Monetary-fiscal policy interaction and fiscal inflation: A Tale of three countries*

Martin Kliem† Alexander Kriwoluzky‡ Samad Sarferaz§

May 21, 2015

Abstract

In this paper, we provide cross-country empirical evidence on the low-frequency relationship between fiscal deficits and inflation by contrasting time-varying estimates of the low-frequency relationship for the US with those for Germany and Italy from 1970 to 1999. Our findings suggest that the low-frequency relationship between fiscal deficits and inflation depends on the interaction between monetary and fiscal policy. We show that the low-frequency estimates are in line with the narrative evidence on changes in the actual monetary and fiscal policy. While the low-frequency relationship for the US is around one during the 1970s and becomes zero with Paul Volcker taking office, it is higher for Italy throughout, where it only becomes relatively small once the Maastricht treaty foreshadows. In contrast to that, the low-frequency relationship for Germany has been around zero throughout the sample.

JEL classification: E42, E58, E61
Keywords: Time-Varying VAR, Inflation, Public Deficits

*We would like to thank Fabio Canova, Evi Papa, Chris Sims, and Fabio Ghironi. Moreover, we have benefited from presentations of earlier drafts at the European University Institute and the Bundesbank. Part of this work was conducted when Martin Kliem was fellow at the Robert Schumann Centre of Advanced Studies at the European University Institute, whose hospitality is gratefully acknowledged. The views expressed in this paper are those of the authors and do not necessarily reflect the opinions of the Deutsche Bundesbank.

†Deutsche Bundesbank, Economic Research Centre, Wilhelm-Epstein-Str. 14, 60431 Frankfurt am Main, Germany, email: martin.kliem@bundesbank.de, tel: +49 69 9566 4759.

‡Martin-Luther-Universität Halle-Wittenberg and Halle Institute for Economic Research (IWH) Halle, Germany, email: alexander.kriwoluzky@wiwi.uni-halle.de

§ETH Zürich, KOF Swiss Economic Institute, Leonhardstrasse 21, 8092 Zürich, email: sarferaz@kof.ethz.ch, tel: +41 44 632 54 32

1 Introduction

In a recent article, Summers (2014) paints a dire picture of future macroeconomic developments in the U.S. and other advances economies. He points to the risk of a secular stagnation with a long period of poor economic growth and permanent negative natural rates of interest. According to Summers, a possible way out of such a secular stagnation is when policy makers manage to further reduce the real interest. However, with nominal interest rates close to zero, monetary policy alone is not up to the task. At this stage, fiscal policy could step in to reduce real interest rates by creating subdued fiscal inflation. Therefore, theories which allow fiscal policy to play an important role for the determination of the price level and the short term real interest are brought into the center of attention.[1]

These theories state that depending on the policy regime in place, fiscal policy can be inflationary. More precisely, in case the fiscal authority is not backing outstanding government debt by future primary surpluses and, at the same time, the monetary authority does not actively fight inflationary pressure, public deficits are inflationary. Contrarily, in case of an actively inflation-fighting monetary policy authority and an accommodating fiscal policy, inflationary pressure due to fiscal policy shocks are neutralized over time.[2]

In this paper, we aim to provide further evidence for the theory on the interaction between monetary and fiscal policy. We focus on the low-frequency relationship between fiscal deficits and inflation and address the question whether this relationship depends on the interaction between monetary and fiscal policy. The focus on the low-frequency is motivated firstly by Lucas (1980) who suggests that change in the systematic relationship between two variables is best recovered beyond business cycle frequencies. Secondly, Cochrane (2001) as well as Bianchi and Melosi (2013) argue that the relationship between fiscal stance and inflation should be especially pronounced at lower frequencies.

Studying US data for the time period from 1900 to 2011, Kliem, Kriwoluzky, and Sarferaz (2015) find that the highest low-frequency relationship occurs in the 1970s. The relationship breaks down with Paul Volcker taking office as chairman as the Federal reserve. In this paper, we contrast the results for the US with two countries, which are well known to have different monetary and fiscal policy interactions between 1970 and 1999. On the one hand, we consider Germany. It is well established that even during the 1970s, Germany had an independent central bank focusing on price stability and a fiscal policy which backed the

[1]The first studies to develop a theory for the interaction between monetary and fiscal policy are Sargent and Wallace (1981) and Leeper (1991).

