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Andreas Thams

Free University Berlin, Collaborative Research Center 649

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# The Relevance of the Fiscal Theory of the Price Level Revisited\*

Andreas Thams<sup>†</sup>

Institut für Statistik und Ökonometrie, Freie Universität Berlin  
Boltzmannstr. 20, 14195 Berlin, Germany, andreas.thams@wiwiss.fu-berlin.de

## Abstract

This paper analyzes empirically the impact of fiscal policy on the price level for Germany and Spain. We investigate, whether the fiscal theory of the price level (FTPL) is able to deliver a reasonable explanation for the different evolutions of the price levels in these two countries during recent years. We apply a Bayesian VAR model with sign restrictions on the impulse responses to assess the relation between surpluses and public debt. The analysis basically evidences non-Ricardian equilibria in Spain, while the opposite is true for Germany. We interpret this as evidence for the inflation differences in these two countries being partially induced by fiscal policy shocks.

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# 1 Introduction

## 1.1 Motivation

Since the introduction of the euro as the common currency in twelve Member States of the European Union (EU) in 2002, there has been a steady debate about the effectiveness of the Stability and Growth Pact (SGP), which requires all countries in the euro zone to have a budget deficit of less than 3% of their nominal GDP. This so-called 3-percent criterion has the aim to prevent excessive government deficits from occurring, which theoretically may lead to substantial increases in the overall price level.

In recent years government deficits have grown in almost all Member States of the European Monetary Union (EMU). In 2004 France, Germany, Greece, Italy and Portugal had a deficit ratio of 3% or higher, while the euro zone average was with 2.7% not considerably smaller than the limit imposed by the SGP. At the same time the rate of inflation in the EMU was quite modest not exceeding 2.2%. This raises the question, whether control of public debt is really a requirement for price stability? Or to put it differently: Is the fiscal theory of the price level (FTPL) a relevant mechanism?

This paper aims to answer this question by investigating German and Spanish data as an example of two countries which performed very differently in terms of inflation during recent years, although both countries were subject to the same monetary policy. As monetary policy cannot be the source of these inflation differences, we analyze, if they are related to fiscal policy.

We base the analysis on an extension of Canzoneri et al. (2001). We modify this approach by using Bayesian techniques and identify fiscal shocks by imposing sign restrictions on the impulse responses. Furthermore, we include short- and long-term interest rates in the analysis to model changes in expectations about future fiscal policy.

To our knowledge, this is the first attempt to test for the relevance of the FTPL with German and Spanish data. The results show that the FTPL is able to explain differences in inflation rates between the two countries.

## 1.2 Literature Review

During the 1990s there has been a considerable amount of theoretical literature devoted on the impact of fiscal policy on inflation. Cornerstones of this theory are the works of Leeper (1991), Sims (1994), Woodford (1994, 1995, 1996 and 2001) and Cochrane (1998, 2000). While traditional theory regards the stock of money as the sole determinant of the price level, the FTPL argues that if fiscal policy is free to set primary surpluses independently of government debt, fiscal shocks may well have an impact on the price level. Whereas traditional theory assumes that fiscal authorities adjust primary surpluses to guarantee solvency of the government for any price level<sup>1</sup>, the FTPL considers the possibility that fiscal policy is able to set primary surpluses independently of government debt accumulated. As a result the price level will adjust

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<sup>1</sup>Barro (1974).

to make the government's intertemporal budget constraint hold at any point of time. Woodford (1995) refers to these two cases of fiscal policy behavior with the terms "non-Ricardian" and "Ricardian". While Ricardian fiscal policy describes the case in which primary surpluses may not be set independently of government debt, "non-Ricardian" refers to the latter case.

In both cases the intertemporal budget constraint holds in equilibrium. The crucial difference between the two scenarios is the causal link between prices and surpluses.

Woodford (1996, 1998) argues that fiscal shocks affect aggregate demand in non-Ricardian environments. This is induced, as he says, by the fact that households regard government debt as net wealth affecting their future path of consumption due to the exogeneity of government deficits.

Sims (1997) states that government commitments to stable prices can easily turn out to be unsustainable. Furthermore, there are practical bounds for governments on primary surpluses and unpredictable disturbances to fiscal balance, which highlights the possibility of an exogenous path of government deficits. For a monetary union Sims concludes that generally an interest-rate-pegging policy, which is what a monetary union finally is about, can only work, if each country with an initial level of public debt larger than zero commits itself to some positive level of primary surpluses in the future. From a game theoretic perspective each government has an incentive to deviate from this strategy to increase welfare of its own citizens leading to an upward jump in the price level. The costs of this policy have to be paid by all members of the monetary union. This implies that a monetary union can only succeed, if national governments have to commit themselves to a deficit or surplus rule, i.e. a limit on borrowing as done by the existing SGP, or as Sims argues to a path of some positive primary surpluses.

Hence, theoretically there seems to be at least some evidence for a causal link between public debt and prices, even if the theoretical relevance of the FTPL is doubted by some contributions such as Buiter (2002). Empirically the evidence for the FTPL is even less clear-cut.

Cochrane (1998) states that the "FTPL per se has no testable implications for the time series of debt, surplus and price level". The budget constraint of the government written in nominal terms holds in both Ricardian and non-Ricardian regimes. If this equilibrium is restored by price or surplus adjustments remains unclear<sup>2</sup>. Hence, all we observe are equilibrium points, but not the fundamentals behind them. Woodford (1995) supports this view saying that it does not make much sense to test the FTPL in empirical terms. Heading in the same direction, Buiter (1999) states that "the government's intertemporal budget constraint is a constraint on the government's instruments that must be satisfied for all admissible values of the economy-wide endogenous variables." So what really matters for the characterization of fiscal policy behavior is the question, whether prices or future surpluses of the government adjust to make the government budget constraint hold.

