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THE CASE OF GERMANY, ITALY AND THE USA

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THE CASE OF GERMANY, ITALY AND THE USA [1]

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In 2006 all ECB publications will feature a motif taken from the €5 banknote.

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Abstract

The debate on the sustainability of public finances is closely related to the analysis of the financial and macroeconomic consequences of government debt accumulation. Focusing on the USA, Germany and Italy over the 1983−2003 period, the central issue addressed in this paper is how the accumulation of government debt affects long-term interest rates, both nationally and across borders. The analysis is based on a small, multivariate econometric model, which allows us to disentangle the more permanent and transitory components of interest rate developments. Empirical evidence shows that in all cases a more sustained debt accumulation leads at least temporarily to higher long-term interest rates. This transitory impact also spills-over into other countries, mainly from the US to the two European countries.

Keywords: Public debt, Long-Term Interest Rates, Cointegration, Common Trends;

JEL: E6, H63.

Non-technical summary

This study contributes to the empirical body of literature analysing the impact of public debt on long-term bond yields. We look at debt and interest rate developments in the US, Germany and Italy because of their importance for the global and the European market. Compared to other studies, this analysis focuses on two aspects which are particularly relevant from a policy perspective. First, for the assessment of fiscal sustainability it seems important to distinguish more persistent trends in public debt from rather transitory developments and to evaluate whether there is any difference in the impact on bond yields. Second, there is an ongoing debate on whether long-term bond yields are mainly driven by international or domestic factors. In the extreme, it is argued that there is a world interest rate and that domestic factors, such as a strong hike in public sector bond supply in an individual country, barely could have any impact on long-term yields if the economy is sufficiently small.

There is substantive empirical evidence pointing to a positive impact of an increase in public deficits and debt on long-term rates, though the overall evidence is by far not unanimous in this respect. Results are affected by differences in econometric models, definitions of government debt and interest rates as well as data sources, which complicates a comparison across studies. Empirical studies often use single equation approaches, which do not account for the interaction of variables derived in theoretical macro-models. Instead this study is based on a multivariate VAR using an identification methodology to disentangle the permanent and transitory effect of debt developments on bond yields. Having identified these components we follow the literature on international capital market linkages to identify international spill-overs of domestic bond market shocks.

As to the first issue, the analysis demonstrates that fiscal developments have played a significant role in determining more transitory developments of long-term interest rate. In all three cases the accumulation of public debt as share of GDP has led to

higher interest rates. The impact of sustained debt accumulation on the more persistent long-term interest rate developments, instead, appears to be different in each of the three countries. In both the US and Germany, the relation between debt and interest rates seems to reflect more the common medium-term output trends affecting both debt accumulation and other macro-economic variables. In the German case, evidence is moreover compatible with arguments pointing to a more persistent crowding-out of private capital accumulation due to the massive fiscal expansion in the aftermath of German reunification. In the Italian case, the more persistent trends in long-term interest rate seem to be mainly driven by nominal developments.

As to the second question, the fiscal developments driving the long-term interest rates more temporarily appear to be strong enough to lead to international spill-over effects. Here the different benchmark status over the sample period and relative financial strength of the three countries are reflected in the intensity of these effects. A fiscal deterioration contributing temporarily to an increase in the US long-term interest rate has a weak, though statistically significant, positive impact on the non-permanent German long-term interest rate developments and a much stronger impact on the Italian rates. Temporary shocks to the German rate tend to have a mild but statistically significant impact only on Italian rates, while transitory changes in Italian rates do not seem to spill over neither to the US nor the German bond market in any statistically significant fashion.

1 Introduction

The creation of a fiscal framework for the European Monetary Union was motivated by the belief that a functioning union requires sustainable public finances. More specifically, there were two major concerns. First, excessive borrowing and non-sustainable public finances increase the default risk and carry externalities for all union members through higher risk premia on bond yields. Second, non-sustainable public finances could lead to higher inflation or at least inflation expectations. Both concerns are not restricted to the existence of a monetary union, but more generally reflect why central banks are concerned about fiscal sustainbility. Unsustainable public finances may affect long-term interest rates and prices, and thereby undermine the efficiency of the monetary transmission process.

This paper contributes to the empirical body of literature analysing the impact of public debt on long-term bond yields and looks at debt and interest rate developments in the US, Germany and Italy because of their importance for the global and the European market. It focuses on two aspects which are particularly relevant from a policy perspective. First, for the assessment of fiscal sustainability it would be important to distinguish more persistent trends in public debt from rather transitory developments and to evaluate whether there is any difference in the impact on bond yields. The first part of the paper applies an empirical framework that allows us to identify and estimate such components and their financial market effect. Second, there is an ongoing debate on whether long-term bond yields are mainly driven by international or domestic factors. In the extreme, it is argued that there is a 'world interest rate' and that domestic factors, such as a strong hike in public sector bond supply in an individual country, barely could have any impact on long-term yields if the economy is sufficiently small. The second part of our analysis disentangles the long-term linkages between financial market developments and looks for possible spill-over effects of fiscal developments.

The theoretical literature does not yield an unambiguous prediction on how public debt should affect long-term bond yields. In a standard model, the short to medium-term effect depends on whether public debt crowds out private capital. Long-term interest rates rise if public debt reduces aggregate savings. This effect does not prevail if the private sector fully compensates the effect and keeps aggregate savings unchanged or the withdrawal of savings is substituted by capital inflows from abroad.[1] The longer-term reaction of bond yields also depends on whether public indebtedness has implications on future potential growth, which may be a function of the quality of debt-financed fiscal policies and their impact on human and physical capital accumulation. In line with these and other transmission channels, the recent literature on fiscal consolidations has, for example, strongly emphasised the expenditure or revenue driven structure of the adjustment efforts as leading to very different macro-economic outcomes and

[1] For a discussion of the crowding-out argument in standard models see Ball and Mankiw (1995).

financial market reactions even in the short-run (see Ardagna 2004). Finally, some financial market related risk factors have been put forward mainly to explain spreads in bond yields or premia. These incentives again work in different directions. High debt levels may imply more liquid markets for actively traded government debt securities and correspondingly a lower liquidity premium, but at the same time may lead to the perception of an increasing default risk. On balance, it seems to be largely an empirical question of how interest rates react to a deterioration of a countries fiscal position.

There are substantive empirical results pointing to a positive impact of an increase in public deficits and debt on long-term rates, though the overall evidence is by far not unanimous in this respect.[2] Results are affected by differences in econometric models, definitions of government debt and interest rates as well as data sources, which complicates a comparison across studies. However, empirical studies often use single equation approaches, which do not account for the endogeneity of variables derived in theoretical macro-models. Some exceptions to this are Evans and Marshall (2001) and Quiang and Phillippon (2004), both looking at US data.[3] While Evans and Marshall find no evidence that fiscal policy shocks induce any significant interest rate response, Quiang and Phillipon report results indicating a significant impact of deficits on the yield curve. The approach chosen in our paper is closer to Evans and Marshall, but we use structural identification according to the common trend methodology (Warne 1993, Mosconi 2002) to disentangle the permanent and transitory impact of debt developments on bond yields.

Having identified these components we follow the literature on international capital market linkages to identify international spill-overs of domestic bond market shocks. Bruneau and Jondeau (1998) perform an analysis of long-run links between US, German and French long-term interest rates, finding a long-run, reciprocal effect between the US and the German rate as well as between the German and the French rate. Barassi *et al.* (2000a) find a set of relations between US, Canada and European interest rates pointing to the US markets as leading world-wide developments The approach employed in this paper has a similar objective and can be considered an adaptation or extension of the Gonzalo-Granger (1995) methodology testing for cointegration relationships among common trends. Our contribution to the literature is thus that we are able to extract the long-term and short-term components of yield movements and analyse their international linkages.

The paper is structured as follows: Section 2 describes the methodology and provides justification for the choice of the variables in the empirical analysis. Section 3 contains the analysis of the impact of public debt on long-term rates. We first determine the time series properties, then analyse the impact of macroeconomic determinants for individual countries. Based on our estimation results we then analyse the linkages between the three country systems in Section 4. Section 5 concludes.

[2] See Gale and Orzag (2001) for a review of the literature pointing out how the choice of methodological approaches affects empirical results in this area.

[3] Another is Engen and Hubbard (2004), who also provide an excellent literature overview.

2 The econometric model

The basic structure of our econometric model follows closely the scheme proposed by Cassola and Morana (2004) and it is based on a small set of key macro-economic relationships.[4] Empirical models of the long-term interest rate often rely on the expectations hypothesis as a theoretical formulation to establish a long-term equilibrium relationship between long and short-term interest rates. We also use the expectations hypothesis as a building block of our analysis. But we augment the model with a premium related to government debt. Moreover, we use the Fisher parity to capture the long-term impact of inflation (the nominal trend) on interest rates. Debt and nominal developments are driven by transitory and permanent components. This provides a sufficiently flexible basis to model the observable non-stationarity of long-term rates and debt/GDP ratios within the sample period considered. The set of variables thus consists of four elements: inflation π_t, short-term interest rate s_t, long-term interest rate l_t, government debt/GDP ratio d_t. This choice aims at capturing the impact of debt accumulation on the long-term interest rate, while allowing for the direct and indirect effect of inflation and money market conditions.[5]

The choice of modelling the long-term interest rate in a system instead of using a single equation approach is motivated by the interest in analysing all the possible interactions between the different determinants of long-term interest rates. The omission of "external variables" at this stage is justified by the research strategy to first disentangle the transitory and permanent component of domestic fundamentals and then to look at international externalities of these components. Long-run linkages will be investigated by testing for cointegration between the permanent components of the three long-term interest rates, i.e. for the possible existence of a common stochastic element among the common trends identified at the national level. Short-run linkages will be investigated by analysing the dynamic properties of a structural VAR constructed stacking together the three (stationary) transitory components driving the long-term interest rate. In this case, we will investigate the possibility of a transitory shock in the interest rates of one country propagating to the other two.

Permanent stochastic processes The model assumes that the four variables are driven by two common stochastic trends in the long run: a component labelled fiscal trend ϕ_t and a nominal trend ν_t. These trends evolve over time according to the following laws of motion

$$(1) \qquad \phi_t = \phi^* + \phi_{t-1} + \varepsilon_t^{\phi} = \phi_0 + t\phi^* + \sum_{i=1}^{t} \varepsilon_i^{\phi};$$

$$(2) \qquad \nu_t = v^* + \nu_{t-1} + \varepsilon_t^{\nu} = \nu_0 + v^* t + \sum_{i=1}^{t} \varepsilon_i^{\nu}$$

[4] Older theoretical reference for the model include Feldstein and Eckstein (1970), Brunner (1986) and Mehra (1994).

[5] See Annex 1 below for details on the variables actually used.

where ε_t^{ϕ} and ε_t^{ν} are uncorrelated white noise processes, ϕ_0 and ν_0 initial conditions and $\phi^* > 0$. ϕ_t and ν_t are $I(1)$ processes. The fiscal trend ϕ_t captures the general orientation of fiscal policy in combination with the underlying trend growth of the economy. It contains a deterministic component $t\phi^*$, reflecting explicit fiscal policy choices, and a stochastic component $\sum \varepsilon_i^{\phi}$, related to cumulated past shocks to debt and GDP. The nominal trend ν_t captures the long-run movement of inflation and of the two nominal interest rates and $v^* > 0$ the deterministic component of nominal changes. It may reflect the fundamental dynamics of nominal wages, labour productivity, commodity prices, monetary policy or a combination of these elements.

Transitory stochastic components The model also contains two transitory stochastic components: a real and financial shock φ_t affecting fiscal positions, and an inflationary shock η_t. Both are assumed to be orthogonal with respect to $\varepsilon_t^{\phi}, \varepsilon_t^{\nu}$. The two transitory components evolve over time according to the following laws of motion

$$(3) \qquad \varphi_t = \rho_1 \varphi_{t-1} + \varepsilon_t^{\varphi} = \tfrac{1}{1-\rho_1 L} \varepsilon_t^{\varphi}, \qquad \rho_1 < 1,$$

$$(4) \qquad \eta_t = \rho_2 \eta_{t-1} + \varepsilon_t^{\eta} = \tfrac{1}{1-\rho_2 L} \varepsilon_t^{\varphi}, \qquad \rho_2 < 1$$

where ε_t^{φ} and ε_t^{η} are uncorrelated white noise processes. Thus, φ_t and η_t are $I(0)$ processes.

Government debt supply The process determining government debt supply is described by

$$(5) \qquad d_t = \beta_{11} \phi_t + \gamma_{11} \varphi_t + \gamma_{12} \eta_t,$$

Equation (5) implies that the movements of the government debt/GDP ratio are determined by the fiscal policy trend and by the two transitory components of the model. Transitory real or financial disturbances φ_t can affect the path of d_t through their impact on the real cost of debt, for example. Inflationary disturbances η_t can affect the path of d_t either through their impact on the cost of debt or via the effect of inflation on government tax receipts and outlays. Being equal to the sum of a $I(1)$ component and two $I(0)$ components the debt/GDP ratio is expected to be $I(1)$.

