.90)	(-0.12 0.83)	-0.18 1.33)	(0.01 1.09)	(0.97 3.50)	(1.10 2.66)	(-0.33 0.64)	(-0.33 0.38)	(-0.23 1.34)	(0.09 0.90)
NETIMP	0.83	0.28	1.05	0.56	1.85	1.66	-0.44	0.09	0.11	0.73
	(-0.42 3.14	(-1.37 2.24)	-0.19 3.12)	(-1.20 6.01)	(0.55 7.42)	-1.57 6.76)	(-1.23 1.45)	-4.03 0.84)	(-0.81 1.95)	(-2.62 3.79)
Germany										
Linear	0.23	0.23	0.53	0.53	1.42	1.42				
	(-0.07 0.49)	(-0.07 0.49)	(0.16 0.81)	(0.16 0.81)	(0.95 1.82)	(0.95 1.82)				
RST	0.27	0.48	0.48	0.89	1.38	1.25				
	(-0.04 0.81)	(-0.07 0.77)	(0.09 1.08)	(-0.05 1.20)	(0.88 1.93)	(0.55 1.97)				
D_ERE	0.40	0.50	0.51	0.86	0.86	1.77				
	(-2.10 0.86)	(-1.18 0.84)	(-1.19 1.40)	(-0.20 1.33)	(0.21 3.66)	(0.79 2.48)				
TNET	0.65	0.55	1.08	0.72	2.40	1.42				
	(0.10 1.01)	(0.10 0.98)	(0.32 1.54)	(0.19 1.26)	(1.41 2.97)	(0.95 2.36)				
USBGR	0.27	0.19	0.31	0.65	1.35	1.38				
	(-0.35 0.66)	(-0.30 0.67)	(-0.41 0.85)	(0.04 1.06)	(0.58 2.07)	(0.63 2.28)				
ST	0.05	0.41	0.22	1.43	1.21	2.91				
	(-0.27 0.46)	(-0.30 0.59)	(-0.21 0.80)	-0.04 1.82)	(0.81 2.33)	(0.72 2.80)				