In recent years there have been some attempts to measure empirically the effect of fiscal policy on the price level. Canzoneri et al. (2001) investigate U.S. data for the period 1951-1995 with a bivariate VAR model in surplus/GDP and liabilities/GDP. This VAR specification allows to identify, whether prices or surpluses adjust in order to make the intertemporal government budget constraint hold. The paper comes to the conclusion that fiscal policy in the U.S. may rather considered to be Ricardian than non-Ricardian.

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<sup>2</sup>We will comment on this issue in greater detail within the next section of this paper.

Bohn (1998) finds out that U.S. fiscal surpluses have responded positively to debt. He argues that this provides evidence that U.S. fiscal policy has been sustainable, and although he does not directly comment on the FTPL, his results are consistent with those of Canzoneri et al. (2001)

Janssen et al. (2002) analyze the impacts of monetary and fiscal policy on the path of inflation in the UK. This paper is especially remarkable as it is built on almost 300 years of data starting in 1705. They also conclude that there is little econometric evidence that fiscal policy has significantly affected the price level or the overall money supply.

For the EMU, Afonso (2002) demonstrates, applying a panel data approach, that the FTPL is not supported for the EU-15 countries during the period 1970-2001. The Member States of the EMU tend to react with larger future surpluses to increases in the government liabilities. Therefore, fiscal policy may be considered to be Ricardian.

So far, there seems to be empirical evidence that Ricardian fiscal policies are possible and likely.

Very recent papers by Davig et al. (2006) as well as Davig and Leeper (2005) analyze regime switches in both fiscal and monetary policy for the U.S. They distinguish between active and passive behavior for monetary and fiscal authorities<sup>3</sup>. Their work shows that tax cuts always generate wealth effects and non-Ricardian outcomes, as long as there is a positive probability for an active fiscal policy in the next period. Therefore, their work may be interpreted as evidence in favor of the FTPL mechanism.

Another attempt to examine fiscal policy regimes in the light of Markov-switching processes is carried out by Favero and Monacelli (2005). They investigate U.S. data for the period 1960-2002 and come to similar conclusions, namely that fiscal policy has switched between active and passive regimes.

The remainder of this paper is structured as follows. In section 2 we introduce a Bayesian version of the approach developed by Canzoneri et al. (2001). Following the method of Uhlig (1999) we identify fiscal shocks by imposing sign restrictions on the impulse responses. After the interpretation of the results obtained for Germany and Spain, we briefly summarize the findings and comment on the policy implications arising from the analysis in section 3. Finally, we attempt to answer the question, whether the FTPL is able to explain the different processes of inflation in these two countries.

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<sup>3</sup>The terms active and non-Ricardian fiscal policy are equivalent as well as passive and Ricardian.

## 2 Deficit-Debt Approach

In the following we introduce a Bayesian version of the method suggested by Canzoneri et al. (2001) to test for the FTPL empirically and apply it to German and Spanish data. We use Bayesian techniques, as they do not require the underlying time series to be stationary on the one hand and allow to formulate prior beliefs about the parameters in question on the other hand<sup>4</sup>. To identify fiscal shocks we impose sign restrictions on the impulse responses.

### 2.1 The Theoretical Foundation of the Model

The government's budget constraint written in nominal terms for period  $t$  is naturally given by

$$B_t = (T_t - G_t) + (M_{t+1} - M_t) + \frac{B_{t+1}}{1 + i_t}, \quad (2.1)$$

where  $M_t$  denotes the stock of base money and  $B_t$  the stock of government debt outstanding at the beginning of period  $t$ . At this point it is important to notice that  $B_t$  and  $M_t$  are quoted in nominal terms and their values are fixed at the beginning of each period. The real value of these two variables is determined by the price level. The difference between taxes  $T_t$  and government expenditures  $G_t$  in period  $t$  yields the primary surplus.  $i_t$  is the nominal interest rate at time  $t$ .

(2.1) states that government liabilities outstanding in period  $t$  have to be repaid by either running a surplus in the same period, monetized by increasing the stock of base money, or financed by issuing new debt at the beginning of the next period.

We divide (2.1) by nominal GDP  $P_t y_t$ . After some rearrangements using simple algebra we obtain

$$\frac{M_t + B_t}{P_t y_t} = \frac{T_t - G_t}{P_t y_t} + \frac{M_{t+1}}{P_t y_t} \frac{i_t}{1 + i_t} + \frac{y_{t+1}/y_t}{(1 + i_t)P_t/P_{t+1}} \frac{M_{t+1} + B_{t+1}}{P_{t+1} y_{t+1}}. \quad (2.2)$$

On the left-hand side of (2.2) we find the ratio of total government liabilities and GDP. As a short form of writing total government liabilities in period  $t$  we use  $L_t$  in the following.