[2]Recently, Bianchi and Ilut (2012) explicitly account for time variation in the interaction between monetary and fiscal policy by estimating a structural Markov-switching dynamic stochastic general equilibrium (MS-DSGE) model.

outstanding government debt. On the other hand, we consider Italy. The Italian central bank, Banca d'Italia, was by law required to buy government securities to a fix interest rate in the 1970s. In the beginning of the 1980s the central bank became gradually independent (a period denoted as the *divorce*). In the foreshadow of the Maastricht-treaty Italy complied with the, e.g., fiscal requirements and the Banca d'Italia became independent.[3]

Consequently, in case the relationship between deficits and inflation depends on the interaction between monetary and fiscal policy, we expect to find the following: Germany should have a low-frequency relationship around zero throughout. While for the US the relationship between deficits and inflation breaks down at the beginning of the 1980, for Italy the relationship should be more pronounced in the 1970s and more long-lasting until the end of 1980s. It should gradually decline around the start of the negotiations about the Maastricht-treaty and become stable at low values during the 1990s. In this regard, we apply a time-varying parameter Vector Autoregression (TVP-VAR) model and estimate the potentially time-varying low-frequency relationship between public deficits and inflation. We estimate a time-varying pattern of the low-frequency relationship which is strikingly in line with the aforementioned narrative evidence. This finding stands in contrast to, e.g., Catão and Terrones (2005) and Lin and Chu (2013) who conclude that fiscal inflation is rather an phenomenon of developing countries then of developed countries. In order to shed further light on the driving forces behind the evolution of the low-frequency relationship we identify two policy shocks: one shock to the fiscal stance and one monetary policy shock. We show that the episodes of high low-frequency relationship in the U.S. as well as in Italy are due to these two policy shocks.

Our findings suggest, that in the past monetary and fiscal interactions have had consequences for long-run inflation and, therefore, have contributed to a sustained higher level of inflation. In this regard, we conclude, that in times of permanent negative real interest rates, coordinated policy actions might be a way out. However, the theories on monetary and fiscal interaction state that the success of such a policy mix crucially depends on its credibility. The historical evidence for Italy and the US illustrate the effort taken by these countries to overcome fiscal inflation and to "anchor expectations" about the policy mix, i.e., to convince people that monetary policy can control inflation because fiscal policy is taking care of outstanding debt.

The remaining paper is structured the following way: the next section presents our dataset and the econometric setup. The third section presents the narrative accounts in more detail and employs them to interpret our estimation results. The last section concludes.

[3]Our choice of the set of countries is in line with Brunner, Fratianni, Jordan, Meltzer, and Neumann (1973), who studied the influence of monetary and fiscal policy on inflation between 1948 and 1971.

2 Data and econometric setup

In this section, we describe the data employed in the estimation, set up the TVP-VAR models, specify the corresponding prior distribution, and describe how we measure the low-frequency relationship.

2.1 Data

In this subsection, we describe the data sources and the transformation of the data. For each country, we set up a data set similarly to Kliem et al. (2015), which contains primary deficits over one-period-lagged debt, inflation, real GDP growth, nominal interest rates, and money growth. To estimate the time variation of the low-frequency relationship between the variables as precisely as possible, we choose for each country the longest coherent time period available. For some variables, this decisions goes along with data limitations which we describe in more detail. The finally employed time series range from 1876Q1 until 2011Q4 for the U.S. and range from 1961Q1 until 1998Q4 for Italy and Germany, respectively. The available time span for Germany and Italy is limited for the following reasons. First, there are no coherent time series available for the time before and during World War II. Second, the introduction of the Euro in 1999 marks a natural end to the countries individual monetary-fiscal policy mix.

The fiscal time series for primary deficits over one-period lagged debt (d_t) for each country is constructed as follows (For the sake of readability, we denote the this variable deficits over debt instead of primary deficits over one-period lagged debt throughout the paper). For the U.S., we use the time series for primary deficit and government debt held by the public from Bohn (2008).[4] For Italy and Germany, we make use of the fiscal database provided by Mauro, Romeu, Binder, and Zaman (2013). Because, the fiscal database contains only ratios relative to GDP, we use annual GDP data from IMF IFS database to construct the deficit over debt variable. Moreover, all fiscal time series are of annual frequency only. Therefore, we decide to interpolate the annual data using the cubic-spline approach. Additionally, time series for government debt for Italy and Germany are only available in par values and not in market values, while market values for the U.S. are just available from 1942 onward. Since we are interested in the low-frequency relationship of the variables, temporary differences between market and par values are not critical (see also Bohn, 1991).[5]

[4]See `http://www.econ.ucsb.edu/~bohn/morepapers.html` for more details and recent updates of these time series. A detailed description of the fiscal data set and its construction is given by Bohn (1991).