Inflation The process determining inflation is described by

$$(5) \qquad \pi_t = \pi_t^* + \gamma_{21} \eta_t, \qquad \gamma_{12} \geq 0,$$

The expression includes a term π_t^* measuring underlying inflation, plus the transitory inflationary component η_t. Underlying inflation is assumed to depend both on the fiscal and nominal trend according to

$$(6) \qquad \pi_t^* = \pi^* + \beta_{21}\phi_t + \beta_{22}\nu_t, \qquad \beta_{21} \geq 0, \beta_{22} \geq 0$$

where π^* measures some initial value of inflation, β_{21} the impact of the fiscal trend on inflation and β_{22} the impact of the nominal trend. The impact of the fiscal trend on inflation may be rationalised either in terms of the fiscal theory of the price level or with a fiscally induced inflation bias. Unless the fiscal and nominal trend are cointegrated, which this model assumes not to be, inflation is expected to be $I(1)$.

Fisher parity Long run variations in the short-term interest rate are assumed to depend exclusively on the path of inflation. In the short run, the short-term interest rate is assumed to also move in response to other cyclical real and financial factors as captured by the transitory shock variable φ_t :

$$(7) \qquad s_t = s^* + \delta_{31}\pi_t + \gamma_{31}\varphi_t;$$

where s^* is the constant long run equilibrium level of the real short-term interest rate, δ_{31} measures how money market rates react to inflation and γ_{31} captures the autonomous impact of real and financial shocks on money market conditions. The impact of fiscal developments on the money market is assumed to work through the inflation component and the monetary reaction to transitory shocks capturing monetary-fiscal policy interaction. Statistically, this should imply that the short-term interest rate inherits the stationarity status of inflation.

The long-term interest rate The long-term interest rate is assumed to depend on two elements: the short-term interest rate and the outstanding stock of government bonds, as measured by the debt/GDP ratio. The equilibrium relationship can be expressed as

$$(8) \qquad l_t = \delta_{41}s_t + \delta_{42}d_t + \gamma_{41}E_t\left[\sum_{i=1}^{m}(s_{t+i} - s_{t+i-1})\right] + \gamma_{42}\eta_t;$$

where δ_{42} measures the cumulative impact of the stock of debt on the long-term interest rate (supply effect, liquidity effect, default-risk effect) and δ_{41} the impact of current money market conditions. The parameter γ_{41} reflects the impact of term structure considerations, i.e. the impact of expected changes in the future level of the short-term interest rate on the current level of the long-term interest rate. Finally, the parameter γ_{42} reflects market expectations with respect to the impact of transitory inflation shocks on the bond market. The presence of the non-stationary debt component makes it possible for the long-term interest rate not to form a bivariate cointegrating relationship with the short-term interest rate (and therefore with inflation) as implied by the standard expectations hypothesis of the term structure.

Steady-state of the model To find the steady state of the model, the initial values of all the exogenous variables (π^*, the deterministic component of fiscal trend ϕ^* and of the nominal trend v^* and the real short-term interest rate s^*) are set equal to zero. Given that all the transitory components are *i.i.d.* with zero mean, constant variances and zero covariances, the steady state is as follows

$$(9) \quad \begin{bmatrix} d_t^{ss} \\ \pi_t^{ss} \\ s_t^{ss} \\ l_t^{ss} \end{bmatrix} = \begin{bmatrix} \beta_{11} & 0 \\ \beta_{21} & \beta_{22} \\ \delta_{31}\beta_{21} & \delta_{31}\beta_{22} \\ \delta_{41}\delta_{31}\beta_{21} + \delta_{42}\beta_{11} & \delta_{41}\delta_{31}\beta_{22} \end{bmatrix} \begin{bmatrix} \phi_t \\ \nu_t \end{bmatrix}$$

The steady-state displays no long-term impact of the nominal trend on the debt-GDP ratio. This assumption can be justified on the basis of the fact that the level of public debt as share of GDP in the long run is politically determined.

2.1 The Estimation Approach

Adopting the same notation as introduced above, the following VAR model in error correction form constitutes the basis of our investigation.

$$(10) \begin{bmatrix} \Delta d_t \\ \Delta \pi_t \\ \Delta s_t \\ \Delta l_t \end{bmatrix} = \sum_{i=1}^{m-1} \Gamma_i \begin{bmatrix} \Delta d_{t-i} \\ \Delta \pi_{t-i} \\ \Delta s_{t-i} \\ \Delta l_{t-i} \end{bmatrix} + \Pi \begin{bmatrix} d_{t-1} \\ \pi_{t-1} \\ s_{t-1} \\ l_{t-1} \end{bmatrix} + \Omega \begin{bmatrix} Const \\ Trend \\ Seas.d \\ \operatorname{Im} p.d \end{bmatrix} + \begin{bmatrix} \varepsilon_t^d \\ \varepsilon_t^\pi \\ \varepsilon_t^s \\ \varepsilon_t^l \end{bmatrix};$$

$$t = 1983 : q1, ..., 2003 : q3$$

$$\varepsilon_t \sim N_4(0, \Sigma)$$

Based on our theoretical assumptions we expect this model to contain two permanent and two transitory components. This implies a rank equal to 2 for the Π matrix, i.e. the presence of two cointegration vectors in the model. The number of cointegration vectors r is determined by referring to the Trace test statistic $-2\ln Q\left(H_1(r) \mid H_1(p)\right) = -T\sum_{i=r+1}^{4}\ln(1-\hat{\lambda}_i)$ and the maximum eigenvalue test statistic $-2\ln Q\left(H_1(r) \mid H_1(r+1)\right) = -T\ln(1-\hat{\lambda}_{r+1})$,[6] where the λ_i solve the eigenvalue problem based on the model likelihood function.

Once the number of cointegration vectors has been identified, structural identification is done according to the common trends methodology (Warne 1993, Mosconi 2002). Omitting the model deterministic component, the moving average representation of the model defines the data generating process as a function of the initial conditions ξ and of the reduced form shocks ε_t. This is given by

[6] The asymptotic distributions of the tests are provided by Johansen (1995).

$$(11) \qquad \begin{bmatrix} d_t \\ \pi_t \\ s_t \\ l_t \end{bmatrix} = \xi + C \sum_{i=1}^{t} \begin{bmatrix} \varepsilon_i^d \\ \varepsilon_i^\pi \\ \varepsilon_i^s \\ \varepsilon_i^l \end{bmatrix} + C^*(L) \begin{bmatrix} \varepsilon_t^d \\ \varepsilon_t^\pi \\ \varepsilon_t^s \\ \varepsilon_t^l \end{bmatrix}$$

where the matrix $C = \beta_\perp \left[\alpha_\perp^{'} (I - \sum_i \Gamma_i)^{-1} \beta_\perp \right] \alpha_\perp^{'}$ measures the impact of cumulated shocks to the system, $C^*(L)$ is an infinite polynomial in the lag operator L. The relationship between reduced form and structural form innovations is assumed to be

$$(12) \qquad \begin{bmatrix} \varepsilon_t^d \\ \varepsilon_t^\pi \\ \varepsilon_t^s \\ \varepsilon_t^l \end{bmatrix} = B \begin{bmatrix} \varepsilon_t^\phi \\ \varepsilon_t^\nu \\ \varepsilon_t^\varphi \\ \varepsilon_t^\eta \end{bmatrix}$$

where B is a 4×4 non-singular matrix. The model in moving average form may therefore be rewritten as

$$(13) \qquad \begin{bmatrix} d_t \\ \pi_t \\ s_t \\ l_t \end{bmatrix} = \xi + CB \sum_{i=1}^{t} B^{-1} \begin{bmatrix} \varepsilon_i^d \\ \varepsilon_i^\pi \\ \varepsilon_i^s \\ \varepsilon_i^l \end{bmatrix} + C^*(L)BB^{-1} \begin{bmatrix} \varepsilon_t^d \\ \varepsilon_t^\pi \\ \varepsilon_t^s \\ \varepsilon_t^l \end{bmatrix} =$$
$$= \xi + \Phi \sum_{i=1}^{t} \begin{bmatrix} \varepsilon_i^\phi \\ \varepsilon_i^\nu \\ \varepsilon_i^\varphi \\ \varepsilon_i^\eta \end{bmatrix} + \Phi^*(L) \begin{bmatrix} \varepsilon_t^\phi \\ \varepsilon_t^\nu \\ \varepsilon_t^\varphi \\ \varepsilon_t^\eta \end{bmatrix}$$

where matrix Φ contains the permanent component of the model, and the matrix polynomial $\Phi^*(L)$ the transitory or cyclical component. The assumption of orthonormal structural innovations places $4(4+1)/2 = 10$ non-linear identification restrictions on B. In order to get exact identification of B, $4(4-1)/2 = 6$ more restrictions are needed. Following Warne (1993), three sources of identification restrictions can be identified: separation of transitory and permanent innovations, long-run effects of permanent innovations, instantaneous impact of transitory and permanent innovations.

As to the first source, our theoretical model implies that only two out of the four structural shocks have a permanent impact on the variables. Given the ordering of the shocks, this is equivalent to restricting to zero the last two columns of matrix Φ. In matrix terms we have

$$(14) \qquad \Phi_s = \Phi U = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}; \qquad U = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Post-multiplying Φ by matrix U we impose $(4-r)r = 2$ restrictions on B.[7] When these restrictions are imposed, the matrix measuring the long-run impact of permanent shocks is Φ_l, where

$$(15) \qquad \Phi_l = \Phi U_{\perp}^{'}; \qquad U_{\perp}^{'} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

Just identification of the two permanent shocks requires imposing $(4-2)(4-2-1)/2 = 1$ restrictions either on Φ_l or on the matrix $\Phi_{01}^{*} = BU_{\perp}^{'}$ which measures the simultaneous impact of permanent innovations. Imposing the neutrality assumption, as indicated by expression (9) above, is equivalent to restricting to zero the $(1,2)$ element of matrix Φ_l. Matrix Φ_{01}^{*} is left unrestricted. Finally, the identification of the two transitory shocks requires imposing $2(2-1)/2 = 1$ restrictions on the matrix $\Phi_{02}^{*} = BU$ which measures the instantaneous impact of transitory shocks on the variables level. In this case, we restrict to zero the simultaneous impact of the shock on inflation, i.e. element $(2,1)$ of matrix Φ_{02}^{*}. The overall number of additional restrictions, equal to $4+1+1 = 6$, plus the 10 orthonormality restrictions guarantees the just identification of the structural model, i.e. of matrix B.

Once the SVEC model has been identified we will check the correspondence between our *a priori* labelling of shocks and their actual contribution to explaining each of the variables by looking at forecast error variance decomposition (FEVD).[8]

The chosen structural identification criterion makes it possible to decompose each of the four time series into the sum of a permanent and of a cyclical component. Concentrating on the long-term interest rate l_t we have

$$(16) \qquad l_t = \xi_l + l_t^P + l_t^T$$

where ξ_l is a function of the initial condition and of the deterministic component of the model, l_t^P is the permanent stochastic component driving the long-term interest rate and l_t^T is the transitory component. Adopting the same notation as introduced above, l_t^P can be further decomposed into the sum of the two cumulated permanent shocks according to the formula

[7] This is obtained by rewriting the first set of restrictions as $\Phi_s = \beta_{\perp}(\alpha'_{\perp}\Gamma\beta_{\perp})^{-1}\alpha'_{\perp}BU = 0_{4,r}$, where $\alpha'_{\perp}BU = 0_{(4-r)r}$, and $r = 2$.

[8] FEVD is defined as the part of the $s-step$ ahead forecast error variance of each variable generated by each of the four identified structural shock (see Warne 1993).

$$(17) \qquad l_t^P = \Phi_{41} \sum_{i=1}^{t} \varepsilon_i^{\phi} + \Phi_{42} \sum_{i=1}^{t} \varepsilon_i^{\nu};$$

where Φ_{41} (Φ_{42}) is the element occupying the fourth row, first (second) column of matrix Φ and Φ_{43} and Φ_{44} are restricted to zero. This decomposition makes it possible to understand to what extent the fiscal trend $\sum \varepsilon_i^{\phi}$ and the nominal trend $\sum \varepsilon_i^{\nu}$contribute to determining the long-run movements of the long-term interest rate in each of the three countries.

The transitory component l_t^C, instead, can be decomposed as follows

$$(18) \qquad l_t^T = \sum_{i=1}^{t} \Phi_{i,41}^{*} \varepsilon_i^{\phi} + \sum_{i=1}^{t} \Phi_{i,42}^{*} \varepsilon_i^{\nu} + \sum_{i=1}^{t} \Phi_{i,43}^{*} \varepsilon_i^{\varphi} + \sum_{i=1}^{t} \Phi_{i,43}^{*} \varepsilon_i^{\eta}$$

where $\Phi_{i,41}^{*}$ is the element occupying the fourth row, first column of matrix Φ_i^{*}. This decomposition makes it possible to understand to what extent each of the four stochastic elements included in the model contributes to determining the cyclical component of the long-term interest rate.

