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Stock and bond returns in Europe with the European Central Bank

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ABSTRACT

This paper examines the relationships between stock and bond returns for key European countries after the establishing of the European Central Bank (ECB) and the introduction of the Euro. It investigates the impact of the ECB monetary policy on stock and bond returns in Germany, Spain, France and Italy. The relations are investigated using vector autoregressive models. Stock and bond returns are found to affect each other in different ways. While shocks to the bond returns have positive impact on stock returns, shocks to the stock returns have negative impact on bond returns. Monetary policy is investigated using a modified Taylor rule. Shocks to the Euribor rate are found to significantly impact on both stock and bond returns in the studied countries. The Euribor rate in turn response to changes in inflation and unemployment gaps.

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1. Introduction

In 1988 the European Economic Community (EEC), with its then twelve member states, decided on the objective to realize an economic and monetary union. A similar attempt in the 1970s had failed (ECB (2006)). The Economic and Monetary Union (EMU) was planned to be established in three steps. The first stage of the process leading to the EMU was initialized in July 1990. The intention was then to prepare for the economic and monetary union. This was to be done by strengthening the internal market, by increasing the coordination of monetary policy and by increasing the financial integration. Financial integration was to be increased through removal of restrictions on capital movements between the member states (ECB (2006)).

In January 1994, the second stage of the EMU was started by the establishment of the European Monetary Institute which was the forerunner to the European Central Bank (ECB). The European Monetary Institute was to prepare for the third stage of the EMU by strengthening the coordination of monetary policy and the cooperation between central banks, while still letting monetary policy and exchange rates be decided by each member state. Regulations and organizational structure required for the ECB and the national central banks in the third stage of EMU was to be developed by the European Monetary Institute (ECB (2006)).

The ECB was established by the European Union in June 1998. This was the start of the third stage of the EMU. The main objective of the bank is to maintain price stability in the euro zone (ECB (2006)). The ECB is the core part of the Eurosystem. The Eurosystem consists of the national central banks of the EMU member states and the ECB. The Governing Council, which is the main decision-making body of the ECB, takes the decisions on monetary policy and the appropriate levels of key interest rates for the euro area (ECB (2006)).

In January 1999, the euro became the single currency for the euro area. Since then a single monetary policy is conducted (ECB (2006)). The introduction of a single currency meant a total elimination of exchange rate risk between the participating countries (Berben and Jansen (2004)). The single currency was also to reduce transaction costs and increase price transparency for consumers and investors (ECB (2006)). Among the eleven countries who fixed their currency to the euro on the 31st of December 1998 were Germany, Spain, France and Italy. Today, sixteen countries have joined the economic and monetary union and adopted the euro. The United Kingdom chose not to participate in the third stage of the EMU.

The process towards EMU, with the establishment of the ECB and the introduction of the euro in 1998-1999, might have given rise to stronger spillover effects in the euro area since 1999. Several studies report increased stock and bond market integration for Europe and the euro zone during recent years (see for example Berben and Jansen (2004)). The effects of the EMU on economic and financial integration are of interest to investors. By removal of restrictions on trade and capital movements, investors get access to more investment opportunities and can increase their risk-adjusted payoffs. However, high correlation between stock markets and bond markets in different countries reduces investors' possibilities of portfolio diversification. This is worsened by the fact that correlation across stock markets of different countries have been seen to increase in times of stock market uncertainty.

Relations between stock and bond returns have important implications for asset allocation and price formation. One of the first portfolio decisions made by investors is the allocation between risky assets, like stocks, and safer assets, like bonds. Even though stocks and bonds tend move together in the long run, the short run relation varies more (Connolly, Stivers and Sun (2005)). Many studies try to explain the weak correlation between stock and bond returns observed for the US (see Connolly, Stivers and Sun (2005), Baele, Bekaert and Ingelbrecht (2007), Stivers and Sun (2002)). A period of negative stock-bond return correlations has been observed for the US after 1998 (Baele, Bekaert and Ingelbrecht (2007)).

In this study I examine spillover effects between stock returns and 10-year government bond returns for four European countries after the establishment of the European Central Bank (ECB) and the introduction of the euro. The studied period is 1999 to 2008 and the studied countries are Germany, Spain, France and Italy. I also examine how these long-term asset returns are affected by the ECB monetary policy, especially looking at the ECB interest rate. I apply time-series econometric models to study the relations. First, a reduced-form vector autoregressive model (VAR) is estimated. The reason for using VARs is to allow for the possibility that the relation between stock and bond returns is a two-way one. Structural VARs are then applied to study the contemporaneous relations. Several studies of stock and bond returns and their comovements have been conducted in the US. Apart from looking at the euro area, this study also investigates the monetary policy of the ECB by implementing a modified Taylor rule.

The questions especially asked in this study are:
How do stock and bond returns in the selected countries relate to each other? What is the effect of ECB monetary policy on stock and bond returns?

The results suggest that stock and bond returns are significantly affected by the Euribor rate. Stock and bond returns in the studied countries are found to affect each other in different directions. While increases in bond returns lead to higher stock returns, stock returns have a negative impact on bond returns. This might be because of the so called flight-to-quality phenomenon where increasing stock market uncertainty makes investors reallocate their portfolios from riskier investments like stocks to safer ones like bonds. This causes bond returns to increase while stock prices fall.

The monetary decisions of the ECB seem to follow a Tailor-type policy rule, with inflation and unemployment gaps as important decision variables. The results indicate some extent of financial market integration with stock and bond returns affecting each other across borders. Especially, French bonds seem to affect the other bond markets while German stocks affect other stock markets. Although there was some evidence of stock and bond market integration, the evidence was not as strong as I would have expected.

The rest of the paper is organized as follows: Section 2 covers some previous literature on the subject of stock and bond returns, section 3 describes the dataset, section 4 specifies the three types of estimated models, section 5 address the issue of model selection and misspecification tests, section 6 summarizes the results, section 7 does some robustness checks and section 8 concludes.

2. Overview of literature

This section covers some previous studies on the subject of stock and bond return comovements and stock and bond market integration. It also introduces the reader to a modified Taylor rule.

2.1 The comovement of stock and bond returns

Baele, Bekaert and Ingelbrecht (2007) examine the comovements between stock and bond returns in the US. They try to identify economic factors explaining the correlations between stock and bond returns. The factors they use are among others measures of inflation, output gap, the nominal risk-free rate, cash flow growth, consumption growth and risk aversion. They argue that the fundamental factors affecting stock and bond returns either have cash flow or discount rate effects. While bonds have fixed nominal cash flows and stocks have stochastic cash flows, they have different exposures to the variables.

Baele, Bekaert and Ingelbrecht (2007) argue that stocks returns should be affected by factors that correlate to the development of real dividends. Cash flow growth, output gap and expected output gap are variables with cash flow effects. Bond returns, on the other hand, are mainly driven by the level of interest rates. Variables with discount rate effects on bonds can be the short-term interest rate, inflation and inflation expectations. They try capturing the risk premiums of stock and bonds by measures of risk aversion and cash flow uncertainty. Different sets of vector autoregressive models were used to try finding a satisfactory fit with stock and bond return correlations. However, they conclude that even their best fit model has a poor fit with the correlation of stock and bond returns.

Campbell and Ammer (1993) decompose long-term asset returns, i.e. the asset returns of stocks and 10-year bonds, into factors that contain news about future discount rates and cash flows. They conclude that while variation in excess stock returns are mainly driven by future expectations on excess stock returns, variation in nominal bond returns are mainly affected by news about future inflation rates. News about expected inflation have different effects on the variation of stocks and bonds and may therefore be one reason to low correlation between stock and bond returns.

Among others examining the stock and bond return comovements are Stivers and Sun (2002) which study how the comovement varies with stock market uncertainty. As their measure of stock market uncertainty they use implied volatility. Their findings suggest that stock-bond return comovements are positive during periods of low volatility while they are more negative during periods of high volatility. This is in line with the flight-to-quality phenomenon where investors chose safer assets rather than riskier ones in times of stock market uncertainty. Stivers and Sun (2002) look upon US data from 1988-2000.

2.2 Spillovers and financial integration

Baele (2005) investigates volatility spillover effects for stocks markets in Europe. He claims that increased financial and economic integration during the 1980s and 1990s has led to a higher interdependence between markets, so that global and regional shocks are transmitted to local stock markets. Cross-market stock correlations have increased during the last decades as markets are more integrated and respond to common factors.

Clare and Lekkos (2000) look upon long-term bond market comovements between Germany, United Kingdom and United States. They find that in bad times, the government bond yield curves are affected by international rather than domestic factors. However, as the crisis ends, domestic factors regain a larger importance. The relationship between international bond markets is of relevance for monetary policy setters. Monetary policy usually have a direct effect on the short term rates, while the longer-term rates change as expectations of future short term rates and inflation changes. If government bonds in different countries commove, the ability to affect the longer-term rates with monetary policy might be reduced (Clare and Lekkos (2000)).

Berben and Jansen (2004) investigate stock and bond market integration in Europe. Their results strongly indicate that stock and bond market integration has increased over the period 1980-2003. Although the European Monetary Union (EMU) have contributed to stock and bond market integration, this is part of a global process of financial integration. The bond market integration has especially increased for the euro zone members during their period of study. While stock markets have also experienced a period of increasing integration, they are still less correlated than the bond markets of the euro area.

While most studies on European stock and bond market integration argue that financial market integration has increased, Sontchik (2003) find that stock market integration has decreased after the introduction of the euro. He gives two possible reasons for this counterintuitive finding; first, while asset returns in the euro area are driven by country specific and common factors, there is also an idiosyncratic risk which might have increased.
Campbell et al. (2001) found idiosyncratic risk to increase noticeably from 1962 to 1997 in the US. Second, Sontchik (2003) argue that asymmetric shocks now have larger impact on national markets in the euro zone, as they can no longer be mitigated by national monetary policy.

2.3 Taylor rule

The main objective of the ECB is to maintain price stability. Central banks need to translate their monetary objectives into monetary policy decisions. The Taylor rule is a simple formula for how the central bank should set its interest rates depending on real gross domestic product (GDP) and inflation. It was originally developed for the United States by John Taylor in 1993[1].

Evans (1998) describes the Taylor rule as that the interest rates should be increased when real GDP is above its trend and inflation above its target rate. Interest rates should be decreased when the opposite occurs. The output gap and inflation gap should also be seen as equally important.

The Taylor rule as described by Evans (1998):

$$i = r + \pi + \frac{1}{2}(y - y^*) + \frac{1}{2}(\pi - \pi^*)$$

Where i is the interest rate set by the central bank, r is the real interest rate, π is the average inflation rate over past four quarters, y is real GDP and y^* its trend, π is inflation and π^* is the target inflation.

Evans (1998) stresses the fact that the data used by Taylor was not available to market participants and monetary policy setters at the time when the decision was made, because Taylor uses final and revised data. Evans (1998) use real-time data to se if the results still holds. In his version of the Taylor rule he uses unemployment rate and consumer price index (CPI) to investigate a modified form of the Taylor rule. He concludes that a modified real-time data Taylor rule roughly captures the movements in the federal funds rate.

The modified Taylor rule with real-time data (Evans (1998)):

$$i = r + \pi + \frac{1}{2} okun\ (u^* - u) + \frac{1}{2}(\pi - \pi^*)$$

where the new variables are the unemployment rate u, the natural rate of unemployment u^* and the $okun$ parameter. The $okun$ parameter refers to Okun's law and expresses the relation between the unemployment gap and the output gap. In the US, Arthur Okun found that a one percent fall in unemployment rate from its natural rate, generated a three percent increase in real GDP relative to its trend (Evans (1998)).

[1] See Taylor (1993) for the original article.

3. Data

This study uses data from 1999 - 2008. The reason is to look at the period after the establishing of the ECB and the introduction of the euro. The data is at the monthly frequency. Datasets for four European countries have been constructed of which all are euro zone countries. The data has been downloaded from DataStream and the ECB homepage. The euro zone countries are Germany, Spain, France, and Italy which all fixed their currencies to the euro in December 1998.

The dataset consists of:

Stock returns, r_s

The returns are calculated from national stock price indices as:

$$r_t \cong \Delta ln\, p_t = \ln p_t - \ln p_{t-1}$$

To make them comparable to the bond returns, the monthly stock returns are multiplied by 12 and expressed as percentages.

Bond returns, r_b

The bond return measure is the 10-year government bond yield. The rates are in percent per annum. The bond returns are used in first differences.

ECB rate, r_{ECB}

Here I first use the 1-year Euro Interbank Rate (Euribor) as the measure of the ECB rate. As a robustness check I then use the marginal lending facility which is one of the key interest rates set by the ECB. The Euribor rate varies more than the marginal lending facility, especially during times of financial crisis. The ECB rates are used in first differences.

Inflation gap

The measure is the annual percentage change in Harmonized Indices of Consumer Prices (HICP) for the euro zone. The first difference of this measure was used in the models, as described in section 4.3.

Unemployment gap

The measure is the total standardized unemployment rate for the euro area measured in percentages. The first difference of this measure was used in the models, as described in section 4.3.