[5]For a detailed discussion and extensive robustness checks regarding interpolation and market value of debt in addition to other changes of specifications see Kliem et al. (2015).

The remaining variables for the U.S. are calculated as follows. Inflation (π_t) is measured as year-to-year first differences of the GDP deflator. Following Sargent and Surico (2011), we use the data taken from the FRED II database starting in 1947Q1 and from Balke and Gordon (1986) before. Similarly, real output growth (Δx_t) is defined as year-to-year first differences of the logarithm of real GDP. From 1947Q1 onward, real GDP (in chained 2010 dollars) is taken from the FRED II database of the Federal Reserve Bank of St. Louis. For the period before 1947, we employ the growth rates of the real GNP series provided by Balke and Gordon (1986) to construct the time series. We apply the same procedure for money growth (ΔM_t) to the M2 stock series from the FRED II database starting in 1959Q1. For the nominal interest rate (R_t), we use the quarterly average of the effective Federal Fed Funds rate from 1954Q3 onward extended by the short term interest rate from Balke and Gordon (1986) for the time before.

For Italy, inflation is measured as year-to-year first differences of the CPI deflator from 1960Q1 onward taken from the IMF IFS database. Real output growth is calculated as year-to-year first differences of the logarithm of real GDP available from the OECD Quarterly National Accounts. Money growth is calculated as year-to-year first differences of the logarithm of M2 stock available from the Banca d'Italia which is seasonal adjusted using Census x13. For the nominal interest rate, we use the IMF IFS database again. In particular, from 1977Q3 until 1998Q4 we use the provided Treasury Bill rate and extend the series with the interest rate on government securities for the time before.

Because of the reunification of Germany the construction of a coherent data set needs some more adjustments to avoid jumps. In particular, we use nominal GDP data and the corresponding GDP deflator from 1991Q1 until 1998Q4, which are extended using corresponding growth rates for West-Germany for the time from 1970Q1 until 1989Q4. All data are taken from the Bundesbank. From these series, we construct real GDP for 1970Q1 onward which is finally extended until 1960Q1 by using growth rates of real GDP provided by the IMF IFS database. Similarly, we combine the CPI deflator for unified Germany from 1991Q1 onward with the CPI deflator for West-Germany from 1960Q1 until 1990Q4, where both series are taken from IMF IFS database. Finally, we calculate our inflation measure as year-to-year first differences of the logarithm of this constructed series. As time series for the nominal interest rate we use the T-Bill rate series from the IMF IFS database from 1977Q3 until 1998Q4 and the Money market rate for the time before.

2.2 Model setup

For each country, we estimate a single TVP-VAR model with the vector of observable variables $\mathbf{y}_t = [d_t, \Delta x_t, \pi_t, R_t, \Delta M_t]$. Each VAR model with time-varying coefficients and stochastic volatilities is defined as

$$\mathbf{y}_t = \mathbf{c}_t + \sum_{j=1}^{p} \mathbf{A}_{j,t}\mathbf{y}_{t-j} + \mathbf{u}_t = \mathbf{X}_t'\mathbf{A}_t + \mathbf{B}_t^{-1}\mathbf{H}_t^{\frac{1}{2}}\epsilon_t \ , \tag{1}$$

where $\mathbf{y}_t$ is a $n \times 1$ vector of macroeconomic time series, $\mathbf{c}_t$ is a time-varying $n \times 1$ vector of constants, $\mathbf{A}_{j,t}$ are p time-varying $n \times n$ coefficient matrices, and $\mathbf{u}_t$ is a $n \times 1$ vector of disturbances with time-varying variance-covariance matrix $\mathbf{\Omega}_t = \mathbf{B}_t^{-1}\mathbf{H}_t\left(\mathbf{B}_t^{-1}\right)'$. The time-varying matrices $\mathbf{H_t}$ and $\mathbf{B_t}$ are defined as

$$\mathbf{H_t} = \begin{bmatrix} h_{1,t} & 0 & \cdots & 0 \\ 0 & h_{2,t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & h_{n,t} \end{bmatrix} \qquad \mathbf{B}_t = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ b_{21,t} & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ b_{n1,t} & \dots & b_{n(n-1),t} & 1 \end{bmatrix}. \tag{2}$$