Notes: See notes 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	
	(0.03 0.46)	(0.03 0.46)	(0.13 0.57)	(0.13 0.57)	(0.78 1.33)	(0.78 1.33)	-0.07 0.19)	(-0.07 0.19)	(0.19 0.51)	(0.19 0.51)
RST	0.33	0.04	0.32	0.43	0.94	1.39	0.06	0.24	0.38	0.69
	-0.19 0.52)	-0.25 0.53)	(-0.22 0.70)	-0.07 0.94)	(0.54 1.42)	(0.78 1.70)	-0.23 0.43)	(-0.28 0.41)	(0.03 0.77)	(0.14 1.04)
D_ERE	0.29	0.28	0.36	0.67	1.14	1.17	0.06	0.08	0.49	0.54
	(0.00 0.56)	(0.00 0.56)	(-0.03 0.72)	(0.23 1.02)	(0.76 1.58)	(0.83 1.63)	-0.13 0.21)	(-0.12 0.19)	(0.16 0.75)	(0.24 0.80)
DSPI	0.58	0.55	0.82	0.78	1.27	1.70	0.25	0.28	0.68	0.68
	(0.16 1.02)	(0.20 1.03)	(0.39 1.47)	(0.36 1.31)	(0.75 1.96)	(1.05 2.27)	-0.07 0.65)	(-0.05 0.60)	(0.15 1.16)	(0.29 1.07)
DM2SA	0.40	0.52	0.57	0.47	1.05	0.98	-0.15	-0.08	0.24	0.60
	-0.19 1.16)	-0.05 0.94)	(0.15 1.18)	(-0.92 1.20)	(0.59 1.77)	(0.38 2.03)	-0.59 0.40)	(-0.58 0.34)	(-0.19 0.77)	(-0.44 1.20)
NETIMP	0.39	0.19	0.58	0.17	1.51	0.89	0.04	0.06	0.50	0.48
	-0.21 0.91)	-0.10 0.99)	(-0.31 1.16)	(-0.30 1.31)	(0.70 2.58)	(0.52 2.33)	-0.57 0.44)	(-0.75 0.42)	(-0.42 1.03)	(-0.27 1.16)
Italy										
linear	0.73		0.77		1.86		0.20		0.49	
	(0.17 1.30)	(0.17 1.30)	(0.12 1.37)	(0.12 1.37)	(1.14 2.63)	(1.14 2.63)	(-0.13 0.53)	(-0.13 0.53)	(0.08 0.82)	(0.08 0.82)
DREER	0.50	0.90	1.00	0.99	2.27	2.00	0.60	0.44	0.46	0.89
	(0.19 1.07)	(0.23 1.05)	(-0.02 1.58)	(0.27 1.13)	(0.99 3.83)	(1.19 2.39)	(-0.20 0.67)	(-0.22 0.66)	(-0.72 0.83)	(0.24 1.12)
DSPI	0.53	0.77	0.32	0.99	2.31	1.67	0.33	0.14	0.68	0.70
	(0.19 1.16)	(0.25 1.19)	(-0.12 0.95)	(0.50 1.54)	(1.44 3.78)	(1.07 2.58)	(-0.15 0.67)	(-0.18 0.58)	(0.03 1.16)	(0.24 1.26)
BIN	0.38	1.99	0.48	3.08	1.46	3.95	0.07	1.97	0.49	3.17
	(0.00 1.81)	(-0.22 4.23)	(0.09 1.93)	-0.49 6.90)	(0.94 3.73)	(0.59 10.9)	(-0.51 1.21)	(-1.13 3.57)	(0.04 1.90)	(-0.96 5.25)
TRADE	0.34	-0.58	0.46	-0.83	1.69	1.58	0.48	-0.19	0.86	0.64
	(-2.90 3.89)	(-1.21 2.31)	(-3.56 4.94)	-2.04 2.69)	(0.52 14.9)	(0.76 8.18)	(-1.01 5.71)	(-0.63 3.39)	(-0.99 9.52)	(-0.31 5.66)
ST	0.73	0.37	0.80	-0.59	2.18	1.38	0.22	-0.05	0.60	0.55
	(-353 17)	(-1.84 8.65)	(-12.60 20)	-8.86 5.65)	(-27 14)	(-6.31 9.20)	(-148 6.27)	(-6.00 3.81)	(-190 6.48)	(-6.35 4.93)
UNEM	1.63	0.37	2.26	0.48	2.92	1.50	1.41	0.07	2.18	0.49
	(-0.83 7.41)	(-0.21 5.47)	(-1.89 4.49)	-0.47 6.07)	-1.91 8.58)	(0.64 5.61)	(-2.15 3.06)	(-0.96 1.14)	(-3.66 4.96)	(-0.05 3.54)
Spain										
linear	0.42		0.57		2.01		-0.15		0.22	
	(-0.14 0.71)	(-0.14 0.71)	(0.00 0.84)	(0.00 0.84)	(1.10 2.37)	(1.10 2.37)	(-0.38 0.14)	(-0.38 0.14)	(-0.20 0.53)	(-0.20 0.53)
DREER	0.55	0.51	0.71	2.16	1.66	1.31	-0.26	-0.27	0.30	0.65
	(-0.22 1.16)	(-0.23 1.25)	(-0.01 1.41)	(0.25 2.81)	(1.04 2.53)	(0.44 2.31)	(-0.75 0.01)	(-0.72 0.05)	(-0.24 0.75)	(-1.47 2.25)
DSPI	0.66	0.66	3.19	0.87	2.00	2.94	0.07	0.07	0.78	1.02
	(-0.05 1.47)	(-0.02 1.41)	(-1.77 3.93)	(0.12 1.78)	(0.55 4.54)	(1.52 4.01)	(-0.86 0.71)	(-0.75 0.69)	(-3.24 3.36)	(0.10 1.77)
DM2SA	1.18	1.02	1.16	1.53	4.19	2.48	0.04	0.16	0.63	0.76
	(-0.13 1.50)	(-0.12 1.46)	(-0.95 2.18)	(0.05 2.37)	(1.49 6.43)	(1.18 3.09)	(-0.69 0.34)	(-0.68 0.31)	-1.53 1.77)	(-0.48 1.50)
TOT	0.03	1.03	0.07	1.22	0.71	2.38	-0.34	-0.20	-0.28	0.62
	(-0.28 2.05)	(-0.23 2.03)	(-0.39 2.60)	(-0.12 2.03)	(0.39 3.51)	(0.44 4.50)	(-0.92 0.35)	(-0.94 0.41)	(-0.93 1.79)	(-0.47 1.53)
BIN	0.13	0.89	0.33	1.74	1.38	2.96	0.08	-0.10	0.40	0.93
	(-0.80 1.32)	(-0.83 1.27)	(-0.91 1.53)	(-0.27 2.11)	(0.30 2.87)	(0.72 3.60)	(-0.42 0.32)	(-0.40 0.35)	(-0.66 1.41)	(-0.39 1.53)
TRADE	0.36	0.71	-0.14	1.11	0.64	2.34	-0.19	-0.24	0.52	0.35
	(-1.28 2.78)	(-0.66 4.02)	-1.83 5.47)	(-1.26 4.15)	(0.31 13.9)	(0.63 6.94)	(-1.67 1.64)	(-1.35 1.25)	(-1.70 5.38)	(-1.43 2.54)
UNEM	0.21	-0.50	0.48	-0.32	1.31	1.19	0.12	-0.26	0.48	-0.16
	(-1.07 1.05)	(-1.69 1.07)	(-0.76 1.37)	(-1.35 1.39)	(0.15 2.12)	(-0.38 3.33)	(-0.66 0.43)	(-0.77 0.37)	(-0.56 1.19)	(-0.77 0.94)