Details on the exact downloaded series can be found in Appendix A. Table 1 reports the summary statistics for each variable.

4. Model specification

4.1 The reduced-form VAR(k) model

The starting point for the analysis was the reduced-form VAR model with k lags[2]:

$$x_t = \Pi_1 x_{t-1} + \Pi_2 x_{t-2} + \cdots + \Pi_k x_{t-k} + \Phi D_t + \varepsilon_t$$

The Π:s are the matrices of coefficients. The D_t contains eleven seasonal dummies and a constant and ε_t is the vector of residuals. x_t is a vector containing the variables:

$$x_t = [r_b^{BD}, r_s^{BD}, r_b^{ES}, r_s^{ES}, r_b^{FR}, r_s^{FR}, r_b^{IT}, r_s^{IT}, r_{ECB}]'$$

where r_b denotes bond returns, r_s denotes stock returns and r_{ECB} denotes the Euribor rate. The countries are Germany (BD), Spain (ES), France (FR) and Italy (IT). The data is at the monthly frequency.

The reduced-form VAR model was first estimated with the variables 10-year government bond returns, stock returns, and Euribor rate for Germany, Spain, France and Italy. Because of the efficient market hypothesis stating that asset prices reflect all known information, one would not expect much significant parameters in the matrixes of coefficients of the reduced-form VAR, as future prices cannot be predicted by analyzing past prices (the lagged variables).

The variables in x_t are assumed to be stationary. This is required for the t-statistics from the simple VAR to be valid. The stationarity of each variable was tested using augmented Dickey-Fuller unit-root tests. However, non-stationarity could not be rejected for the bond returns and ECB rate why the first differences of these variables were used. The variables in first differences were tested and found to be stationary.

4.2 The structural VAR model

After estimating the reduced-form VAR, the next step was to estimate a structural VAR-model (hereafter SVAR):

$$A_0 x_t = \Pi_1 x_{t-1} + \Phi D_t + \varepsilon_t$$

The new thing is the matrix A_0. In a simple VAR, the $\mathrm{A}_0 = \mathrm{I}$, i.e. there are no contemporaneous relations. In the SVAR environment some of the off-diagonal elements are non-zero, i.e. we allow for contemporaneous effects.

[2] For details about the VAR model see Juselius (2006) or Enders (2004), chapters 5-7.

The interest is now on which variables have contemporaneous effects on each other. First we need to set restrictions on the A_0 matrix as to match with the relations we want to investigate and economic theory. There is a limit to the number of non-zero parameters in the A_0 matrix. To determine the structural parameters we need at least $n(n-1)/2$ identifying restrictions to eliminate indeterminacy in the SVAR model (Sims (2002)).

After defining the A_0 matrix and estimating the SVAR we want to study the impulse responses. The impulse responses tell us how a shock in one variable today will affect the future values of the variables in x. Our main interest is in the impact at time zero. If one rewrite the SVAR model as:

$$A_0 x_t = \Pi_1 x_{t-1} + \Phi D_t + B\varepsilon_t$$

Where B is the identity matrix in our setting. We can then solve for x_t:

$$x_t = A_0^{-1}\Pi_1 x_{t-1} + A_0^{-1}\Phi D_t + A_0^{-1}B\varepsilon_t$$

The $A_0^{-1}B$ matrix is now of interest since it tells us how a shock in a variable in ε_t will affect the elements of x_t. The $A_0^{-1}B$ matrix impacts are the ones shown in the impulse response graphs.

Two set-ups were used for the structural VAR. The first was the model with financial variables only. Second, macro variables were included following the approach in Baele, Bekaert and Ingelbrecht (2007).

4.3 The structural VAR model with macro variables

Now we want to account for the fact that central banks care about inflation and economic activity when setting their monetary policy. I implement a modified form of the Taylor rule. As in the study by Evans (1998) I use the consumer price index (CPI) as the inflation measure and unemployment rate as the measure of economic activity.

I start from the modified Taylor rule described in section 2.3:

$$i_t = r_t + \pi_t + \frac{1}{2} okun\,(u_t^* - u_t) + \frac{1}{2}(\pi_t - \pi_t^*)$$

The Euribor rate will then be affected by the inflation and unemployment rate. This can be rewritten as:

$$r_t^{ECB} = r_t + \pi_t + \frac{1}{2} okun\, u_t^* - \frac{1}{2}\pi_t^* - \frac{1}{2} okun\, u_t + \frac{1}{2}\pi_t$$

I assume the real interest rate, the inflation target π_t^*, the natural rate of unemployment u_t^*, and the $okun$ parameter to be constant over the period. I can then write:

$$r_t^{ECB} = a + b\, u_t \ + c\, \pi_t$$

In the model the Euribor rate is used in differences so the formula will be:

$$r_t^{ECB} - r_{t-1}^{ECB} = b(u_t - u_{t-1}) + c(\pi_t - \pi_{t-1}) + \varepsilon_t$$

Evans (1998) sets the $okun$ parameter to three for the US. The $\frac{1}{2}$ factors before the economic activity and inflation measures assign equal weight to the two gaps. If I apply the same numbers to the euro area I get:

$$\Delta\, r_t^{ECB} = -\frac{3}{2}(u_t - u_{t-1}) + \frac{1}{2}(\pi_t - \pi_{t-1})$$

I will estimate the relationship between the Euribor and the inflation and unemployment gaps to see if the euro area relation is similar to the US one.

The new variables are added to the VAR model so that the x_t becomes:

$$x_t = [r_b^{BD}, r_s^{BD}, r_b^{ES}, r_s^{ES}, r_b^{FR}, r_s^{FR}, r_b^{IT}, r_s^{IT}, r_{ECB}, \Delta\pi, \Delta u]'$$

Inflation and output gap was used in the study of stock and bond returns comovements by Baele, Bekaert and Ingelbrecht (2007) as variables that might generate different exposures to stock and bond returns.

5. Model selection

5.1 The reduced-form VAR(k) model

The natural starting point was to estimate a simple first-order VAR model with a constant only. Several model-checking tests were then employed to evaluate whether this was a good decision.

The residuals were checked for normality, independence and homoscedasticity. The multivariate Doornik and Hansen non-normality test strongly rejected normality of the residuals. The Portmanteau test and Breusch-Godfrey LM test for residual autocorrelation showed different results. The tests for ARCH effects showed signs of heteroskedasticity. Since the residual autocorrelation and ARCH tests require the assumption of normally distributed errors, we cannot be sure that the results can be trusted when we have evidence of non-normality in the errors (Juselius (2006), p.77).

Because of the misspecification problems, several set-ups were tested including seasonal variables, trends and dummies for the dot-com bubble (2000-2003) and the financial crisis (2007-2009). When the results persisted, the next step was to have a look at the lag-order selection statistics. The model was tested for optimal number of lags with four different criterions. The results are reported in Table 3. The high number of lags for the Akaike Information Criterion is expected since the Akaike measure goes for over-specified models, i.e. it does not penalize free parameters as strongly as the other measures. The Hannan-Quinn Criterion and the Schwarz Criterion with a constant only indicate that the VAR(1) model could capture most of the dynamics of the data. However, when including seasonal dummies all criterions suggested a lag length of ten lags.

Ten lags would cause problems with the degrees of freedom and also seems unreasonably high, the model was therefore expanded step by step including more lags and running the misspecification tests until something reasonable was found. Including three lags, seasonal dummies and a dummy for the dot-com bubble (2000 - 2003) and the financial crisis (2007-2009) improved the results of the misspecification tests. Including three lags seems reasonable for capturing the dynamics of the data. The misspecification tests for this set-up are reported in Table 4.

5.2 The structural VAR model with financial variables

Here I specify the identification scheme of the A_0 matrix. The A_0 matrix is specified under the assumption that bond returns are affected by the Euribor rate. This is in line with the theory that bond returns are driven by the level of interest rates, as pointed out by Baele, Bekaert and Ingelbrecht (2007). I do not expect that stock returns are affected by the Euribor rate. Campbell and Ammer (1993) find evidence that stock returns are mainly driven by news about future stock returns.

The A_0 matrix is chosen so that the domestic markets for stocks and bonds are allowed to affect each other. Clare and Lekkos (2000) argued that while stocks and bonds commove across borders in times of crises, the domestic factors regain influence when bad times are over. The euro zone country Germany also had the strongest influence of domestic factors of their studied countries. The specification scheme chosen for stocks, bonds and the Euribor rate was thus:

$$A_0 = \begin{bmatrix} * & * & 0 & 0 & 0 & 0 & 0 & 0 & * \\ * & * & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & * & * & 0 & 0 & 0 & 0 & * \\ 0 & 0 & * & * & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & * & * & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * & * & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & * & * & * \\ 0 & 0 & 0 & 0 & 0 & 0 & * & * & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & * \end{bmatrix}$$

The order of the variables in x_t is the same as in the reduced-form VAR:

$$x_t = [r_b^{BD}, r_s^{BD}, r_b^{ES}, r_s^{ES}, r_b^{FR}, r_s^{FR}, r_b^{IT}, r_s^{IT}, r_{ECB}]'$$

Where BD denotes Germany, ES denotes Spain, FR denotes France and IT denotes Italy. The last column of the A_0 matrix above shows the effect of the Euribor rate. The other columns allow for the stocks and bonds in each country to affect each other.

Next the specifications were chosen to study whether stocks and bonds commove across borders because of increased market integration. Several studies show that stock and bond market integration have increased significantly during the last decades (see for example Baele (2005), Clare and Lekkos (2000) and Berben and Jansen (2004)). Berben and Jansen (2004) point out that bond market integration for euro zone members have increased especially much. However, because the A_0 matrix requires a lot of restrictions (i.e. zeros) and the $n(n-1)/2$ identifying restrictions are not enough to ensure identification, I could not simply allow for all effects at once. Therefore different sets of specification schemes were used to investigate if there were evidence of spillovers across borders. To conserve space, not all results for different identification schemes are reported. Here, I will assume that Italy and Spain do not affect the other countries but that they are affected by the bigger economies Germany and France. I especially expect the German bond market to influence the others, as Germany is the biggest economy in the euro area. Côté and Graham (2004) find that the German bond market has more effect on the euro area bonds than the US one. Below is the A_0 matrix specification which allows for the bonds in Germany and France to contemporaneously affect the other countries bonds, still allowing for domestic effects from bonds to stocks and stocks to bonds. Bonds are also allowed to be affected by the Euribor rate:

$$A_0 = \begin{bmatrix} * & * & 0 & 0 & * & 0 & 0 & 0 & * \\ * & * & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ * & 0 & * & * & * & 0 & 0 & 0 & * \\ 0 & 0 & * & * & 0 & 0 & 0 & 0 & 0 \\ * & 0 & 0 & 0 & * & * & 0 & 0 & * \\ 0 & 0 & 0 & 0 & * & * & 0 & 0 & 0 \\ * & 0 & 0 & 0 & * & 0 & * & * & * \\ 0 & 0 & 0 & 0 & 0 & 0 & * & * & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & * \end{bmatrix}$$

The same set-up but for the stocks in Germany and France being allowed to contemporaneously affect the other countries stocks was also tried:

$$A_0 = \begin{bmatrix} * & * & 0 & 0 & 0 & 0 & 0 & 0 & * \\ * & * & 0 & 0 & 0 & * & 0 & 0 & 0 \\ 0 & 0 & * & * & 0 & 0 & 0 & 0 & * \\ 0 & * & * & * & 0 & * & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & * & * & 0 & 0 & * \\ 0 & * & 0 & 0 & * & * & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & * & * & * \\ 0 & * & 0 & 0 & 0 & * & * & * & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & * \end{bmatrix}$$

5.3 The structural VAR model with macro variables

The A_0 matrix is now larger because of the two new variables:

$$x_t = [r_b^{BD}, r_s^{BD}, r_b^{ES}, r_s^{ES}, r_b^{FR}, r_s^{FR}, r_b^{IT}, r_s^{IT}, r_{ECB}, \Delta\pi, \Delta u]'$$

The same identification schemes as before were obtained for the new model, except now we let the inflation and unemployment gap variables affect the Euribor rate, implementing the real-time data Taylor rule proposed by Evans (1998):

$$A_0 = \begin{bmatrix} * & * & 0 & 0 & 0 & 0 & 0 & 0 & * & 0 & 0 \\ * & * & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & * & * & 0 & 0 & 0 & 0 & * & 0 & 0 \\ 0 & 0 & * & * & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & * & * & 0 & 0 & * & 0 & 0 \\ 0 & 0 & 0 & 0 & * & * & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & * & * & * & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & * & * & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & * & * & * \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & * & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & * \end{bmatrix}$$

Also, from the theory expressed by Baele, Bekaert and Ingelbrecht (2007) I expect output and inflation gaps to have cash flow and discount rate effects on stock and bond returns. Since the unemployment gap measures the economic activity, this will substitute for the output gap. Because of the bonds having nominal cash flows while stocks have stochastic cash flows, Baele, Bekaert and Ingelbrecht (2007) argue that these variables are subject to different exposures to the variables. Stock returns are here assumed to mainly be affected by the cash flow effects of the unemployment gap. As changes in unemployment gap produce changes in output gap, this should in turn affect the stock returns. Bond returns are assumed to be affected by the discount rate effects from inflation. Campbell and Ammer (1993) also use cash flow and discount rate variables in their models of stock and bond returns. The next A_0 matrix specification was therefore chosen to let these variables affect stock and bonds as well. This would mean that the last two columns of the A_0 matrix above would have stars for the first eight rows as well.