At first glance the right-hand side seems to be somewhat more complicated.  $\frac{T_t - G_t}{P_t y_t}$  is the primary surplus of the government in period  $t$  set in relation to nominal GDP. When we think of the government as renting the money supply to the private sector<sup>5</sup> charging  $\frac{i_t}{1 + i_t}$ , then the second term represents the central bank transfers also set in relation to current nominal GDP. Thus, the first two terms on the right-hand side of (2.2) add up to the total surplus-GDP ratio of the government, which we will denote in the following by  $S_t/Y_t$ . In the notation introduced above  $\frac{M_{t+1} + B_{t+1}}{P_{t+1} y_{t+1}}$  boils down to  $L_{t+1}/Y_{t+1}$ , where  $Y_t = P_t y_t$ . Finally,  $\frac{y_{t+1}/y_t}{(1 + i_t)P_t/P_{t+1}}$  has as numerator real growth of GDP and the denominator gives the real interest rate using the well-known Fisher equation. Thus, we may interpret this term as a discount factor of next period's total government liabilities. In the following we will refer to this discount factor as  $\beta_t$ .

This enables us to simplify (2.2) so that we obtain

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<sup>4</sup>We will comment on this issue in greater detail later on.

<sup>5</sup>Obstfeld and Rogoff (1996), p. 537.

$$\frac{L_t}{Y_t} = \frac{S_t}{Y_t} + \beta_t \frac{L_{t+1}}{Y_{t+1}}. \quad (2.3)$$

Iterating this equation forward and recursively substituting  $\frac{L_{t+1}}{Y_{t+1}}$  we end up with

$$\frac{L_t}{Y_t} = \frac{S_t}{Y_t} + E_t \sum_{j=t+1}^{\infty} \left( \prod_{k=t}^{j-1} \beta_k \right) \frac{S_j}{Y_j}, \quad (2.4)$$

which is equivalent to the transversality condition

$$\lim_{T \rightarrow \infty} E_t \left( \prod_{k=t}^{T+t-1} \beta_k \right) \frac{L_{t+T}}{Y_{t+T}} = 0, \quad (2.5)$$

with  $E_t$  being the expectations operator conditional on information available at time  $t$ . The flow budget constraint (2.4) has to be fulfilled at any point of time, which can be achieved in two ways<sup>6</sup>:

1. Consider the case in which the surpluses follow an endogenous process so that (2.4) is fulfilled by adjustments in the sequence of  $S_t$ , whereby the values of the discount factor  $\beta_t$  and nominal GDP  $Y_t$  are determined outside the system. We refer to this type of fiscal policy behavior as Ricardian, as both real GDP and inflation remain unaffected by changes of the fiscal variables.
2. Let the sequence of primary surpluses be determined by an arbitrary exogenous process. Now, to make (2.4) hold, either the discount factor or the liabilities-GDP ratio have to move. As mentioned before, we assume nominal government liabilities to be fixed at the beginning of each period. That means that the numerator in  $\frac{L_t}{Y_t}$  remains unchanged, as it was the case before in the Ricardian scenario. Hence, equality of (2.4) can only be restored through  $Y_t$  in the denominator, which also implies an impact on the discount factor  $\beta_t$ . Fiscal policy is said to be non-Ricardian.

That means, whenever surpluses are set independently of the stock of government debt accumulated, nominal income is determined by fiscal policy actions. By definition, nominal GDP is the product of real GDP  $y_t$  and the price level  $P_t$ . Thus, an increase in nominal GDP will generally affect both real GDP as well as the price level<sup>7</sup>.

Using these basic insights in the FTPL we now try to figure out which of the variables considered above, responds to changes in the fiscal variables using German and Spanish data.

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<sup>6</sup>Note that the stock of total nominal government liabilities  $B_t + M_t$  is fixed at the beginning of each period.

<sup>7</sup>A theoretical quantification of the impact fiscal policy has on both real GDP and inflation can be found for instance in Woodford (1996).

## 2.2 The Model

In the following we investigate, how total government liabilities divided by nominal GDP react to changes in the surplus-GDP ratio.

Assume that  $\frac{S_t}{Y_t}$  increases in period  $t$ . Then, if fiscal policy is Ricardian, we should either expect future surpluses to decrease or to use the surplus to repay the debt, if possible. Thus, an indicator for a Ricardian policy behavior would be a negative or zero-response of  $L_t/Y_t$  to a positive shock in  $S_t/Y_t$ . This Ricardian interpretation would only be reasonable, if the surplus shock is persistent in a sense that it does not immediately change in sign to a deficit so that the impact is immediately diminished. For this reason it will be important to regard the pattern of  $S_t/Y_t$  for conclusions about the character of the shock. Furthermore, the discount factor  $\beta$  should remain unaffected, if the response of  $L_t/Y_t$  is strong enough to leave the price level unaffected.

The non-Ricardian case is somewhat easier to describe in terms of the results we should expect. A non-Ricardian fiscal policy is definitively at work, if the reaction of  $L_t/Y_t$  is positive to a positive shock in  $S_t/Y_t$  for reasons which should be obvious from equation (2.4). Furthermore, a negative response of  $L_t/Y_t$  should also be considered to be non-Ricardian, if  $S_t/Y_t$  is significantly negatively autocorrelated, i.e. the shock is not positively autocorrelated and quickly changes in sign, or if the discount factor reacts negatively to a significant shock in  $S_t/Y_t$  combined with a negative reaction of  $L_t/Y_t$ .

