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**"Fiscal Policy, Housing and Stock Prices"**

António Afonso
Ricardo M. Sousa

**NIPE WP 21 / 2008**

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# Fiscal Policy, Housing and Stock Prices*

*António Afonso* # *and Ricardo M. Sousa* $

December 2008

**Abstract**

This paper investigates the link between fiscal policy shocks and movements in asset markets using a Fully Simultaneous System approach in a Bayesian framework. Building on the works of Blanchard and Perotti (2002), Leeper and Zha (2003), and Sims and Zha (1999, 2006), the empirical evidence for the U.S., the U.K., Germany, and Italy shows that it is important to explicitly consider the government debt dynamics when assessing the macroeconomic effects of fiscal policy and its impact on asset markets. In addition, the results from a VAR counter-factual exercise suggest that: (i) fiscal policy shocks play a minor role in the asset markets of the U.S. and Germany; (ii) they substantially increase the variability of housing and stock prices in the U.K..; and (iii) government revenue shocks have apparently contributed to an increase of volatility in Italy.

Keywords: Bayesian Structural VAR, fiscal policy, housing prices, stock prices.

JEL classification: C32, E62, G10, H62.

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## Non-technical summary

This paper analyzes the effects of fiscal policy on economic activity, with an emphasis on asset markets. In particular, we ask how stock prices and housing prices are affected by fiscal policy shocks, and look at the persistence of the effects.

We identify fiscal policy shocks using information about the elasticity of fiscal variables to the economic activity. In addition, we estimate a Fully Simultaneous System approach in a Bayesian framework, therefore, accounting for the posterior uncertainty of the impulse-response functions.

Another added value of the paper is that we explicitly include the feedback from government debt in our estimations.

In addition, we use quarterly fiscal data to analyze empirical evidence from the U.S., the U.K., Germany, and Italy respectively for the periods 1970:3-2007:4; 1971:2-2007:4; 1979:2-2006:4; 1986:2-2004:4. The set of quarterly fiscal data is taken from national accounts (in the case of the U.S. and the U.K.) or based on fiscal cash data (for Germany and Italy).

The main results of our work can be summarized as follows. Government spending shocks: (i) have a positive and persistent effect on GDP in the case of the U.S. and the U.K., while for Germany and Italy, the (positive) impact is temporary and becomes negative after 4 to 8 quarters; (ii) have a positive and persistent effect on housing prices, although housing markets tend to respond with a lag of around 4 quarters; (iii) have a negative effect on stock prices, although the time of reaction is faster than for housing prices; (iv) have positive effects on the price level in the case of the U.K. and Italy, and negative effects for the U.S. and Germany; and (v) reduce unemployment only in the U.S. On the other hand, government revenue shocks: (i) have an initial negative effect on GDP that later becomes positive; (ii) have a negative impact on housing prices for the U.S. and Italy, and a positive impact for the U.K. and Germany; (iii) have a small and positive effect on stock prices; (iv) have, in general, a negative and persistent effect on the price level; and (iv) have a positive and persistent impact on the unemployment rate.

When we explicitly take into account the link between government debt and deficits, including the feedback from government debt, long-term interest rates and GDP are more responsive and the effects on these variables also become more persistent.

Finally, in a VAR counter-factual exercise, we show that fiscal policy shocks play a minor role in the patterns that one observes for stock prices and housing prices in the U.S. and Germany. Nevertheless, while both spending and revenue shocks seem to have an important effect on asset markets for the U.K., for Italy only government revenue shocks have contributed to an increase of volatility in housing and stock prices, in particular, in the nineties.

## 1. Introduction

This paper evaluates the effects of fiscal policy on economic activity, with a particular emphasis on the linkages between fiscal policy and asset markets. We ask how stock and housing prices are affected by fiscal policy shocks, and, to the extent that we find a link between them, we look at the magnitude and the persistence of the effects.

We identify fiscal policy shocks using information about the elasticity of fiscal policy variables to economic activity, therefore, taking into account the automatic response of government spending and revenue to output, inflation, and the interest rate as in Blanchard and Perotti (2002). Moreover, we account for the posterior uncertainty of the impulse-response functions by estimating a Fully Simultaneous System of equations in a Bayesian framework based on the works of Leeper and Zha (2003), and Sims and Zha (1999, 2006).

Another added value of the paper is that we explicitly include the link between government debt and deficits in our framework, and, consequently, including the government debt feedback dynamics in our estimations. In this respect, the present work follows Favero and Giavazzi (2008) so we consider the response of fiscal variables to the level of the debt.

Finally, using quarterly fiscal data, we analyze empirical evidence from the U.S., the U.K., Germany, and Italy respectively for the periods 1970:3-2007:4; 1971:2-2007:4; 1979:2-2006:4; 1986:2-2004:4. The set of quarterly fiscal data, is taken from national accounts (in the case of the U.S. and the U.K.) or based on fiscal cash data (for Germany and Italy).

The main results of our work can be summarized as follows. Government spending shocks: (i) have a positive and persistent effect on GDP in the case of the U.S. and the U.K., while for Germany and Italy, the (positive) impact is temporary and becomes negative after 4 to 8 quarters; (ii) have a positive and persistent effect on housing prices, although housing markets tend to respond with a lag of around 4 quarters; (iii) have a negative effect on stock prices, although the time of reaction is faster than for housing prices; (iv) have mixed effects on the price level, that is, the response is positive in the case of the U.K. and Italy, and negative for the U.S. and Germany; and (v) reduce unemployment only in the U.S. On the other hand, government revenue shocks: (i) have an initial negative effect on GDP that later becomes positive; (ii) have a negative impact on housing prices for the US and Italy, and a positive impact for the U.K. and Germany; (iii) have a small and positive effect on stock prices; (iv) have, in general, a negative and persistent effect on the price level; and (iv) have a positive and persistent impact on the unemployment rate.

When we include the feedback from government debt in the estimations long-term interest rates and GDP become more responsive, and the effects on these variables also become more persistent.

Finally, we perform a VAR counter-factual exercise, and show that fiscal policy shocks play a minor role in the patterns that one observes for stock prices and housing prices in the U.S. and Germany. Nevertheless, while both spending and revenue shocks seem to have an important effect on asset markets for the U.K., in the case of Italy only government revenue shocks have contributed to an increase of volatility in housing and stock prices, in particular, in the nineties.

The rest of the paper is organized as follows. Section two briefly reviews identification schemes of fiscal policy shocks in the related literature. Section three explains the empirical strategy used to identify the effects of fiscal policy shocks, and to take into account the automatic response of fiscal policy to economic activity and the uncertainty regarding the posterior distribution of the impulse-response functions. Section four provides the empirical analysis and discusses the results. Section five concludes with the main findings and policy implications.

## 2. Identification of fiscal shocks

While a large number of studies have been devoted to the analysis of the macroeconomic effects of monetary policy,[1] the empirical evidence on the role of fiscal policy as a tool for economic stabilization is somewhat lagging and there is no consensus about the identification of fiscal policy shocks.

Rotemberg and Woodford (1992) identify exogenous movements in U.S. government purchases with innovations to defence purchases. In contrast, Ramey and Shapiro (1998) use the “narrative approach” to isolate political events that led to three large military build-ups unrelated to developments in the U.S. economy. They find that whilst nondurable consumption displays a small decline, durables consumption falls persistently after a brief rise. In the same vein, Edelberg et al. (1999) show that specific episodes of military build-ups (identified in Ramey and Shapiro, 1998) have a

[1] See, for example, Christiano et al. (2005), Sims and Zha (1999, 2006), and Leeper and Zha (2003).

significant and positive short-run effect on U.S. output and consumption, and allowing for anticipation effects of fiscal policy does not change the sign of the response.

Fatás and Mihov (2001) and Favero (2002) consider a Cholesky ordering in the identification of fiscal shocks. They rely on the effects of changes in government spending, and base their decision on two arguments: (i) alternative theories imply different economic dynamics following a change in government spending while having qualitatively similar predictions for the effects of changes in tax rates; and (ii) it does not require that one models the contemporaneous interaction between taxes and economic activity. They suggest that increases in government expenditures are expansionary, but lead to an increase in private investment that more than compensates for the fall in private consumption, a feature that goes against the predictions of the Real Business Cycle (RBC) model.

Blanchard and Perotti (2002) exploit the decision lags in policymaking and use information about the elasticity of fiscal variables to economic activity, to identify the automatic response of fiscal policy, and find that expansionary fiscal shocks increase output, and have a positive effect on private consumption and a negative one on private investment.

Mountford and Uhlig (2005) use sign restrictions on the impulse responses, and identify an expenditure shock by a positive response of expenditure for up to four quarters after the shock. The authors also find a negative effect in residential and non-residential investment.

Despite the different identification schemes of fiscal policy shocks aimed at analysing the macroeconomic effects of fiscal policy, less attention has been given to the potential role played by fiscal policy on asset markets or the discussion has been centred on its effects on long-term interest rates.[2] In fact and to the best of our knowledge, only Afonso and Sousa (2008) have tried to tackle this question. The authors estimate a Bayesian Structural Vector Autoregression model based on a recursive identification scheme and: (i) look at the impact of fiscal policy on the composition of output; (ii) assess its effects on asset markets (via housing stock prices, and interest rates) and on the external sector (via exchange rate); and (iii) analyze the potential interactions between fiscal and monetary policy. The scope of the paper is,

[2] For a revision of the effects of fiscal policy on long-term interest rates, see, for example, Gale and Orszag (2003), Laubach (2003), and Brook (2003).

therefore, a more generalist one, as it discusses the macroeconomic effects of fiscal policy.

In this paper, we identify fiscal policy shocks using a Fully Simultaneous system of equations approach in a Bayesian framework based on the works of Blanchard and Perotti (2002), Leeper and Zha (2003), and Sims and Zha (1999, 2006). Therefore, we take into consideration the automatic response of fiscal policy to economic activity. Moreover, we do not assume that the government reacts only to variables that are predetermined relative to policy shocks, and assume that there are no predetermined variables with respect to fiscal policy shock.

## 3. A Fully Simultaneous System approach

Consider the following structural VAR (SVAR)

$$\underbrace{\Gamma(L)}_{n\times n}\underbrace{X_t}_{n\times 1} + \gamma_i d_{t-1} = \Gamma_0 X_t + \Gamma_1 X_{t-1} + \ldots + \gamma_i d_{t-1} = c + \varepsilon_t \tag{1}$$

$$d_t = \frac{1+i_t}{(1+\pi_t)(1+\mu_t)} d_{t-1} + \frac{G_t - T_t}{P_t Y_t} \tag{2}$$

$$v_t = \Gamma_0^{-1} \varepsilon_t \ , \tag{3}$$

where $\varepsilon_t \mid X_s, s < t \sim \mathrm{N}(\underline{0}, \Lambda)$, *Γ(L)* is a matrix valued polynomial in positive powers of the lag operator *L*, *n* is the number of variables in the system, $\varepsilon_t$ are the fundamental economic shocks that span the space of innovations to $X_t$.

As in Favero and Giavazzi (2008), we explicitly include the feedback from government debt as shown by specification (2), where $i_t$, $G_t$, $T_t$, $\pi_t$, $Y_t$, $P_t$, $\mu_t$ and $d_t$ represent, respectively, the interest rate (or the average cost of debt refinancing), government primary expenditures and government revenues, inflation, GDP, price level, real growth rate of GDP, and the debt-to-GDP ratio at the beginning of the period *t*.[3][4]

[3] We follow Favero and Giavazzi (2008), that is, we add the government debt to the VAR and append a non-linear budget identity to accumulate debt. This is in contrast with Chung and Leeper (2007), who linearize the intertemporal budget constraint and impose it as a set of cross-equation restrictions on the estimated VAR coefficients.

4 A feedback from the level of debt ratio to government revenue and government spending could be important in the fiscal reaction function whenever fiscal authorities attach some weight to debt stabilization and their behaviour is Ricardian. Additionally, interest rates depend on future expected monetary policy and on the risk premium, and both may be affected by the debt dynamics. Finally, the impact of the level of debt on inflation (Canzoneri et al., 2001) cannot be ruled out ex-ante. Moreover, debt may also have an impact on output fluctuations (Barro, 1974; Kormendi, 1983).

The vector $v_t$ contains the innovations of $X_t$, where $v_t \sim \underline{\mathrm{N}}(0,\Sigma)$ and $\Sigma := \Gamma_0^{-1}\Lambda(\Gamma_0^{-1})'$. Moreover, $\Gamma_0$ pins down the contemporaneous relations among the variables in the system. We use the normalization $\Lambda=I$.

The structural VAR approach that we follow is built on the estimation of fully simultaneous systems as in Leeper and Zha (2003) and Sims and Zha (2006), and on the identification procedure of Blanchard and Perotti (2002). We use Bayesian inference to assess the posterior uncertainty about the impulse-response functions in the Fully Simultaneous system of equations and consider a Monte Carlo importance sampling weight algorithm. Appendix A provides a detailed description of the computation of the error bands.