6. Results

6.1 The reduced-form VAR(3) model

The first model was estimated for the stock and bond returns of Germany, Spain, France and Italy and the Euribor rate. The results for the reduced-form VAR model with 3 lags are reported in Table 2. The results where obtained by first using a Sequential Elimination of Regressors (SER) procedure. The procedure eliminates those regressors that lead to the greatest reductions in a chosen information criterion. The criterion used was the Hannan-Quinn Criterion. Several restriction setting procedures were tested and gave similar results for the parameter estimates.

The results in Table 2 indicate that there is some predictability in asset returns since there are several significant parameters for the lagged variables. There are much more significant coefficients for the first lag than for the second and third lag. The efficient market hypothesis states that asset prices reflect all known information; therefore I did not expect much significant parameters for the lagged variables in the reduced-form VAR. However, some recent studies challenge this view and claim that asset returns are indeed predictable (see Cochrane (1999), Campbell and Yogo (2006), Ferson and Campbell (1991)). According to Cochrane (1999) both stock and bond returns are to some level predictable. It is therefore feasible to find non-zero elements in the matrices of coefficients for the VAR above.

Looking at the parameters and their significance in Table 2, the reduced-form VAR seem to indicate that the Euribor rate have a lagged effect on stock returns and that the bond returns of Germany and Spain affect other countries stock returns. The effects from German and Spain stocks seem to differ in sign which might indicate that these countries have differences in the underlying factors affecting the comovement of stock and bond returns. However, the results from the reduced-form VAR should be interpreted with caution as they are probably the effect of transmission inefficiencies in a world were the efficient market hypothesis only nearly holds. The relations need to be investigated further looking at the contemporaneous affects of the variables.

6.2 The structural VAR(3) with financial variables

The starting point was the A_0 matrix which allows for domestic effects and for the Euribor rate to affect the bond returns. The A_0 matrix estimates and their significance are reported in

Table 5. The coefficients for different countries show very similar patterns in signs and magnitudes. One should not misinterpret a negative sign for a parameter estimate in the A_0 matrix as a negative relation of the variables since these will be transferred to the other side when solving for the contemporaneous effect on x_t. The results indicate that the Euribor rate contemporaneously affect bonds in all of the studied countries. We find significant own effects (i.e. the effect of a variable on itself). The bonds and stocks in each country also seem to affect each other in similar ways.

The impulse response graphs for the variables in each country are shown in Figure 1-4. As mentioned, the impulse responses tell us how a shock in one variable today will affect the future values of the variables in x. The Figures indicate that while the Euribor rate is not contemporaneously affected by the stock and bond returns, it has contemporaneous impact on stock and bond returns. The impacts of a shock to the Euribor rate on the bond returns of each country are shown by the impulse response graphs in Figure 5. They all show a similar pattern with an impact at time zero and then the effect decreases with time. The contemporaneous effects are positive and significant in all cases. The impacts of a shock to the Euribor rate on the stock returns of each country are shown by the impulse response graphs in Figure 6. The Figure shows that, contrary to my assumption, stock returns are also significantly affected by shocks to the Euribor rate. Shocks to the Euribor rate might communicate information about future stock returns or have discount rate effects on stock returns. Looking at Figure 5 and 6, the stocks in each country seem to be more strongly affected by the Euribor rate than the bonds. This might be because of the effect mentioned by Clare and Lekkos (2000) that the long-term government bond rates might be harder to affect by monetary policy if bond markets commove to high degree between countries.

Next we investigate the relations between stock and bond returns for each country. Figure 7 shows the impacts of bond returns on stock returns. Even though the patterns differ somewhat between countries, all countries show positive and significant impacts at time zero. This would be in line with positive comovements between bonds and stocks. As the bond returns increases, so does the stock returns. However, looking at the impacts of stocks on bonds in Figure 8, we see a different effect. Here, the stock returns have a negative contemporaneous impact on bond returns. The reason for stock returns to have a negative impact on bond returns might be the flight-to-quality phenomenon. When there is uncertainty in the stock market, investors flee from risky assets to safer ones like government bonds. So the negative impact of stocks on bonds might be due to the fact that when stock returns fall, the bond returns rises as investors reallocate their investments. However, looking at the A_0 matrix of Table 5, this effect only shows to be significant for Spain and Italy. This might be because the flight-to-quality phenomenon is smaller for the somewhat bigger economies, Germany and France. The flight-to-quality phenomenon was studied by Connolly, Stivers and Sun (2005) for the US. They concluded that bond returns are higher relative to stock returns in periods with higher stock market uncertainty.

I then look at the impacts between countries using several identification schemes for the A_0 matrix. The results for the specification where German and French bonds are allowed to affect the other countries bonds are reported in Table 6. Here we see that German bonds seem to contemporaneously affect the Italian bonds while French bonds seem to affect all the other bond markets. Looking at the impulse response graphs in Figure 9, we see that both countries have similar patterns with positive impacts on the other bond markets at time zero and then decreasing with time. However, the confidence intervals indicate that German bond returns do not significantly impact the other countries bonds while France bonds do.

Table 6 also reports the results for German and French stocks being allowed to affect other countries stocks. Table 6 shows several significant relations between the countries. The impulse response graphs for German and French stocks affecting other countries stocks are reported in Figure 10. Both countries show positive contemporaneous impacts on the other countries stock returns, the effects then rapidly decline and seem to be gone at t+1. This would indicate that new information about the stock returns in France and Germany are quickly absorbed by the other countries stock markets. Here, the German impacts on other stock markets are significant while the French are not. I also wanted to see if Spain and Italy could impact on the other markets. Because identification of the A_0 matrix did not allow me to test it directly, I allowed for them to affect the others one at the time. Spain and Italy (not reported) were found to have insignificant impacts on the other stock markets.

Looking at the international relations, France bond returns seem to impact on other countries bond returns, while stock returns are most affected by Germany. This is reasonable as Germany and France are the two largest economies in the euro zone and should give some indication of financial stock market integration. However, as Germany is the largest economy, I would have expected an impact from this country's bonds on the others countries bonds.

6.3 The structural VAR(3) with macro variables

Table 7 reports the estimates of the structural VAR with macro variables. Inflation and unemployment gaps are allowed to affect the Euribor rate, implementing a modified Taylor rule. Both inflation and unemployment gaps have significant contemporaneous effects on the Euribor rate. The coefficient for the inflation gap is 0.94 while the coefficient for the unemployment gap is -8.16 (when solving for the contemporaneous effect). Both these values are a higher than the ones for the US described in section 4.3. We expect some differences as we are working with euro zone data instead. The reason for the inflation coefficient to be higher might be that most of the time from 1999 to 2008 was characterized by growth, so the ECB did probably care more about inflation than unemployment. Also the $okun$ parameter seems to be higher indicating that changes in unemployment in the euro area produces greater changes in output than for the US. The impulse response graphs for inflation and unemployment are shown in Figure 11. As expected from the modified Taylor rule, the inflation gap has a positive impact on the Euribor rate while the unemployment gap has a negative impact. Increases in inflation above its target rate leads to increases in the Euribor rate. Decreases in unemployment below its natural rate leads to increases in the Euribor rate.

Next I want to see if the results from the structural VAR with financial variables change when including the macro variables. Looking at the results for the A_0 matrix in Table 7 I notice very similar patterns to those in the structural VAR with financial variables only. This can also be seen by comparing the impulse response graphs for Germany with the two models (see Figure 1 and Figure 12). The impulse response graphs for the other countries are not reported as they also show similar patterns. As before, the variables have significant contemporaneous own effects, the Euribor rate affect both stock and bond returns significantly with the strongest impact on stock returns. While bond returns positively impact on stock returns, the stock returns have a negative impact on bond returns. As before, the impact of stocks on bonds is significant for Spain and Italy, while the impacts in Germany and France are insignificant. Also, the impacts between countries are the same as before, with French bonds affecting the other countries bonds and the German stocks affecting the other countries stocks.

When employing the SVAR which allows inflation and unemployment to affect the stock and bond returns, the only significant impact was from the unemployment gap on stock returns. Figure 13 shows the negative impact of unemployment gap on stock returns. This relation was expected as changes in unemployment gap produce changes in output gap, which in turn should have cash flow effects on stock returns. The reason why inflation was not found to impact on bond or stock returns is probably that holders of long-term assets care more about inflation expectations than inflation itself. Campbell and Ammer (1993) argue that bond returns are mainly driven by news about future inflation.

7. Robustness checks

7.1 An alternative ECB rate

The 1-year Euribor rate might not be the best measure of the ECB rate. The marginal lending facility rate, which is one of the key interest rates set by the ECB, was therefore tested as an alternative rate. The results for the financial variables SVAR are reported in Table 8. The results are similar to those for the Euribor rate, but the magnitudes are smaller and less significant. Also, the estimates of the effects of the marginal lending facility rate were not significant. This is probably because the marginal lending facility rate is a target rate which is constant over long periods. For example, the marginal lending facility was constant over the period from the 6th June 2003 to the 5th December 2005, i.e. for almost two and a half year. The Euribor rate and the marginal lending facility rate are plotted in Figure 14. The rates show similar patterns over the period, with the main difference that the Euribor rate is more variable. The correlation between the two rates over the sample is 0.91.

7.2 Excess returns

The analysis so far has been made for gross stock and bond returns. It would therefore be interesting to see if the same results hold for excess returns. The risk-free rate recommended by DataStream for the euro zone is the Euribor three month rate. Stock and bond returns were therefore calculated in excess of the Euribor three month rate series from DataStream. The summary statistics for excess returns are reported in Table 9.

The reduced-form VAR (3) with constants, seasonal dummies and dummies for the dot-com bubble and financial crisis was again found to be the best model according to the misspecification tests. The results for the reduced-form VAR are not reported to conserve space. The results were very similar to those reported for gross returns, except that now, the Euribor rate also had significant effects for the first lag on bond returns, not only stocks.

The results for the first specification of the A_0 matrix are reported in Table 10. The parameters show similar patterns as for the gross returns in Table 5. The magnitudes of the parameters are somewhat smaller than before. The own effects are not significant in the new estimation, which seems rather counterintuitive. Looking at the impulse response graphs (not reported) for this specification I see similar effects as before; the Euribor rate contemporaneously affect the stock and bond returns, bonds have a positive impact on stocks while stocks negatively impact on bonds.

When trying to study the international effects the standard errors get large so that most estimates become insignificant. This happens for both stock and bond returns. The results for the specification where bonds affect bonds across borders are reported in Table 10. The results would indicate that the different markets do not affect each other across borders. However, it might also be that the 3-month Euribor is a bad measure of the risk-free rate. The true risk-free rate might differ between the euro zone countries.

8. Implications and conclusions

The objective of this paper was to examine spillover effects between stock and bond returns in euro zone countries after the introduction of the ECB. The impact of ECB monetary policy on the returns of stocks and bonds were studied in depth by implementing a modified Taylor rule.

To examine the relations of stock and bond returns in the euro zone I have employed three models, a reduced-form VAR, a structural VAR with financial variables and a structural VAR with macro and financial variables. In the last set-up a modified Taylor rule was incorporated in the model. The results from the reduced-form VAR indicated that the efficient market hypothesis only nearly holds for the euro zone market. The results from the financial variables SVAR are discussed below and were confirmed by the SVAR with financial and macro variables.

The stock and bond markets in each country were found to similarly affect each other in all four studied countries. While shocks to the bond return variable were found to have a positive contemporaneous impact on stock returns, stock returns seem to affect bond returns negatively. This is most probably due to the flight-to-quality phenomenon where people switch from riskier to safer assets in times of stock market volatility, which makes bond returns rise when stock returns are declining. The latter effect was only found to be significant for Spain and Italy. This would indicate that the diversification benefits from holding a portfolio of stocks and bonds are greater in Spain and Italy. I also found some evidence of stock and bond returns in different countries affecting each other, indicating that stock and bond markets in the euro zone are integrated. French bond returns seem to impact on other countries bond returns while German stock returns impact on other countries stocks. Although there was some evidence of stock and bond market integration, the evidence was not as strong as I would have expected.

The variables for inflation and unemployment were found to significantly impact on the Euribor rate, indicating that monetary policy decisions in the euro area can be modeled by a Taylor-type policy rule. The Euribor rate was also found to have significant impacts on the bond and stock returns, indicating that monetary policy affect the financial markets in the euro zone. However, using the marginal lending facility as an alternative rate I could not confirm these findings. This might be because of the low variability of the marginal lending facility rate. More research on the stock and bond returns and the effect of monetary policy in the euro area are needed to further explore and confirm the relations. As more data become available, the analysis could be extended to include more euro zone countries.