UK										
linear	0.40		0.67		1.64		-0.07		0.37	
	(0.09 0.80)	(0.09 0.80)	(0.32 1.16)	(0.32 1.16)	(1.06 2.23)	(1.06 2.23)	-0.26 0.17)	(-0.26 0.17)	(0.08 0.70)	(0.08 0.70)
RST	0.36	0.09	0.54	0.21	0.90	0.98	-0.34	-0.17	0.04	0.19
	(-0.10 1.06)	(-0.06 1.17)	(-0.13 1.24)	(0.01 1.20)	(0.29 2.03)	(0.59 2.50)	-0.62 0.52)	(-0.43 0.43)	-0.74 0.85)	-0.09 0.78)
DREER	0.93	0.93	0.78	0.93	1.54	1.39	-0.50	-0.76	0.41	-0.19
	(0.00 1.52)	(0.21 1.57)	(-0.59 1.82)	(0.25 1.75)	(0.34 2.90)	(0.56 2.29)	(-1.36 -0.07)	(-1.28 -0.21)	-1.45 1.27)	-0.77 0.46)
USBCL	1.00	-0.07	1.14	-1.01	1.27	-0.11	-1.05	-1.09	-0.54	0.29
	(-257 ∞)	(-322 ∞)	(-161 ∞)	(-168 ∞)	(-438 ∞)	(-86 ∞)	(-229 529)	(-57 ∞)	(-280 ∞)	(-32 ∞)
ST	0.70	0.32	1.42	0.58	3.64	1.63	1.06	-0.12	1.79	0.35
	(-0.17 1.26)	(-0.11 0.95)	(-0.19 1.73)	(0.00 1.23)	(0.98 3.91)	(1.11 2.99)	(-0.34 1.06)	(-0.34 0.56)	-0.24 1.71)	(0.06 1.04)
NETIMP	0.99	0.00	1.17	0.51	1.91	1.08	-0.67	1.33	-0.03	0.95
	(-25.1 9.5)	(-14.7 3.2)	(-26.7 18.2)	(-16.6 16.3)	(-8.2 57.5)	(-4.3 24.6)	(-4.1 24.6)	(-4.5 11.4)	-2.9 28.2)	(-6.6 8.8)
Germany										
linear	0.23		0.52		1.43					
	(-0.07 0.50)	(-0.07 0.50)	(0.16 0.85)	(0.16 0.85)	(0.94 1.83)	(0.94 1.83)				
RST	0.24	0.46	0.44	0.90	1.34	1.26				
	(-0.20 0.92)	(-0.25 0.95)	(-0.02 1.20)	(-0.11 1.37)	(0.88 2.05)	(0.48 1.94)				
D_ERE	0.63	0.73	0.50	1.10	1.12	1.98				
	(-2.70 1.24)	(-0.60 1.17)	(-1.45 1.74)	(-0.46 1.62)	(-0.12 4.59)	(0.78 2.80)				
TNET	0.95	0.72	1.39	0.87	2.66	1.56				
	(0.05 1.43)	(0.04 1.47)	(0.32 2.00)	(0.17 1.73)	(1.28 3.53)	(0.83 2.88)				
USBGR	0.42	0.19	0.45	0.62	1.47	1.40				
	(-0.33 0.85)	(-0.21 0.91)	(-0.24 0.99)	(0.11 1.14)	(0.51 2.20)	(0.74 2.39)				
ST	0.07	0.53	0.24	1.70	1.24	3.38				
	(-0.27 0.64)	(-0.32 0.90)	(-0.23 0.97)	(-0.05 1.83)	(0.81 3.17)	(0.71 3.45)				

Notes: See notes of Table 3.