We consider the following set of variables $X_t = [SP_t, G_t, T_t, Y_t, P_t, i_t, U_t, HP_t]'$, where $SP_t$ represents the stock price index, $G_t$, the government expenditures, $T_t$, the government revenue, $Y_t$, the GDP, $P_t$, the GDP deflator, $U_t$, the unemployment rate, $i_t$, the average cost of debt financing (or long-term interest rate), and $HP_t$, the housing price index. In particular, we partition the data such that $X_t = [X_{1t}', G_t, T_t, X_{2t}']'$, where:

$$X_{1t} = [SP_t]; \qquad X_{2t} = \begin{bmatrix} Y_t \\ P_t \\ i_t \\ U_t \\ HP_t \end{bmatrix}.$$

The economy is divided into 3 sectors: a financial, a public and a production sector. The financial sector - summarized by stock prices index, $SP_t$ – reacts contemporaneously to all new information, in recognition of the fact that they are determined in markets characterized by a continuous auction structure. The public sector – that allows for simultaneous effects –, comprises the equations for government spending and government revenue, and links them with the log real GDP, $Y_t$, the GDP deflator, $P_t$, and the average cost of financing debt, $i_t$. The production sector consists of log real GDP, $Y_t$, the GDP deflator, $P_t$, unemployment rate, $U_t$, and the housing price index, $HP_t$. The orthogonalization within this sector is irrelevant to identify fiscal policy shocks correctly. All these variables are not predetermined relative to the fiscal policy shocks but it is assumed that the policy shock can influence them contemporaneously.

Additionally, we adopt an identification of the fiscal policy shocks based on Blanchard and Perotti (2002) and Perotti (2004). This identification scheme consists of two steps: (i) institutional information about tax and transfer systems and the timing of tax collections is used to identify the automatic response of taxes and government spending to economic activity, that is, to compute the elasticity of government revenue and spending to macroeconomic variables; and (ii) the fiscal policy shock is estimated.

The identifying restrictions on the matrix of contemporaneous effects, $\Gamma_0$, can be defined as:

$$\Gamma_0 = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} & \gamma_{15} & \gamma_{16} & \gamma_{17} & \gamma_{18} \\ 0 & \gamma_{22} & \gamma_{23} & -\xi_{G,Y}\cdot\gamma_{22} & -\xi_{G,\pi}\cdot\gamma_{22} & -\xi_{G,i}\cdot\gamma_{22} & 0 & 0 \\ 0 & \gamma_{32} & \gamma_{33} & -\xi_{G,Y}\cdot\gamma_{33} & -\xi_{G,\pi}\cdot\gamma_{33} & -\xi_{G,i}\cdot\gamma_{33} & 0 & 0 \\ 0 & 0 & 0 & \gamma_{44} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \gamma_{54} & \gamma_{55} & 0 & 0 & 0 \\ 0 & 0 & 0 & \gamma_{64} & \gamma_{65} & \gamma_{66} & 0 & 0 \\ 0 & 0 & 0 & \gamma_{74} & \gamma_{75} & \gamma_{76} & \gamma_{77} & 0 \\ 0 & 0 & 0 & \gamma_{84} & \gamma_{85} & \gamma_{86} & \gamma_{87} & \gamma_{88} \end{bmatrix} \begin{bmatrix} SP_t \\ G_t \\ T_t \\ Y_t \\ P_t \\ i_t \\ U_t \\ HP_t \end{bmatrix} \quad (4),$$

where the parameters $\xi_{ij}$ can be identified using external information. For instance, $\xi_{G,Y}$, $\xi_{G,\pi}$, and $\xi_{G,i}$ are the elasticities of government spending respectively to GDP, GDP deflator, and long-term interest rate. The description of the elasticities used in the identification procedure is reported in Table 1.

Table 1 – Elasticities of Government Spending and Revenue.

| | Elasticities of Government Spending | | | Elasticities of Government Revenue | | |
|---|---|---|---|---|---|---|
| | $\xi_{G,Y}$ | $\xi_{G,\pi}$ | $\xi_{G,i}$ | $\xi_{T,Y}$ | $\xi_{T,\pi}$ | $\xi_{T,i}$ |
| U.S. | 0 | -0.5 | 0 | 1.85 | 1.25 | 0 |
| U.K. | 0 | -0.5 | 0 | 1.85 | 1.25 | 0 |
| Germany | 0 | -1 | 0 | 0.95 | -0.05 | 0 |
| Italy | 0 | -0.9 | 0 | 0.3 | -0.4 | 0 |

Note: The estimates of the elasticities for the U.S. are based on Blanchard and Perotti (2002), Perotti (2007) and Favero and Giavazzi (2008). The estimates of the elasticities for the U.K. are considered to be the same as in the U.S. The estimates for Germany and Italy are based respectively on Heppke-Falk et al. (2006) and Giordano et al. (2006).

## 4. Results and discussion

### 4.1 Data

We use quarterly data for four countries: U.S., U.K., Germany and Italy. All the variables are in natural logarithms unless stated otherwise. A detailed description of the data is provided in Appendix B.

For the identification of the fiscal policy shocks, we use the following variables; the production sector includes the log real GDP, $Y_t$, the GDP deflator, $P_t$, and the unemployment rate, $U_t$, the average cost of financing the debt, $i_t$, and the housing price index, $HP_t$. Whilst Leeper and Zha (2003) summarize the financial sector by a commodity prices index, we use a stock price index, $SP_t$, instead, as the focus of our analysis is on the reaction of different asset markets (housing and financial markets) to fiscal policy shocks. Finally, as measure of the fiscal policy instruments we use either the government expenditures or the government revenues. In the set of exogenous variables, we include a constant (or quarterly seasonal dummies), and the government debt-to-GDP ratio as described in the previous section. For Germany, we also include two dummies: (i) one for 1991:1, corresponding to the German reunification; and (ii) another one for 2000:3, to track the spike in government revenue associated with the sale of UMTS (Universal Mobile Telecommunications System) licenses.

Regarding the quarterly fiscal data, we consider the Federal Government spending and revenue in the case of the U.S.A., and the Public Sector spending and revenue in the case of the U.K. Both for the U.S.A. and the U.K., quarterly fiscal data is available directly from national accounts. In what concerns Germany and Italy, we compute the quarterly series of government spending and revenue using the fiscal cash data, which is monthly published by the fiscal authorities of both countries. In this case, data for government spending and revenue are available in a cash basis, and refer to the Central Government.

The data are available over the following samples: 1970:3-2007:4, in the case of the U.S.A.; 1971:2-2007:4, in the case of the U.K.; 1979:2-2006:4, in the case of Germany; and 1986:2-2004:4, in the case of Italy.

### 4.2 VAR results

We start by estimating a Bayesian Structural VAR (B-SVAR) *without including the debt feedback*. That is, in practice, we look at specification (1) not considering, as is commonly done in the existing literature, the identity that links government revenues, government spending, government debt, GDP, real GDP growth, inflation and the interest rate, as defined in (2).

We also provide the results of the estimation of the structural VAR *including the feedback from government debt* as described by specifications (1), (2), and (3).

Figures 1, 3, 5, and 7 plot the impulse-response functions to a fiscal policy shock. The solid line corresponds to the median response when the VAR is estimated without the debt feedback, and the dashed lines are, respectively, the median response and the 68 percent posterior confidence intervals from the VAR estimated by including the feedback from government debt. The confidence bands are constructed by using a Monte-Carlo importance sampling normalized weights algorithm, and based on 1000 draws.

We also plot in Figures 2, 4, 6, and 8 the forecast-error variance decompositions to a fiscal policy shock, including the debt dynamics. The thinner line corresponds to the median estimate, and the dashed lines indicate the 68 percent posterior confidence intervals estimated by using a Monte-Carlo importance sampling normalized weight algorithm, and based on 1000 draws.

*U.S.*

Figure 1a displays the impulse-response functions of all variables in $X_t$ to a shock in government spending in the U.S.

When the model is estimated without including the feedback from government debt, the results show that government spending declines steadily following the shock, and it roughly vanishes after 12 quarters. Moreover, the increase in government spending is followed by a short fall in government revenue that erodes after 6 quarters. The effects on GDP are positive and relatively large in magnitude, peaking at after 6 quarters. The evidence also suggests that government spending shocks have a negative and persistent impact on the price level. On the other hand, there is a negative effect on long-term interest rates, shown as the cost of debt. In what concerns the reaction of asset markets the empirical evidence suggests that whilst there is a positive but almost negligible effect on stock markets, the reaction of housing prices is large and persistent, peaking at after 8 to 10 quarters. The effects on unemployment are negative and also persistent.

When one includes the debt feedback, the effects of a government spending shock on GDP become smaller. On the other hand, and contrary to the previous findings, there is initially a positive impact on the average cost of refinancing the debt, which later becomes negative. Looking at the reaction of asset markets, the shock has a small and negative (although) persistent impact on stock prices, whilst the effect on housing prices remains positive. Unemployment also becomes less volatile.

Figure 1b shows the impulse-response functions of all variables to a shock in government revenue. When the debt feedback is not taken into account in the, the results suggest that government revenue declines steadily following the shock which erodes after 10 quarters. Additionally, the shock is initially followed by a fall in government spending which then recovers and becomes positive. Contrary to a shock in government spending, the effects on GDP are slightly negative and very persistent, peaking at after 10 quarters. The evidence also suggests that government revenue shocks have a positive and persistent effect on the price level. On the other hand, there is a positive and persistent effect on long-term interest rates. In what concerns the reaction of asset markets, the empirical evidence suggests that the effects of revenue shocks tend to be rather small: despite a very small positive impact on housing and stock prices that persists for around 6 to 8 quarters, the effects then mean revert, erodes and become even slightly negative. The effects on the unemployment rate also point to a persistent increase that peaks at after around 12 quarters.

When one includes the debt feedback, the results suggest that government revenue also increases after the shock, reflecting the fall in debt-to-GDP ratio. The effects on GDP are initially negative, but mean-revert at after around 6 quarters and become positive. Moreover, the evidence suggests that government revenue shocks have a positive (but not persistent) effect on the price level, whilst the effect on long-term interest rates flips sign (vis-à-vis the absence of the budget constraint) and now becomes persistently negative in accordance to the debt stabilizing effects. In what concerns the reaction of asset markets, the empirical evidence suggests that the effects of revenue shocks tend to be amplified: stock prices are positively and persistently impacted by the shock, whilst housing prices move in the opposite direction. The effects on the unemployment rate point to an increase that peaks at after around 4 quarters, therefore, shorter than in the previous case.

Figure 2a plots the forecast error-variance decomposition of all variables to a shock in government spending. The empirical findings show that government spending shocks explain only a small percentage of the forecast-error variance decomposition of the majority of the variables included in the VAR. Interestingly, whilst the forecast-error variance decomposition of stock prices remains roughly constant at around a 2% level over time (reflecting the quick response of stock markets to the shock), the forecast-error variance decomposition of housing prices slightly increases up to 5% (in accordance to a slow adjustment of housing markets to the shock). In addition, government spending shocks explain a very important share of the forecast-error variance decomposition of government spending: initially, they represent more than 90% of the forecast-error and even after 20 quarters they correspond to around 40%, therefore, implying a high degree of persistence.

The forecast-error variance decompositions plotted in Figure 2b are also similar to the ones for the government spending shock, and show that government revenue shocks play a minor role.

*U.K.*

Figure 3a displays the impulse-response functions of all variables to a shock in government spending in the U.K. Contrary to the U.S., the results show that although government spending declines following the shock, this occurs at a very slow pace so the effect does not vanish even after 20 quarters. This is also reflected on the government revenue which increases persistently after the shock. On the other hand, the effects on GDP tend to be similar to the ones for the U.S.: they are positive and persistent. The evidence also suggests that government spending shocks have a negative effect on the price level. As for the long-term interest rates, the effects are negative, peaking at after 10 quarters. In the case of asset markets, housing prices increase with a lag of around 4 quarters and remain at a persistently higher level. Regarding stock prices they record a small fall following the spending shock, but they recover after 8 quarters and reach a persistently higher level. Contrary to the U.S., unemployment initially rises but the effect mean reverts after 14 quarters and even becomes negative.

Contrary to the case in which we do not consider the debt feedback, the results suggest that, following the shock in government spending, government revenues increase but the effect is now less persistent and erodes after around 8 quarters. Additionally, whilst there is still a negative impact on long-term interest rates, the effect is substantially smaller in magnitude and less pronounced. This, therefore, explains why GDP initially falls and mean-reverts at after around 12 quarters, whilst the price level initially goes up and mean-reverts at after 8 quarters. The debt dynamics is also responsible for the response patterns of the asset markets: housing prices are now negatively impacted by the shock, whilst the initial negative effect on stock prices becomes more pronounced. Finally, the rise in unemployment is more persistent.

Figure 3b shows the impulse-response functions of all variables to a shock in government revenue. Similarly to a shock in government spending, the results show that government revenue declines following the shock, but at a very slow pace so the effect vanishes only after 20 quarters. The shock is also followed by a persistent fall in government spending. On the other hand, the effects on GDP are marginally positive for around 12 quarters but then become negative, whilst the price level is negatively impacted by the shock on government revenue. Interest rates fall after the shock in government revenue but the effect becomes positive after around 10 quarters. Regarding the reaction of asset markets, the empirical evidence suggests that the effects of revenue shocks tend to be significant and positive both for housing and stock prices, although more persistent in the first case: housing prices remain at a persistently higher level after 20 quarters with the peak of the effect being reached at after around 12 quarters; and stock prices increase for around 12 quarters, but then the effect disappears and becomes negative as a result of the downturn in GDP. The effect on unemployment is negative peaking at after 8 quarters.