The time-varying coefficients are assumed to follow independent random walks with fixed variance-covariance matrices. In particular, laws of motions for the vector $\mathbf{a}_t = \text{vec}[\mathbf{c}_t \ \mathbf{A}_{1,t} \ ... \ \mathbf{A}_{p,t}]$, $\mathbf{h}_t = \text{diag}(\mathbf{H_t})$, and the vector $\mathbf{b}_t = [b_{21,t}, (b_{31,t} \ b_{32,t}), ..., (b_{n1,t} \ ... \ b_{n(n-1),t})]'$ containing the equation-wise stacked free parameters of $\mathbf{B}_t$ are given by

$$\mathbf{a}_t = \mathbf{a}_{t-1} + \nu_t, \tag{3}$$

$$\mathbf{b}_t = \mathbf{b}_{t-1} + \zeta_t, \tag{4}$$

$$\log \mathbf{h}_t = \log \mathbf{h}_{t-1} + \eta_t. \tag{5}$$

Finally, we assume that the variance-covariance matrix of the innovations is block diagonal:

$$\begin{bmatrix} \epsilon_t \\ \nu_t \\ \zeta_t \\ \eta_t \end{bmatrix} \sim N(0, V) \text{ , with } \mathbf{V} = \begin{bmatrix} \mathbf{I}_n & 0 & 0 & 0 \\ 0 & \mathbf{Q} & 0 & 0 \\ 0 & 0 & \mathbf{S} & 0 \\ 0 & 0 & 0 & \mathbf{W} \end{bmatrix} \text{ and } \mathbf{W} = \begin{bmatrix} \sigma_1^2 & 0 & \cdots & 0 \\ 0 & \sigma_2^2 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & \sigma_n^2 \end{bmatrix} , \tag{6}$$

where $\mathbf{I}_n$ is an n-dimensional identity matrix and $\mathbf{Q}$, $\mathbf{S}$, and $\mathbf{W}$ are positive definite matrices. Moreover, it is assumed that matrix $\mathbf{S}$ is also block-diagonal with respect to the parameter blocks for each equation and $\mathbf{W}$ is diagonal.

2.3 Prior specification

For the prior specifications of the aforementioned models we follow the recent literature. In this regard, some of the prior parameters are based on a training sample with a length of 40 quarters from the beginning of each observation period. Therefore, we estimate a time-invariant VAR(2) model with ordinary least squares (OLS) and use the point estimates to calibrate some of the prior distributions (see, e.g., Cogley and Sargent, 2005; Primiceri, 2005). Similar to Bianchi and Civelli (2014), we choose the same hyperparameters across the TVP-VAR models, however, given the training sample approach the final prior for each model are different.

In particular, we use multivariate normal distributions for the priors on the initial conditions of the time-varying VAR coefficients which are parameterized with the corresponding OLS estimates.

$$\mathbf{a}_0 \sim N\left(\hat{a}^{OLS}, Var\left(\hat{a}^{OLS}\right)\right)$$

Similarly, the prior for the starting values of the off-diagonal elements B_t is

$$\mathbf{b}_0 \sim N\left(\hat{b}^{OLS}, k_b \cdot V\left(\hat{b}^{OLS}\right)\right),$$

where $\hat{b}^{OLS}$ are the off-diagonal element of the OLS estimate of the VAR variance-covariance matrix, $\hat{\Omega}^{OLS}$. $V\left(\hat{b}^{OLS}\right)$ is assumed to be a diagonal with elements equal to the absolute value of the corresponding $\hat{b}^{OLS}$. The hyperparameter k_b is set to 11 which is equal to $(1 + dim\left(\hat{b}^{OLS}\right))$. The prior for the diagonal elements of the VAR variance-covariance matrix is

$$\log h_0 \sim N\left(\log \hat{h}^{OLS}, I_n\right),$$

where $\hat{h}^{OLS}$ are the diagonal elements of $\hat{\Omega}^{OLS}$.

In addition, we use an inverse Wishart distribution for priors on the variance-covariance matrices of the error terms in the time-varying parameter equations, $\mathbf{Q}$ and $\mathbf{S}$. In particular, we follow Cogley and Sargent (2005) and choose the prior for $\mathbf{Q}$ as

$$\mathbf{Q} \sim IW\left(k_Q \cdot Var\left(\hat{a}^{OLS}\right), T\right),$$

where $k_Q = 3.5 \cdot 10^{-4}$ and the degrees of freedom $T = 60$. While the minimum degrees of freedom are equal to $1 + dim\left(\hat{a}^{OLS}\right)$ our choice is slightly higher following Primiceri (2005). Similarly, we follow Primiceri (2005) by specifying the prior for $\mathbf{S}$. Because $\mathbf{S}$ is block diagonal, we choose for each block i the following inverse-gamma distribution