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Appendix A

Data series

Data has been downloaded from DataStream and the ECB homepage[3]. The downloaded data series for each country are (DataStream code in parentheses):

Stock indices:
Germany: DAX 30 (DAXINDX), Spain: IBEX 35 (IBEX35I), France: FRANCE CAC 40 (FRCAC40), Italy: MILAN MIB 30 (ITMIB30). Downloaded from DataStream.

Bonds:
Government 10-year bond yields downloaded from DataStream:
Germany: (BDESSFUB), Spain: (ESESSFUB), France: (FRESSFUB), Italy: (ITESSFUB).

ECB rates:
1-year Euribor (Euro Interbank Offered Rate) downloaded from ECB home page. The series is expressed in percent per annum.
Marginal lending facility downloaded from ECB home page. Marginal lending facility is one of the key interest rates set by the ECB. The series is expressed in percent per annum.

Unemployment rate:
The measure is the total standardized unemployment rate for the euro area measured in percentage of civilian workforce. Seasonally adjusted.

Inflation:
Annual rate of change in Harmonized Indices of Consumer Prices (HICP) for the euro zone downloaded from the ECB home page. Not seasonally adjusted.

Risk-free rate:
3-month Euribor (EIBOR3M) downloaded from DataStream.

[3] The ECB homepage (Statistical Data Warehouse): http://sdw.ecb.int/ [2009-05-15]

Table 1 - Summary statistics

This table reports summary statistics for each variable over the period 1999-2008. All data is at the monthly frequency and expressed in percentages per annum. Rs is the stock return, rb is the bond return, r_Euribor is the 1- year Euro Interbank Offered Rate, r_ECB is the marginal lending facility set by the ECB, CPI growth is growth in the Consumer Price Index and unemp is the unemployment rate.

	France	Germany	Italy	Spain	Euro area
Max of rs	136.98	219.53	175.26	160.99	
Average of rs	-1.80	-0.84	-4.81	-0.93	
Min of rs	-221.41	-277.07	-215.28	-230.04	
StdDev of rs	69.03	82.13	69.00	70.63	
Max of rb	5.66	5.54	5.75	5.76	
Average of rb	4.38	4.28	4.58	4.44	
Min of rb	3.13	3.05	3.29	3.09	
StdDev of rb	0.62	0.61	0.62	0.68	
Max of r_Euribor					5.39
Average of r_Euribor					3.52
Min of r_Euribor					2.01
StdDev of r_Euribor					1.02
Max of r_ECB					5.75
Average of r_ECB					4.11
Min of r_ECB					3.00
StdDev of r_ECB					0.91
Max of CPI growth					4.00
Average of delta CPI growth					2.19
Min of CPI growth					0.80
StdDev of CPI growth					0.61
Max of unemp					9.81
Average of unemp					8.45
Min of unemp					7.22
StdDev of unemp					0.63

Table 2 – The reduced-form VAR (3) model

This table shows the estimated coefficients for the VAR (3) model for Germany (BD), Spain (ES), France (FR) and Italy (IT). The "---" denotes regressors that has been deleted in the Sequential Elimination of Regressors procedure using the Hannan-Quinn criterion. Rb denotes bond returns, rs denote stock returns and r_ECB denotes the Euribor rate. Significant values (at the 5% level) are reported in bold.

	BD_rb (t-1)	**BD_rs (t-1)**	**ES_rb (t-1)**	**ES_rs (t-1)**	**FR_rb (t-1)**	**FR_rs (t-1)**	**IT_rb (t-1)**	**IT_rs (t-1)**	**r_ECB (t-1)**
BD_rb	---	---	---	---	**0.356**	**0.001**	-0.138	---	---
BD_rs	**549.330**	---	**-564.496**	---	---	---	---	---	**171.684**
ES_rb	---	---	---	---	**0.231**	**0.001**	-0.005	**0.000**	---
ES_rs	**431.641**	---	**-531.309**	**-0.223**	---	**0.451**	---	**-0.254**	**135.952**
FR_rb	---	---	**0.184**	---	---	**0.001**	0.012	---	---
FR_rs	**511.566**	---	**-586.766**	---	---	**0.157**	---	**-0.181**	**188.718**
IT_rb	---	---	-0.007	---	---	**0.001**	0.221	**0.000**	---
IT_rs	**617.699**	---	**-722.694**	---	---	**0.359**	---	**-0.320**	**173.101**
r_ECB	---	---	---	---	**0.885**	**0.001**	**-0.975**	**-0.001**	**0.571**
	(t-2)	**(t-2)**	**(t-2)**	**(t-2)**	**(t-2)**	**(t-2)**	**(t-2)**	**(t-2)**	**(t-2)**
BD_rb	---	---	---	---	---	---	---	---	---
BD_rs	---	---	---	---	---	---	---	---	-69.978
ES_rb	**0.266**	---	---	---	**-0.299**	0.000	---	0.000	---
ES_rs	---	**0.222**	---	**-0.281**	---	---	---	---	**-101.900**
FR_rb	---	---	---	---	-0.009	0.000	---	0.000	---
FR_rs	---	---	---	---	---	---	---	---	-53.264
IT_rb	---	---	---	---	-0.039	0.000	---	0.000	---
IT_rs	---	---	---	---	13.355	---	---	---	-54.677
r_ECB	**0.993**	**0.001**	**-1.065**	**-0.001**	---	---	---	---	---
	(t-3)	**(t-3)**	**(t-3)**	**(t-3)**	**(t-3)**	**(t-3)**	**(t-3)**	**(t-3)**	**(t-3)**
BD_rb	---	---	---	---	---	---	---	---	---
BD_rs	---	---	---	---	---	---	---	---	---
ES_rb	**-0.338**	**0.000**	---	---	**0.366**	---	---	0.000	---
ES_rs	---	---	---	---	---	---	---	---	---
FR_rb	0.053	0.000	---	---	-0.067	---	---	0.000	---
FR_rs	---	---	---	---	---	---	---	---	---
IT_rb	-0.359	0.000	---	---	0.352	---	---	0.000	---
IT_rs	---	**-0.171**	-173.557	**0.293**	---	---	120.165	---	**50.146**
r_ECB	**-1.060**	---	---	---	**1.112**	---	---	---	---

Table 3 – Lag-order selection statistics

This table shows the optimal number of lags selected by the different information criteria for the reduced-form VAR model with stock and bond returns for each country and the Euribor rate.

	Constant only	**Constant and seasonal dummies**
Criterion	Lags	Lags
Akaike Info Criterion:	10	10
Final Prediction Error:	10	10
Hannan-Quinn Criterion:	0	10
Schwarz Criterion:	0	10

Table 4 - Misspecification tests

Misspecification tests for the VAR(3) model with constant, seasonal dummies and dummy for the dot-com bubble and financial crisis. Tests are for residual non-normality, heteroskedasticity and autocorrelation.

Doornik & Hansen test for residual non-normality	
Joint test-statistic:	24.03
P-value:	0.15
Skewness only:	13.01
P-value:	0.16
Kurtosis only:	11.02
P-value:	0.27

ARCH-LM test with 16 lags

Variable	**Test-statistic**	**P-value (χ^2)**
u1	16.21	0.44
u2	22.14	0.14
u3	17.67	0.34
u4	15.07	0.52
u5	15.74	0.47
u6	25.19	0.07
u7	12.79	0.69
u8	12.32	0.72
u9	13.27	0.65

Portmanteau test for residual autocorrelation	
Tested order:	12
Test-statistic:	773.27
P-value:	0.12

Table 5 – Structural VAR with financial variables – the first specification

This table reports the estimates and significance for the A_0 matrix allowing for the Euribor rate to affect bonds and each country's bonds and stocks to affect each other. The countries are Germany (BD), Spain (ES), France (FR) and Italy (IT). Notice the similarity in magnitudes and signs of the variables for different countries. Rb denotes bond returns, rs denote stock returns and r_ECB denotes the Euribor rate. Significant values (at the 5% level) are reported in bold.

	BD_rb	**BD_rs**	**ES_rb**	**ES_rs**	**FR_rb**	**FR_rs**	**IT_rb**	**IT_rs**	**r_ECB**
BD_rb	**8.081**	0.002	0	0	0	0	0	0	**-6.313**
BD_rs	**-2.153**	**0.014**	0	0	0	0	0	0	0
ES_rb	0	0	**8.762**	**0.005**	0	0	0	0	**-7.031**
ES_rs	0	0	**-3.163**	**0.016**	0	0	0	0	0
FR_rb	0	0	0	0	**7.995**	0.004	0	0	**-6.272**
FR_rs	0	0	0	0	**-2.634**	**0.018**	0	0	0
IT_rb	0	0	0	0	0	0	**8.200**	**0.008**	**-6.355**
IT_rs	0	0	0	0	0	0	**-3.315**	**0.018**	0
r_ECB	0	0	0	0	0	0	0	0	**7.738**

Table 6 – Structural VAR with financial variables – expanding the A_0 matrix

This table reports the estimates and significance for the A_0 matrix allowing for the Euribor rate to affect bonds and each country's bonds and stocks to affect each other. In Panel A German and French bonds are also allowed to affect other bonds. In Panel B, German and French stocks are allowed to affect other stocks. The countries are Germany (BD), Spain (ES), France (FR) and Italy (IT). Rb denotes bond returns, rs denote stock returns and r_ECB denotes the Euribor rate. Significant values (at the 5% level) are reported in bold.

Panel A: Bonds affect other countries bonds.

	BD_rb	**BD_rs**	**ES_rb**	**ES_rs**	**FR_rb**	**FR_rs**	**IT_rb**	**IT_rs**	**r_ECB**
BD_rb	**45.886**	-0.001	0	0	**-42.320**	0	0	0	-3.135
BD_rs	-1.185	**0.014**	0	0	0	0	0	0	0
ES_rb	-4.302	0	**40.968**	0.000	**-31.613**	0	0	0	**-3.233**
ES_rs	0	0	**-1.674**	**0.0167**	0	0	0	0	0
FR_rb	-18.531	0	0	0	25.689	0.0043	0	0	**-5.485**
FR_rs	0	0	0	0	**-2.709**	**0.018**	0	0	0
IT_rb	**13.834**	0	0	0	**-44.592**	0	**33.934**	0.0034	-0.4321
IT_rs	0	0	0	0	0	0	**-1.416**	**0.018**	0
r_ECB	0	0	0	0	0	0	0	0	**7.738**

Panel B: Stocks affect other countries stocks.

	BD_rb	**BD_rs**	**ES_rb**	**ES_rs**	**FR_rb**	**FR_rs**	**IT_rb**	**IT_rs**	**r_ECB**
BD_rb	**8.005**	0.003	0	0	0	0	0	0	**-6.310**
BD_rs	**-2.646**	-0.002	0	0	0	0.0207	0	0	0
ES_rb	0	0	**9.307**	0.000	0	0	0	0	**-6.707**
ES_rs	0	**-0.012**	-0.659	**0.029**	0	**-0.011**	0	0	0
FR_rb	0	0	0	0	**8.417**	-0.002	0	0	**-5.952**
FR_rs	0	**0.040**	0	0	0.748	**-0.048**	0	0	0
IT_rb	0	0	0	0	0	0	**8.845**	0.001	**-5.913**
IT_rs	0	**-0.010**	0	0	0	**-0.021**	-0.165	**0.039**	0
r_ECB	0	0	0	0	0	0	0	0	**7.738**

Table 7 – Structural VAR with macro variables

This table reports the estimates and significance for the A_0 matrix allowing for the Euribor rate to affect bonds and each country's bonds and stocks to affect each other. I also allow for inflation and the unemployment gap to affect the Euribor rate, implementing a modified Taylor rule. The countries are Germany (BD), Spain (ES), France (FR) and Italy (IT). Notice the similarity in magnitudes and signs of the variables for different countries, and the similarity with the SVAR with financial variables in Table 5. Rb denotes bond returns, rs denote stock returns, r_ECB denotes the Euribor rate, infl denotes inflation and unemp the unemployment gap. Significant values (at the 5% level) are reported in bold.

	BD_rb	**BD_rs**	**ES_rb**	**ES_rs**	**FR_rb**	**FR_rs**	**IT_rb**	**IT_rs**	**r_ECB**	**infl**	**unemp**
BD_rb	**8.417**	0.003	0	0	0	0	0	0	**-6.423**	0	0
BD_rs	**-2.465**	**0.014**	0	0	0	0	0	0	0	0	0
ES_rb	0	0	**8.625**	**0.006**	0	0	0	0	**-7.361**	0	0
ES_rs	0	0	**-3.714**	**0.016**	0	0	0	0	0	0	0
FR_rb	0	0	0	0	**8.346**	0.004	0	0	**-6.393**	0	0
FR_rs	0	0	0	0	**-2.708**	**0.018**	0	0	0	0	0
IT_rb	0	0	0	0	0	0	**8.467**	**0.008**	**-6.636**	0	0
IT_rs	0	0	0	0	0	0	**-3.151**	**0.018**	0	0	0
r_ECB	0	0	0	0	0	0	0	0	**8.650**	**-0.943**	**8.164**
infl	0	0	0	0	0	0	0	0	0	**4.470**	0
unemp	0	0	0	0	0	0	0	0	0	0	**33.991**

Table 8 – An alternative ECB rate

This table reports the estimates and significance for the A_0 matrix allowing for the marginal lending facility rate to affect bonds and each country's bonds and stocks to affect each other. The countries are Germany (BD), Spain (ES), France (FR) and Italy (IT). Notice how the ECB rate now has smaller and insignificant impacts. Rb denotes bond returns, rs denote stock returns and r_ECB denotes the marginal lending facility rate. Significant values (at the 5% level) are reported in bold.