A major difference relative to the previous findings is that the average cost of financing the debt is roughly unaffected – whilst it is negatively affected when the debt dynamics is not included – as a result of the smaller GDP growth.

Figure 4a plots the forecast-error variance decomposition of all variables in the VAR. Government spending shocks explains around 20% of the forecast-error variance decomposition of government spending. In addition, spending shocks explain around 5% of the forecast-error of stock prices, and only 2% of housing prices.

Figure 4b displays the forecast-error variance decompositions and shows that government revenue shocks explain around 35% of the forecast-error in housing prices and 15% of the forecast-error in stock prices.

*Germany*

Figure 5a displays the impulse-response functions of all variables to a shock in government spending in Germany. Similarly to the U.S., the results show that government spending declines quickly after the shock, eroding after around 12 quarters. The shock is followed by a very short but positive impact on government revenue. The effects on GDP are positive, peak at after 4 quarters, and erode after 12 quarters. On the other hand, the evidence suggests that government spending shocks have a negative and persistent effect on the price level, although small in magnitude. As for the long-term interest rates, there is a negative effect that persists even after 20 quarters. This aspect is also an important determinant of the dynamics that one observes in the asset markets:

housing prices go up persistently; stock prices also rise but the effect quickly disappears after 4 quarters. Finally, the results suggest that after a government spending shock, the unemployment slightly rises.

When we include the debt feedback, the effect on GDP is smaller whilst the cost of refinancing debt is positively affected, suggesting that debt dynamics is important. As a result, stock prices are negatively impacted (before the effect was positive) and housing prices react less positively to the shock.

Figure 5b shows the impulse-response functions of all variables to a shock in government revenue. Similarly to the U.S., the results show that government revenue declines quickly after the shock, eroding after 2 quarters, and being followed by a reduction in government spending that persists for around 8 quarters. On the other hand, contrary to the U.S. and despite a very small and negative initial impact, the effects on GDP are positive although small. Additionally, both the price level and the long-term interest rates are positively and persistently impacted by the shock. Regarding the reaction of asset markets, the empirical evidence suggests that the effects of revenue shocks tend to be positive *only* for housing prices, which react with a lag of around 4 quarters. Stock prices initially rise but the effect later mean reverts and becomes negative after 8 quarters. Finally, the evidence suggests that government revenue shocks have a very pronounced and negative effect on the unemployment rate, which peaks at after around 8 quarters.

Including the feedback from government debt implies that the average cost of financing debt is now negatively impacted as a result of the debt dynamics, that is, the implicit fall in the debt-to-GDP ratio. The fall in long-term interest rates also affects the reaction of asset markets: by including the debt feedback, *both* housing and stock prices are positively impacted, whilst before that happened *only* in the case of housing prices.

Figure 6a shows the forecast-error variance decompositions of all variables to a shock in government spending. It can be seen that government spending shocks explain a large share (initially, close to 80%) of the forecast-error for government spending. Moreover, it shows that shocks to spending also play an important role for the forecast-error of the housing prices (around 20%), price level (10%), and just a small share (less than 5%) of stock prices.

Figure 6b shows the forecast-error variance decompositions of all variables to a shock in government revenue. Interestingly and contrary to government spending, government revenue shocks explain a smaller percentage of the forecast-error variance decomposition for the majority of the variables included in the system.

*Italy*

Figure 7a displays the impulse-response functions of all variables to a shock in government spending in Italy. The results show that government spending declines quickly after the shock, eroding after 2 to 4 quarters. The effects on GDP are also similar: GDP (despite a very small positive initial effect) falls after the shock in government spending, suggesting a “crowding-out” effect. The empirical evidence also suggests that government spending shocks have a positive and persistent effect on both the price level and the long-term interest rate. In what concerns the reaction of asset markets, the shock in government spending has a positive impact on housing prices (that peaks at after around 6 to 8 quarters) and negative and very persistent effect on stock prices. The fall in stock prices peaks after 2 quarters showing that stock markets react quickly. Finally, there is no evidence of a significant effect of government spending on the unemployment rate.

The results are similar in the case where the debt feedback is not included.

Figure 7b shows the impulse-response functions of all variables to a shock in government revenue. Similarly to a shock in government spending, the results show that government revenue declines quickly after the shock, eroding after 2 quarters. Additionally, the effects on GDP are negative, although not persistent as they vanish after 4 quarters. Regarding the reaction of asset markets, the empirical evidence shows that the effects of government revenue shocks tend to be positive for stock prices and negative for housing prices. This suggests that whilst the credit channel (that is, the fall in interest rates) impacts positively in stock markets, for housing markets that channel is annihilated by the “crowding-out” effects. Finally, the evidence suggests that unemployment rate rises after the shock in government revenue, whilst there are no significant effects on the price level.

The results are again similar to the case where the feedback from government debt is not included in the estimation.

Figure 8a shows the error-forecast variance decompositions of all variables to a government spending shock and shows that it plays a minor role for asset prices.

Similarly, Figure 8b displays the forecast-error variance decompositions and shows that government revenue shocks explain a small share of the forecast-error for the majority of the non-fiscal variables.

### 4.3 A VAR counter-factual exercise

In this sub-section, we describe a VAR counter-factual exercise aimed at describing the effects of shutting down the shocks in government spending or government revenue. In practice, after estimating the fully simultaneous system of equations summarized by (1), (2) and (3), we construct the counter-factual (*CFT*) series as follows:

$$\underbrace{\Gamma(L)}_{n\times n}\underbrace{X_t^{CFT}}_{n\times 1} + \gamma_i d_{t-1} = \Gamma_0 X_t^{CFT} + \Gamma_1 X_{t-1}^{CFT} + \ldots + \gamma_i d_{t-1} = c + \varepsilon_t^{CFT} \qquad (5)$$

$$d_t = \frac{1+i_t}{(1+\pi_t)(1+\mu_t)} d_{t-1} + \frac{G_t - T_t}{P_t Y_t} \qquad (6)$$

$$v_t^{CFT} = \Gamma_0^{-1} \varepsilon_{\mathrm{t}}^{\mathrm{CFT}} \; . \qquad (7)$$

Since we are interested in analysing the role played by fiscal policy shocks, this is equivalent to consider the following vector of structural shocks

$$\varepsilon_t^{CFT} = \left[\varepsilon_t^{SP}, 0, \varepsilon_t^{T}, \varepsilon_t^{Y}, \varepsilon_t^{P}, \varepsilon_t^{i}, \varepsilon_t^{U}, \varepsilon_t^{HP}\right]' \qquad (8)$$

$$\varepsilon_t^{CFT} = \left[\varepsilon_t^{SP}, \varepsilon_t^{G}, 0, \varepsilon_t^{Y}, \varepsilon_t^{P}, \varepsilon_t^{i}, \varepsilon_t^{U}, \varepsilon_t^{HP}\right]' \qquad (9),$$

where we shut down, respectively in (8) and in (9), the government spending shock and the government revenue shock, and then use these vectors of counter-factual structural shocks to build the counter-factual series for all endogenous variables of the system.

Figure 9a and 9b plot the actual and the counter-factual series for stock prices and housing prices in the U.S. and in the case of, respectively, a shock to government spending and a shock to government revenue. The results show that fiscal policy shocks play a minor role as the difference between the actual and the counterfactual series are negligible.

Similarly, Figures 10a and 10b plot the actual and the counter-factual series for stock prices and housing prices in the U.K. and in the case of, respectively, a shock to government spending and a shock to government revenue. Contrary to the U.S., the results show that fiscal policy shocks play an important role. In fact, it can be seen that the actual and the counter-factual series are substantially different, in particular: (i) during the nineties, in the case of stock prices; and (ii) in the late eighties and early nineties, for housing prices.

Figures 11a and 11b depict the actual and the counter-factual series for stock prices and housing prices in Germany and in the case of, respectively, a shock to government spending and a shock to government revenue. The results suggest that fiscal policy shocks are less relevant determinants of asset markets. In fact, whilst the difference between actual and counter-factual series are negligible for stock prices, in the case of housing prices that difference seems significant only after 2000 and contributed to a more stable performance of the market.

Figure 12a and 12b show the actual and the counter-factual series for stock prices and housing prices in Italy and in the case of, respectively, a shock to government spending and a shock to government revenue. The results suggest that fiscal policy shocks, in particular, those on the revenue side, are important determinants of asset markets. Moreover, they show that unexpected variance in the fiscal policy stance has a disturbing effect on those markets, increasing their volatility. This is particularly so after the second half of the nineties and notably for a government revenue shock.

## 5. Conclusion

This paper evaluates the effects of fiscal policy on economic activity, with a particular emphasis on the linkages between fiscal policy and asset markets.

The fiscal policy shocks are identified using external information about the elasticity of fiscal variables to the economic activity as in Blanchard and Perotti (2002). Moreover, we use a Fully Simultaneous System approach in a Bayesian framework built on the works of Leeper and Zha (2003), and Sims and Zha (1999, 2006), therefore, accounting for the posterior uncertainty of the impulse-response functions. In addition, we explicitly include the feedback from the government debt in our framework.

We show that government spending shocks: (i) have a positive and persistent effect on GDP in the U.S. and the U.K., while for Germany and Italy, the (positive) impact is temporary and becomes negative after 4 to 8 quarters; (ii) have a positive and persistent effect on housing prices, although housing markets tend to respond with a lag of around 4 quarters; (iii) have a negative effect on stock prices, although the time of reaction is faster than for housing prices; (iv) have positive effects on the price level in the case of the U.K. and Italy, and negative effects for the U.S. and Germany; and (v) reduce unemployment only in the U.S. On the other hand, government revenue shocks:

(i) have an initial negative effect on GDP that later becomes positive; (ii) have a negative impact on housing prices for the U.S. and Italy, and a positive impact for the U.K. and Germany; (iii) have a small and positive effect on stock prices; (iv) have, in general, a negative and persistent effect on the price level; and (iv) have a positive and persistent impact on the unemployment rate.

Long-term interest rates and GDP become more responsive and the effects on these variables also become more persistent when we explicitly include the debt feedback in the estimations.

Finally, in a VAR counter-factual exercise, we show that: (i) fiscal policy shocks play a minor role in the patterns that one observes for stock prices and housing prices in the U.S. and Germany; (ii) both spending and revenue shocks have an important effect on asset markets in the U.K.; and (iii) for Italy, government revenue shocks increased the volatility in housing and stock prices, in particular, in the nineties.

A possible extension of the current work is to introduce a disaggregated approach, by analyzing the effects of shocks in the different components of government revenue (direct taxes on households, direct taxes on corporations, indirect taxes, and employers' social security contributions) and government spending (wages, non-wage expenditure).

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## Appendix A. Assessing posterior uncertainty in a Fully Simultaneous SVAR

To be able to identify the structural fiscal policy shocks we need at least *(n-1)n/2* linearly independent restrictions. With enough restrictions in the $\Gamma_0$ matrix and no restrictions in the matrix of coefficients on the lagged variables, the estimation of the model is numerically simple since the log-likelihood will be

$$l(B,a,\Gamma_0) = -\frac{T}{2} + \log|\Gamma_0| - \frac{1}{2} trace\left[S(B,a)\Gamma_0{}'\Gamma_0\right] \qquad \text{(A.1)}$$

where $S(B,a) = \sum_{t=1}^{T}(B(L)X_t - a)(B(L)X_t - a)'$. Integrating $l(B,a,\Gamma_0)$ (or the posterior with conjugate priors) with respect to *(B, a)* the marginal log probability density function of $\Gamma_0$ is proportional to

$$-\frac{T-k}{2}\log(2\pi) + (T-k)\log|\Gamma_0| - \frac{1}{2} trace\left[S(\hat{B}_{OLS}, \hat{a}_{OLS})\Gamma_0{}'\Gamma_0\right]. \qquad \text{(A.2)}$$

The impulse-response function to a one standard-deviation shock is given by:

$$B(L)^{-1}\Gamma_0{}^{-1}. \qquad \text{(A.3)}$$

This implies that to assess posterior uncertainty regarding the impulse-response function we need joint draws for both *B(L)* and $\Gamma_0$.

Since equation (A.2) is not in the form of any standard probability density function, we cannot draw $\Gamma_0$ from it directly to make inference. Nevertheless, taking a second order expansion around its peak, we get the usual Gaussian approximation to the asymptotic distribution of the elements in $\Gamma_0$.

In addition, since this is not the true form of the posterior probability density function, we cannot use it directly to produce a Monte Carlo sample. Therefore, we follow an importance sampling approach, in which we draw from the Gaussian approximation but weigh the draws by the ratio of (A.2) to the probability density function from which we draw. The weighted sample cumulative density function then approximates the cumulative density function corresponding to (A.2).