Formally, we analyze a VAR of the form

$$\begin{bmatrix} S_t/Y_t \\ L_t/Y_t \\ \beta_t \end{bmatrix} = const + \sum_{s=1}^p \underbrace{\begin{bmatrix} B_{11}(s) & B_{12}(s) & B_{13} \\ B_{21}(s) & B_{22}(s) & B_{23} \\ B_{31}(s) & B_{32}(s) & B_{33} \end{bmatrix}}_{B(s)} \begin{bmatrix} S_{t-s}/Y_{t-s} \\ L_{t-s}/Y_{t-s} \\ \beta_{t-s} \end{bmatrix} + \underbrace{\begin{bmatrix} u_{1t} \\ u_{2t} \\ u_{3t} \end{bmatrix}}_{u_t}, \quad (2.6)$$

where the  $B(s)$  are a set of  $p$  ( $m \times m$ ) coefficient matrices with  $m$  denoting the number of dependent variables included ( $m = 3$ ).  $u_t$  is Gaussian with zero mean and

$$E[u_t u_t' | (S_{t-s}/Y_{t-s}; L_{t-s}/Y_{t-s})] = \Omega \quad (2.7)$$

with  $\Omega$  being the positive definite symmetric and time-invariant covariance matrix of size ( $m \times m$ ).

## 2.3 The Data

All data used corresponds to statistics of the International Monetary Fund except for German GDP, which is taken from the Federal Statistical Office Germany. All data is denoted in nominal terms and has a quarterly frequency. For monetary liabilities  $M_t$  we take the monetary base including both money in circulation and reserves. Government debt  $B_t$  is represented by total government debt, which includes in the case of Germany both debt of federal and federal state authorities.  $L_t$  is then defined as the sum of total government debt  $B_t$  and the monetary base  $M_t$ . For  $S_t$  we decided to take the difference of total government revenues and expenditures. As all



other variables GDP enters in nominal terms and is seasonally adjusted. To capture movements in  $\beta_t$ , we included the interest rate as a proxy for the discount factor. We analyze separately the impact of a fiscal shock on short-term and long-term interest rates. For the short-term interest rate we use the average 3-month money market rate and for long-term interest rates we take the yield on a 10-year government bond. The data has a quarterly frequency and starts for Germany with the 1<sup>st</sup> quarter 1970 and ends with the 4<sup>th</sup> quarter 1998<sup>8</sup>. To take the German reunification into account we introduced a shift dummy in the German case, which is zero before 1991 and one from 1991 onwards<sup>9</sup>. Unfortunately, the corresponding data for Spain is only partially available before 1986 so that the analysis of Spanish fiscal policy has to rely on the period 1986-1998.

## 2.4 Estimation Method

In opposite to Canzoneri et al. (2001) we choose a Bayesian instead of a classical approach. Bayesian inference has the advantage that it does generally not raise specific difficulties like classical inference when the data analyzed is non-stationary, as the application of Bayes' theorem does not require the data to be stationary. This is particularly helpful, when the statistical properties of the data with respect to stationarity issues contradict economic theory.

When examining the data for both Germany and Spain it should be quite obvious that government liabilities as well as government liabilities divided by GDP is steadily increasing for almost the entire observation period. That means that the sample data is not mean reverting and hence not stationary in a common sense. When we perform an ADF test for the four series in the two countries, i.e.  $S/Y$ ,  $L/Y$  and short- and long-term interest rates, the null of a unit root may not be rejected<sup>10</sup>. It turns out that all variables are  $I(1)$ . The non-stationarity of liabilities/GDP is statistically reasonable, but from an economic point of view it implies that any point between plus and minus infinity is equally likely. If this were really true for the series of liabilities/GDP, fiscal policy would definitively not be sustainable, as government debt may grow without bound. A classical approach would suggest an estimation of the VAR in differences or a cointegration analysis in order to obtain statistically reasonable results. But this procedure would be problematic from an economic point of view for the same reasons as stated above, i.e. we would implicitly assume a non-stationary behavior for the process of government debt, which would imply a non-sustainability of fiscal policy. By applying a Bayesian approach we still allow for these scenarios to occur, when choosing an appropriate prior, but we do not impose any restrictions with respect to stationarity or non-stationarity of the data in advance. So to speak we let the data speak for themselves. Another advantage of Bayesian techniques is that they provide a more general way to test an existing theory, as they do not rely on asymptotic theory.

Within a Bayesian analysis we aim at finding the posterior probability density function (pdf)

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<sup>8</sup>As the approach requires the stock of money to be included, the analysis is restricted to this period.

<sup>9</sup>Alternatively, we did the regression with an impulse dummy for the years 1991-1993, which left the results generally unchanged.

<sup>10</sup>It should be obvious that allowing for a deterministic trend is not reasonable from the nature of the data. The lag length was chosen according to the Akaike criterion.

of the parameters. This posterior pdf is obtained in two steps. First, we choose a prior pdf, which expresses our prior beliefs about the coefficients in  $B(s)$  and the covariance matrix  $\Omega$ . Afterwards, we may compute the likelihood function, i.e. the joint pdf of the data, conditional on the unknown parameters.

As Uhlig (1994) suggests, it is reasonable to assume a Normal Wishard distribution for the prior and the posterior pdf,  $\phi_{NW}(B, \Omega^{-1} | \bar{B}, N, \Lambda, v)$ , with  $\bar{B}$  being the mean coefficient matrix of size  $(p \times m)$ ,  $\Lambda$  the positive definite mean covariance matrix of size  $(m \times m)$ ,  $N$  a semi-positive definite matrix of size  $(p \times p)$  and finally  $v \geq 0$  denotes the degrees of freedom to describe the uncertainty about  $B$  and  $\Omega$  around  $(\bar{B}, \Lambda)$ . The prior distribution of the inverse of the covariance matrix  $\Omega^{-1}$  follows a Wishard distribution of the form  $W_m(\Lambda^{-1}/v, v)$ . For the specification of the prior we have to choose values for  $\bar{B}, \Lambda, N, v$ .