	BD_rb	**BD_rs**	**ES_rb**	**ES_rs**	**FR_rb**	**FR_rs**	**IT_rb**	**IT_rs**	**r_ECB**
BD_rb	**6.186**	0.004	0	0	0	0	0	0	-1.124
BD_rs	-3.276	**0.014**	0	0	0	0	0	0	0
ES_rb	0	0	5.895	0.006	0	0	0	0	-0.982
ES_rs	0	0	-4.768	**0.015**	0	0	0	0	0
FR_rb	0	0	0	0	5.431	0.008	0	0	-1.032
FR_rs	0	0	0	0	-4.628	**0.015**	0	0	0
IT_rb	0	0	0	0	0	0	**7.212**	0.002	-0.606
IT_rs	0	0	0	0	0	0	-1.876	**0.018**	0
r_ECB	0	0	0	0	0	0	0	0	**6.825**

Table 9 – Summary statistics for excess returns

This table reports summary statistics for excess returns of stocks and bonds over the period 1999-2008. All data is at the monthly frequency and expressed in percentages per annum. Rs is the stock excess return and rb is the bond excess return. The rates are in excess of the 3-month Euro Interbank Offered Rate.

	France	**Germany**	**Italy**	**Spain**
Max of rs	134.45	217.00	171.63	157.76
Average of rs	-5.16	-4.20	-8.17	-4.29
Min of rs	-224.78	-280.35	-218.94	-234.77
StdDev of rs	69.29	82.35	69.26	70.90
Max of rb	2.49	2.34	2.58	2.62
Average of rb	1.02	0.92	1.22	1.08
Min of rb	-1.11	-1.41	-0.51	-0.82
StdDev of rb	0.86	0.89	0.79	0.84

Table 10 – Structural VARs with excess returns.

This table reports the estimates and significance for the A_0 matrix allowing for the Euribor rate to affect bonds and each country's bonds and stocks to affect each other (Panel A). It also reports the estimates and their significance for a A_0 matrix specification allowing the bonds in different countries to affect each other (Panel B). The countries are Germany (BD), Spain (ES), France (FR) and Italy (IT). Rb denotes bond excess returns, rs denote stock excess returns and r_ECB denotes the Euribor rate. Significant values (at the 5% level) are reported in bold.

Panel A: The first A_0 matrix specification with excess returns.

	BD_rb	**BD_rs**	**ES_rb**	**ES_rs**	**FR_rb**	**FR_rs**	**IT_rb**	**IT_rs**	**r_ECB**
BD_rb	**3.282**	**0.011**	0	0	0	0	0	0	**-2.142**
BD_rs	**-4.464**	**0.009**	0	0	0	0	0	0	0
ES_rb	0	0	1.911	**0.016**	0	0	0	0	**-3.179**
ES_rs	0	0	**-5.367**	0.006	0	0	0	0	0
FR_rb	0	0	0	0	2.538	**0.016**	0	0	**-2.578**
FR_rs	0	0	0	0	**-4.862**	0.009	0	0	0
IT_rb	0	0	0	0	0	0	1.557	**0.019**	**-3.213**
IT_rs	0	0	0	0	0	0	**-5.312**	0.004	0
r_ECB	0	0	0	0	0	0	0	0	**7.921**

Panel B: Bonds in different countries are allowed to affect each other.

	BD_rb	**BD_rs**	**ES_rb**	**ES_rs**	**FR_rb**	**FR_rs**	**IT_rb**	**IT_rs**	**r_ECB**
BD_rb	**45.149**	0.000	-23.206	0	-42.620	0	20.699	0	0.668
BD_rs	-0.364	**0.014**	0	0	0	0	0	0	0
ES_rb	17.293	0	**25.988**	**-0.007**	-17.990	0	**-23.582**	0	-0.981
ES_rs	0	0	0.14	**0.016**	0	0	0	0	0
FR_rb	0.543	0	-25.315	0	37.072	-0.002	-12.978	0	-1.701
FR_rs	0	0	0	0	-0.209	**0.017**	0	0	0
IT_rb	-5.733	0	-1.148	0	3.211	0	4.879	**0.019**	**-2.833**
IT_rs	0	0	0	0	0	0	**-5.343**	0.004	0
r_ECB	0	0	0	0	0	0	0	0	**7.921**

Figure 1 – Impulse response graphs for Germany

This figure plots the impulse response graphs for Germany with bond returns, stock returns and the Euribor rate as impulse and response variables. To the left are the graphs with bond returns as impulse variable. In the middle the graphs with stock returns as impulse variable. To the right are the graphs with the Euribor rate as impulse variable. The graphs cover 14 periods. 95% bootstrap confidence intervals are marked with dashed lines.

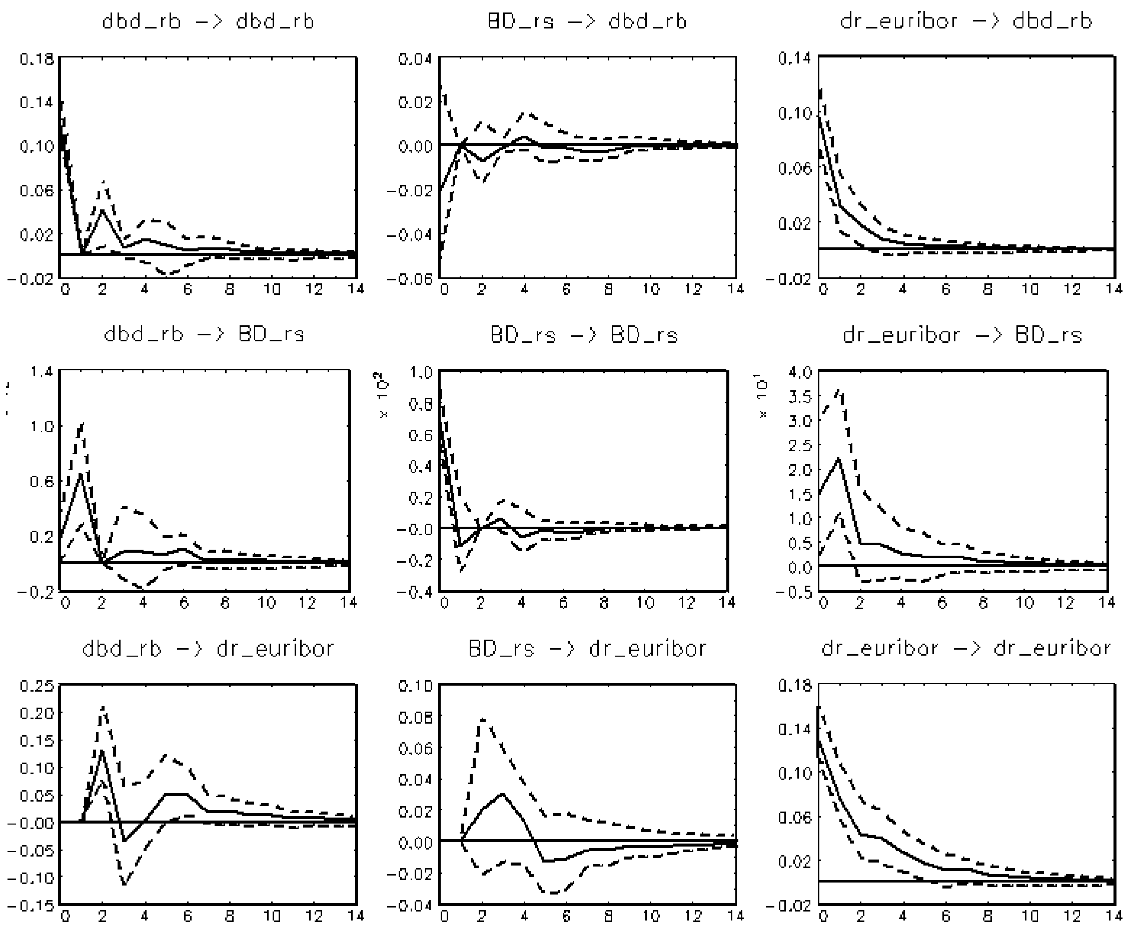

Figure 2 – Impulse response graphs for Spain

This figure plots the impulse response graphs for Spain with bond returns, stock returns and the Euribor rate as impulse and response variables. To the left are the graphs with bond returns as impulse variable. In the middle the graphs with stock returns as impulse variable. To the right are the graphs with the Euribor rate as impulse variable. The graphs cover 14 periods. 95% bootstrap confidence intervals are marked with dashed lines.

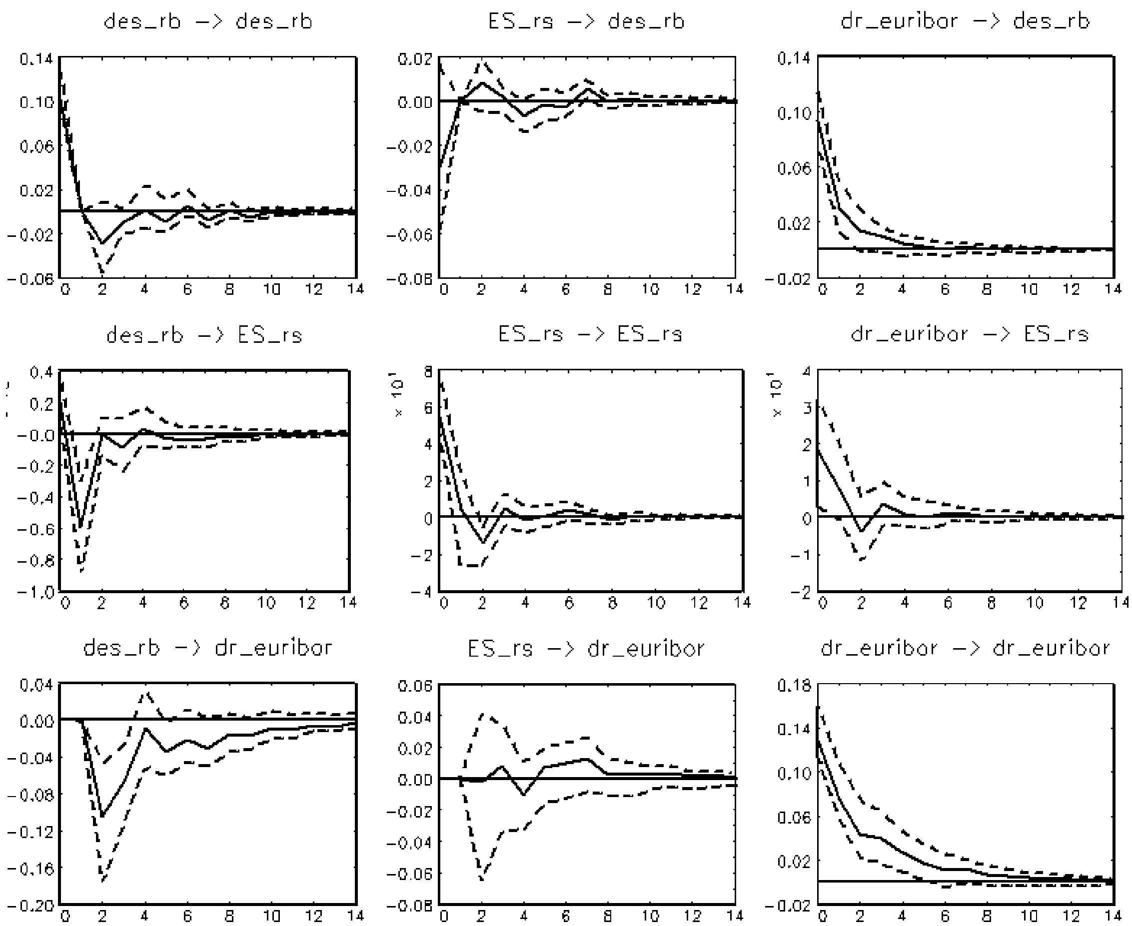

Figure 3 – Impulse response graphs for France

This figure plots the impulse response graphs for France with bond returns, stock returns and the Euribor rate as impulse and response variables. To the left are the graphs with bond returns as impulse variable. In the middle the graphs with stock returns as impulse variable. To the right are the graphs with the Euribor rate as impulse variable. The graphs cover 14 periods. 95% bootstrap confidence intervals are marked with dashed lines.