$$\mathbf{S}_i \sim IW\left(k_S \cdot (i+1)\, V\left(\hat{b}_i^{OLS}\right), (i+1)\right),$$

with $k_S = 0.01$ and $V\left(\hat{b}_i^{OLS}\right)$ is diagonal with elements equal to the absolute values of the corresponding blocks of $\hat{b}^{OLS}$. Finally, for the prior for σ_i^2 which are the diagonal elements of $\mathbf{W}$, we use the following inverse-gamma distribution:

$$\sigma_i^2 \sim IG\left(\frac{10^{-3}}{2}, \frac{1}{2}\right)$$

2.4 Estimation

For the estimation of each model, we choose a lag length $p = 2$ and employ a Metropolis-within-Gibbs sampling algorithm. The sampler is structured as follows. We start by initializing $\mathbf{b}^T$, $\boldsymbol{H}^T$,$\mathbf{V}$ with estimates from our training sample. We then draw the VAR coefficients $\mathbf{a}^T$ from $p(\mathbf{a}^T|\ \mathbf{y}^T,\ \mathbf{b}^T,\ \boldsymbol{H}^T,\ \mathbf{V})$, where the superscript T denotes the history of the variable (or vector of variables) up to time T. In the next step we draw the $\mathbf{b}^T$ from $p(\mathbf{b}^T|\ \mathbf{y}^T,\ \mathbf{a}^T,\ \boldsymbol{H}^T,\ \mathbf{V})$. Up to this step, the our sampler is identical to the one described in Primiceri (2005). In the fourth step we deviate from the Gibbs sampler of Primiceri (2005) and draw the log volatilities using the Metropolis-Hastings algorithm suggested by Watanabe and Omori (2004). We hence draw $\boldsymbol{H}^T$ from $p(\boldsymbol{H}^T|\ \mathbf{y}^T,\ \mathbf{a}^T,\ \mathbf{b}^T,\ \mathbf{V})$. In the last step we draw the variance-covariance matrix $\mathbf{V}$, by sampling $\mathbf{Q}$ from $p(\mathbf{Q}|\ \mathbf{y}^T,\ \mathbf{A}^T,\ \mathbf{B}^T,\ \boldsymbol{H}^T)$, $\mathbf{W}$ from $p(\mathbf{W}|\ \mathbf{y}^T,\ \mathbf{A}^T,\ \mathbf{B}^T,\ \mathbf{H}^T)$ and $\mathbf{S}$ from $p(\mathbf{S}_1|\ \mathbf{y}^T,\ \mathbf{A}^T,\ \mathbf{B}^T,\ \boldsymbol{H}^T)\ldots p(\mathbf{S}_{n-1}|\ \mathbf{y}^T,\ \mathbf{A}^T,\ \mathbf{B}^T,\ \boldsymbol{H}^T)$. This last step is again identical to the one described in Primiceri (2005).

During the simulation, we ensure stationarity of the VAR coefficients in the posterior distribution. Finally, we take 250,000 draws with a burn-in phase of 230,000 draws. We check for convergence by calculating various statistics and diagnostics which can be found in the corresponding appendix. After the burn-in phase, we keep only each 10th draw to reduce autocorrelation. This yields a sample of 2000 draws from the posterior density which is the basis for all presented results throughout the paper.

2.5 The low-frequency relationship

As our measure for the low-frequency relationship between two variables, we follow the suggestion by Lucas (1980). After filtering the data to extract the low-frequency components of each time series, Lucas (1980) computed the regression coefficient in an ordinary-least-square regression. In our case, the variables of interest are deficits and inflation. We denote the regression coefficient of a regression of deficits on inflation by b_f. Whiteman (1984) shows that the regression coefficient can be approximated in the following way:

$$b_f \approx \frac{S_{\pi d}(0)}{S_d(0)} \ , \tag{7}$$

where S_d is spectrum of d and $S_{\pi d}$ is the cross spectrum of π and d at frequency zero. In order to estimate the relationship using unfiltered data in the TVP-VAR model, we follow the procedure described in Sargent and Surico (2011). We use the state-space representation of the TVP-VAR model:

$$\begin{aligned} \mathbf{X}_t &= \hat{\mathbf{A}}_{t|T}\mathbf{X}_{t-1} + \hat{\mathbf{B}}_{t|T}\mathbf{w}_t \\ \mathbf{y}_t &= \hat{\mathbf{C}}_{t|T}\mathbf{X}_t \ , \end{aligned} \tag{8}$$