3 Country-by-country analysis

3.1 USA

Figure 1 depicts the graphs of the US data. The profile of the debt/GDP ratio (upper left corner) indicates a deteriorating fiscal situation from the beginning of the sample period up to 1995, followed by fiscal retrenchment in the second half of the 1990s and renewed deterioration from 2000 onwards. The graph of inflation (upper right corner) shows an irregular seasonal pattern with two outliers in $1986 : q2$ and $2001 : q4$. The short and the long-term interest rate fluctuate over the sample period. Spikes in the series appear in 1984 for both interest rates and in 1988 for the short-term interest rate only.

A cointegrated VAR model with unrestricted constant, restricted trend and centered seasonal dummies is chosen as the statistical model to analyse the data.[9] As to the optimal number of lags, the Akaike Information criterion (AIC) and the Final Prediction Error (FP) criterion suggest choosing three lags, the Hannan and Quinn criterion (HQ) and the Schwarz criterion (SC) suggest one lag. Reduction from lag 4 to lag 3 is not rejected by the data. Reduction to a lower number of lags, instead, is rejected according by the F-test $F(16, 183) = 2.50$ [0.00]. Graphic and residual analysis suggest adding seven impulse dummies to the system.[10] Misspecification tests for residual autocorrelation, normality and heteroscedasticity indicate that the model is well specified.[11] Univariate tests (available on request) confirm this result.

[9] Model specification is obtained using Jmulti 3.03, PCGive 10 and CATS for RATS.

[10] The dummies refer to the following quarters: $1984 : q2, q4$ (interest rate spike), $1986 : q2$ (inflation outlier), $1988 : q2$ (spike in the short-term interest rate), $1990 : q3$ (sharp decline in inflation and in the short-term interest rate), $2000 : q2$ (spike in the short-term interest rate),

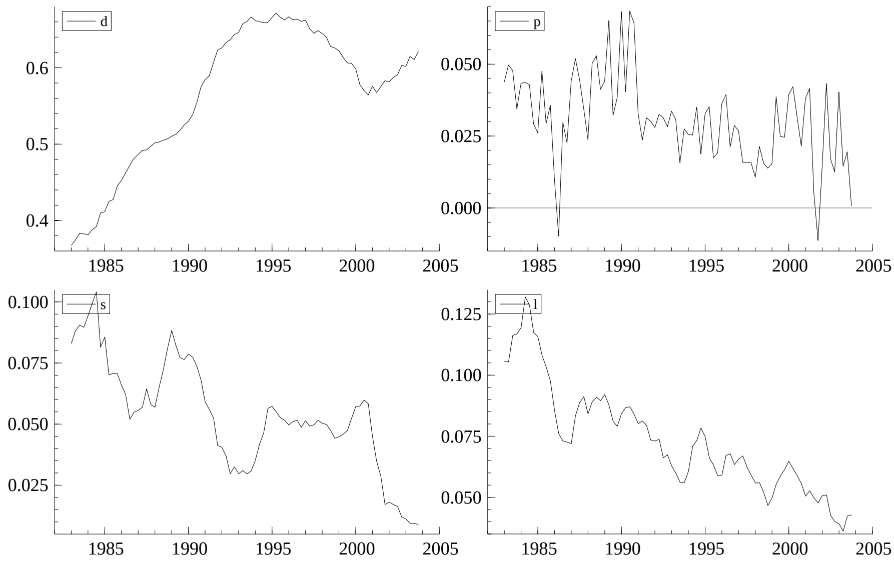

Figure 1: The US data

Table 1. Trace and maximum eigenvalue cointegration tests, USA

λ_i	$Trace$	$p-val$	$H_0 : r \leq$	$Max\ \lambda$	$p-val$
0.43583	95.94	[0.00]	0	46.36	[0.00]
0.32625	49.58	[0.01]	1	31.99	[0.00]
0.15083	17.59	[0.38]	2	13.24	[0.32]
0.05227	4.35	[0.69]	3	4.35	[0.69]

Table 1 reports the result of the two cointegration tests. In both cases the hypothesis of two cointegration vectors and two common trends is not rejected at the 5% confidence level, as we expected on the basis of theoretical considerations.

Figure 2 contains the Forecast Error Variance Decomposition (FEVD) graphics. The first stochastic component of the model explains almost entirely the FEV of the debt/GDP ratio, marginally contributing to determining the FEV of the other three variables. The graphs contained in the second column conform with the neutrality assumption and with the second stochastic component of the model being closely related to the short-term interest rate. The graphs in the third column indicate that the only significant contribution of the third stochastic component of the model is to the FEV of the long-term interest rate. Finally, the graphs of the fourth column conform with our identification of the fourth stochastic component of the model as a transitory inflation shock.

$2001 : q1$ (negative spike in inflation).

[11] Vector AR 1-5 test: $F(80, 136) = 0.82$ [0.83], Vector Normality test: $\chi^2(8) = 9.47$ [0.30], Vector hetero test: $F(260, 222) = 0.52$ [1.00]. Details on the methodology to compute these tests may be found in Doornik and Hendry (2001), p. 258-262.

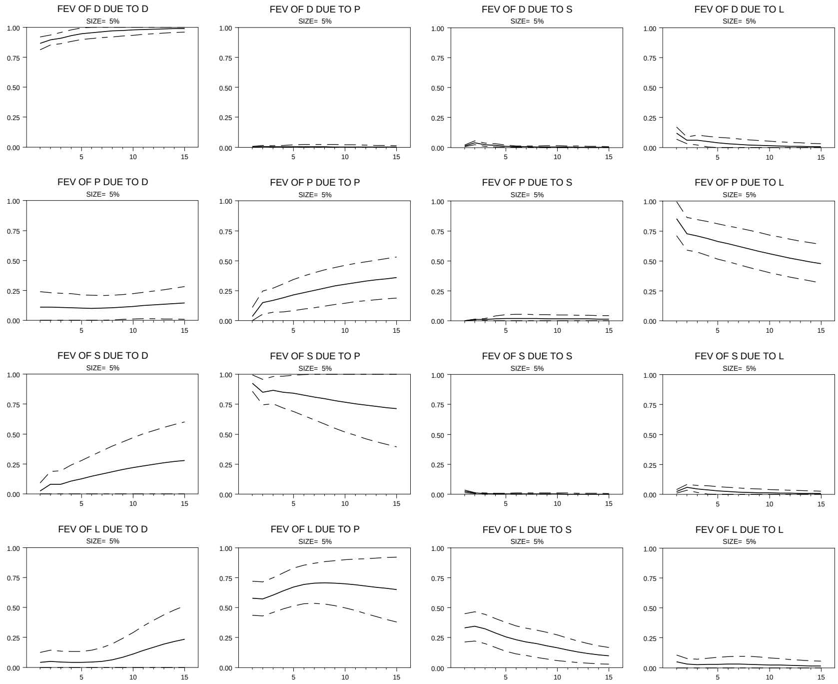

Figure 2: Forecast Error Variance Decomposition, USA, column 1 (contribution of shock ε^{ϕ}), column 2 (contribution of shock ε_i^{ν}), column 3 (contribution of shock ε_i^{φ}), column 4 (contribution of shock ε_i^{η}).

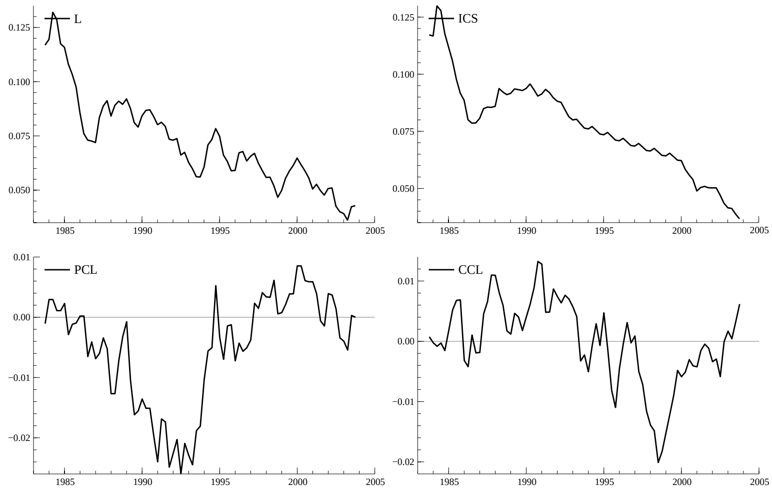

Figure 3: Decomposing the US long-term interest rate according to $l_t = \xi_l + l_t^p + l_t^c$, l (upper panel, left), ξ_l (upper panel, right), l_t^p(lower panel, left), l_t^c (lower panel, right).

Figure 3 portrays the graph of the long-term interest rate (upper left panel) and of its three components as indicated by Equation 17 in Section 2.2. As the figure shows, the element associated to initial conditions plus deterministic component (upper right panel) captures the disinflation of the US economy, sharp at the beginning of the sample period in the wake of the Volker years, more gradual from the second half of the 1990s onwards. The contribution of the permanent stochastic component to the level of the long-term interest rate has been negative up to the mid 1990s (i.e. at the time of fiscal deterioration in the USA). The contribution of the transitory component, instead has been positive during the first half of the sample period, negative thereafter.

Figure 4 decomposes the permanent stochastic component associated to the movement in the long-term interest rate (dashed line) into its two determinants: the fiscal trend (upper panel) and the nominal trend (lower panel). This is the graphic counterpart of Equation 18 in Section 2.2. As the graphs indicate, the long-term stochastic component of the US long-term interest rate appears to be entirely explained by the fiscal trend with the correspondence being particularly enhanced between 1983 and 1994, i.e. at the time of major fiscal deterioration in the USA. From 1994 onwards this effect shrinks, turning positive after 1997, i.e. at the time of the debt/GDP ratio decline. This development is a mirror image of real GDP growth over the last two decades. Output growth was declining during the mid-1980s and ended in the downturn of the early 1990s. Thereafter growth recovered leading to the boom in the late 1990s and the year 2000, which ended harshly with the bust in early 2001. The permanent stochastic component thus seems to mainly capture the medium term developments in the denominator of the debt-to-GDP ratio, which could feed into monetary policy and long-term interest rates.

Figure 5 portrays the transitory stochastic component driving the US long-term interest rate (dashed line) and the relative contribution of the four structural shocks to its formation (solid lines). This is the graphic counterpart of Equation 19 in Section 2.2. above. As the four graphs indicate, the transitory component of the long-term interest rate is entirely determined by the first shock (fiscal developments) and to a minor extent by the third one (transitory real and financial shock), with the contribution of the two nominal shocks being close to zero. The transitory impact of fiscal developments on the long term interest rate is consistent with long-term interest rate increasing (decreasing) during phases of fiscal deterioration (consolidation). This pattern fits nicely with the crowding-out hypothesis or a short-term positive fiscal multiplier. The direction of changes would also be compatible with a fluctuation in default risk premia, although the magnitude is much larger of what one could expect given the credit status of US debt. On all accounts, the contribution of the temporary component seems to be more closely related to the developments in the nominator of the debt-to-GDP ratio as captured by the permanent stochastic fiscal trend. The episodes in the mid-1980s, mid-1990s and after 2000, where the transitory component is more closely linked to the transitory real and financial shock, most likely capture some bond market shocks at the time.

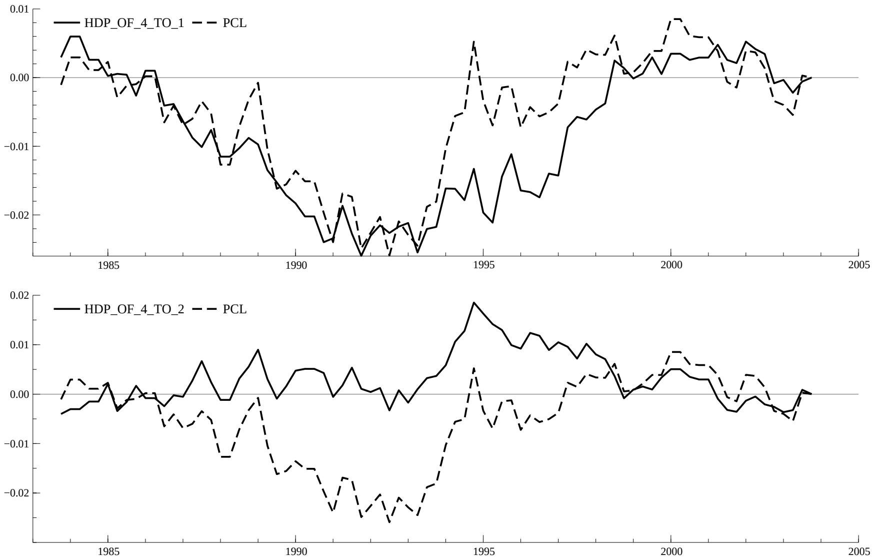

Figure 4: Permanent component, long-term interest rate, USA. The graph portrays $\Phi_{41} \sum \varepsilon_i^{\phi}$ (solid line, upper panel) and $\Phi_{42} \sum \varepsilon_i^{\nu}$ (solid line, lower panel) plus the sum of the two l_t^P (dashed line). See above Equation 18.