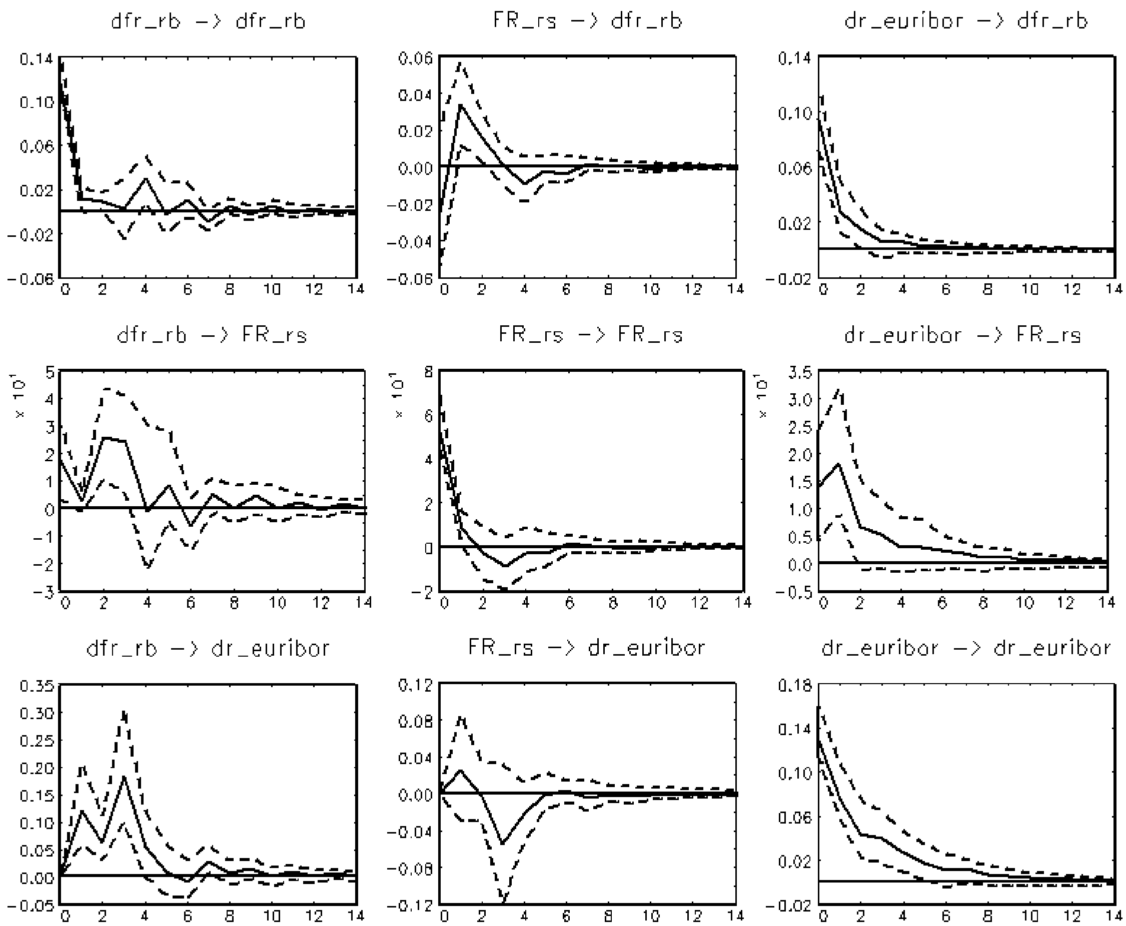

Figure 4 – Impulse response graphs for Italy

This figure plots the impulse response graphs for Italy with bond returns, stock returns and the Euribor rate as impulse and response variables. To the left are the graphs with bond returns as impulse variable. In the middle the graphs with stock returns as impulse variable. To the right are the graphs with the Euribor rate as impulse variable. The graphs cover 14 periods. 95% bootstrap confidence intervals are marked with dashed lines.

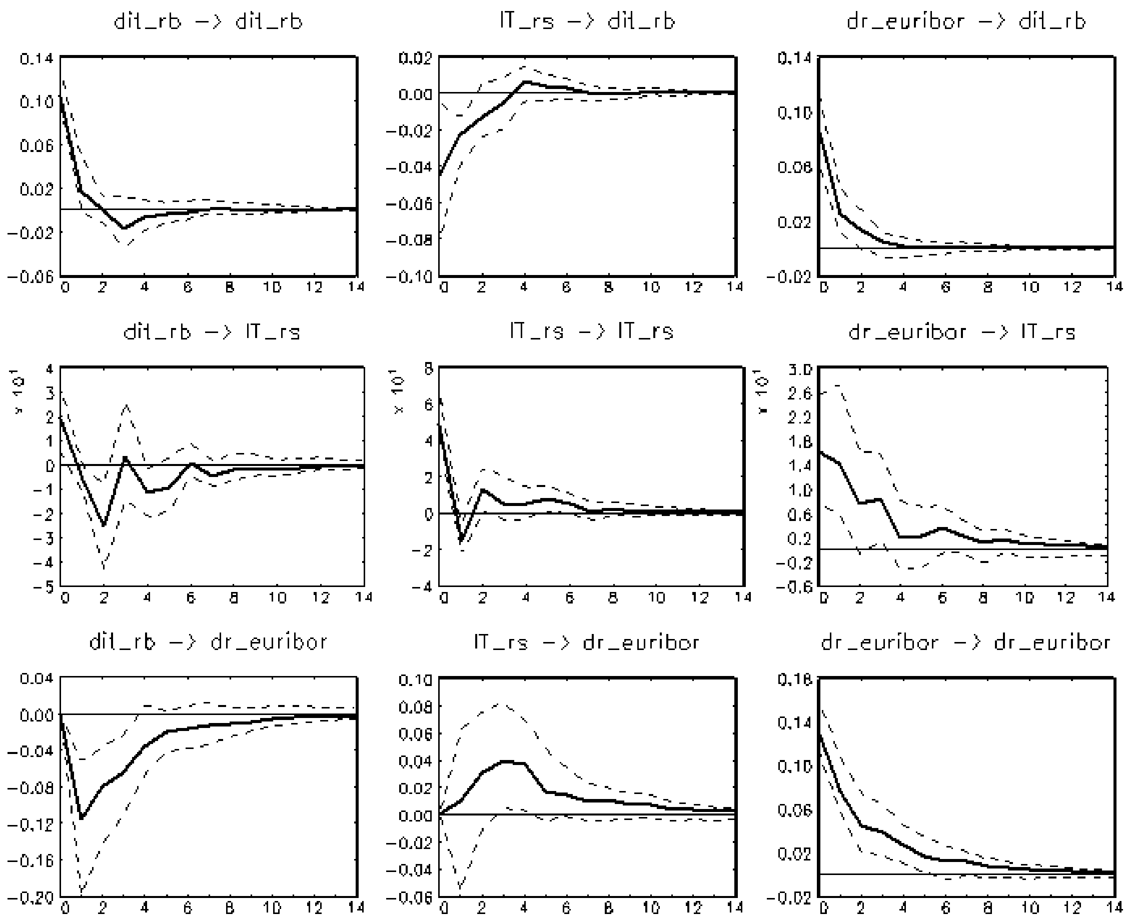

Figure 5 – Impulse response graphs for Euribor rate→bonds

This figure shows the impulse response graphs with the Euribor as the impulse variable and the bond returns of each country as the response variables for the first specification of the A_0 matrix. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. The first graph is for Germany, then Spain, France and last Italy. The figure has been included to facilitate comparison between the countries.

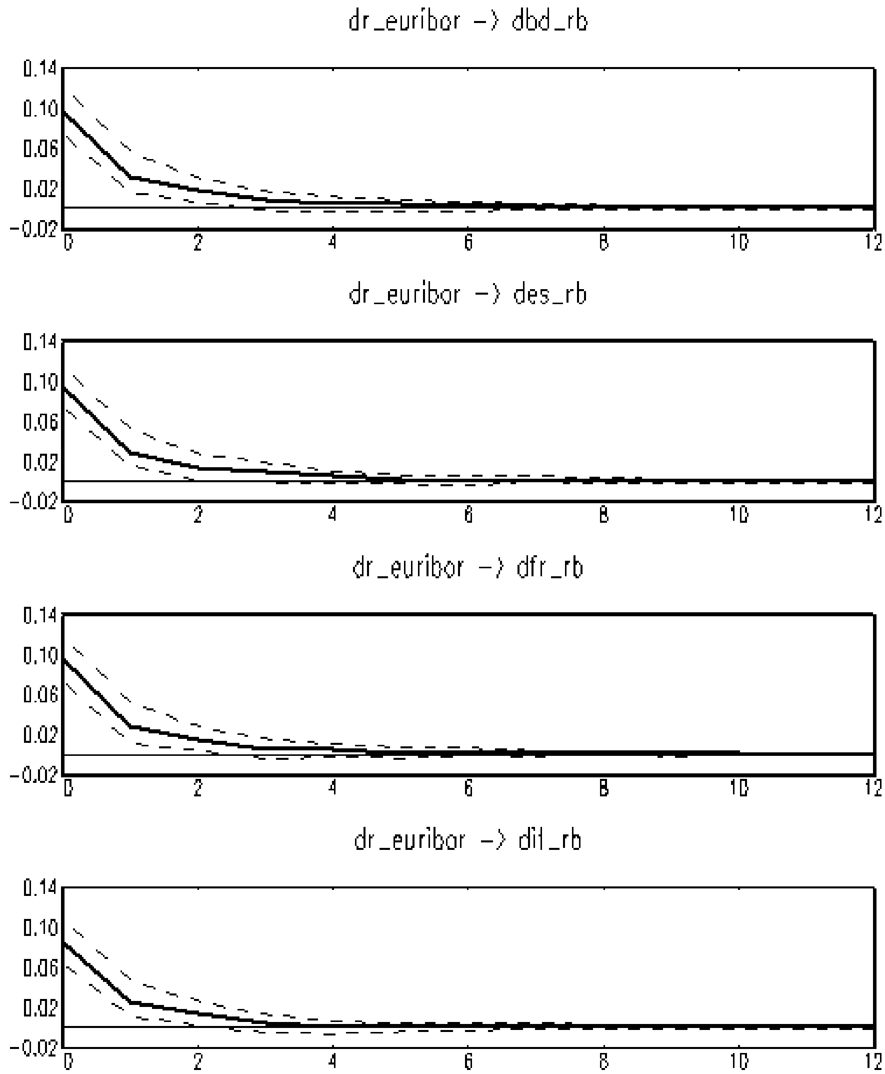

Figure 6 – Impulse response graphs for Euribor rate→stocks

This figure shows the impulse response graphs with the Euribor as the impulse variable and the stock returns of each country as the response variables for the first specification of the A_0 matrix. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. The first graph is for Germany, then Spain, France and last Italy. The figure has been included to facilitate comparison between the countries.

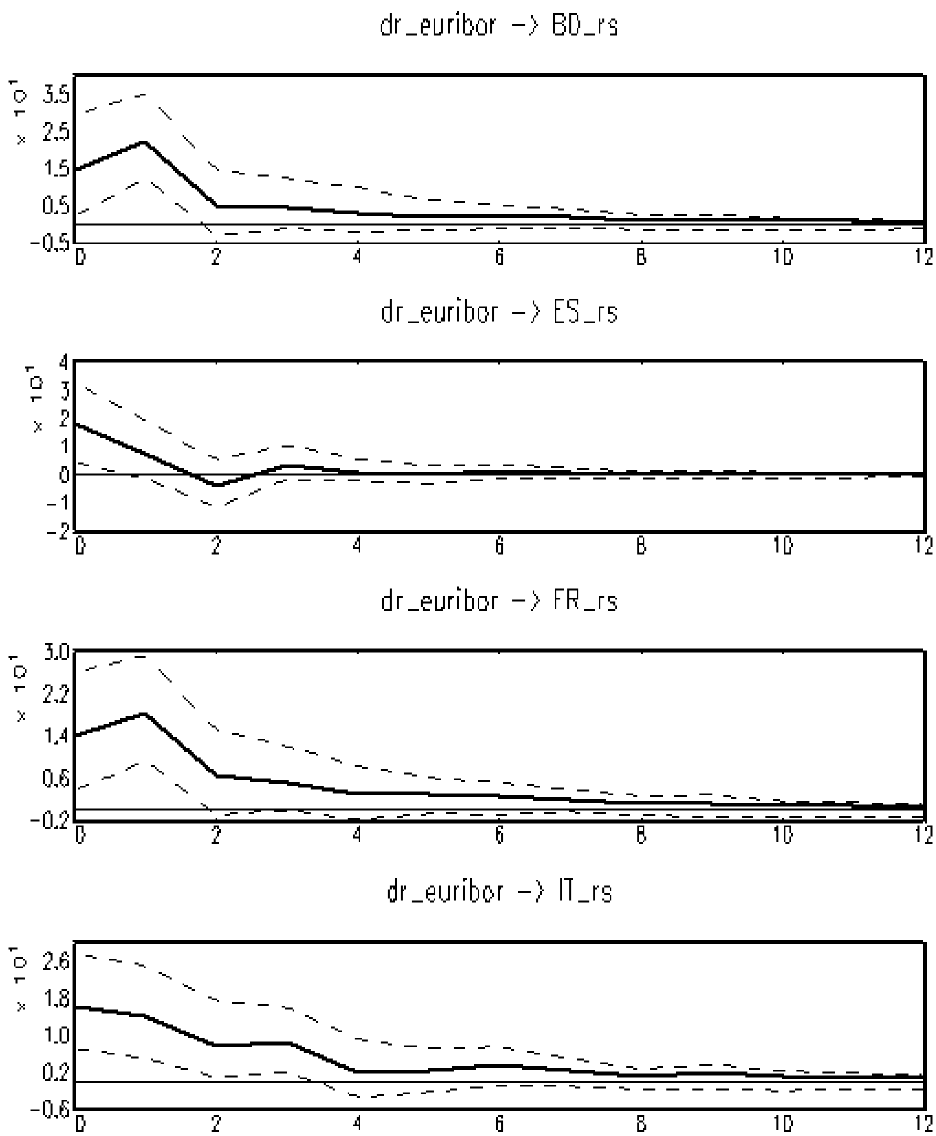

Figure 7 – Impulse response graphs for bonds→stocks

This figure shows the impulse response graphs with the bond returns as impulse variables and the stock returns of each country as the response variables for the first specification of the A_0 matrix. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. The first graph is for Germany, then Spain, France and last Italy. The figure has been included to facilitate comparison between the countries.