Note also that the distribution of *B(L)*, given $\Gamma_0$, is the usual normal distribution:

$$vech(B(L))\,|\,\Gamma_0 \sim \mathrm{N}(vech(\hat{B}_{OLS}), \Gamma_0{}^{-1}(\Gamma_0{}^{-1})' \otimes (X'X)^{-1}). \qquad \text{(A.4)}$$

Therefore, we can take joint draws using the following simple algorithm: (i) draw $\Gamma_0$ using importance sampling; and (ii) draw *vech(B(L))* using the expression above.

Error bands for the impulse-response function are then constructed from the weighted percentiles of the Monte Carlo sample and computed as follows.

Denote $\hat{H}$ the numerical Hessian from the minimization routine at the point estimate and $\hat{\Gamma}_0$ the maximum-likelihood estimator, and follow the following algorithm:

1. Check that all the coefficients on the main diagonal of $\Gamma_0$ are positive. If they are not, flip the sign of the rows that have a negative coefficient on the main diagonal (that is, our point estimates are normalized to have positive elements on the main diagonal).
2. Set $i=0$.
3. Draw $vech(\Gamma_0)$ from a normal $\mathrm{N}(vech(\Gamma_0), V)$, where $V=H^{-1}$ and *vech(.)* vectorizes the unconstrained elements of a matrix. That is, this step draws from the asymptotic distribution of $\Gamma_0$. There are 3 possible options to handle draws in which some of the diagonal elements of $\Gamma_0$ are not positive:

a. reject the draw and go back to 2. to take another draw (this is what is done in Sims and Zha (2006) and we follow their approach);
b. reject the draw if and only if one of the negative entries on the main diagonal are more than "alpha" standard deviations away from the maximum-likelihood estimator;
c. accept the draw and continue.

4. Compute and store the importance sampling weight, *m*,

$$m_i = \exp\left[\begin{array}{c} T\log\left|\det(\tilde{\Gamma}_0)\right| - \frac{1}{2}trace\left[S(\hat{B}_{OLS},\hat{a}_{OLS})\tilde{\Gamma}_0{}'\tilde{\Gamma}_0\right] \\ -\log\left|\hat{V}\right|^{-\frac{1}{2}} + .5(vech(\tilde{\Gamma}_0) - vech(\tilde{\Gamma}_0))'\hat{V}^{-1}(vech(\tilde{\Gamma}_0) - vech(\hat{\Gamma}_0)) \\ -SCFT \end{array}\right]$$

where SCFT is a scale factor that prevents overflow/underflow (a good choice for it is normally the value of the likelihood at its peak).[5]

5. Draw $vech(\tilde{B}(L))$ from a normal $N(vech(\hat{B}_{OLS}),\tilde{\Gamma}_0{}^{-1}(\tilde{\Gamma}_0{}^{-1})'\otimes(X'X)^{-1})$ to get a draw for $\tilde{B}(L)$.
6. Compute the impulse-response function and store it in a multidimensional array.
7. If $i < \#draws$, set $i = i+1$ and go back to 3.

The stored draws of the impulse-response function, jointly with the importance sampling weights, are used to construct confidence bands from their percentiles. Moreover, the draws of $\Gamma_0$ are stored to construct posterior confidence interval for these parameters from the posterior (weighted) quantiles.

Normalized weights that sum up to 1 are simply constructed as:

$$\omega_i = \frac{m_i}{\sum_{i=1}^{\#draws} m_i}.$$

When the number of draws is sufficiently large for the procedure outlined above to deliver accurate inference, the plot of the normalized weights should ideally show that none of them is too far from zero - that is, one single draw should not receive 90% of the weight.[6]

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5 Confidence bands constructed using unweighted quantiles are asymptotically justified (due to the asymptotic Gaussianity), and are good to give a quick look at the shape of the impulse-response function using a small number of draws. The unweighted approach should be used with caution since: (i) it is likely to produce unrealistically tight bands in the presence of multiple local maxima; and (ii) will not capture asymmetries of the confidence bands (what are important in detecting whether and impulse-response function is significantly different from zero).

6 When the importance sampling performs too poorly (due to the variability in the weights), one can replace that part of the algorithm with the random walk Metropolis Markov-Chain Monte Carlo of Waggoner and Zha (1997) *using also their approach to handle switch in the sign of the rows of* $\Gamma_0$ (that is, use a normalization for each draw that minimizes the distance of $\Gamma_0$ from the maximum likelihood estimate).

## Appendix B. Data sources

*B.1 U.S. Data*

Housing Sector

Housing prices are measured using two sources: (a) the Price Index of New One-Family Houses sold including the Value of Lot provided by the U.S. Census, an index based on houses sold in 1996, available for the period 1963:1-2006:3; and (b) the House Price Index computed by the Office of Federal Housing Enterprise Oversight (OFHEO), available for the period 1975:1-2007:4. Data are quarterly, seasonally adjusted.

Housing Market Indicators

Other Housing Market Indicators are provided by the U.S. Census. We use the Median Sales Price of New Homes Sold including land and the New Privately Owned Housing Units Started. We seasonally adjust quarterly data for the Median Sales Price of New Homes Sold including land using Census X12 ARIMA, and the series comprise the period 1963:1-2007:4. The data for the New Privately Owned Housing Units Started are quarterly (computed by the sum of corresponding monthly values), seasonally adjusted and comprise the period 1959:1-2007:4.

GDP

The source is Bureau of Economic Analysis, NIPA Table 1.1.5, line 1. Data for GDP are quarterly, seasonally adjusted, and comprise the period 1947:1-2007:4.

Price Deflator

All variables were deflated by the GDP deflator. Data are quarterly, seasonally adjusted, and comprise the period 1967:1-2007:4. The source is the Bureau of Economic Analysis, NIPA Tables 1.1.5 and 1.1.6, line 1.

Stock Market Index

Stock Market Index corresponds to S&P 500 Composite Price Index (close price adjusted for dividends and splits). Data are quarterly (computed from monthly series by using end-of-period values), and comprise the period 1950:1-2007:4.

Government Spending

The source is Bureau of Economic Analysis, NIPA Table 3.2. Government Spending is defined as primary government expenditure, obtained by subtracting from total Federal Government Current Expenditure (line 39) net interest payments at annual rates (obtained as the difference between line 28 and line 13). Data are quarterly, seasonally adjusted, and comprise the period 1960:1-2007:4.

Government Revenue

The source is Bureau of Economic Analysis, NIPA Table 3.2. Government Revenue is defined as government receipts at annual rates (line 36). Data are quarterly, seasonally adjusted, and comprise the period 1947:1-2007:4.

Debt

Debt corresponds to the Federal government debt held by the public. The source is the Federal Reserve Bank of St Louis (series “FYGFDPUN”). Data are quarterly, seasonally adjusted, and comprise the period 1970:1-2007:4.

Average Cost of Financing Debt

The average cost of financing debt is obtained by dividing net interest payments by debt at time *t-1*.

Long-Term Interest Rate
Long-Term Interest Rate corresponds to the yield to maturity of 10-year government securities. Data are quarterly, and comprise the period 1960:1-2007:4. The source is the OECD, Main Economic Indicators (series "USA.IRLTLT01.ST").

Unemployment Rate
Unemployment rate is defined as the civilian unemployment rate (16 and over) (series "LNS14000000"). Data are quarterly (computed from monthly series by using end-of-period values), seasonally adjusted and comprise the period 1948:1-2007:4. The source is the Bureau of Labour Statistics, Current Population Survey.

*B.2 U.K. Data*
Housing Prices
Housing prices are measured using two sources: (a) the Mix-Adjusted House Price Index (Feb 2002 = 100) provided by the Office of the Deputy Prime Minister (ODPM), seasonally adjusted, and available for the period 1968:2-2007:4; and (b) the All-Houses Price Index (1952Q4 = 100 and 1993Q1=100) computed by the Nationwide Building Society, which we seasonally adjust using Census X12 ARIMA, and is available for the period 1952:4-2007:4.

GDP
Data for GDP are quarterly, seasonally adjusted, and comprise the period 1955:1-2007:4. The source is the Office for National Statistics, Release UKEA, Table A1 (series "YBHA").

Price Deflator
All variables were deflated by the GDP deflator. Data are quarterly, seasonally adjusted, and comprise the period 1955:1-2007:4. The source is the Office for National Statistics, Release MDS, Table 1.1 (series “YBGB”).
Stock Market Index
Stock Market Index corresponds to the FTSE-All Shares Index (1962:2=100 or 1962 April=100). Data are quarterly, and comprise the period 1962:2-2007:4. The source is Datastream.

Government Spending
The source is the Office for National Statistics (ONS), Release Public Sector Accounts. Government Spending is defined as total current expenditures of the Public Sector ESA 95 (series “ANLT”) less net investment (series “ANNW”), to which we subtract net interest payments (obtained as the difference between interest and dividends paid to private sector (series “ANLO”) and interest and dividends received from the private sector and the Rest of World (series “ANBQ”). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1947:1-2007:4.

Government Revenue
The source is the Office for National Statistics (ONS), Release Public Sector Accounts. Government Revenue is defined as total current receipts of the Public Sector ESA 95

(series “ANBT”). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1947:1-2007:4.

Debt
The source is the Office for National Statistics (ONS), Release Public Sector Accounts. Debt is defined as the Public Sector net debt (series “BKQK”). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1962:4-2007:4.

Average Cost of Financing Debt
The average cost of financing debt is obtained by dividing net interest payments by debt at time $t-1$.

Long-Term Interest Rate
Long-Term Interest Rate corresponds to the yield to maturity of 10-year government securities. Data are quarterly, and comprise the period 1957:1-2007:4. The source is the IMF, International Financial Statistics (series "61...ZF").

Unemployment Rate
The source is the Office for National Statistics, Labour Market Statistics. Unemployment rate is defined as the U.K. unemployment rate among all aged 16 and over (series "MGSX"). Data are: quarterly, seasonally adjusted and comprise the period 1971:1-2007:4.

*B.3 Germany Data*
Housing Prices
Housing prices correspond to the residential property price index. Data are quarterly, seasonally adjusted, and available for the period 1970:1-2006:4. The source is the Bank for International Settlements (BIS).

GDP
Data for GDP are quarterly, seasonally adjusted, and comprise the period 1960:1-2007:4. The source is the IMF, International Financial Statistics (series "IFS.Q.134.9.9B.B$C.Z.F.$$$").

Price Deflator
All variables were deflated by the GDP deflator (2000=100). Data are quarterly, seasonally adjusted, and comprise the period 1960:1-2007:2. The source is the IMF, International Financial Statistics (series "IFS.Q.134.9.9B.BIR.Z.F.$$$”).

Stock Market Index
Stock Market Index corresponds to the MSCI-Gross Return Index (1969:4=100). Data are quarterly, and comprise the period 1969:4-2007:4. The source is Morgan Stanley Capital International.

Government Spending
The source is the Bundesbank and the Monthly Reports released by the German Ministry of Finance. Government Spending is defined as Central Government total expenditure (on a cash basis). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1979:1-2007:3.

Government Revenue

The source is the Bundesbank and the Monthly Reports released by the German Ministry of Finance. Government Revenue is defined as Central Government total revenue (on a cash basis). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1979:1-2007:3.

Debt

The source is the Bundesbank and the Monthly Reports released by the German Ministry of Finance. Debt is as the Central, state and local government debt (excluding hospitals). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1966:4-2007:4.

Average Cost of Financing Debt

The average cost of financing debt is obtained by dividing net interest payments by debt at time *t-1*.

Long-Term Interest Rate

Long-Term Interest Rate corresponds to the yield to maturity of 10-year government securities. Data are quarterly, and comprise the period 1957:1-2007:4. The source is the IMF, International Financial Statistics (series "61...ZF").

Unemployment Rate

The source is the OECD, Main Economic Indicators. Unemployment rate is defined as the registered unemployment rate among all persons (series "MEI.Q.DEU.UNRTRG01.STSA"). Data are quarterly, seasonally adjusted, and comprise the period 1969:1-2007:4.

*B.4 Italy Data*

Housing Prices

Housing prices correspond to the residential property price index. Data are quarterly, seasonally adjusted, and available for the period 1970:1-2006:4. The source is the Bank for International Settlements (BIS).

GDP

Data for GDP are quarterly, seasonally adjusted, and comprise the period 1960:1-20073. The source is the IMF, International Financial Statistics (series "IFS.Q.136.9.9B.B$C.Z.F.$$$").

Price Deflator

All variables were deflated by the GDP deflator (2000=100). Data are quarterly, seasonally adjusted, and comprise the period 1980:1-2007:2. The source is the IMF, International Financial Statistics (series "IFS.Q.136.9.9B.BIR.Z.F.$$$").

Stock Market Index

Stock Market Index corresponds to the MSCI-Gross Return Index (1969:4=100). Data are quarterly, and comprise the period 1969:4-2007:4. The source is Morgan Stanley Capital International.

Government Spending

The source is the Bank of Italy and the Italian Ministry of Finance. Government Spending is defined as Central Government total expenditure (on a cash basis). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1960:1-2007:4.

Government Revenue

The source is the Bank of Italy and the Italian Ministry of Finance. Government Revenue is defined as Central Government total revenue (on a cash basis). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1960:1-2007:4.