Table 6
Cumulated response in 2001:4 to a shock in 2000:4

Country	Transition Variable	US shock	Actual Effect
France	DREER	--	-3.2
	TRADE	-1.0	
	ST	-2.0	
	Average	-1.5	
	Linear	-1.2	
Italy	DREER	-1.6	-2.5
	TRADE	-1.5	
	ST	-2.0	
	Average	-1.7	
	Linear	-1.9	
Spain	DREER	-1.7	-1.2
	TRADE	-2.6	
	ST	-0.3	
	Average	-1.5	
	Linear	-1.7	
UK	DREER	-2.3	-1.1
	TRADE	-1.7	
	ST	-1.7	
	Average	-1.9	
	Linear	-2.0	
Germany	DREER	-1.6	-3.3
	TRADE	-3.1	
	ST	-0.7	
	Average	-1.8	
	Linear	-1.6	

Note: Values in percentage points per year. The size of the US shock is -3 which is about the forecast error made by the IMF for US growth in 2001 (Actual growth for 2001 in WEO, October 2002, minus Forecast growth for 2001 in WEO, October 2000, exact forecast error is -3.2). The responses are obtained either from OAT-VARs with the indicated transition variables, or as the average of the responses from OAT-VARs (Average), or from a linear VAR (Linear). Actual Effect indicates for each country the difference of actual growth for 2001 as in WEO, October 2002, and the forecast growth for 2001, as in WEO, October 2000. The estimation algorithm for OAT-VAR for France with DREER as transition variable does not converge.

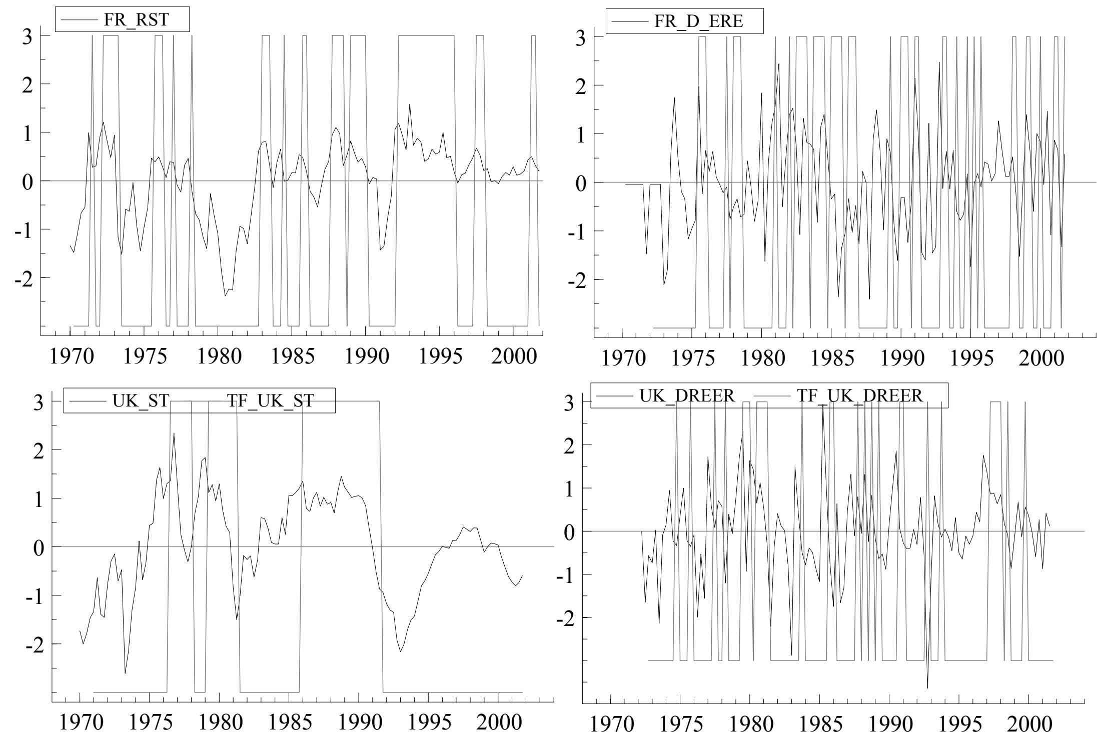

Figure 1: Transition Variables and transition functions chosen for OAT-VAR for France (upper panel) and UK (lower panel) (see acronyms of transition variables at Table1).