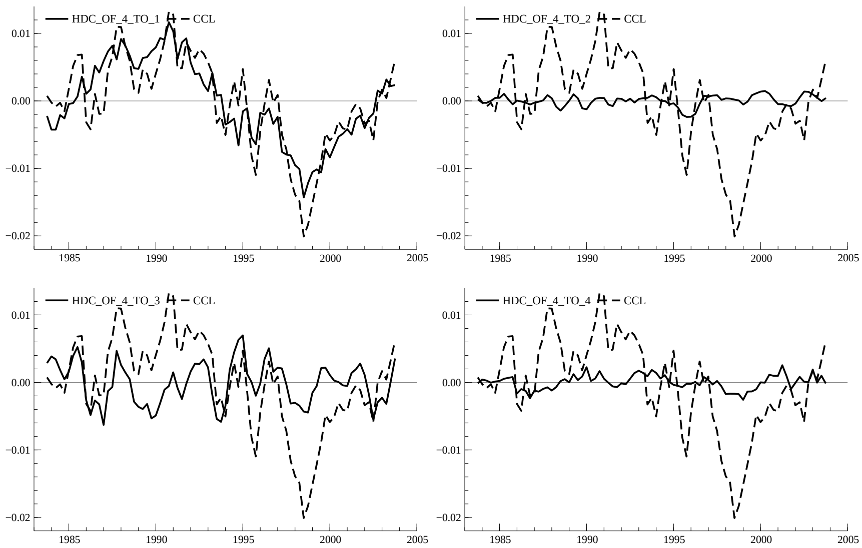

Figure 5: Transitory component, long-term interest rate, USA. The graph portrays $\sum \Phi_{i,41}^{*} \varepsilon_i^{\phi}$ (solid line, upper left corner), $\sum \Phi_{i,42}^{*} \varepsilon_i^{\nu}$ (solid line, upper right corner), $\sum \Phi_{i,43}^{*} \varepsilon_i^{\varphi}$ (solid line, lower left corner) and $\sum \Phi_{i,43}^{*} \varepsilon_i^{\eta}$ (solid line, lower right corner) plus their sum l_t^C (dashed line). See above Equation 19.

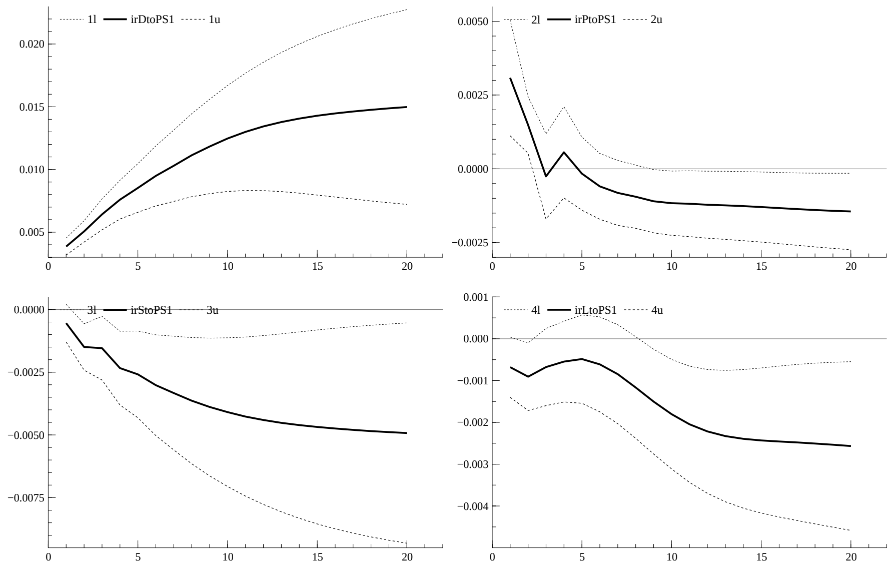

Figure 6: Impulse response of the debt/GDP ratio (upper panel, left), inflation (upper panel, right), the short-term interest rate (lower panel, left) and the long-term interest rate (lower panel, right) to a fiscal shock, USA.

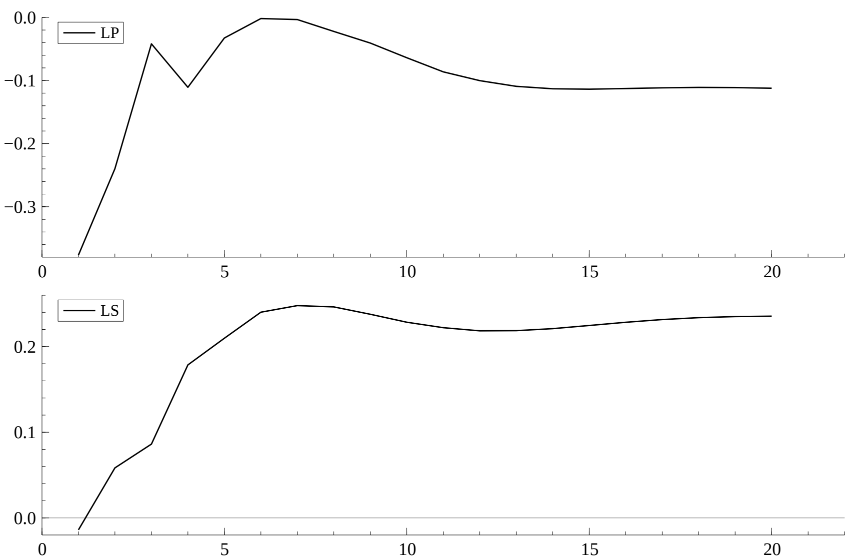

Figure 7: Impact of a permanent fiscal shock on the real long-term interest rate (upper section) and on the slope of the yield curve (lower section), USA

Figure 6 contains the impulse responses of the four variables of the system to an innovation hitting the first stochastic component of the model. Overall they are compatible with the interpretation offered above that the impact of the fiscal trend on the permanent component of long-term interest rates mainly reflects negative output shocks. After being hit by a shock, the debt/GDP ratio increases by 1.5 percentage points, stabilizing thereafter. The impact of a shock in public debt on inflation is positive but of a transitory nature. This pattern is compatible with a short-run positive fiscal multiplier of public debt or a dominance of negative supply shocks over the sample period, while the longer-term impact is compatible with a reduction in potential output and hence inflation. The negative response of the short-term interest rate is consistent with a monetary policy reaction to negative output and future inflationary developments. Finally, the last panel of Figure 6 indicates that an adverse fiscal shock has a negative impact on the level of the nominal long-term interest rate. Given the magnitude of the impulse on inflation and the nominal long-term rate, the shock in the fiscal trend is associated with a reduction in the long-term real rate.

This result is directly shown in the upper panel of Figure 7 which is obtained by subtracting the impulse response function of inflation from that of the long-term interest rate. It is a measure of how the *real ex-post long term interest rate* reacts to an adverse fiscal shock. The line drawn in the lower panel, instead, is obtained by subtracting the impulse response of the short-term interest rate to a fiscal shock from that of the long-term interest rate. It is a measure of how *the slope of the yield curve* shifts in response to an adverse fiscal shock. According to our calculations, an adverse fiscal shock leads to real long-term interest rate to fall by 0.10% (ten basis points) and the slope of the yield curve to increase by 0.20% (20 basis points). Jointly, these results again seem to be compatible with a reduction of long-run expectations of the natural real rate due to a permanent fiscal trend capturing a negative output growth trend, leading to an increase in debt and decline of inflation as well as short-term real and long-term real rates.

Summarizing the available evidence, and excluding the presence of any default risk effect in the case of the USA, the increase of the government debt to GDP ratio looks as having had two opposite effects on the level of the US nominal long-term interest rate: first, a contribution of the fiscal trend to the permanent stochastic component of long-term interest rates which seems to reflect above all the impact of negative output shocks, i.e. the role of the denominator of the debt-to-GDP level in determining public debt as well as other macro variables; and second, the positive impact of the permanent fiscal trend compatible with a crowding out of private capital operating through the transitory stochastic component of long-term bond yields and driving the long-term interest rate upwards.

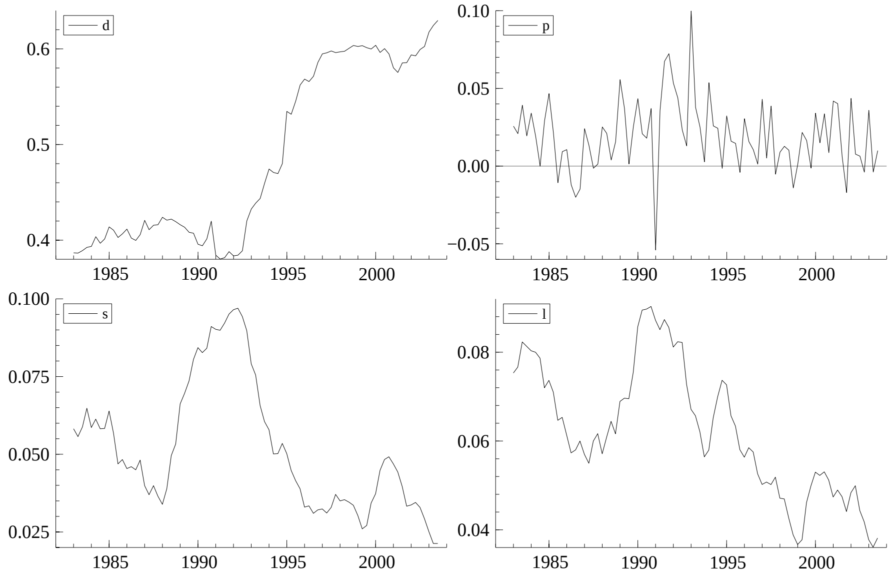

Figure 8: The German data

3.2 Germany

Figure 8 depicts the graphs of the German data. The profile of the debt/GDP ratio (upper left corner) indicates the insurgence of major fiscal deterioration after 1992, due to the costs of the German reunification. The graph of inflation presents an irregular seasonal pattern with one clear outlier in $1991 : q1$. None of the variables appears to move along a linear trend. Both interest rates and inflation increase up to 1992, sharply falling thereafter. This should reflect inflationary pressures unleashed by the German reunification, and the Bundesbank prompt intervention to extinguish them. Indications of an asynchronous movement between inflation rates and the debt/GDP ratio emerge again at the end of the sample period.

The cointegrated VAR model with (unrestricted) constant, trend and centered seasonal dummies is chosen as the starting point to analyse data. The trend, however, is found to be statistically not significant and is therefore eliminated from the model. As to the optimal number of lags, AIC suggests choosing four lags, FP and HQ suggest two lags, SC one lag one. Reduction from lag 4 to lag 3 is not rejected by the data. Reduction from three to two lags instead, is rejected by the F-test $F(16, 171) = 2.25$ [0.00]. Graphic and residual analysis suggests adding four impulse dummies to account for as many outliers.[12]

[12] The dummies refer to the following quarters: $1987 : q1$ (spike in the debt/GDP ratio due to contracting real GDP), $1991 : q1$ (negative spike in the inflation), $1992 : q4$ (EMS crisis), $1995 : q1$ (spike in the debt/GDP ratio).

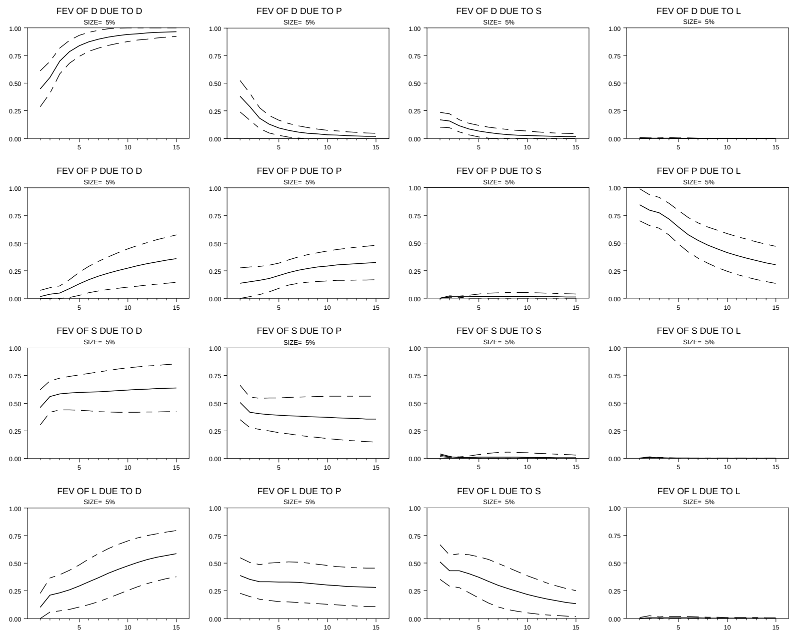

Figure 9: Forecast Error Variance Decomposition, Germany, column 1 (contribution of shock ε^{ϕ}), column 2 (contribution of shock ε_i^{ν}), column 3 (contribution of shock ε_i^{φ}), column 4 (contribution of shock ε_i^{η}).