We assume that our prior information is diffuse so that basically the parameters in  $B(s)$  may take any value in the interval  $-\infty$  to  $\infty$  with equal probability. This implies that our prior beliefs are best represented by a flat prior. We obtain a flat prior by setting  $N_0 = v_0 = 0$  and  $\bar{B}_0$  as well as  $\Lambda_0$  arbitrarily under the restriction that  $\Lambda_0$  has to be positive definite.

Thus, the analysis applies to both explosive and nonexplosive cases. If the process is actually explosive or not, will be determined by the sample information we have<sup>11</sup>. That means that inferences are unaffected by information external to the current data<sup>12</sup>.

As stated above, we aim at examining the reaction of  $L_t/Y_t$  to a positive shock in  $S_t/Y_t$ . For the sake of completeness we want to mention at this point that following the method of Dolado and Lütkepohl (1996) the null of no Granger causality from  $S_t/Y_t$  to  $L_t/Y_t$  may be rejected at the 5-percent level in both countries. Generally, the reaction or impulse response of  $L_t/Y_t$  to a shock in  $S_t/Y_t$  may be both positive and negative in sign. When we do not differentiate between these two scenarios in the analysis, we may possibly obtain an ‘‘average’’ response, which may be misleading in measuring and evaluating the impacts of a shock. Furthermore, we know from the theoretical considerations given above that a positive response of  $L_t/Y_t$  leads to a non-Ricardian interpretation of the data in the corresponding period.

For the case differentiation between responses which are positive and negative in sign we have chosen the pure-sign-restriction approach by Uhlig (1999). Using this approach we only consider those cases in which the orthogonalized impulse responses head for the desired direction in the period the shock takes place<sup>13</sup>. We divide the sample in those impulse responses which are candidates for a Ricardian interpretation and those which are candidates for a non-Ricardian interpretation, i.e.

1. A positive (negative) shock in  $S_t/Y_t$  immediately leads to a zero or negative (positive) impact on  $L_t/Y_t$ .

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<sup>11</sup>For a general discussion on choosing the appropriate prior pdf, the interested reader may have a look at Zellner (1971).

<sup>12</sup>See Gelman et al. (1995).

<sup>13</sup>The sign restriction is binding for only one period. The orthogonalized impulse responses are obtained from a Cholesky decomposition.

2. A positive (negative) shock in  $S_t/Y_t$  immediately leads to a positive (negative) impact on  $L_t/Y_t$ .

The discount factor remains unrestricted. Our focus will then lie on the question, if the further process, i.e. the process of the three variables after the shock has occurred, also matches a Ricardian pattern in case of scenario 1 and how many of the draws generally match scenario 1 and 2. We made 1,000 draws from the reduced-form posterior density and for each reduced-form draw 50 draws of the  $\alpha$ -vector<sup>14</sup>. The lag length  $p$  is set to 2<sup>15</sup>.

## 2.5 The Results

In the following we give the results for the two countries in form of impulse responses to a one-standard-deviation shock in  $S/Y$ . All impulse responses show the median response as well as the 18% and 84% quantiles corresponding to a one standard deviation band, if the distribution was normal.

### 2.5.1 Germany

Figures 1 and 2 show the results obtained for Germany in the period 1970-1998, when short-term and long-term interest rates are alternatively used to model changes in the discount factor. Basically, we can see that a positive shock in  $S/Y$  leads to a significant and negative response of  $L/Y$  in the first period. This should not be surprising, as we used a sign restriction on the impulse responses to exclude all cases in which a positive surplus-GDP shock leads to a positive impact on  $L/Y$ . As the impact of the shock is significant and almost persistent in the process of  $L/Y$  for a horizon of at least 5 years, the analysis so far suggests a Ricardian interpretation of figures 1 and 2. The initial shock disappears after about one year, but does not change in sign, which gives further evidence for a Ricardian fiscal policy behavior. Furthermore, the median response of both short-term and long-term interest rates is hardly significant with the upper and lower quantiles being symmetrically distributed around zero. With respect to long-term interest rates the impulse responses are even more closely distributed around zero. That means that following a fiscal shock the liabilities-GDP ratio reacts strong enough to leave interest rates unaffected. Hence, we may say that a fiscal shock has no influence on the discount factor. Taking the three pictures in figures 1 and 2 together, the analysis provides strong evidence that German fiscal policy was characterized by a Ricardian behavior during the sample period. In addition, this result is also confirmed by the fact that more than 60% of the overall number of impulse responses drawn from the posterior distribution match the prior sign restrictions, i.e. they follow a Ricardian pattern, so that the FTPL mechanism does not seem to be relevant for Germany in the period 1970-1998. The fact that both short- and long-term interest rates remain unaffected by the fiscal shock highlights that individuals expect fiscal policy to remain Ricardian in the future, as otherwise we should expect a significant reaction of long-term interest rates.

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<sup>14</sup>Details about the meaning of the  $\alpha$ -vector may be found in section 4.1 of the appendix.

<sup>15</sup>The model was also estimated with a higher number of lags, which left the results basically unchanged.