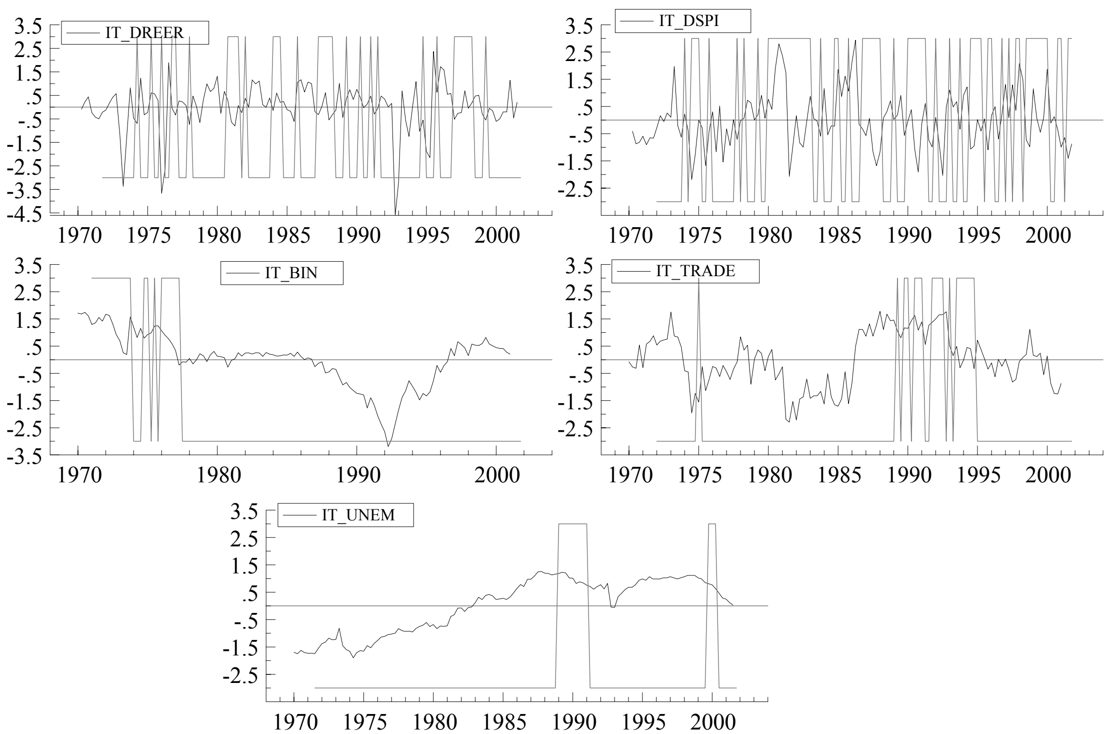

Figure 2: Transition Variables and transition functions chosen for OAT-VAR for Italy (see acronyms of transition variables at Table1).