Table 2. Trace and maximum eigenvalue cointegration tests, USA

λ_i	$Trace$	$p-val$	$H_0 : r \leq$	$Max\ \lambda$	$p-val$
0.55070	94.79	[0.00]	0	80.57	[0.00]
0.22272	30.79	[0.04]	1	20.16	[0.07]
0.12252	10.63	[0.24]	2	10.46	[0.19]
0.00219	0.18	[0.68]	3	0.18	[0.68]

Misspecification tests for residual autocorrelation, normality, heteroscedasticity[13] and univariate tests (available on request) confirm that the model is adequately specified.

Table 2 reports the result of the two cointegration tests. In both cases the hypothesis of two cointegration vectors and two common trends is not rejected at the 10% confidence level.

Figure 9 contains the Forecast Error Variance Decomposition (FEVD). The first stochastic component of the model explains almost entirely the FEV of the debt/GDP ratio. Its contribution to explaining the FEV of the two interest rates appears to be more relevant than in the case of the USA.

[13] Vector AR 1-5 test: $F(80, 140) = 1.03$ [0.43], Vector Normality test: $\chi^2(8) = 9.81$ [0.28], Vector hetero test: $F(240, 265) = 0.51$ [1.00].

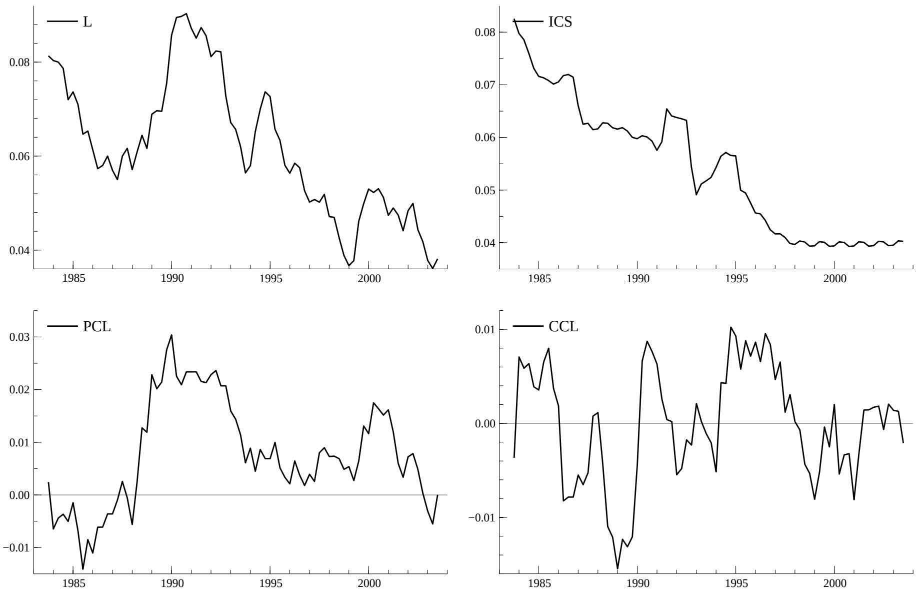

Figure 10: Decomposing the German long-term interest rate according to $l_t = \xi_l + l_t^p + l_t^c$, l (upper panel, left), ξ_l (upper panel, right), l_t^p(lower panel, left), l_t^c (lower panel, right).

The graphs contained in the second column of Figure 9 conform with the assumption that debt is not determined by permanent nominal shocks and with the second stochastic component of the model being related to the nominal magnitudes of the system. The graphs in the third column indicate that the only significant contribution of the third stochastic component of the model is to explaining the FEV of the long-term interest rate. Finally, the graphs of the fourth column conform with our identification of the fourth stochastic component of the model as a transitory inflation shock.

Figure 10 portrays the graph of the long-term interest rate (upper left panel) and of its three components. As the panel in the upper right corner shows, the element associated to the initial conditions plus deterministic component captures the disinflation of the international and German economies and the effects of price stability under EMU. The contribution of the permanent stochastic component to the level of the long-term interest rate has been positive almost throughout the entire sample period, particularly so from the end-1980s onwards. The contribution of the transitory component, instead has been oscillating during the sample period without showing a clear connection with the pattern of fiscal deterioration.

Figure 11 decomposes the permanent stochastic component associated to the movement in the German long-term interest rate (dashed line) l_t^P into its two determinants: the fiscal trend (upper panel) and the nominal trend (lower panel).

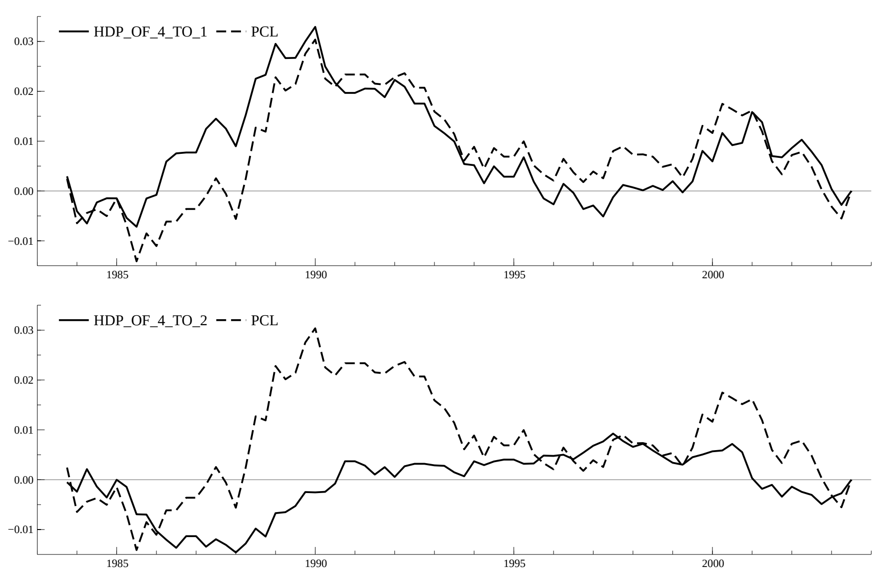

Figure 11: Permanent component, long-term interest rate, Germany. The graph portrays $\Phi_{41} \sum \varepsilon_i^{\phi}$ (solid line, upper panel) and $\Phi_{42} \sum \varepsilon_i^{\nu}$ (solid line, lower panel) plus the sum of the two l_t^P (dashed line). See above Equation 18.

As the graphs indicate, the long-term stochastic component of the German long-term interest rate appears to be entirely explained by the fiscal trend throughout the observation period in the context of our identification scheme. Similar to the US, the development of the permanent fiscal trend presents a mirror image of medium-term trends in output growth. Economic recovery from the early 1980s were gaining force in the second half of the decade. After a relatively short term boom supported by reunification, however, growth dropped in the early 1990s and later on remained at rather moderate levels. The small economic upswing in the late-1990s and 2000 was similarly followed by more severe economic weaknesses from 2001 onwards. Based on this correlation, it seems likely that the contribution of the long-term fiscal trend in the debt-to-GDP ratio on the permanent component of interest rates also reflects the denominator effect.

Figure 12 portrays the transitory component of the German long-term interest rate (dashed line) l_t^C and the relative contribution of the four structural shocks to its formation (solid line). As the four graphs indicate, German l_t^T is entirely determined by the first (fiscal developments) and the third structural stochastic component (transitory financial shock), with the contribution of the two nominal shocks being borderline significant. The contribution of the permanent fiscal development is closely correlated to the development of the fiscal position of successive German governments. The fact that there was a positive push starting in 1990, i.e. preceding the deterioration of the debt to GDP ratio, should not be disturbing.

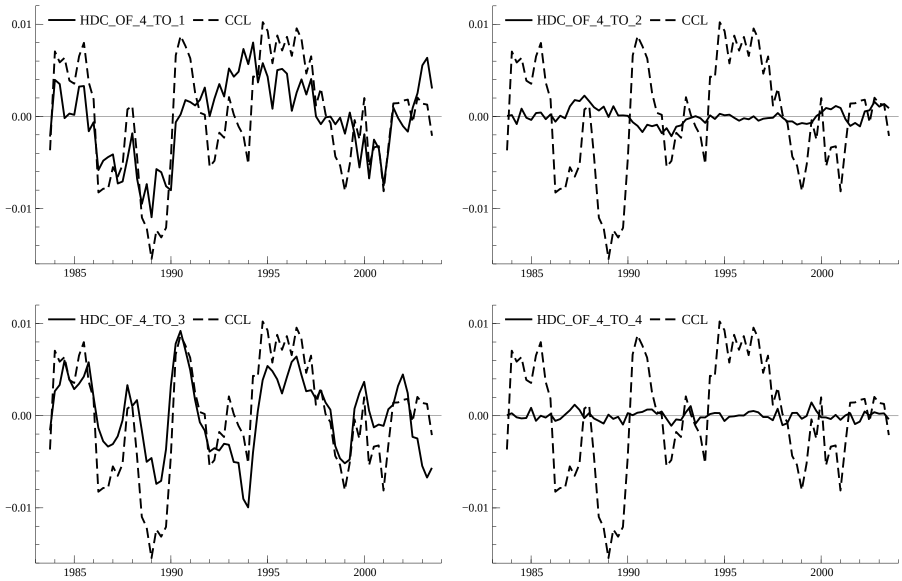

Figure 12: Transitory component, long-term interest rate, Germany. The graph portrays $\sum \Phi^*_{i,41}\varepsilon_i^{\phi}$ (solid line, upper left corner), $\sum \Phi^*_{i,42}\varepsilon_i^{\nu}$ (solid line, upper right corner), $\sum \Phi^*_{i,43}\varepsilon_i^{\varphi}$ (solid line, lower left corner) and $\sum \Phi^*_{i,43}\varepsilon_i^{\eta}$ (solid line, lower right corner) plus their sum l_t^T (dashed line). See above Equation 19.

It may reflect the fact that the massive financing of reunification before 1995 was largely done outside the official general government budget using special funds (see von Hagen and Strauch 1999). By comparison, there is no clear explanation for the more erratic contribution of the transitory real and financial factors working through public finances on long-term bond yields. The relevance of this third stochastic component (transitory financial shock) is nevertheless more pronounced than what is observed in the US case.

According to the graphs reported in Figure 13, once hit by an adverse fiscal shock the German debt/GDP ratio permanently increases by one percentage point, inflation declines on impact and in a statistically significant way. The response of the two interest rates is consistent with that of inflation and with the fact that, over the sample period, German inflation and interest rates, especially the short-term ones, have increased before the accumulation of the debt-GDP ratio and fell once that accumulation was under way (see Figure 8).[14] At first sight this pattern is similar to the US and compatible with the interpretation of the fiscal trend as mainly reflecting negative output shocks factoring into the debt-to-GDP ratio and corresponding monetary policy reactions.

[14] This pattern might reflect the absence of a fiscally-induced inflation bias (Bundesbank effect), the propensity of German fiscal authorities to allow public finances to deteriorate only in the context of falling inflation and lower interest rates (anticyclical fiscal policy), or stock-flow adjustment effects.

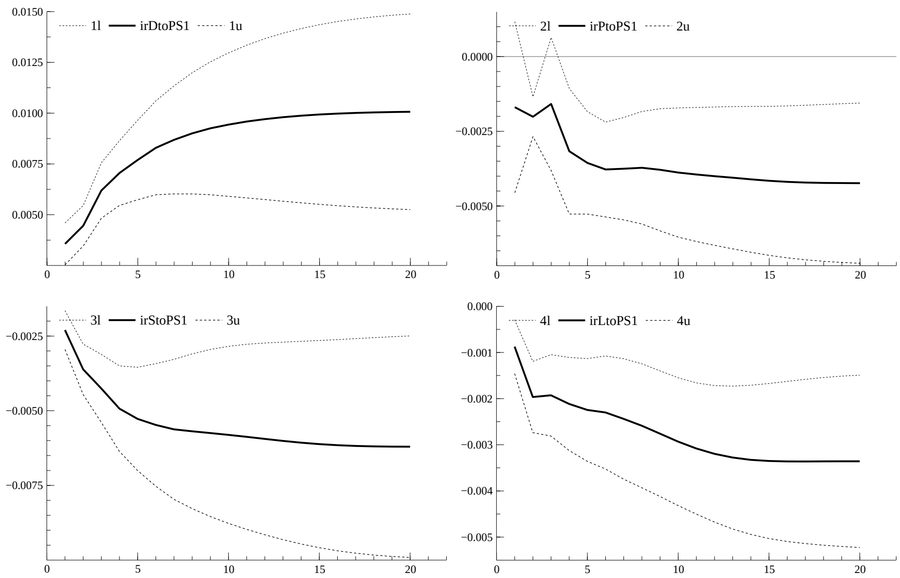

Figure 13: Impulse response of the debt/GDP ratio (upper panel, left), inflation (upper panel, right), the short-term interest rate (lower panel, left) and the long-term interest rate (lower panel. right) to a fiscal shock, Germany.