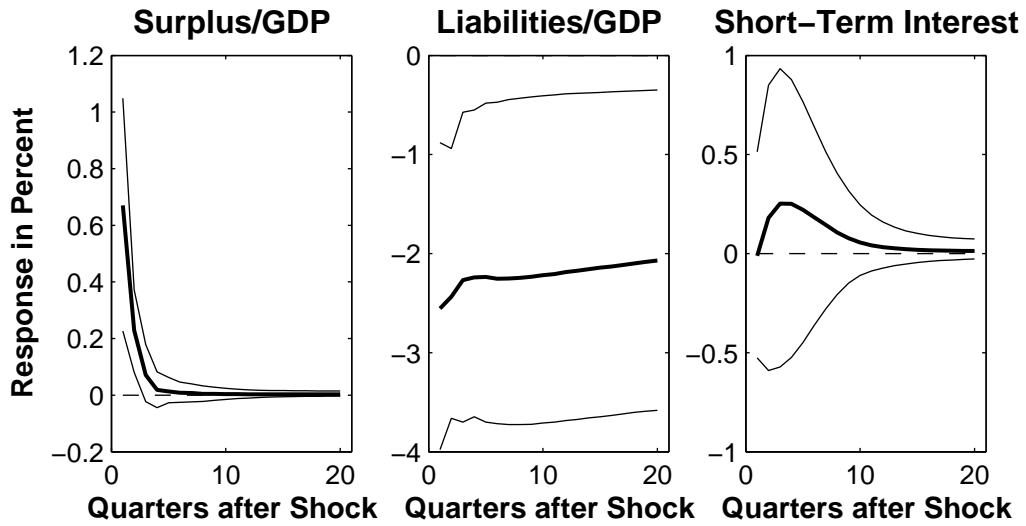


Figure 1: *Germany, 1970-1998, Response to a Surplus/GDP Shock in % with 68% Error Bands and Short-Term Interest Rates Included.*

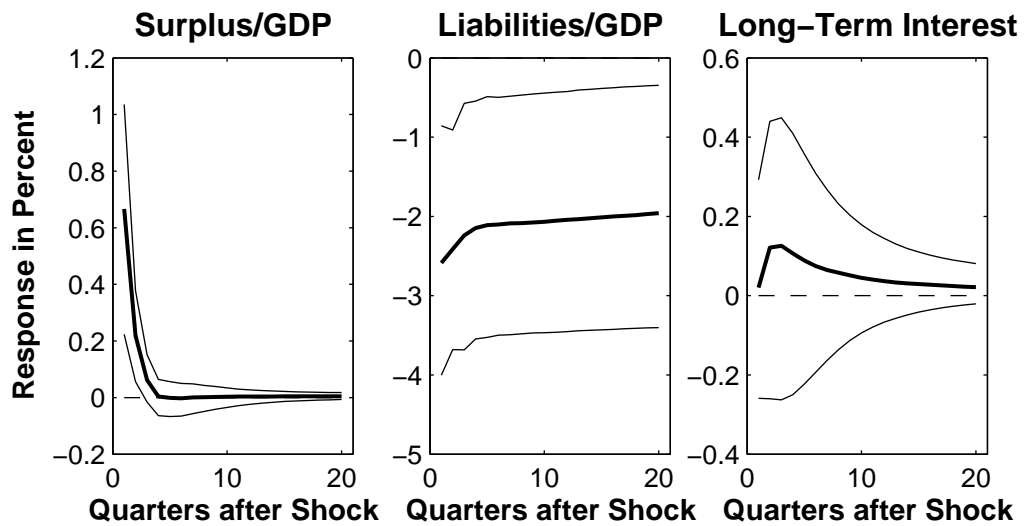


Figure 2: *Germany, 1970-1998, Response to a Surplus/GDP Shock in % with 68% Error Bands and Long-Term Interest Rates Included.*

Finally, regarding the quality of the model we shall mention that the fiscal shock accounts for about 50% of the variation in  $L/Y$  and less than 20% of the variation in  $S/Y$ . Thus, we find that a sizable fraction of the variation in  $L/Y$  can be attributed to fiscal shocks, while the opposite is true for the interest rates.

### 2.5.2 Spain

The results for Spain are given in figures 3 and 4. In terms of the fiscal variables we can basically see the same pattern as for Germany. That means that both  $S/Y$  and  $L/Y$  generally fulfill the requirements for fiscal policy to be Ricardian, i.e. following a positive shock in the surplus-GDP ratio, we observe a negative response of the liabilities-GDP ratio. Therefore, we should expect interest rates to remain unaffected by the fiscal shock. Surprisingly, this is not the case. Regardless of the interest rate definition chosen, we see a strong and positive response of interest rates. By the definition of the  $\beta$  this corresponds to a negative response of the discount factor. Thereby, the median response is of almost equal size for both short- and long-term interest rates with the long-term interest rates showing a somewhat smaller response. Basically, there are two different explanations for a situation like the one depicted in figures 3 and 4 to occur. One would be that the reaction of future liabilities is not strong enough to leave the discount factor and hence the interest rates unaffected. Another one would be that Spanish fiscal policy was indeed Ricardian during the period analyzed but individuals place a positive probability on fiscal policy to switch to a non-Ricardian regime in the near future, as both short- and long-term interest rates are affected by the fiscal shock. This in turn would imply that remaining in or returning to a Ricardian regime in the long run is not credible, as indicated by the reaction of the long-term interest rates.

As the response of interest rates becomes significant after five quarters in the case of short-term interest rates and after about eight quarters in the case of long-term interest rates, which basically coincides with the turning point in the run of  $L/Y$ , we conclude from this that the former explanation is more reasonable, i.e. the reaction of liabilities is not strong enough to leave the discount factor unaffected. The fact that both short- and long-term interest rates react similarly, shows that individuals do not expect fiscal policy to switch to a Ricardian regime in the future.