where $\mathbf{X}_t$ is the $n_x \times 1$ state vector, $\mathbf{y}_t$ is an $n_y \times 1$ vector of observables, $\mathbf{w}_t$ is an $n_w \times 1$ Gaussian random vector with mean zero and unit covariance matrix that is distributed identically and independently across time. The matrices $\hat{\mathbf{A}}$, $\hat{\mathbf{B}}$, and $\hat{\mathbf{C}}$ are functions of a vector of the time-varying structural model parameters. The corresponding spectral density at time $\mathbf{t}$ of matrix Y hence is

$$S_{Y,t|T}(\omega) = \hat{\mathbf{C}}_{t|T}\left(I - \hat{\mathbf{A}}_{t|T}e^{-i\omega}\right)^{-1}\hat{\mathbf{B}}_{t|T}\hat{\mathbf{B}}'_{t|T}\left(I - \hat{\mathbf{A}}'_{t|T}e^{i\omega}\right)^{-1}\hat{\mathbf{C}}'_{t|T} \tag{9}$$

and the temporary low-frequency relationship between deficits over debt and inflation at time t is computed as[6]

$$\hat{b}_{f,t|T} = \frac{S_{\pi,d,t|T}(0)}{S_{d,t|T}(0)} \ . \tag{10}$$

3 Results

Before we turn to the presentation of the results and their interpretation, we present a narrative account on the interaction between monetary and fiscal policy in Germany, Italy, and the US respectively.

3.1 Narrative evidence

In the period we consider all countries can be regarded as reasonable similar. All countries have been part of the group of leading industrialized countries formed in 1975. All countries have been subject to similar technological change. While the countries experienced different

[6] See Sargent and Surico (2011) and Kliem et al. (2015) for a more detailed discussion.

business cycles, these differences are taken out by the low-frequencies filter. The exception is the German reunification. It stands out as a permanent idiosyncratic shock to Germany relative to Italy and the US. We therefore take this event up again when discussing the narrative evidence. With all the characteristics shared the most poignant difference between the countries is the evolution of the interaction between monetary and fiscal policy. In the following paragraphs we briefly summarize the main developments of this interaction for each country.

3.1.1 Germany

Sargent (1982), among other authors, describes the key event to shape German's attitude towards inflation after 1923: the German Hyperinflation between 1921 and 1923. This event led to the loss of most private savings in Germany and high inflation aversion in Germany.[7] Consequently, in order to attain trust in the newly issued currency after World War II, the Bundesbank as well as its predecessor the Bank deutscher Länder have been strongly committed to maintain price stability.

As Beyer, Gaspar, Gerberding, and Issing (2013) describe in their thorough study, the Bundesbank adopted a monetary targeting framework in the early 1974 after the break-down of the Bretton-Woods system.[8] Consequently, inflation in Germany peaked at 7.8% in the mid-1970's but remained stable at lower rates afterwards. Though the Bundesbank was also involved in buying government bonds during the mid-70s, the amount bought by the Bundesbank never exceeded 0.2 percent of GDP. Even the second oil price shock did not lead to high inflation rates around at the end of the 1970s and the beginning of the 1980's.

Furthermore, Germans well understood that the Hyperinflation in the 1920s was caused by the central bank monetizing the government debt accumulated during and after World War I. Thus, the Bundesbank enjoyed independence from the fiscal authority early on. Throughout the time period we consider, there have been no strong attempts of the fiscal authority to weaken the independence of the Bundesbank. Here, the German reunification is a case in point. During the reunification the currency of Eastern Germany (GDR) was exchanged above market value into Western German currency. The favorable exchange rate for people from the GDR was politically motivated. If there ever was an opportunity to force the Bundesbank to accommodate the action of the fiscal authority, it would have been this moment of patriotic happiness. It did not happen. In order to maintain price stability after the increase in the monetary aggregate the Bundesbank raised interest rates sharply,

[7] This widely accepted view is in more detail established by Issing (2005).

[8] See Benati and Goodhart (2010) and Bordo and Siklos (2015) for further descriptions of the conduct of monetary policy in Germany. Both studies agree with the account given in this paragraph.

contributing to the recession in 1993.

We summarize the description of the monetary and fiscal interaction in Germany in the following way: the Bundesbank has been independent from the fiscal authority and it has been committed to price stability throughout our sample. At the same time, the fiscal authority ensured that the outstanding government debt is backed by future primary surpluses. Thus, we expect that deficits and inflation are not correlated at the low frequency.