Debt

The source is the Bank of Italy. Debt is as the stock of General Government short-term (“S571730M”), and medium and long-term securities (“S605216M”). We seasonally adjust quarterly data using Census X12 ARIMA, and the series comprise the period 1984:4-2007:4.

Average Cost of Financing Debt

The average cost of financing debt is obtained by dividing net interest payments by debt at time *t-1*.

Long-Term Interest Rate

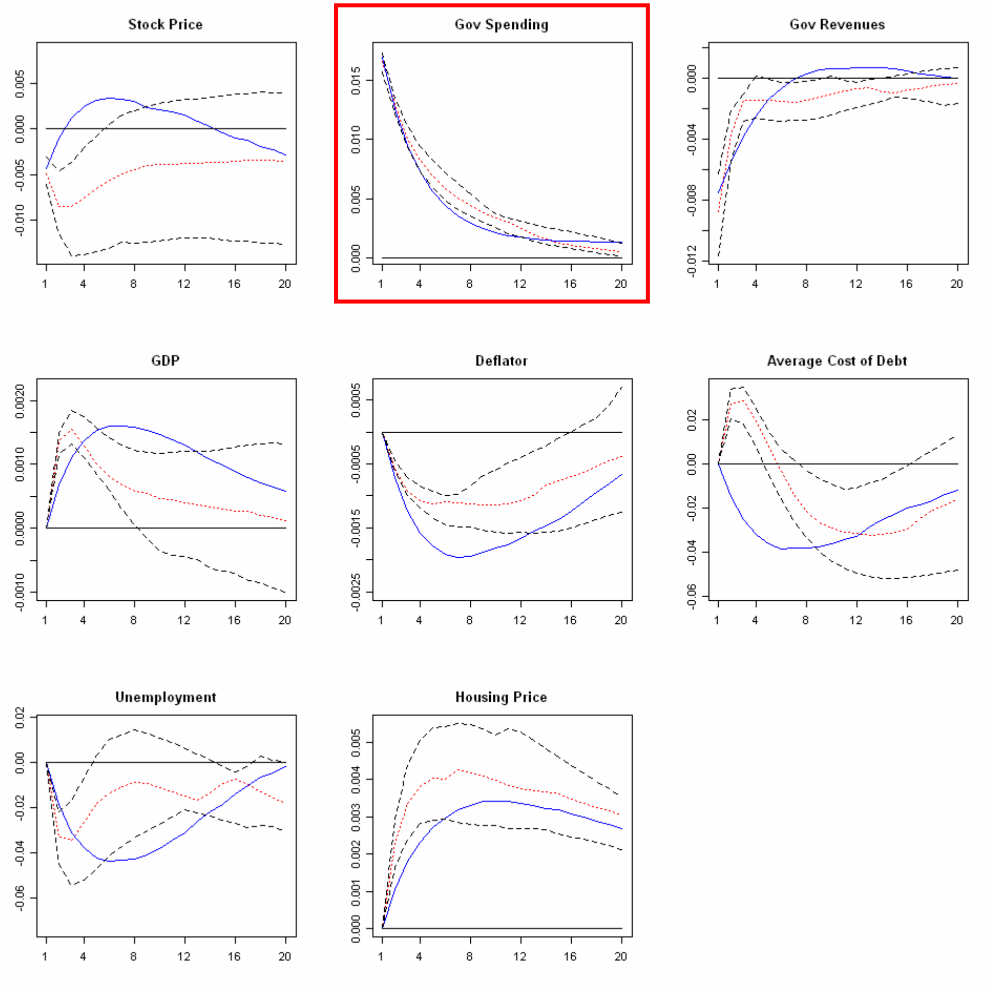
Long-Term Interest Rate corresponds to the yield to maturity of 10-year government securities. Data are quarterly, and comprise the period 1957:1-2007:4. The source is the IMF, International Financial Statistics (series "61...ZF").

Unemployment Rate

The source is the OECD, Main Economic Indicators. Unemployment rate is defined as the registered unemployment rate among all persons (series “MEI.Q.ITA.UNRTSUTT.STSA”). Data are quarterly, seasonally adjusted, and comprise the period 1960:1-2007:4.

Figure 1 – Impulse-response functions, US.

1a – spending shock




1b – revenue shock

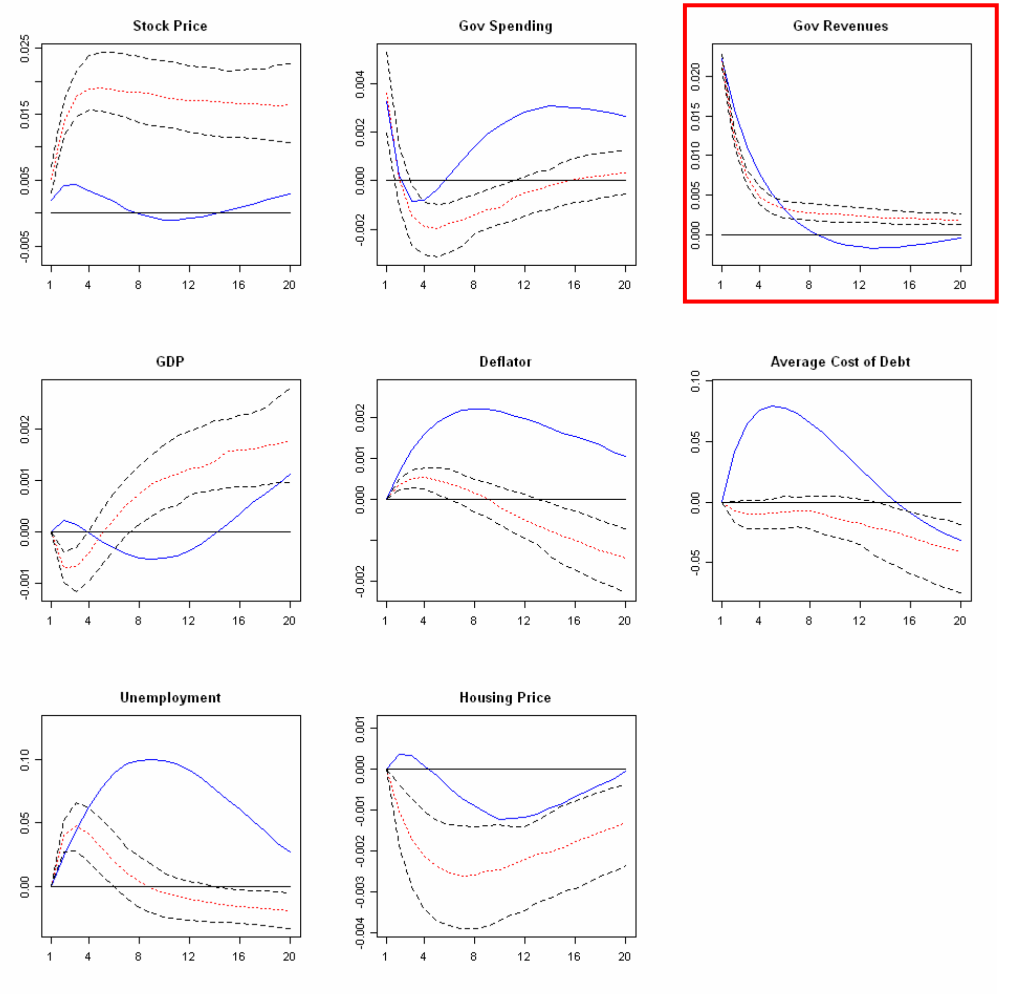
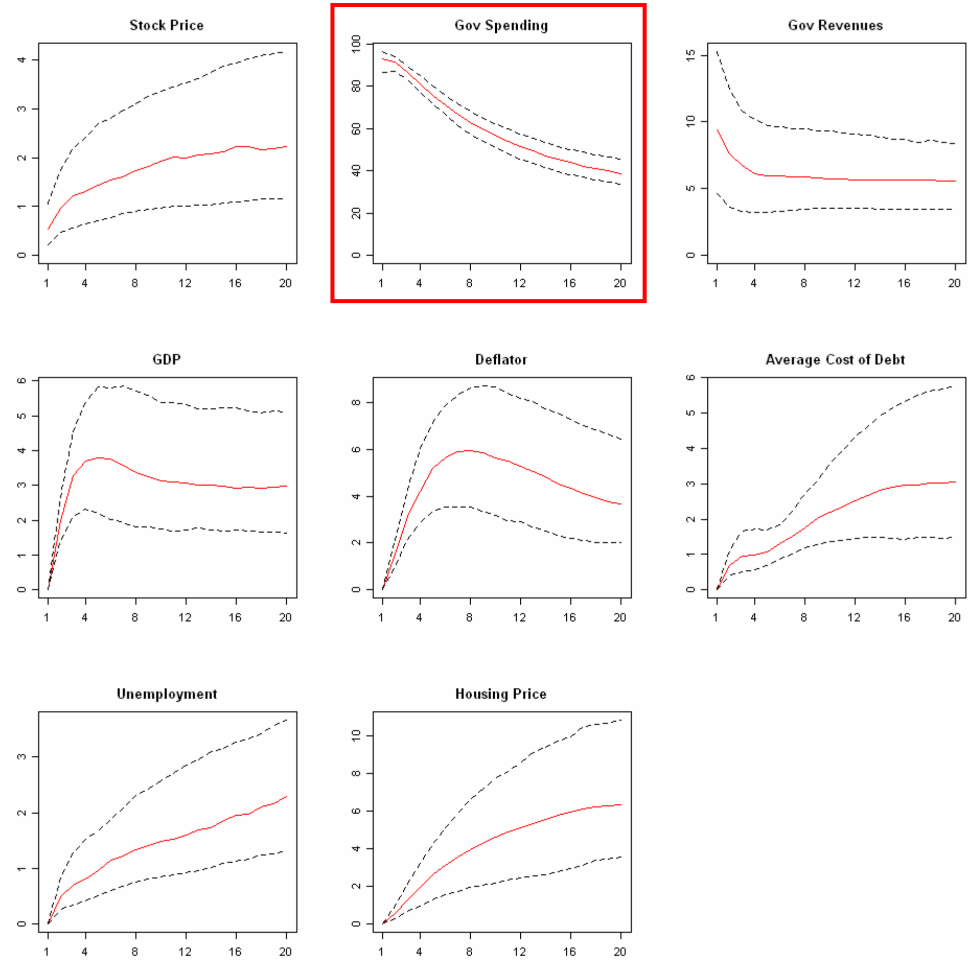


Figure 2 – Forecast-error variance decomposition, US.

2a – spending shock




2b – revenue shock

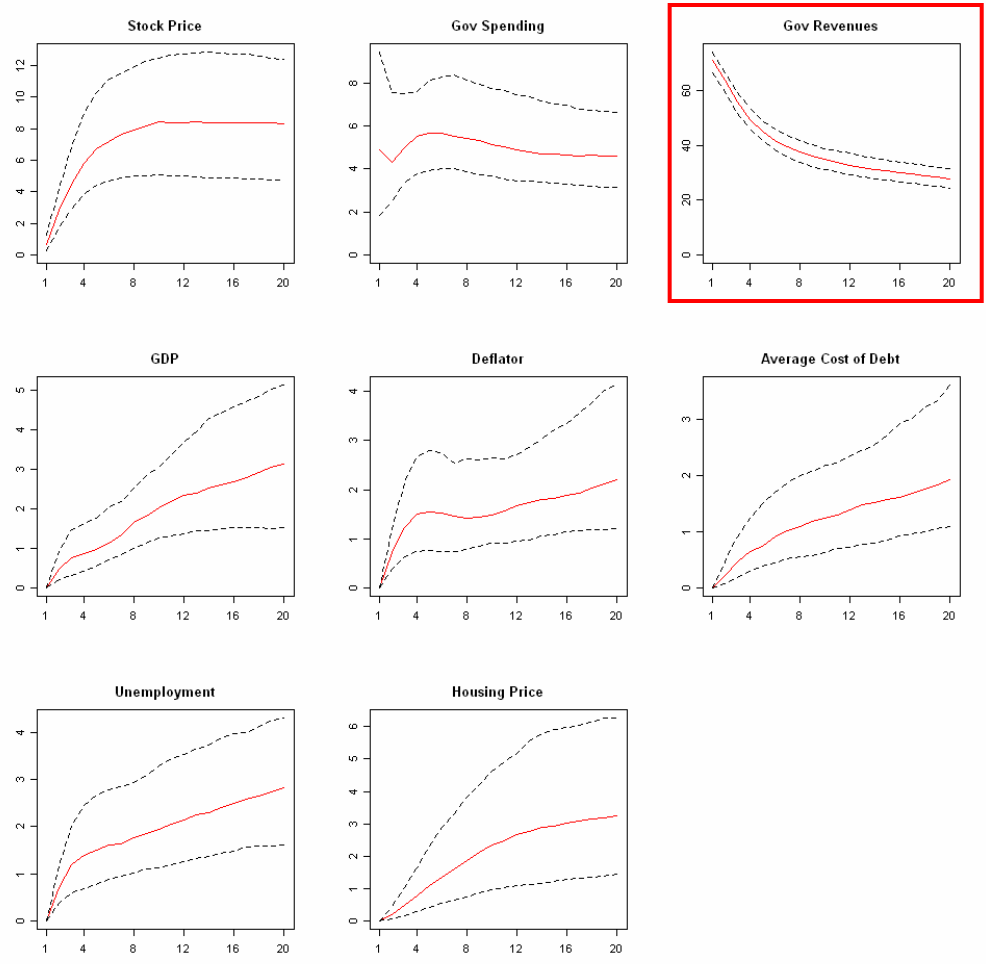


Figure 3 – Impulse-response functions, UK.