The non-Ricardian interpretation of the results are confirmed by the variation in both  $L/Y$  and interest rates explained by the fiscal shock. With 50% a sizeable fraction of variation in  $L/Y$  can be attributed to the fiscal shock. In opposite to Germany we now find that also 40% of the variation in interest rates are attributeable to the fiscal shock, which should not be the case, if fiscal policy were indeed Ricardian leaving interest rates unaffected.

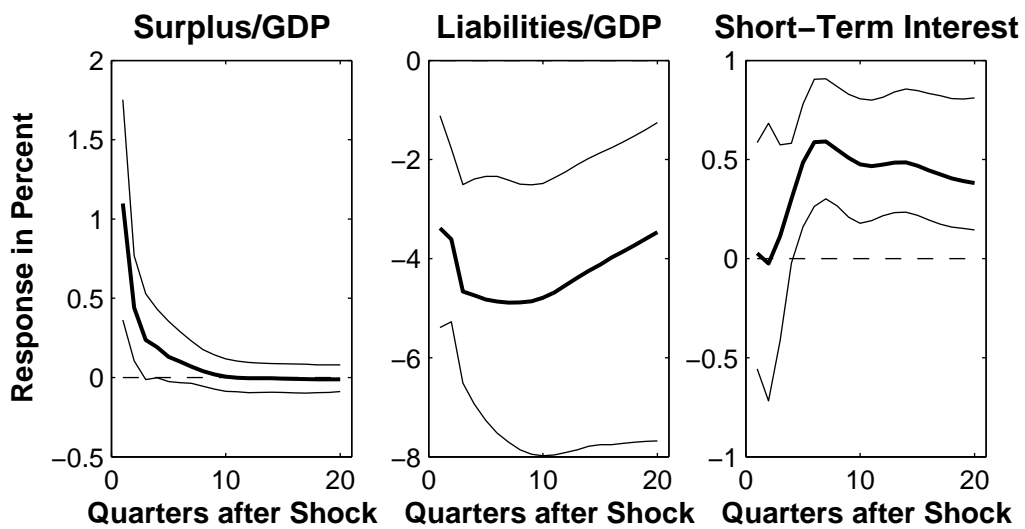


Figure 3: *Spain, 1986-1998, Response to a Surplus/GDP Shock in % with 68% Error Bands and Short-Term Interest Rates Included.*

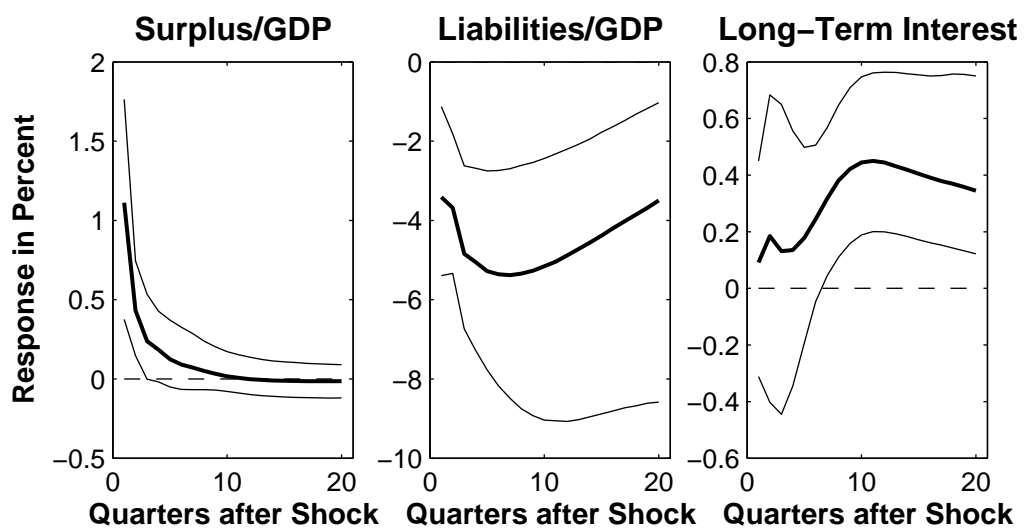


Figure 4: *Spain, 1986-1998, Response to a Surplus/GDP Shock in % with 68% Error Bands and Long-Term Interest Rates Included.*

### 3 Conclusions and Policy Implications

The analysis has provided deeper insights in the relevance of the FTPL. It is shown that

1. Despite increasing debt-output ratios during the sample period Germany's fiscal policy clearly follows Ricardian patterns. We find evidence that this Ricardian policy behavior is credible, as long-term interest rates provide no significant response.
2. Spanish fiscal policy exhibits non-Ricardian characteristics with interest rates being substantially affected by fiscal policy shocks. With long-term interest offering almost the same reaction to the fiscal shock as short-term interest rates, the analysis suggests that a change in Spanish policy behavior toward Ricardian characteristics does not seem to be credible.

The analysis yields evidence for the existence of the FTPL mechanism in Spanish data. The findings suggest that the FTPL is one relevant factor among others in explaining the differences in inflation rates between Germany and Spain. With the distinction between short- and long-term interest rates the results provide evidence that not only the current characteristics of fiscal policy matter for the price level to be determined by fiscal actions, but moreover individuals' beliefs about future fiscal policy. In this context then, it is essential for the price level to be unaffected by fiscal policy actions that individuals believe fiscal policy to remain Ricardian or to return to a Ricardian regime in the future. Theoretically, this rationale has been elaborated by Davig et al. (2006).