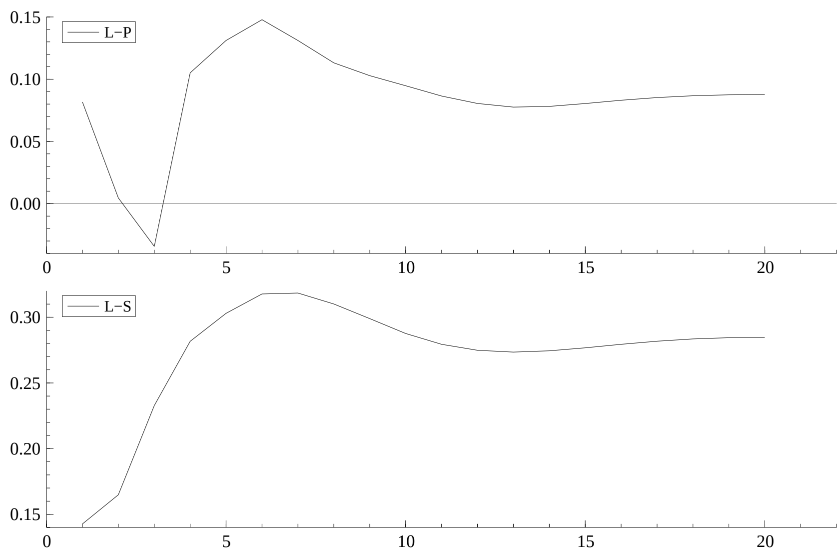

Figure 14: Impact of a permanent fiscal shock on the real long-term interest rate (upper section) and on the differential between the long and the short-term interest rate (lower section), Germany.

However, as shown in Figure 14, both the real long-term interest rate and the differential between the long and the short-term interest rate tend to increase as a consequence of an adverse fiscal shock. The real long-term interest rate increases by 0.1 percentage point (10 basis points) while the differential between long and short-term interest widens by slightly less than 0.3 percentage point (30 basis points). Both effects are positive, stronger and more persistent than those observed in the case of the US and might reflect a different market perception of the fiscal solidity of the two countries. Interpreting the positive impact on the real rate is not straight forward due to the uncertainty on future growth prospects and changes in expectations following the reunification process. It is nevertheless clear that reunification created a tremendous demand for capital, both public and private, for a number of years to rebuild the capital stock in former East-Germany. The positive impulse on the real interest rate should therefore also reflect some crowding-out of private capital acquisition through (partly extra-) budgetary financing requirements of the public sector.

Summarizing the evidence presented so far, and excluding the presence of any default risk effect in the case of Germany, the accumulation of government debt appears to have contributed to rising the level of the long-term interest rate via a supply effect, working its way both through the permanent and transitory stochastic components. While the evolution of the permanent fiscal trend seems to reflect mainly the negative impact of medium-term output trends, the positive impact of the permanent fiscal shock on the long-term rate points also to some crowding out of private capital under the specific circumstances of German reunification. As for the transitory element of long-term rates, German data replicate the alignment of fiscal deterioration and rising nominal rates already apparent in the US.

3.3 Italy

As Figure 15 recalls, between 1980 and 1992, the Italian economy has been subject to an episode of major structural fiscal deterioration, pushing the debt/GDP ratio from 60% to 120%. After 1992 fiscal retrenchment set in and the debt/GDP ratio began declining. Inflation sharply declined between 1983 and 1986, stabilising around an average of 5% up to 1996-1997 and on a lower average (approximately 2.5 %) after the start of EMU, while presenting an irregular seasonal pattern through the sample period. Both interest rates move along a declining trend. The short-term interest rate presents a spike corresponding to the 1992 EMS crisis. On the basis of these considerations, the cointegrated VAR model with unrestricted constant, restricted trend and centered seasonal dummies is chosen as the baseline specification to analyse the data. As to the optimal number of lags, AIC and FP suggest choosing four lags both with and without seasonal dummies. HQ suggests choosing four lags if no seasonal dummies are included, two lags otherwise. SC indicates two and one lag respectively. Reduction from lag 4 to lag 3 is borderline not rejected. With 4 lags, however, two out of the three seasonal dummies are found to be statistically not significant, and with 3 lags plus dummies strong residual autocorrelation appears.

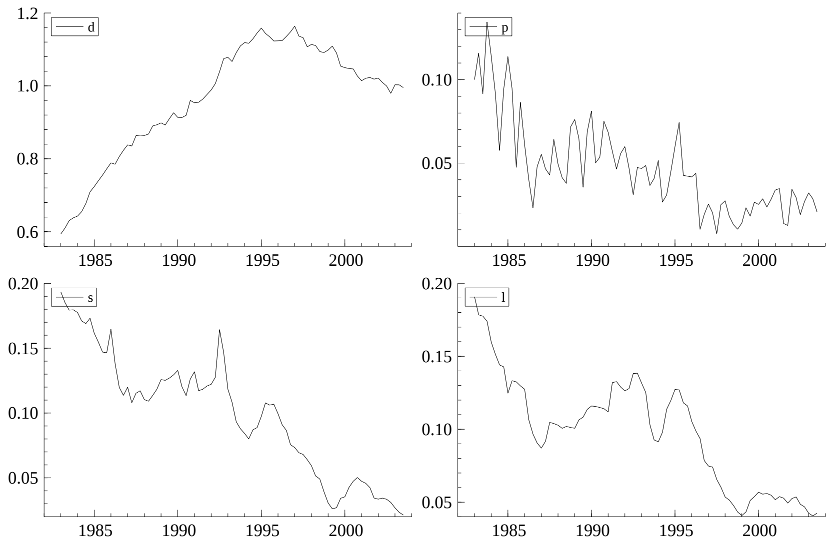

Figure 15: The Italian data

Our preferred specification, therefore, includes four lags and the linear trend (restricted to the cointegration space) but excludes the (borderline statistically significant) seasonal dummies. Graphic and residual analysis suggests adding three impulse dummies to account for as many outliers.[15] Misspecification tests for residual autocorrelation, normality, heteroscedasticity indicate that the model appears well specified.[16] Univariate tests (available on request) confirm this result.

Table 3. Trace and maximum eigenvalue cointegration tests, Italy

λ_i	$Trace$	$p-val$	$H_0 : r \leq$	$Max\ \lambda$	$p-val$
0.51902	130.4	[0.00]	0	57.8	[0.00]
0.48724	72.6	[0.00]	1	52.7	[0.00]
0.17735	19.8	[0.24]	2	15.4	[0.18]
0.054527	4.43	[0.68]	3	4.43	[0.68]

As reported in Table 3, both cointegration tests, support our preferred choice of two cointegration vectors and two common trends.

Moving on to FEVD, the first column of Figure 16 indicates, as is the case for the other two countries, that the first stochastic component absorbs almost entirely the FEV of the debt/GDP ratio and contributes significantly to explaining the FEV of the long-term interest rate, but not that much of the short-term interest rate.

[15] The dummies refer to the following quarters: $1986 : q1$ (sharp drop in inflation and interest rates), $1990 : q4$, $1992 : q3$ (EMS crisis).

[16] Vector AR 1-5 test: $F(80, 140) = 1.21$ [0.16] , Vector Normality test: $\chi^2(8) = 13.5$ [0.10], Vector hetero test: $F(320, 162) = 0.41$ [1.00].

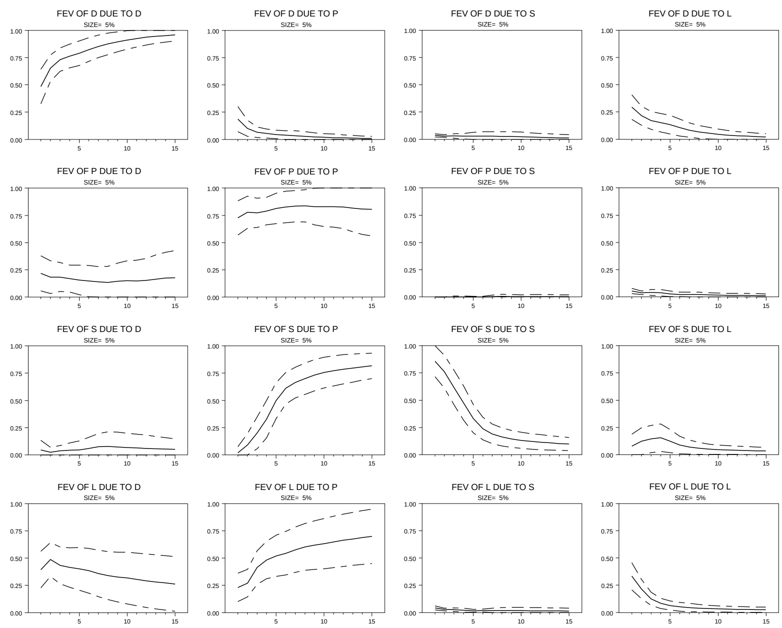

Figure 16: Forecast Error Variance Decomposition, Italy, column 1 (contribution of shock ε^{ϕ}), column 2 (contribution of shock ε_i^{ν}), column 3 (contribution of shock ε_i^{φ}), column 4 (contribution of shock ε_i^{η}).

According to the graphs of the second column, innovations to the second structural component of the model are consistent with the assumption that nominal shocks do not impact on debt development and explain almost entirely the FEV of inflation and of the short-term interest rate from the eighth quarter onwards. The contribution to the FEV of the long-term interest rate is significant too. The third column of Figure 16 places the source of transitory real and financial shocks in the money market, whereas in the US and German case, the third stochastic component of the model contributed to explaining the FEV of the long-term interest rate only. Finally, the fourth column indicates that contribution of the fourth stochastic component of the model is in all cases borderline statistically significant.

Figure 17 portrays the graph of the Italian long-term interest rate (upper panel left) and of its three components. As the figure shows, the element associated to the initial conditions plus deterministic component (upper panel, right) captures the disinflation of the Italian economy in the run-up to EMU and the effects of the fiscal and exchange rate crisis of the first 1990s.The contribution of the permanent stochastic component to the level of the long-term interest rate has been negative between 1983 and 1988, positive between 1992 and 1996, close to zero in between. No clear link between this pattern and that of fiscal deterioration appears. The contribution of the transitory component instead has been increasing between the start of the sample period and 1992, positive

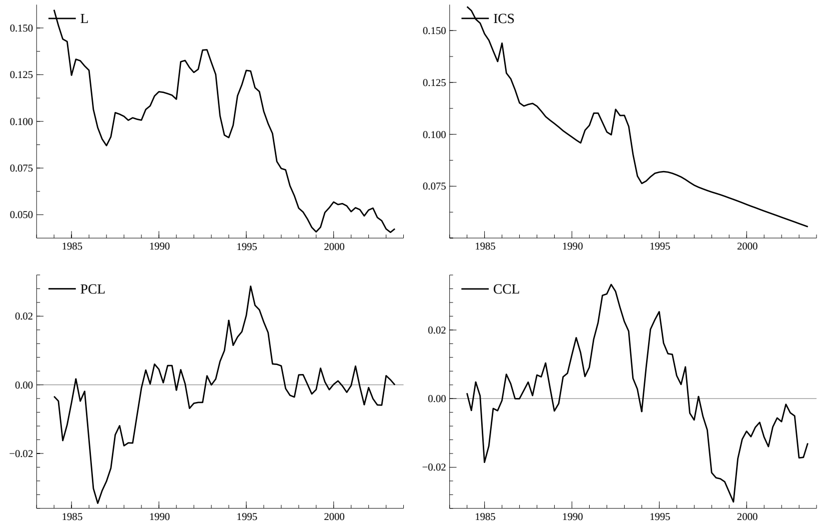

Figure 17: Decomposing the Italian long-term interest rate according to $l_t = \xi_l + l_t^p + l_t^c$, l (upper panel, left), ξ_l (upper panel, right), l_t^p(lower panel, left), l_t^c (lower panel, right).

from 1986 to 1997, and negative thereafter.