3a – spending shock

3b – revenue shock

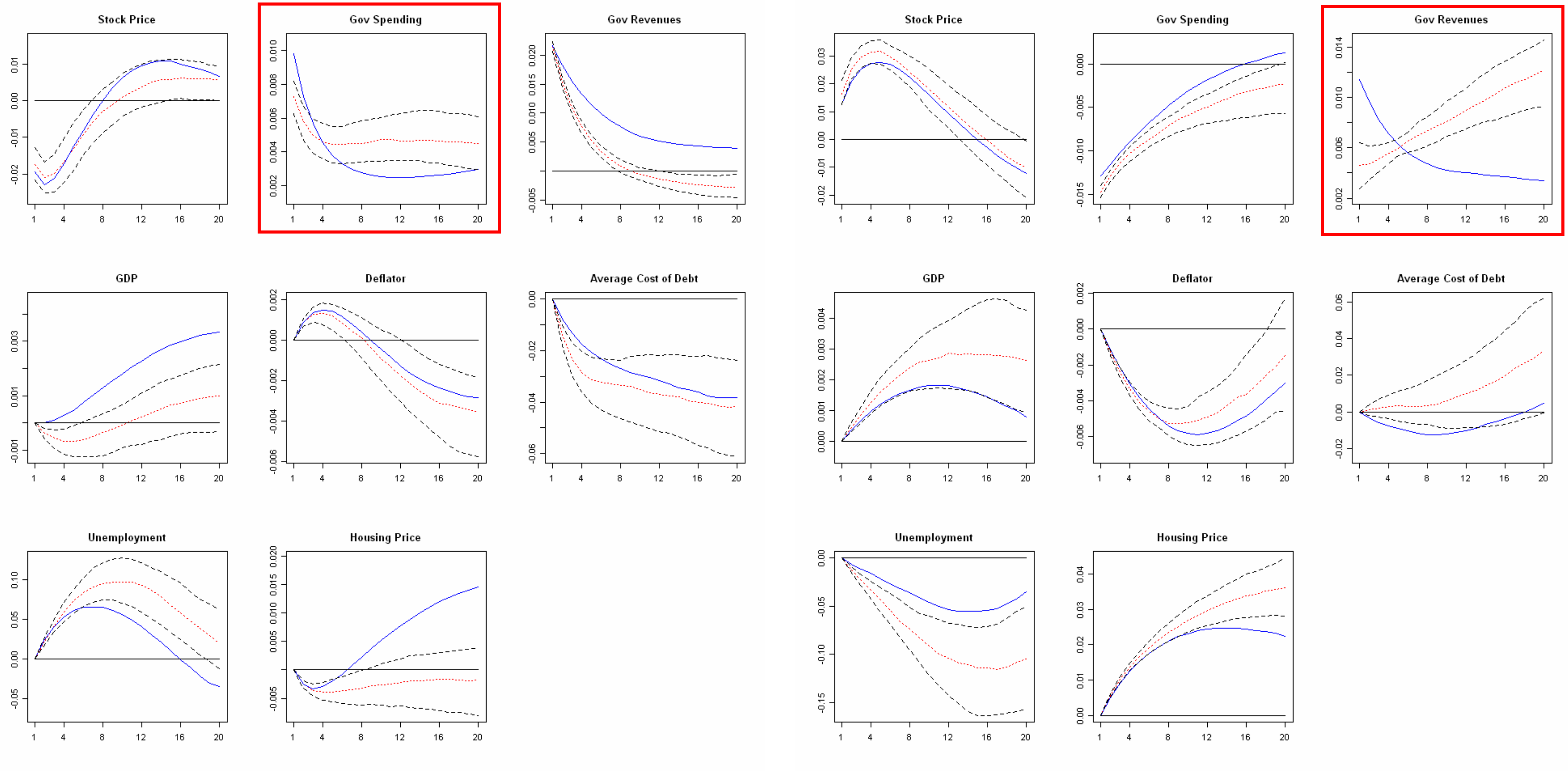
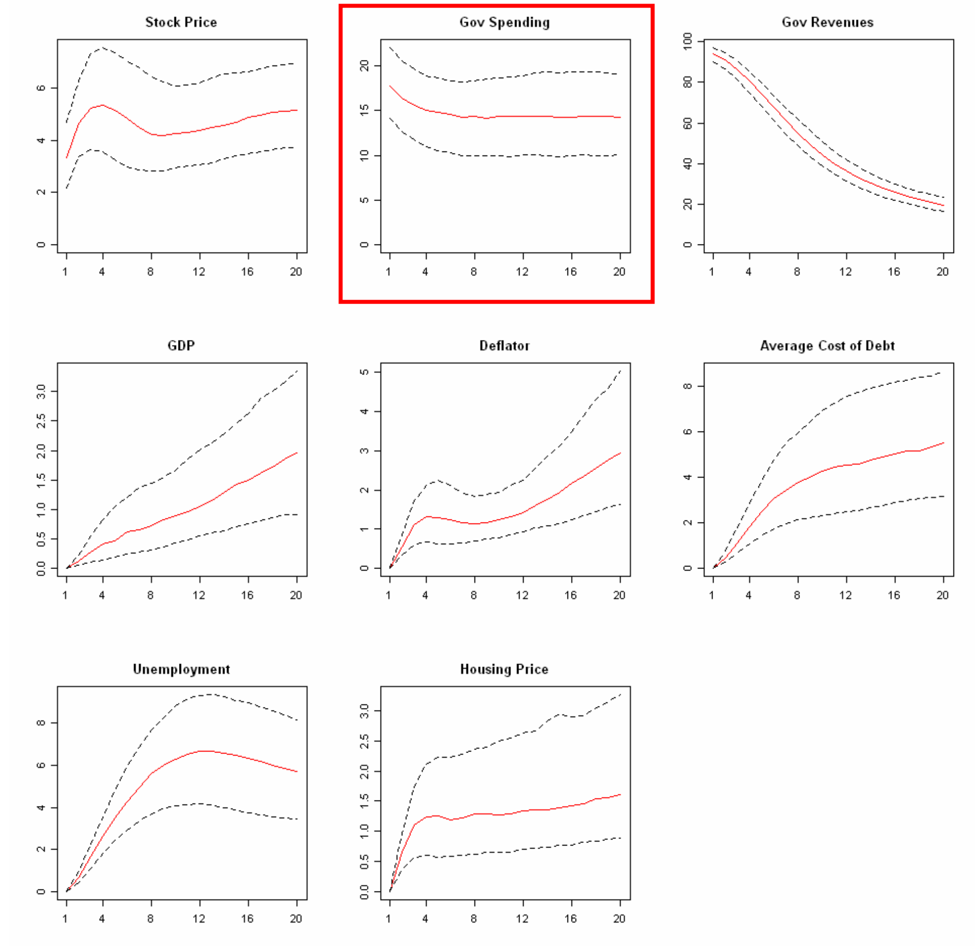


Figure 4 – Forecast-error variance decomposition, UK.

4a – spending shock




4b – revenue shock

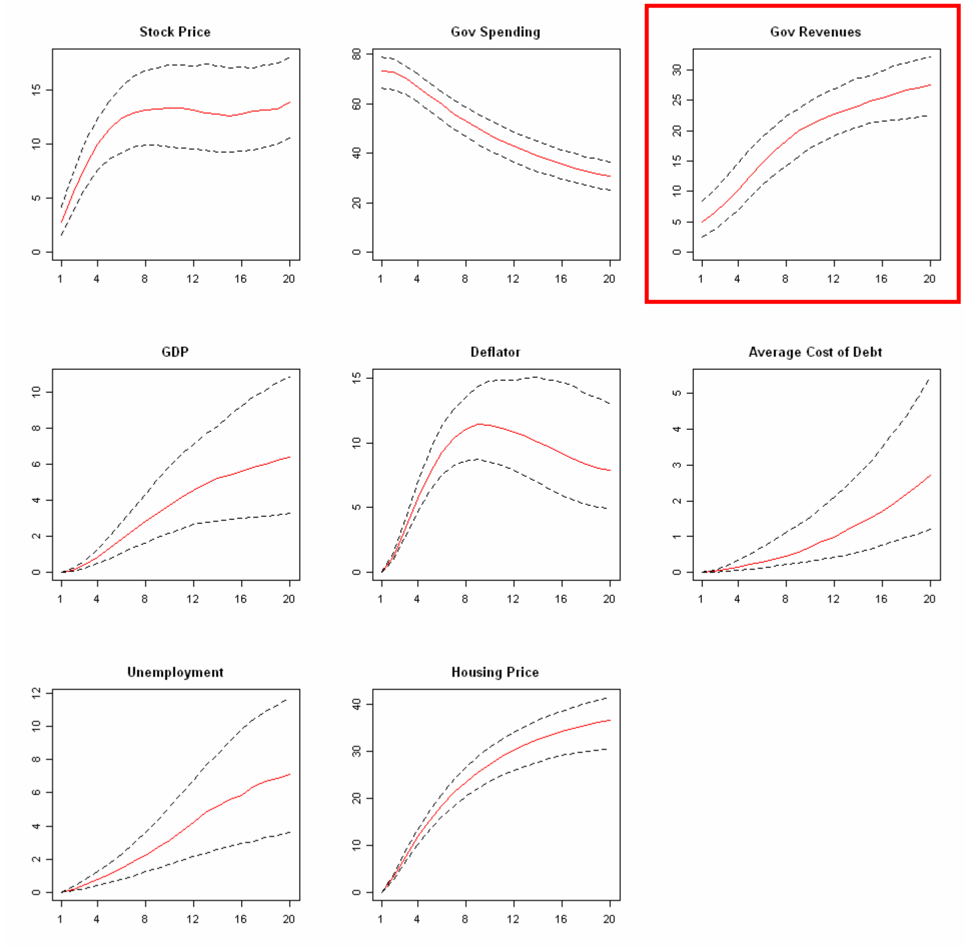


Figure 5 – Impulse-response functions, Germany.