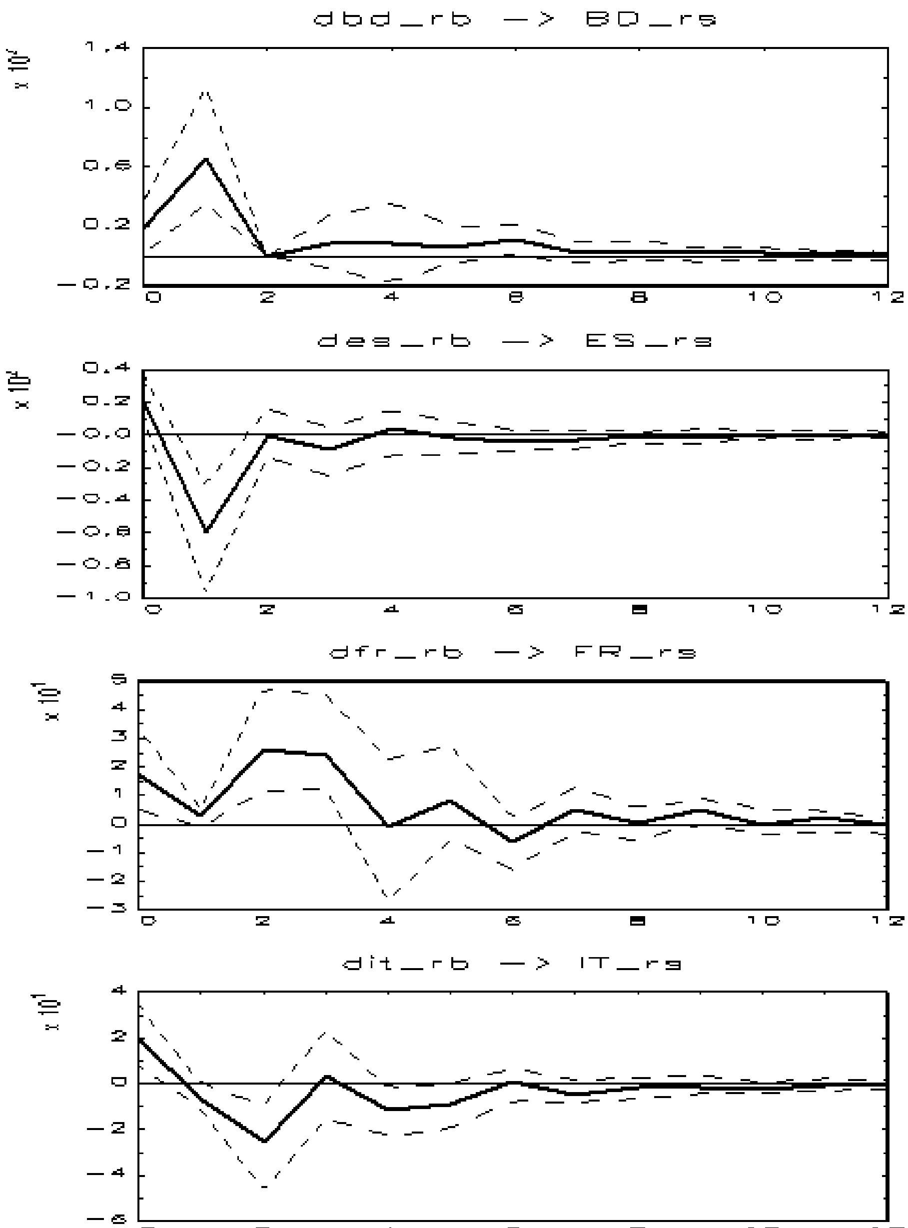

Figure 8 – Impulse response graphs for stocks→bonds

This figure shows the impulse response graphs with the stock returns as impulse variables and the bond returns of each country as the response variables for the first specification of the A_0 matrix. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. The first graph is for Germany, then Spain, France and last Italy. The figure has been included to facilitate comparison between the countries.

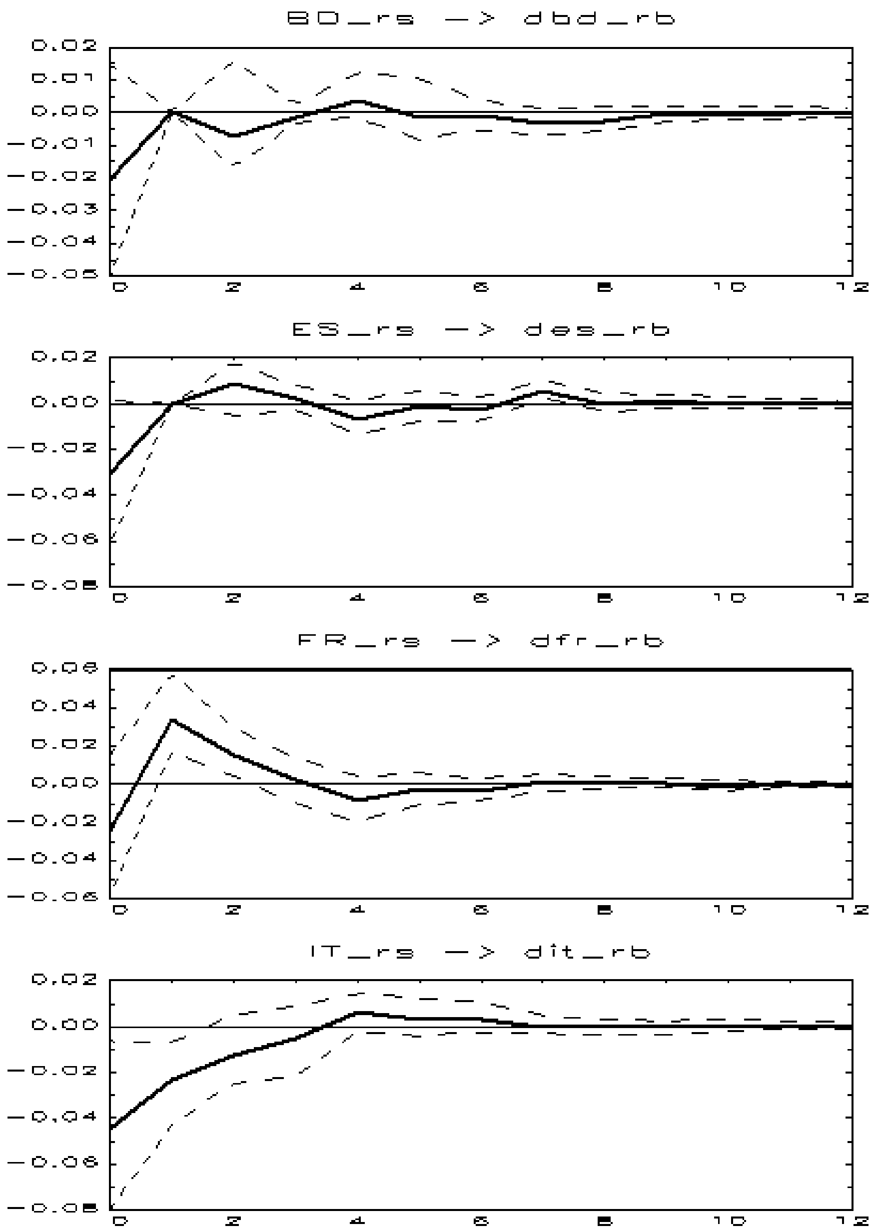

Figure 9 – Impulse response graphs for bonds→bonds. international

This figure shows the impulse response graphs with the bond returns of Germany and France as impulse variables and the bond returns for each country as response variables. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. The first column is for German bonds affecting bonds, the second column for French bonds affecting bonds.

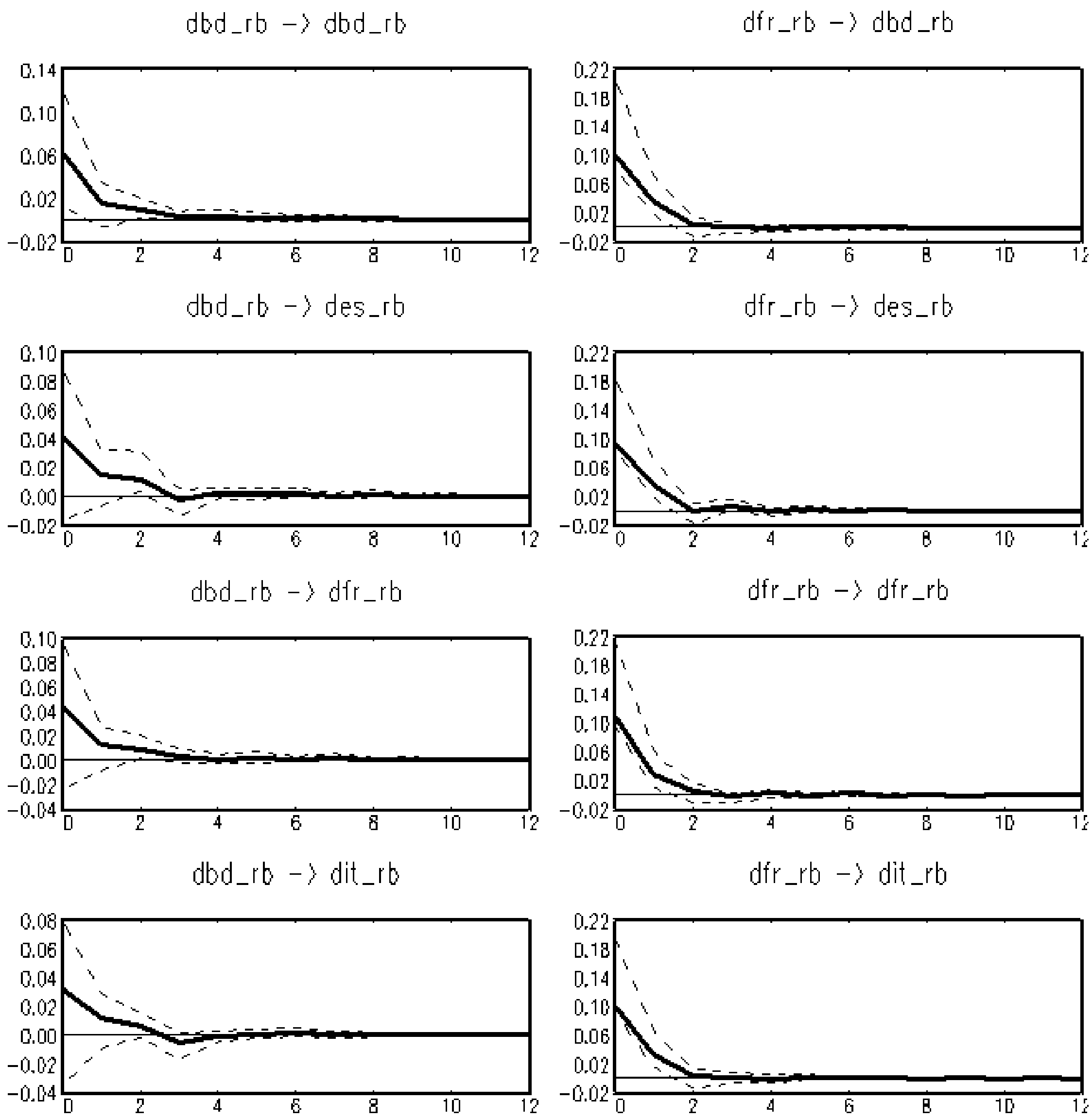

Figure 10 – Impulse response graphs for stocks→stocks. international

This figure shows the impulse response graphs with the stock returns of Germany and France as impulse variables and the stock returns of all countries as the response variables. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. The first column is for German stocks affecting stocks, the second column for French stocks affecting stocks.