The upper panel of Figure 18 indicates that the contribution of the fiscal trend to the formation of the permanent component driving the Italian long-term interest rate has been close to zero for the best part of the observation period, while that of the nominal trend is absolutely dominant. Thus, in contrast to the other two cases, the contribution of the permanent fiscal trend to the long-term development of interest rates seems not to capture any underlying trend in real output growth. Instead, this result is consistent a pricing of bonds giving much stronger weight on the level of inflation and the term and exchange rate premia reflecting nominal uncertainties and fluctuations. In fact, for the best part of the observation period, the bulk of Italy's sharply rising government debt took the shape either of short or medium-term indexed bonds (Missale 1999). The possibility of issuing long-term fixed rate bonds in Italy has always been linked to the above mentioned factors and, concomitantly, issues started to enlarge as chances of participating to EMU from the start increased. This should explain the patterns presented on Figure 18.

Figure 19 portrays the structure of the transitory stochastic component driving Italy's long-term interest rate. Symmetrically with respect to the other two countries, the contribution of the fiscal trend (graph in the upper left corner) is absolutely dominant with respect to those of the other three components and there is a high correlation between development of the fiscal trend reflecting nominal bond issuance, or in other terms the government financing requirement which should roughly correspond to fiscal deficits, and the transitory part of long-term yields.

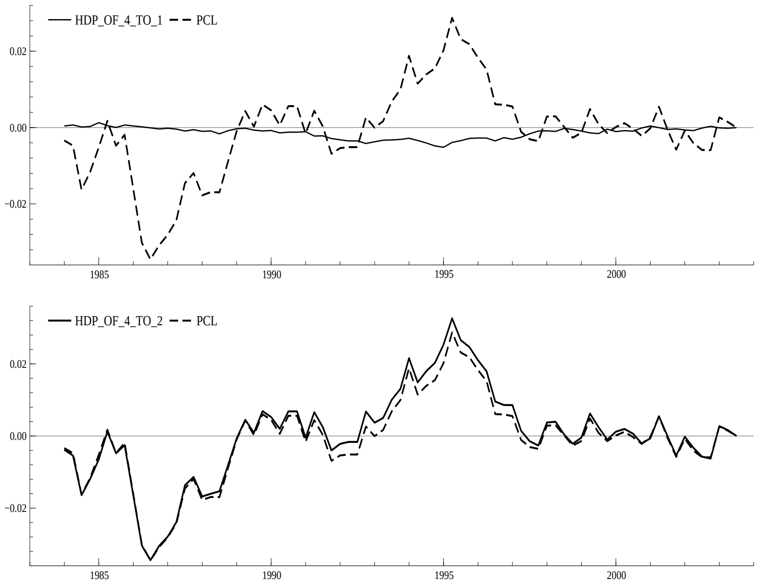

Figure 18: Permanent component, long-term interest rate, Italy. The graph portrays $\Phi_{41}\sum\varepsilon_i^{\phi}$ (solid line, upper panel) and $\Phi_{42}\sum\varepsilon_i^{\nu}$ (solid line, lower panel) plus the sum of the two l_t^P (dashed line). See above Equation 18.

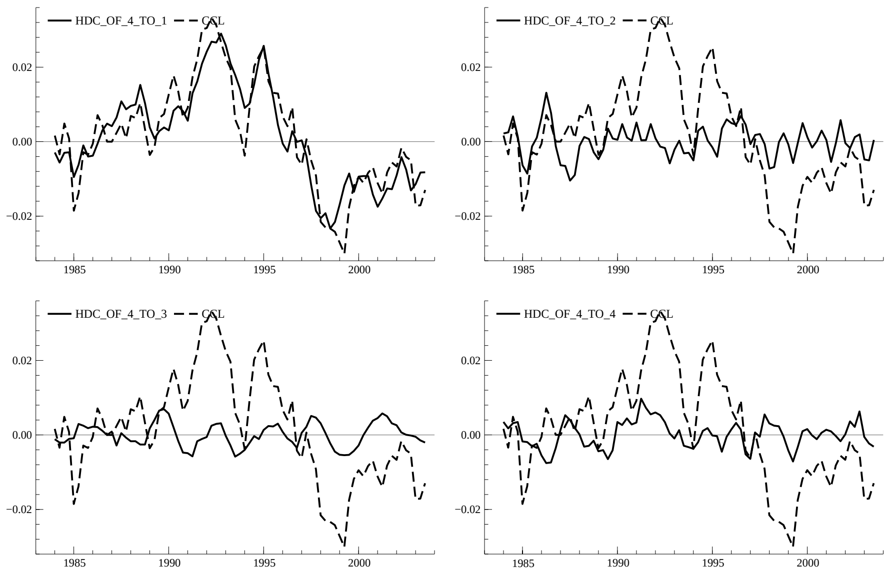

Figure 19: Transitory component, long-term interest rate, Italy. The graph portrays $\sum\Phi^*_{i,41}\varepsilon_i^{\phi}$ (solid line, upper left corner), $\sum\Phi^*_{i,42}\varepsilon_i^{\nu}$ (solid line, upper right corner), $\sum\Phi^*_{i,43}\varepsilon_i^{\varphi}$ (solid line, lower left corner) and $\sum\Phi^*_{i,43}\varepsilon_i^{\eta}$ (solid line, lower right corner) plus their sum l_t^T (dashed line). See above Equation 19.

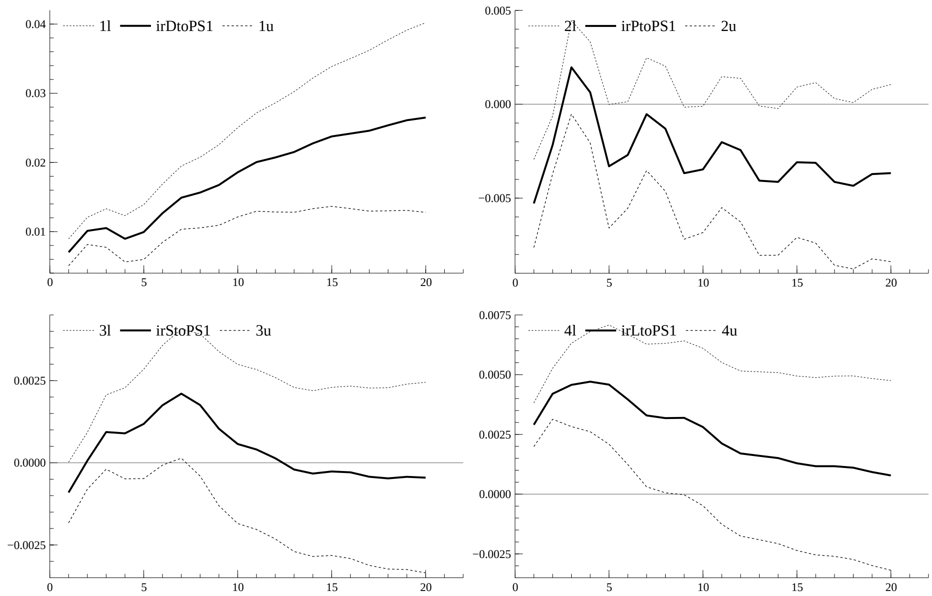

Figure 20: Impulse response of the debt/GDP ratio (upper left panel), inflation (upper right panel), the short-term interest rate (lower left panel) and the long-term interest rate (lower right panel) to a fiscal shock, Italy.

The shape of this contribution is consistent with a supply and default risk effect having a positive impact on the level of the long-term interest rate from the beginning of the sample period up to 1994-1995, when the growth of Italy's debt/GDP ratio was finally stabilized.

Figure 20 shows the effects of a permanent fiscal shock. Contrary to the American and German case, the overall picture of impulse response functions corresponds much more to fiscal imbalances reflecting the governments fiscal stance and the burden of past accumulated debt as driving the permanent stochastic component. In line with this interpretation and the record of Italy's debt/GDP ratio over the sample period, a fiscal shock has a positive impact on debt and does not stabilize after a while, but keeps increasing. Twenty quarters ahead the debt/GDP ratio has increased by 2 percentage points. The impact on inflation and on the short-term interest rate is statistically not significant, while the positive impact on the long-term interest rate is significant up to 10 quarters ahead and consistent with the transitory supply effect. Nevertheless, the direction of change of inflation and short-term rates would be in line with a short term demand push following the fiscal impulse and a counter-acting monetary policy reaction. The fact that the impact of the fiscal impulse on long-term rates is dying out relatively quickly is consistent with the stronger contribution of this factor in explaining temporary rather than permanent fluctuations of long-term rates.

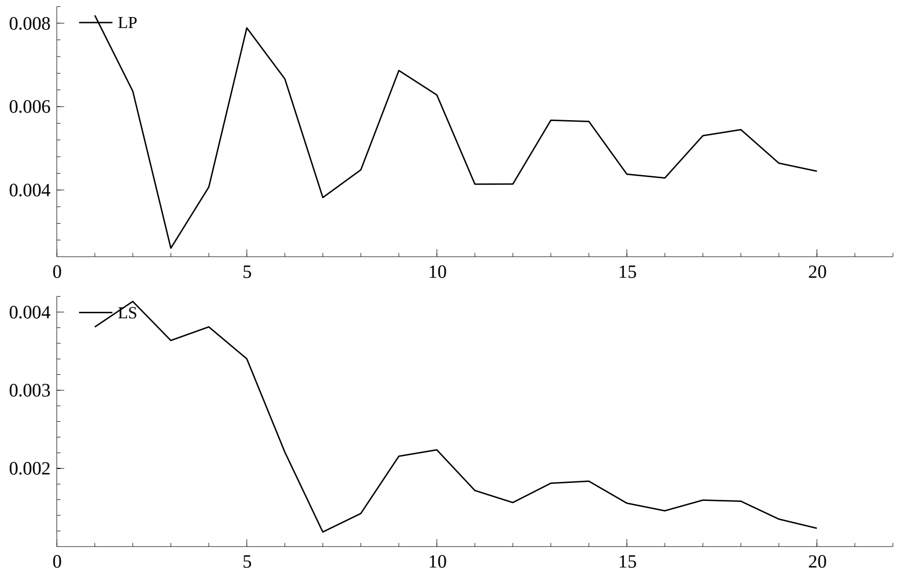

Figure 21: Impact of a permanent fiscal shock on the real long-term interest rate (upper section) and on the differential between the long and the short-term interest rate (lower section), Italy.

From these considerations one would expect that fiscal shocks have a positive impact on the long-term real rate, at least temporarily. Figure 21 shows that the real rate actually increases permanently by 50 basis points on average. To explain this result is its important to keep in mind the difference in the underlying fiscal scenario. Contrary to what happens in the USA and Germany, where an adverse fiscal shock leads to debt/GDP ratio to permanently increase by a certain amount, a fiscal shock in Italy leads the debt/GDP ratio to increase continuously, which prolongs the impact on bond yields.

Summarizing the evidence presented so far, in the case of Italy, one finds much more support for a standard increasing impact of public debt on long-term interest rates reflecting bond supply and possibly a temporary output stimulus. In addition, we cannot exclude the possibility of a default risk effect of fiscal deterioration on the level of the long-term interest rate, adding to the normal supply effect observed in the US and German case. Given the limited impact of the permanent stochastic trend on long-term interest rate developments, this pattern is driven by the temporary component, which appears to have completely overshadowed any liquidity effect which might have been occurring at the same time.[17]

[17] In Italy, the liquidity effect has become relevant in the second part of the sample period, once an electronic trading system for government debt was created (the Mercato Telematico dei Titoli di stato) and BOTs and CCTs, for which a secondary market hardly existed, were substituted by negotiable fixed rate BTPs.

4 Cross-country linkages

The analysis of cross-country linkages between three long-term interest rates is based on the permanent-temporary decomposition described above and will consist of two different steps. First, we test whether the three $I(1)$ permanent stochastic components driving the long-term interest rates are cointegrated over the sample period. The purpose of this test, which can be viewed as an extension of the Gonzalo and Granger (1995) methodology to investigate the properties of large cointegrated system, is to check for the possibility of long-term stochastic linkages between the series, once the effect of initial conditions, deterministic component and of transitory stochastic elements has been eliminated. Second, we analyse the properties of the trivariate VAR containing the three $I(0)$ transitory components contained in the long-term interest rate. The purpose of this test is to investigate the possibility of short-term or transitory linkages between the series.

4.1 Long-term linkages

The Trace cointegration test reported in Table 4 below indicates that the permanent components, respectively driving the US (PCL_{USA}), German (PCL_{GER}) and the Italian (PCL_{ITA}) long-term interest rate do not share any stochastic element among themselves.[18]

Table 4. Johansen Trace Test on l^P_{USA}, ; l^P_{GER}, l^P_{ITA}

Included lags (levels): 1					
Intercept included					
r_0	LR	$pval$	90%	95%	99%
0	24.57	0.4317	32.25	35.07	40.78
1	11.34	0.5174	17.98	20.16	24.69
2	4.17	0.3994	7.60	9.14	12.53
Optimal lag selection					
$AK:1$, $FP:1$, $SC:1$, $HQ:1$					

This result indicates that domestic factors, including the different timing and magnitude of fiscal deterioration in each of the three countries and the different debtor status, appear to have been more important in determining the permanent movements of long-term interest rates, than international market dynamics related to the gradual lowering of financial barriers.