5a – spending shock                                        5b – revenue shock

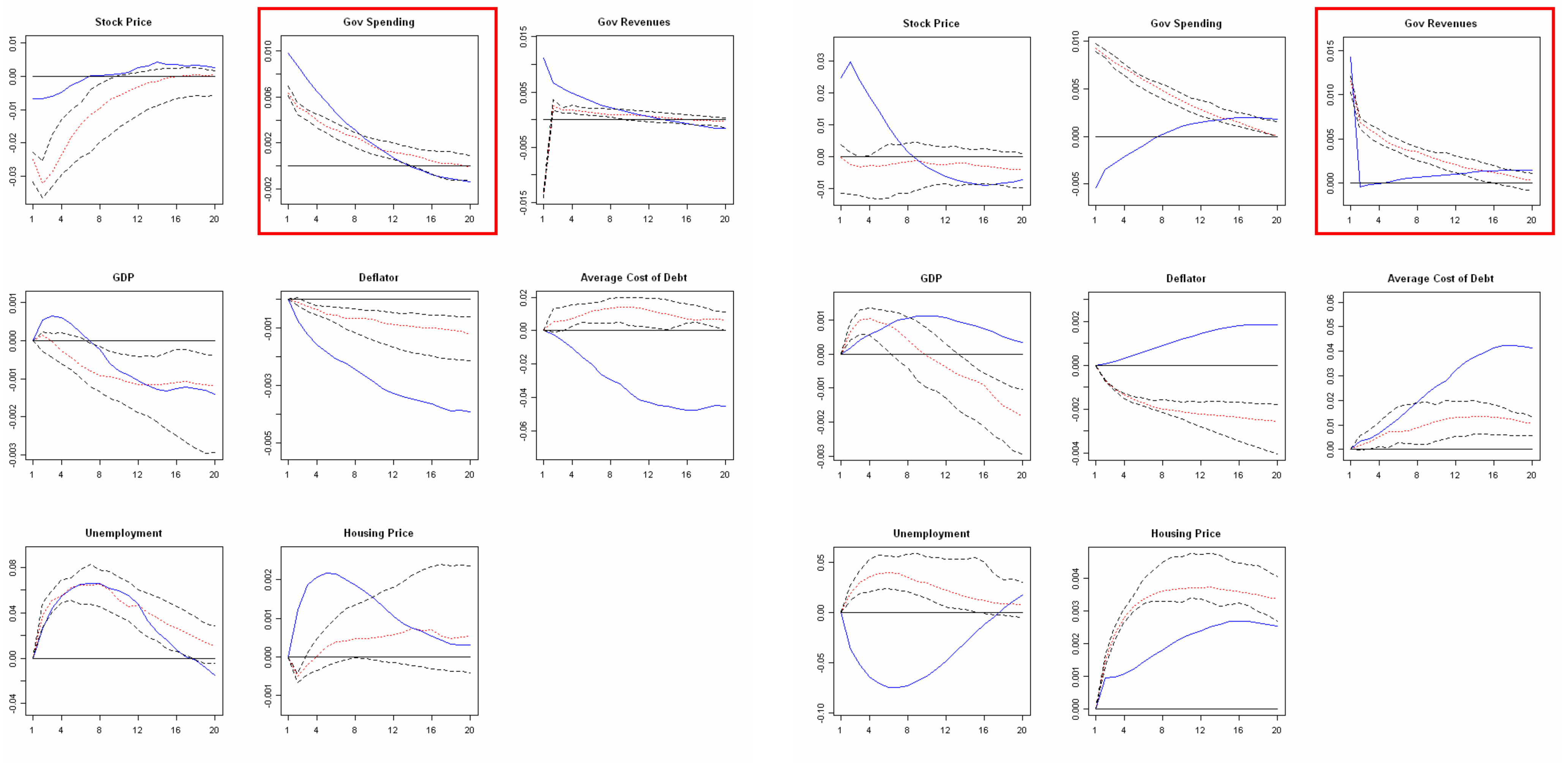
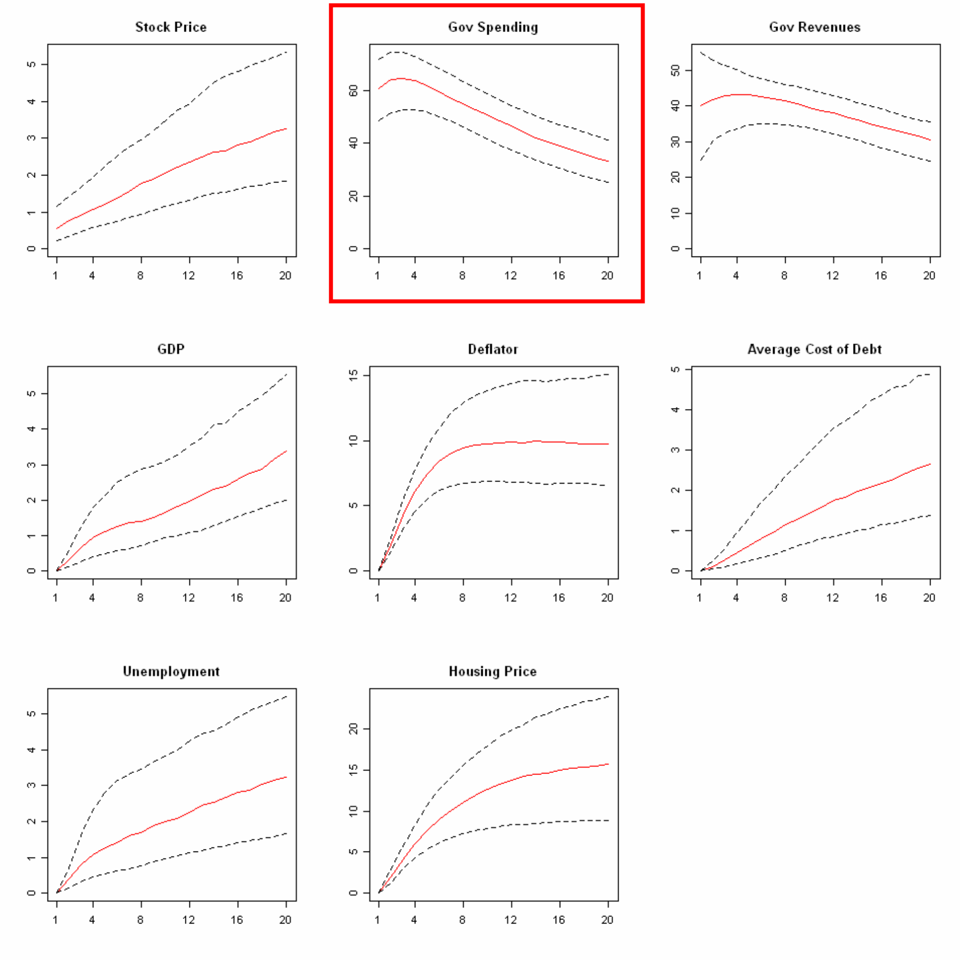


Figure 6 – Forecast-error variance decomposition, Germany.

6a – spending shock




6b – revenue shock

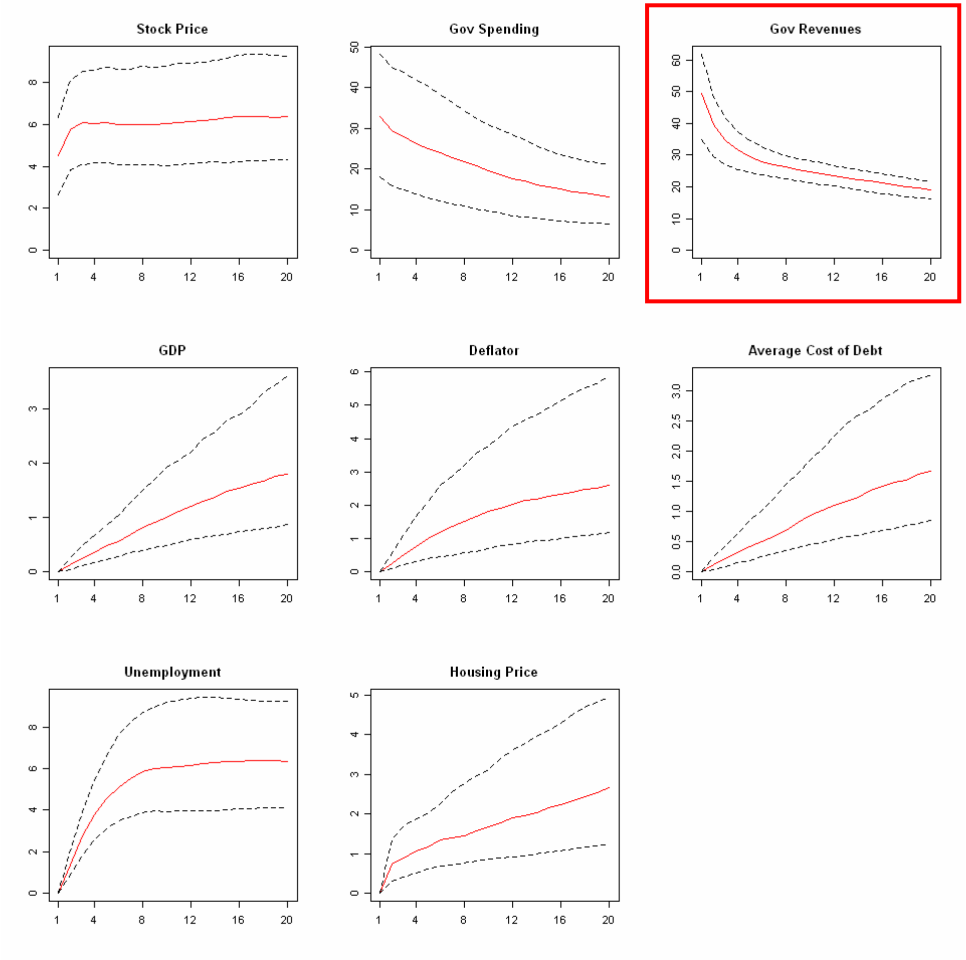
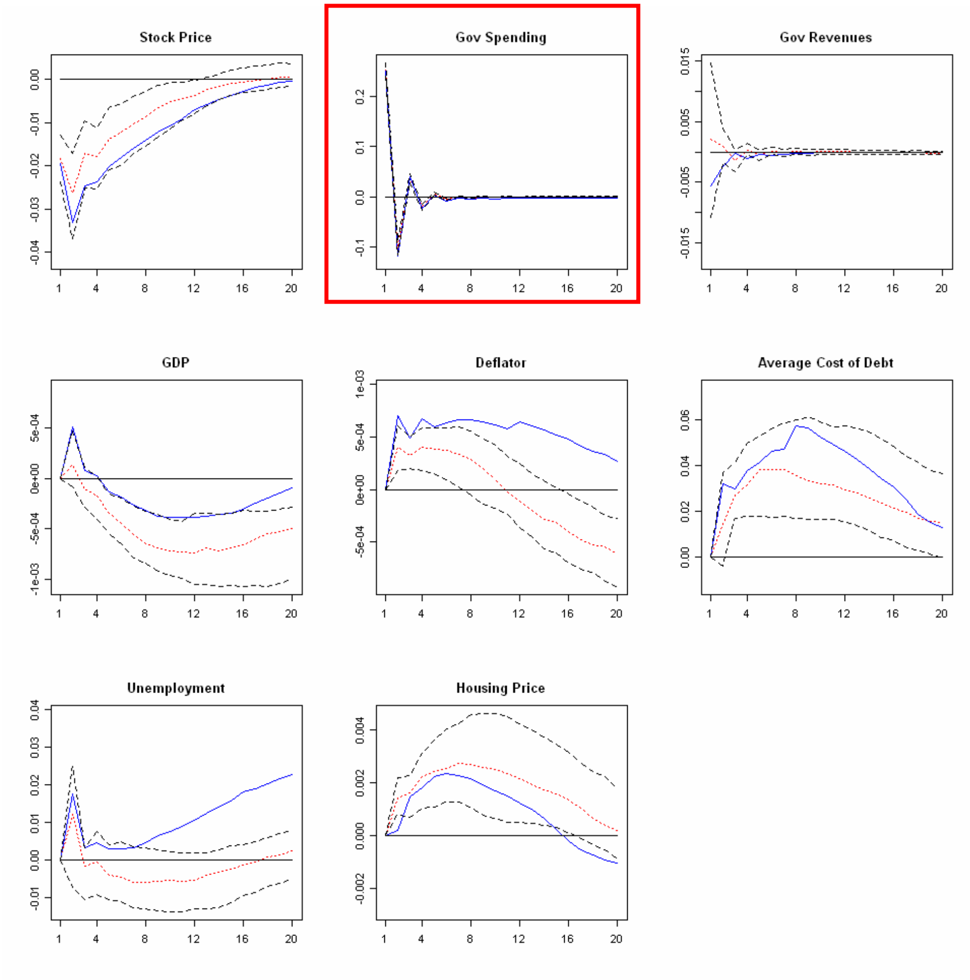


Figure 7 – Impulse-response functions, Italy.

7a – spending shock




7b – revenue shock

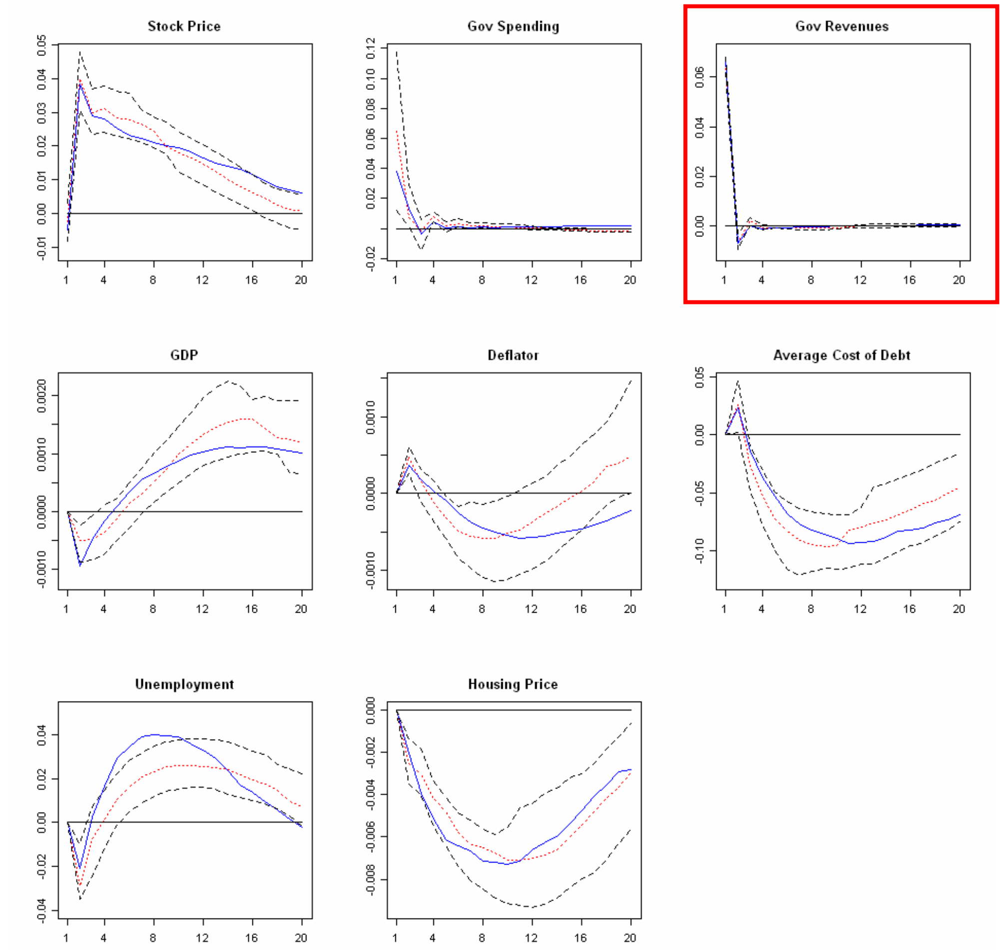


Figure 8 – Forecast-error variance decomposition, Italy.