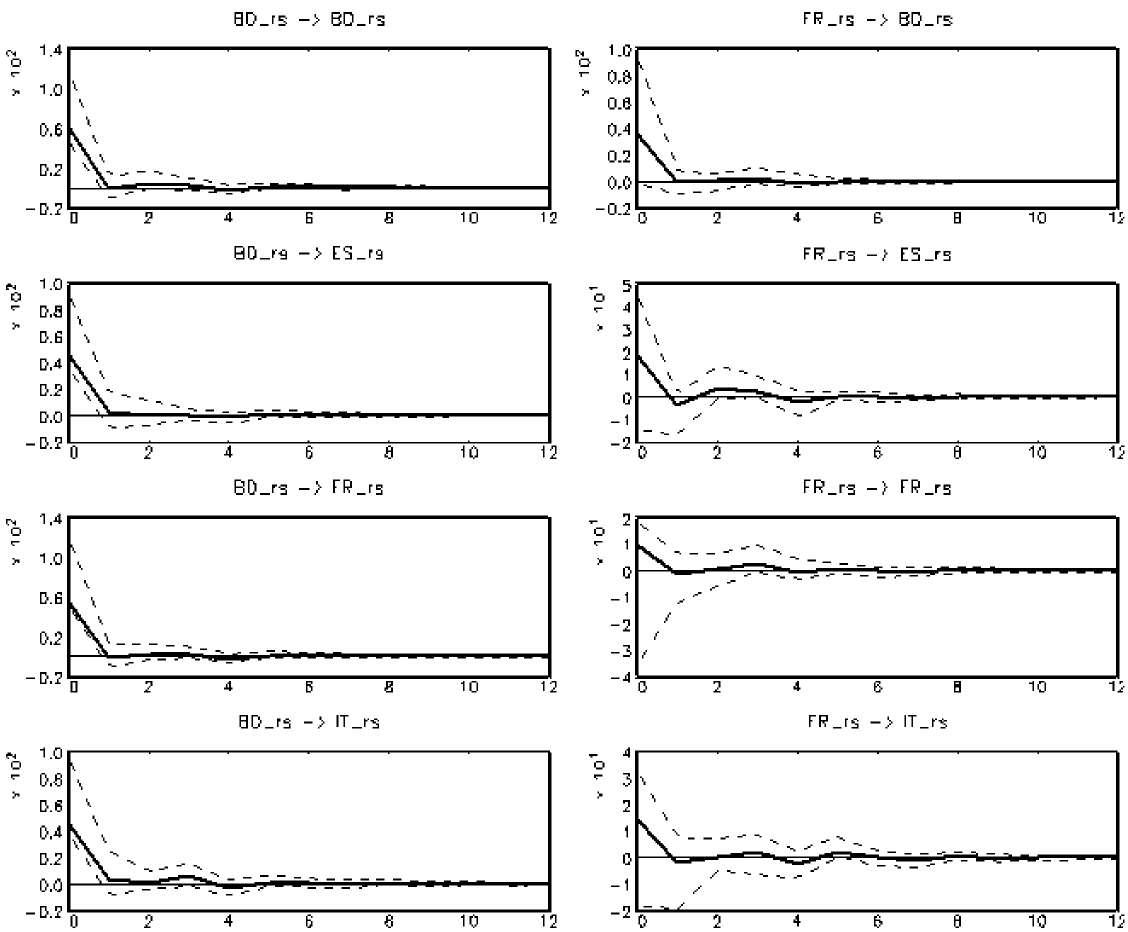

Figure 11 – Impulse response graphs for the Taylor rule variables

This figure plots the impulse response graphs with inflation and unemployment as impulse variables, respectively, and the Euribor rate as response variable. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. Notice the positive impact of inflation and the negative impact of unemployment.

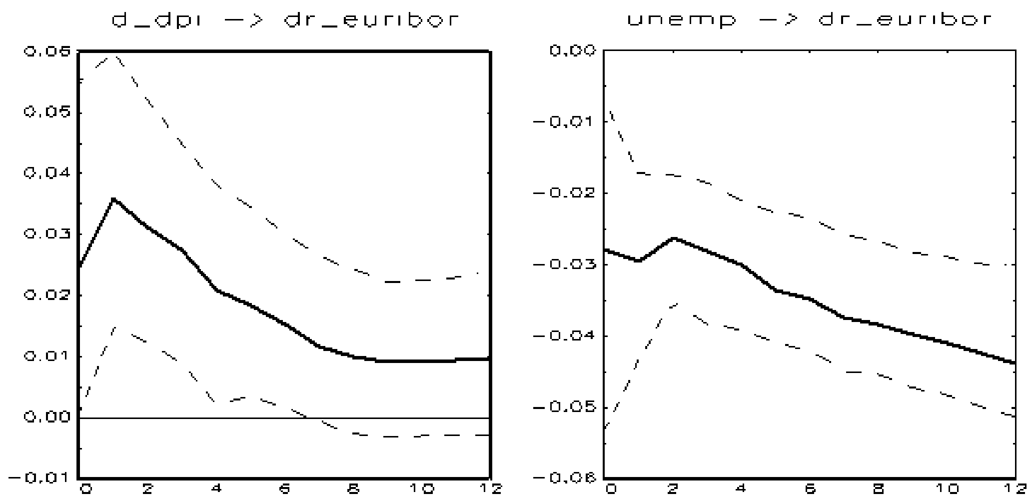

Figure 12 – Impulse response graphs for Germany in the macro variables model

This figure plots the impulse response graphs for Germany with bond returns, stock returns and the Euribor rate as impulse and response variables. To the left are the graphs with bond returns as impulse variable. In the middle the graphs with stock returns as impulse variable. To the right are the graphs with the Euribor rate as impulse variable. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. Notice the similarities to the impulse responses of the financial variables SVAR in Figure 1.

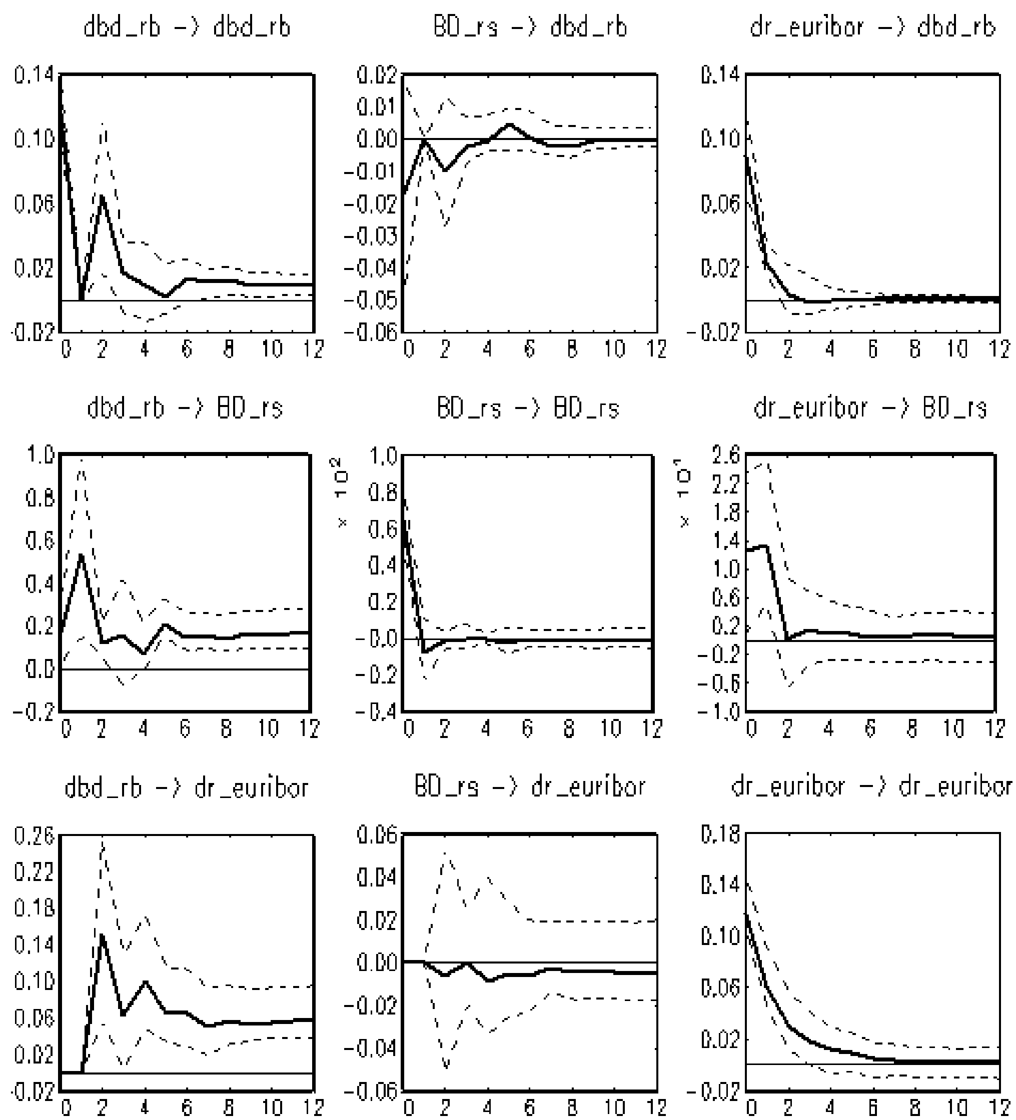

Figure 13 – Impulse response graphs for unemployment→stock returns

This figure plots the impulse response graphs with unemployment as impulse variable and the stock returns in each country as response variables. The graphs cover 12 periods. 95% bootstrap confidence intervals are marked with dashed lines. The first graph is for Germany, then Spain, France and last Italy.

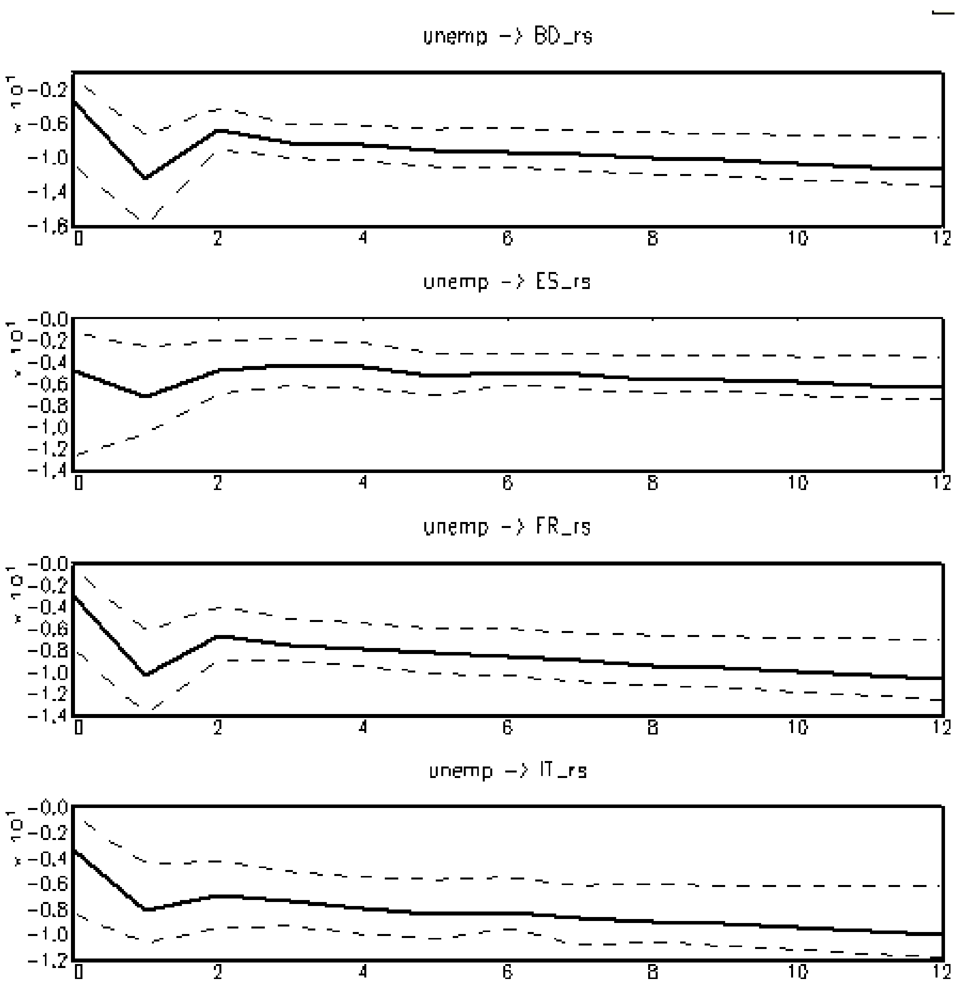

Figure 14 – The ECB rates

This figure plots the Euribor rate and marginal lending facility rate set by the ECB. The rates are in percentages per annum.