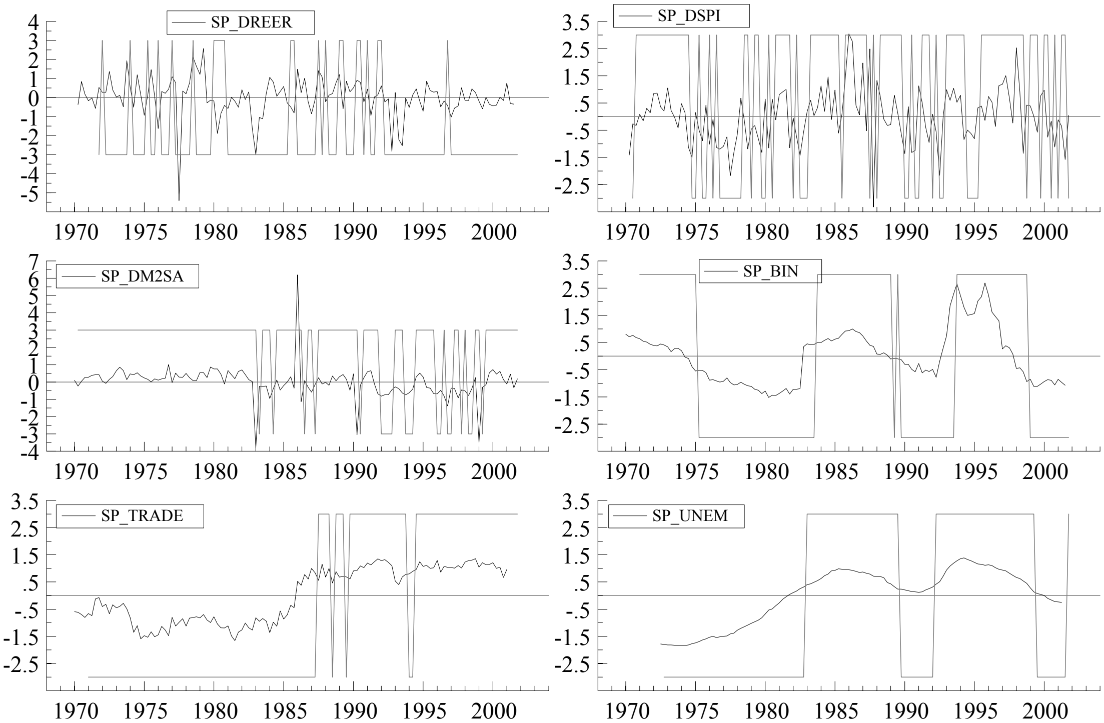

Figure 3: Transition Variables and transition functions chosen for OAT-VAR for Spain (see acronyms of transition variables at Table1).

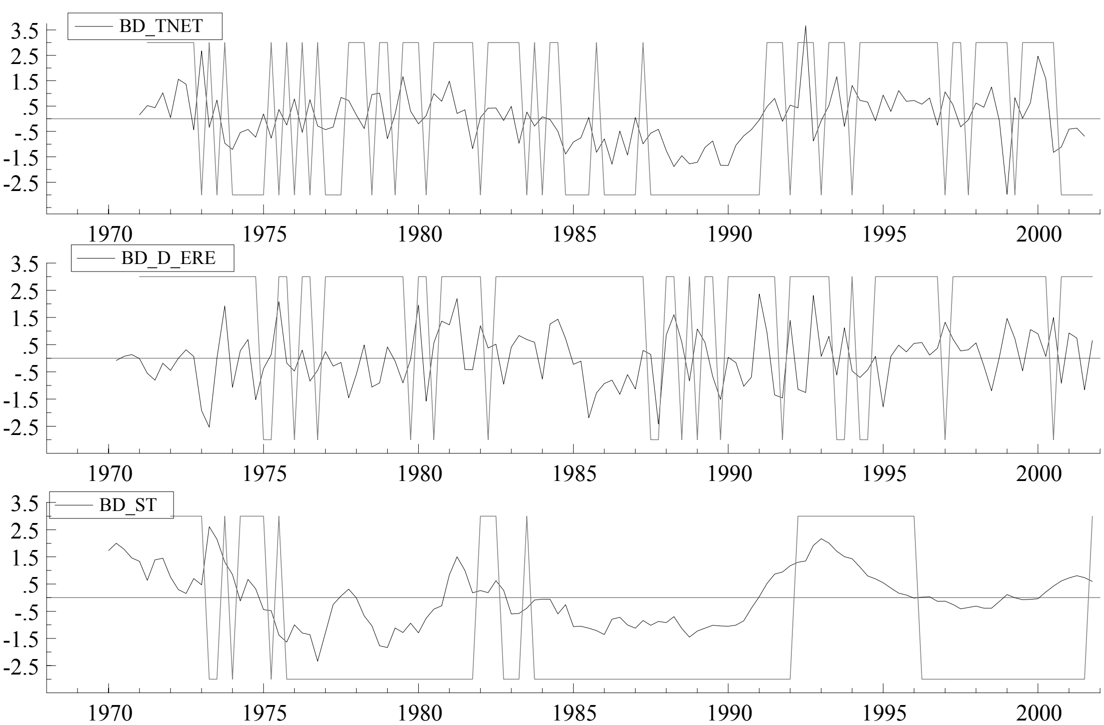

Figure 4: Transition Variables and transition functions chosen for OAT-VAR for Germany (see acronyms of transition variables at Table1).