4.2 Short-term linkages

The second step of the analysis of cross-country linkages consists in estimating a SVAR model containing the three stationary transitory components driving the USA, German and Italian long-term interest rate, respectively labelled: l^T_{USA}, l^T_{GER}, and l^T_{ITA}.

[18] These tests and those contained in the following Section are obtained using Jmulti 3.03.

Optimal lag length determination criteria suggest choosing lag 2. A constant is also included in the model. Misspecification tests for residual autocorrelation, normality, heteroscedasticity indicate that the model is well specified.[19] The SVAR model is identified using the Cholesky structure reported in Table 5, with l^T_{USA} having a simultaneous impact on l^T_{GER} and l^T_{ITA} and l^T_{GER} having a simultaneous impact on l^T_{ITA}.

Table 5. The matrix of simultaneous relationships
(Standard errors in brackets)

	l^T_{USA}	l^T_{GER}	l^T_{ITA}
l^T_{USA}	1.00	.	.
l^T_{GER}	-0.22 0.11	1.00	.
l^T_{ITA}	-0.26 0.19	-0.51 0.19	1.00

As Table 6 indicates, FEVD based on the SVAR model indicates that, as might be expected, in all of the three cases the domestic element is by far the most important explanatory variable. After all, the previous analysis indicates that all of the three transitory stochastic components driving the long-term interest rates are determined by fiscal developments and in two out of three cases (the US and the German case) by idiosyncratic shocks. In the US case, only the contribution of the German component is marginally significant, absorbing 13% of the overall FEVD twelve quarters ahead. In the German case, both the US and the Italian component play a role in explaining the FEV of l^T_{GER}. In the Italian case, the FEVD of l^T_{ITA} appears to be influenced more by l^T_{USA} than by l^T_{GER}.

Table 6. SVAR FEVD

	l^T_{USA} exp *by* l^T			l^T_{GER} exp *by* l^T			l^T_{ITA} exp *by* l^T		
Qrts. ahead	*USA*	*GER*	*ITA*	*USA*	*GER*	*ITA*	*USA*	*GER*	*ITA*
1	1.00	0.00	0.00	0.05	0.95	0.00	0.04	0.08	0.88
4	0.99	0.01	0.00	0.10	0.89	0.01	0.18	0.07	0.75
8	0.91	0.07	0.01	0.09	0.82	0.09	0.34	0.06	0.60
12	0.86	0.13	0.02	0.09	0.80	0.11	0.38	0.11	0.51

SVAR impulse response functions, depicted on Figure 22, shed more light on the relationship between the three temporary components driving the three long-term interest rates. A positive shock to the transitory component driving the US long term interest rate has a positive impact on itself and on the other two rates.

The impact on l^T_{GER} is borderline statistically significant and lasts two quarter only. The positive impact on l^T_{ITA} instead, is statistically significant between

[19] Limiting ourselves to the $p - values$ we obtain Portmanteau test (16) [0.77], LM-test for autocorrelation of order 5 [0.79], Test for non-normality (Doornik & Hansen) [0.18], Jarque-Bera test [0.34, 0.66, 0.14], ARCH-LM test with 16 lags [0.97, 0.63, 0.95]. Reference on these tests may be found in the help file of Jmulti 3.03.

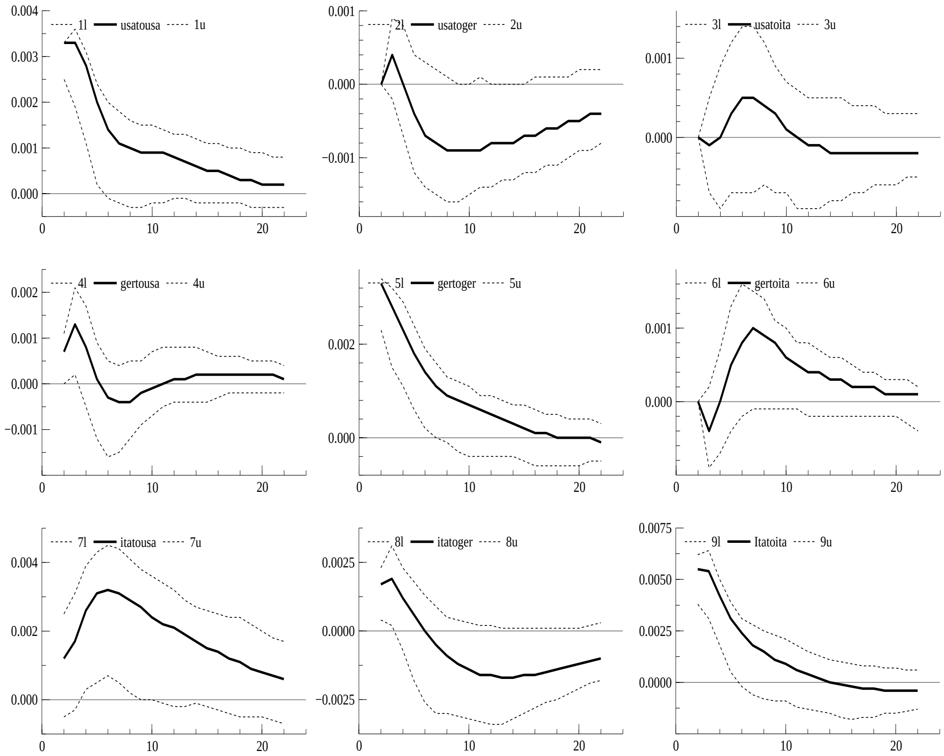

Figure 22: Impact of a positive shock to the transitory component driving the long-term interes rate of a country on itself and on the other two transitory components: shock to l^T_{USA} (first column), shock to l^T_{GER} (second column), shock to l^T_{ITA} (third column).

the third and the ninth quarter and stronger than in the German case. A positive shock to transitory component driving the German long term interest rate (second column) has a temporary positive impact, lasting only one quarter, on l^T_{ITA}. The impact on l^T_{USA}, albeit initially positive, is statistically not significant. Finally, a positive shock to the transitory component driving the Italian long term interest rate has no statistically significant impact on any of the other two transitory components.

Having shown that the transitory stochastic component driving each of the three interest rates is strongly dominated by fiscal developments in all of the three case, in a way consistent with fiscal deterioration leading to a higher temporary component, and by idiosyncratic shocks in two out of the three cases (the USA and Germany), the previous impulse responses are consistent with the possibility of spill-over effects from the US to the German and Italian interest rates and from the German to the Italian interest rates.

5 Conclusions

Focusing on the USA, Germany and Italy, over the 1983 – 2003 period this paper has investigated two interrelated problems: a) whether the accumulation of government debt has an impact on long-term interest rates, after controlling for inflation and monetary policy; and b) whether there are spill-over effects across countries.

As to the first issue, the analysis demonstrates that fiscal developments have played a significant role in determining the transitory stochastic component driving the long-term interest rate in all of the three cases and in a way consistent with fiscal deterioration (increasing debt/GDP ratio) leading to higher interest rates. The impact of debt accumulation on the permanent stochastic component of the long-term interest rate, instead, appears to be different in each of the three countries. Both in the US and Germany, the contribution of the permanent component seems to reflect the negative impact of medium-term output trends on debt and other macro-variables. In the German case, this component may capture some crowding out of private capital accumulation being associated the special circumstances of German reunification and the subsequent massive fiscal expansion. In the Italian case, the permanent stochastic component of interest rates is predominantly driven by nominal developments and not real or fiscal shocks. As to the second question, linkages between the three transitory stochastic components driving the long-term interest rates appear to be strong enough to make spill-over effects possible. Here too the different status (and relative financial strength) of the three countries are reflected in the intensity of the spill-over effects. A positive shock to the transitory component driving the US long-term interest rate has a weak statistically significant positive impact on the transitory component driving the German long-term interest rate and a strong impact on the Italian rates. Shocks to the German and Italian temporary components, tend to move the other two elements of the system in the same direction but with statistically not significant effects.

6 The data

6.1 USA

Table 1A. The quarterly data.

Code	Description	Label
Official US data	TOTAL GOVERNMENT DEBT	D
IFS..11199B.CZF...	GDP SA	Y
IFS..132641...ZF...	CONSUMER PRICES	P
BISM.M.HEEP.US.72	TREASURY BILL RATE	S
IFS...Q.11161.ZF	GOVERNMENT BOND YIELD	L
Source: IMF Int. Financial Statistics, BIS, Bureau of Public Debt		
at http://www.publicdebt.treas.gov/opd/opd.htm		

The time series used in the empirical analysis are obtained by appropriate transformation of the original dataset. Government debt/GDP ratio $d = D/Y$. The short-term interest rate $s = (S/100)$, the long-term interest rate $l = (L/100)$, inflation $\pi = 4 * \Delta log(P)$.

Augumented unit root tests are calculated on the variables in levels and first differences. Results are reported in Table 2A below. According to unit root tests all the variables can be treated as $I(1)$ in levels. Inflation, however, is borderline stationary.

Table 2A. Unit root tests.
$1983 : q1 - 2003 : q4$

	Lag	Det	ADF		Lag	Det	ADF
d	2	c, t, sd	-1.03	Δd	1	c, sd	-2.91
π	2	c	-2.72	$\Delta \pi$	1	$c = 0$	-7.21
s	2	c	-1.76	Δs	1	$c = 0$	-4.34
l	2	c	-1.84	Δl	1	$c = 0$	-5.74
				10%			5%
ADF	$c = 0$			-1.62			-1.94
ADF	c			-2.57			-2.86
ADF	c, t			-3.13			-3.41

6.2 Germany

Table 3A. The quarterly data.

Code	Description	Label
Official German data	TOTAL GOVERNMENT DEBT	D
IFS..13499B.CZF...	GDP SA	Y
IFS..134641...ZF...	CONSUMER PRICES	P
IFS..134660B	MONEY MARKET RATE	S
IFS...Q.13461.ZF	GOVERNMENT BOND YIELD	L
Source: IMF Int. Financial Statistics, BIS, Bundesbank		

The time series used in the empirical analysis are obtained by appropriate transformation of the original dataset. The steps in the GDP and the Government Debt figure are eliminated by cumulating post-step growth rates to pre-step levels.[20] The short-term interest rate $s = (S/100)$, the long-term interest rate $l = (L/100)$, inflation $\pi = 4 * \Delta log(P)$. Unit root tests reported in Table 4A are consistent with treating all the variables as $I(1)$.

Table 2A. Unit root tests.
$1983 : q1 - 2003 : q4$

	Lag	*Det*	*ADF*		*Lag*	*Det*	*ADF*
d	4	c	-0.34	Δd	3	$c = 0$	-2.24
π	3	c	-2.75	$\Delta \pi$	2	$c = 0$	-11.4
s	3	c	-1.87	Δs	1	$c = 0$	-3.01
l	4	c	-1.36	Δl	1	$c = 0$	-4.22
				10%			5%
ADF	$c = 0$			-1.62			-1.94
ADF	c			-2.57			-2.86
ADF	c, t			-3.13			-3.41

6.3 Italy

Table 5A. The quarterly data.

Code	Description	Label
13688B..ZF (ZW) ...	TOTAL DEBT	D
13699B.CZF...(CZW)	GDP SA, (SA,inEURO)	Y
13660B..ZF...	MONEY MARKET RATE	S
13661...ZF...	GOVERNMENT BOND YIELD	L
13664...ZF...	CONSUMER PRICES	P
Source: IMF IFS., CD Rom April 2004;		

The time series used in the empirical analysis are obtained by appropriate transformation of the original dataset. Government debt/GDP ratio $d = D/(4Y)$,the short-term interest rate $s = (S/100)$, the long-term interest rate $l = (L/100)$, inflation $\pi = 4 * \Delta log(P)$. The tests suggest borderline stationarity of inflation (strong trend stationarity).

[20] Since July 1, 1999 the Federal Government has assumed joint responsibility for the debts of the redemption Fund for Inherited Liabilities, the Federal railway Fund and the equalization Fund for safeguarding the Use of Coal (see Bundesbank 1999, p. 56*, footnote 6).

Table 6A. Unit root tests.
$1981:q1-1998:q4$

	Lag	*Det*	*ADF*		*Lag*	*Det*	*ADF*
d	4	c,t	-0.79	Δd	3	c,t	-3.73
π	2	c,sd	-3.40	$\Delta\pi$	1	$c=0$	-4.43
s	0	c	-1.27	Δs	0	$c=0$	-7.42
l	4	c	-1.25	Δl	3	$c=0$	-4.92
				10%			5%
ADF	$c=0$			-1.62			-1.94
ADF	c			-2.57			-2.86
ADF	c,t			-3.13			-3.41

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