3.1.2 Italy

The interaction between monetary and fiscal policy in Italy in the 1970's is characterized by fiscal dominance. During this period the Banca d'Italia had to act as an residual buyer at treasury bills auctions and thus to monetize the public debt. The resulting high inflation rates in the 1970s and the entry into the European Monetary System (EMS) in 1979 led to a change in the interaction between monetary and fiscal policy: the *divorce* of the Banca and the Tresoro in 1981. More precisely, both institutions agreed that the central bank would gradually become independent.[9] The entry into the EMS was associated with the EMS serving as an inflation stabilizing device.[10]

Although the *divorce* event marks a significant change in the interaction of these institutions, "one should be careful not to jump to the conclusion that 1981 represented a sharp breaking point between the previous regime of fiscal dominance and the new regime of central bank independence" (Fratianni and Spinelli, 1997). The view of the authors is supported by the fact that inflation rates in Italy remained among the highest in the EMS. Furthermore, the gradual independence of the central bank was not supported by the fiscal authority. As Bartoletto, Chiarini, and Marzano (2013) point out the Italian government continued to run deficits in the beginning of the 1980s instead of ensuring the outstanding government debt with primary surpluses. Only from the mid-1980s does debt stabilization become a target of the fiscal authority (see Balassone, Francese, and Pace (2013)).

The final regime change in Italy happened in accordance with the efforts taken by Italy to join the European Monetary Union (EMU). The Banca d' Italia became operational independent in 1992. Moreover, in order to comply with the Maastricht treaty, the law which could force the monetary authority to act as an residual buyer at treasury bills auctions, was abolished de jure.

We summarize the interaction between the monetary and fiscal authority for Italy in the following way: in the 1970s the fiscal authority was dominant and the monetary authority

[9] Carlo Ciampi, the governor of the Banca d'Italia at that time expressed this agreement in a speech May 30th 1981 to shareholders.

[10] Giavazzi and Pagano (1991) provide an economic model for the effects of the adoption of a fixed exchange rate regime on inflation.

acted accommodatively. During the 1980s, both authorities started a gradual process towards central bank independence and a fiscal authority which stabilizes its debt using primary surpluses. This process was concluded successfully in the the beginning of the 1990s with Italy joining the EMU and signing the Maastricht treaty. Consequently, we expect a high low-frequency relationship between fiscal deficits and inflation in the 1970s, which gradually declines in the 1980s and becomes stable at a low level in the 1990s.

3.1.3 United States

The interaction between monetary and fiscal policy for the US after 1970 has been extensively studied. We therefore give a only brief summary of the development between 1970 and 1999, which is supposedly well known to the reader.

The period of the 1970s is usually characterized either by a central bank not responding strongly to inflation (e.g. Clarida, Gali, and Gertler, 2000; Lubik and Schorfheide, 2004) or by a central bank which has lost its ability to control inflation (Sims, 2011), while the fiscal authority was playing a dominant role (e.g. Davig and Leeper, 2007; Bianchi and Ilut, 2012; Bianchi and Melosi, 2013). Meltzer (2010) characterizes the period of the 1960s and 1970s as one of the Fed accepting "its role as a junior partner by agreeing to coordinate actions with the administration's fiscal policy." Similarly, Greider (1987) argues that Arthur Burns ran an unusually expansionary policy because he believed it would increase his chances of being nominated for another term.

However, the interaction changes after Paul Volcker became Fed Chairman. As Meltzer (2010) points out, Volcker rebuilt much of the independence and credibility the Federal Reserve had lost during the two previous decades. In this regard, Martin (2013) presents the number of meetings at the White House between the U.S. President and the Fed Chairman. He shows that the number of meetings with Presidents Nixon and Ford (1969-1977) were quite frequent and took place four times more often than the next four presidents put together. Additionally, Martin (2013) shows that President Johnson (1963-1969) met with the Fed Chairman 300 times during his five years in office.Cochrane (2014) argues that, at the same time Volcker rebuilt the independence of the Federal Reserve, the fiscal authority implemented fiscal reforms to back the outstanding government debt by future primary surpluses. Using the narrative account of Romer and Romer (2010), Kliem et al. (2015) also reason that the public expected the fiscal authority to accommodate the actions by the central bank.

After the regime change in the beginning of the 1980s, the monetary authority continued to be independent throughout out our sample. Additionally, the fiscal authority further backed the outstanding fiscal deficits with future primary surpluses. In line with this narrative account, Kliem et al. (2015) find a high low-frequency relationship between public deficits and inflation in the 1970s, which breaks down with Paul Volcker taking office in 1979. Afterwards, the low-frequency between the two variables remains stable around zero. From our reading of the narrative accounts, we expect the fiscal dominance to be more pronounced in Italy than in the U.S.