8a – spending shock

8b – revenue shock

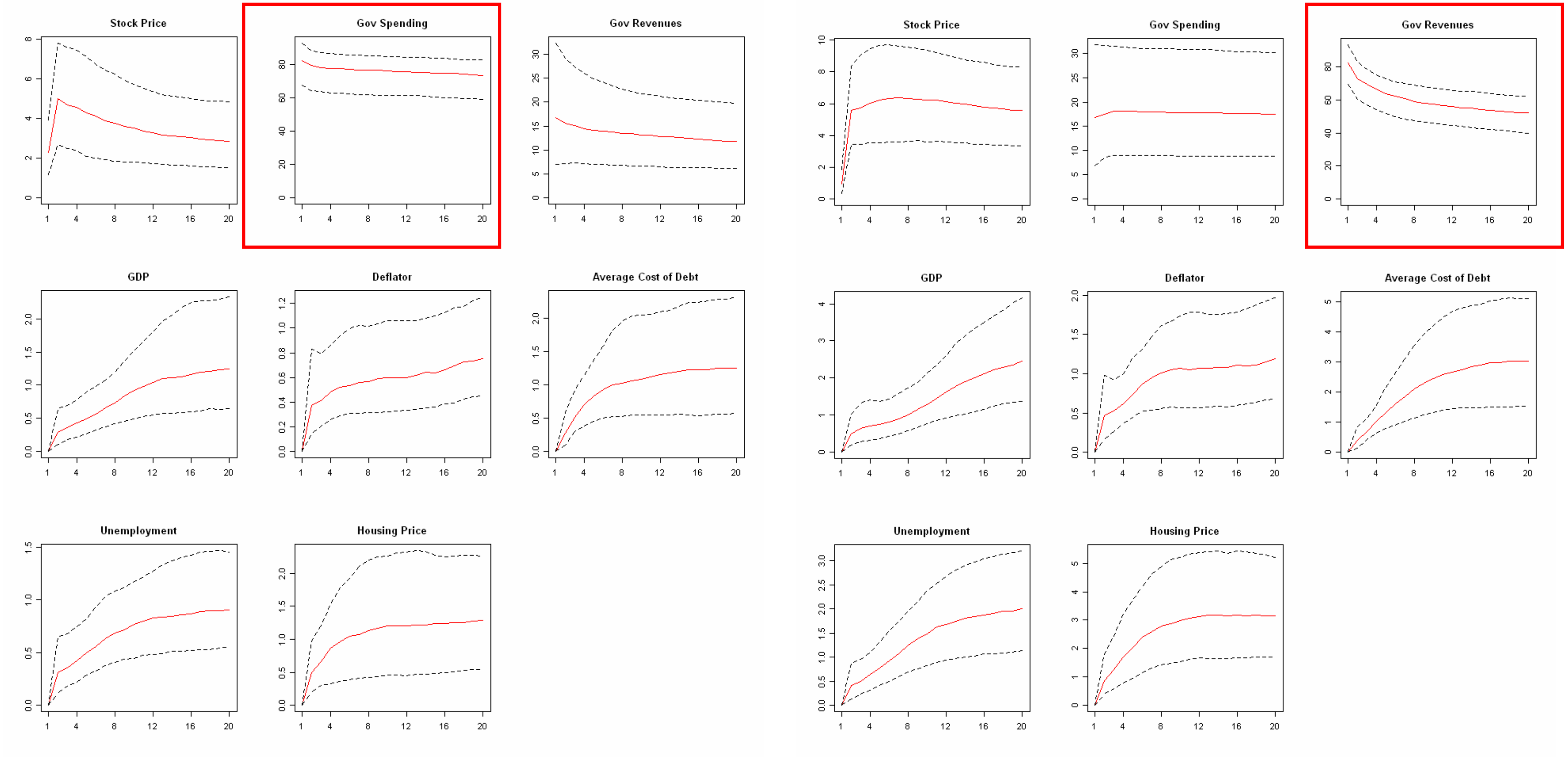
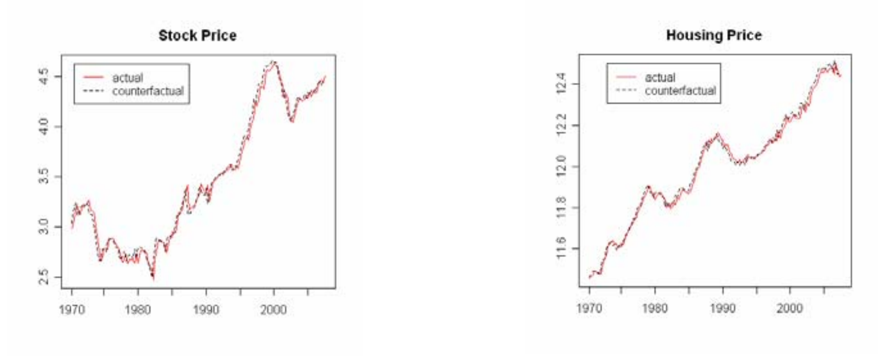


Figure 9 – VAR counterfactual, U.S..

9a – spending shock




9b – revenue shock

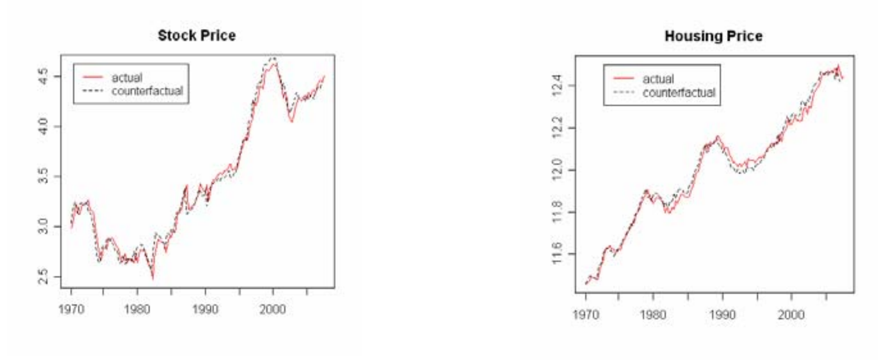
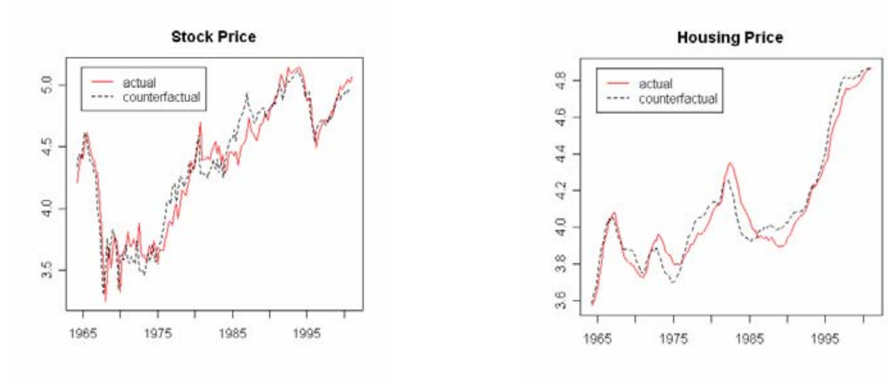



Figure 10 – VAR counterfactual, U.K..

10a – spending shock




10b – revenue shock

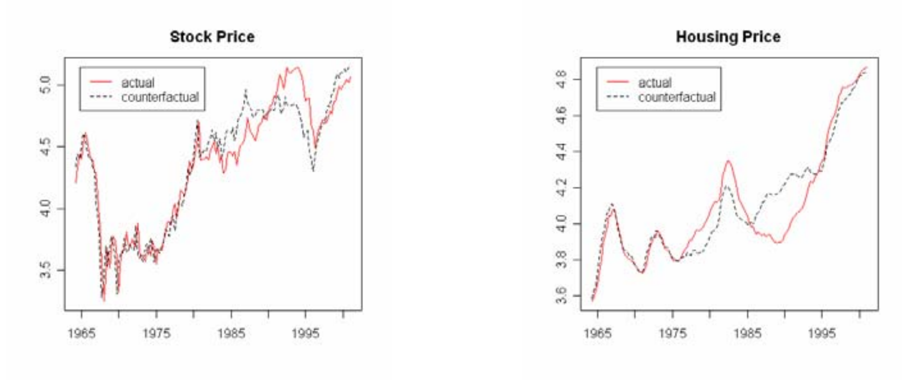
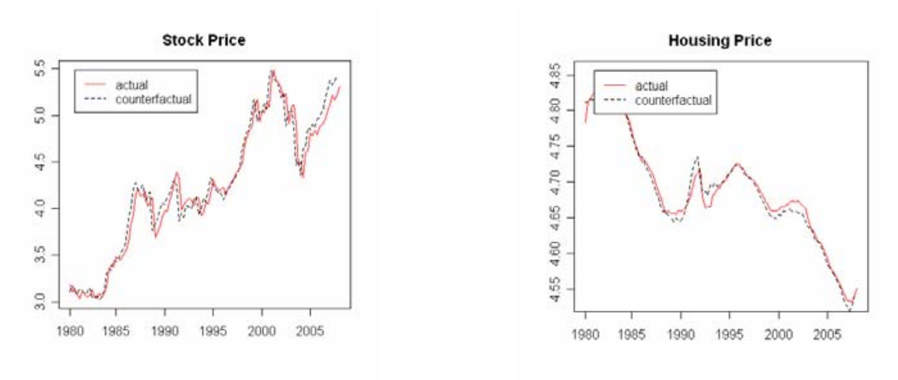


Figure 11 – VAR counterfactual, Germany.

11a – spending shock




11b – revenue shock

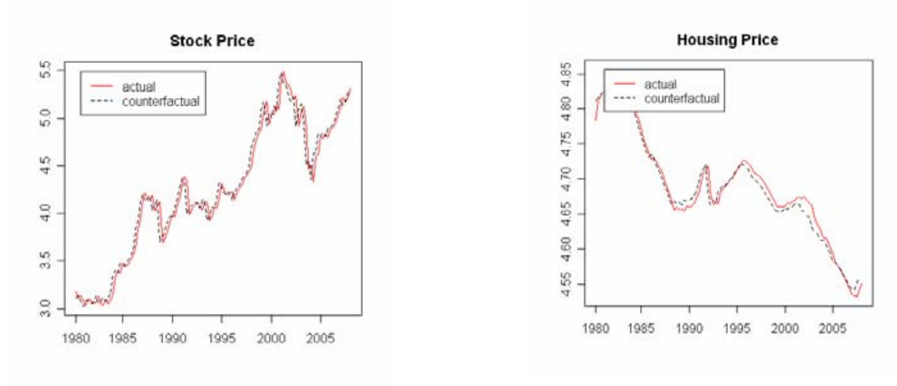
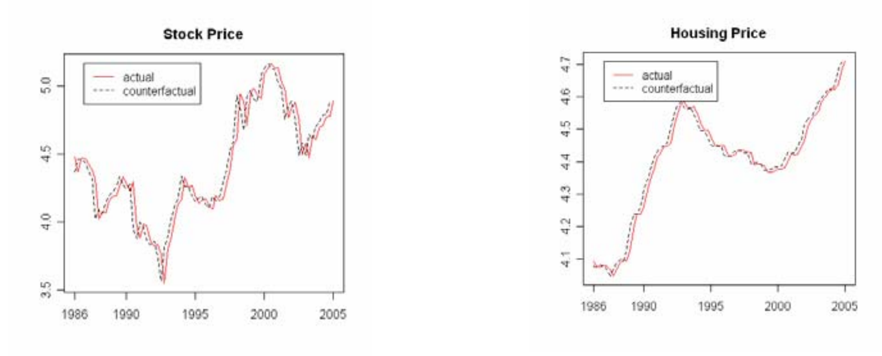
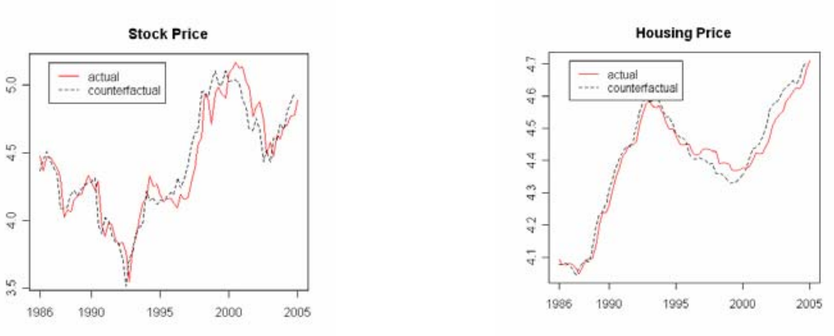



Figure 12 – VAR counterfactual, Italy.

12a – spending shock




12b – revenue shock



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