The results highlight the necessity of a debt on borrowing as imposed by the SGP, as it is shown that there is a causal link between prices and public debt. Furthermore, fiscal policy needs to be credible, as even the possibility of a change in the underlying policy regime may have substantial effects on the economy.

## 4 Appendix

### 4.1 Pure-Sign-Restriction Approach

The basic idea of the pure-sign-restriction approach is to consider only those impulse responses heading in the desired direction for at least  $Z$  periods. Let  $a \in \mathbf{R}^m$  be an impulse vector, if there exists a matrix  $A$  such that  $\Omega = AA'$  with  $a$  being a column of  $A$ . Following the notation used throughout the paper,  $\Omega$  denotes the covariance matrix,  $m$  the number of variables in the vector of dependent variables  $X_t$ , and  $p$  the lag length. Furthermore, let  $e_i$  for  $i = 1, \dots, m$  be the eigenvectors of  $\Omega$ , normalized to form an orthonormal basis of  $\mathbf{R}^m$ , and  $v_i$  the corresponding eigenvalues. Then, if there are coefficients  $\alpha_i$  for  $i = 1, \dots, m$  such that  $\sum_{i=1}^m \alpha_i^2 = 1$ , the impulse vector  $a$  is given by

$$a = \sum_{i=1}^m (\alpha_i \sqrt{v_i}) e_i. \quad (4.1)$$

To obtain the corresponding impulse responses we define  $\mathbf{a} = [a', 0_{1,m(p-1)}]$ . Given the impulse vector  $a$ , the impulse response of variable  $j$  with  $j = 1, \dots, m$  at horizon  $z$  may be computed as

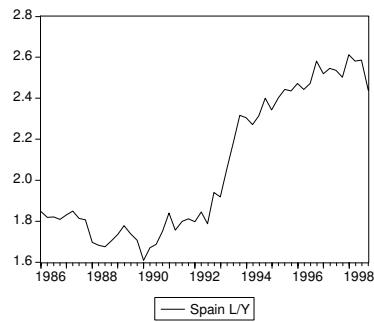
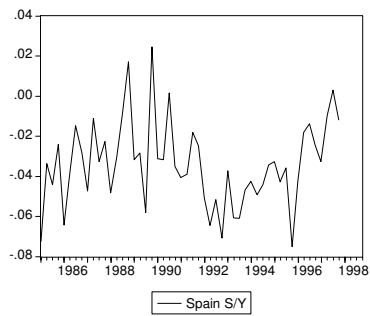
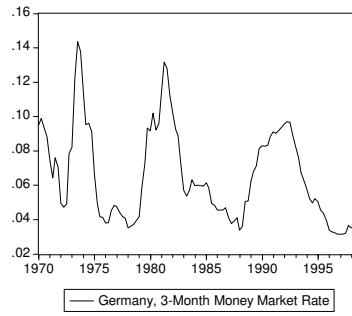
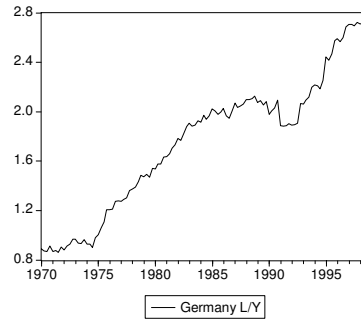
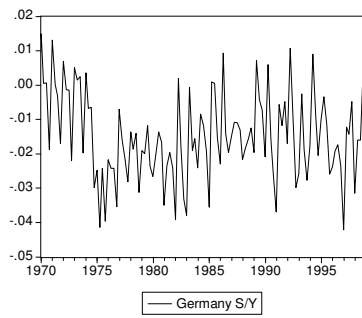
$$r_{z,j} = (\Gamma^z \mathbf{a}), \quad (4.2)$$

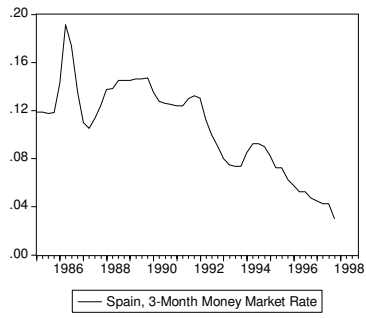
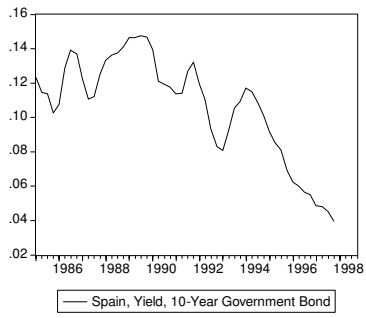
where  $\Gamma = \begin{bmatrix} & B & \\ I_{m(p-1)} & & 0_{m(p-1),m} \end{bmatrix}$ .

For the application of the sign-restriction approach we make joint draws from both the posterior distribution of the VAR parameters and a uniform distribution over the  $(m-1)$ -dimensional sphere  $(\alpha_1, \dots, \alpha_{m-1})$ . It is then possible to obtain the impulse vector  $a$  according to (4.1), which then may be used to calculate the impulse responses. Then, if the impulse response fulfills the sign restrictions imposed, we keep the draw. Otherwise we drop it from the further analysis.



## 4.2 The Data





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