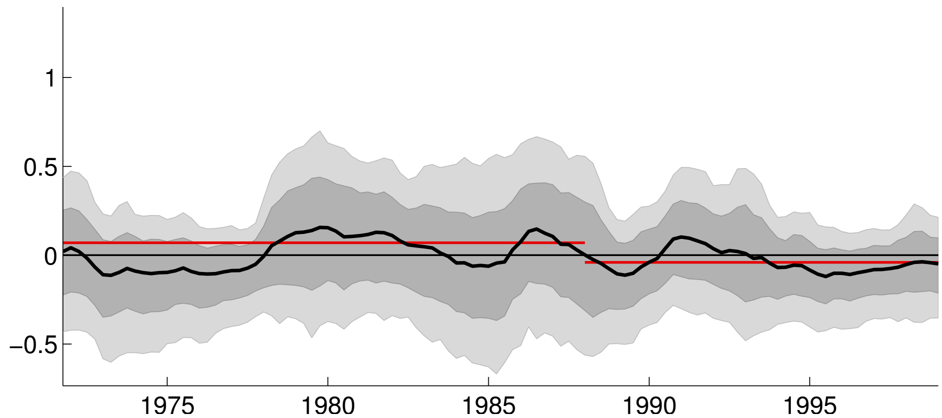
3.2 Estimation results

In this section we present our estimation results for the low-frequency relationship between fiscal deficits and inflation.

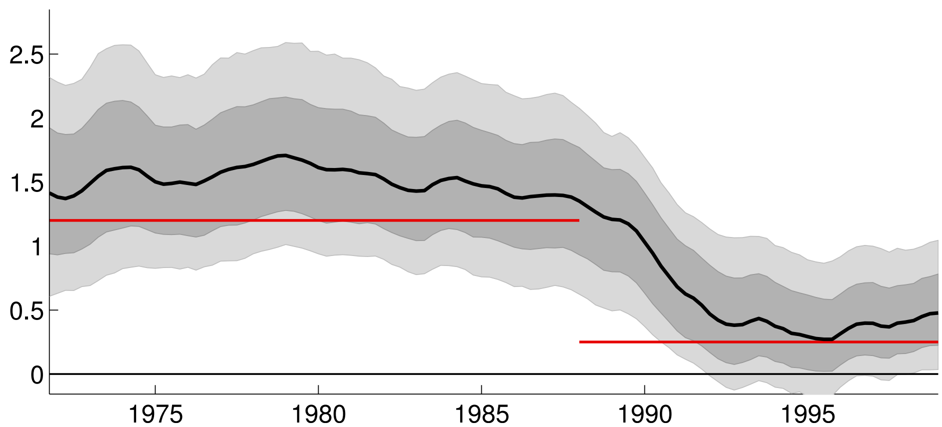
Figure 1(a) presents evidence on the low-frequency relationship between deficits and inflation for Germany. We observe that the low-frequency relationship is around zero over the whole sample. While there is some movement in our measure of the low-frequency relationship, it is always within the (-0.1,0.2) interval. The 90 percent posterior probability mass is also including the zero line throughout the whole sample. The absence of a long-run relationship between deficits and inflation is most likely due to the policy conducted by the Bundesbank during that period. Furthermore, there was never a regime switch in the interaction between fiscal policy and the conduct of monetary policy in Germany for the period studied, which is reflected in the low-frequency relationship reported in Figure 1(a) .

Figure 1(b) reports the low-frequency link between deficits and inflation for Italy, which is positive and remarkably high during the 70s and 80s. The relationship suddenly drops to moderate levels during the end of the 80s beginning of the 90s, where the 90 percent posterior probability mass includes the zero line during most of this period. The high low-frequency values during the 70s and beginning 80s probably stems from the lack of credibility of the Banca d'Italia, which acted as a junior partner to the Tesoro during this period of fiscal dominance. During the 80s, the Banca d'Italia went through a gradual process towards independence, however loosening the ties to the Tesoro only slowly. Hence, it was not the *divorce* of the Banca d'Italia from the Treasury in 1981, which resulted into a drop in the low-frequency relationship. The decrease in the low-frequency relationship between deficits and inflation rather occurred when Italy finally entered the home stretch on their *road to Maastricht* during the end of the 80s.

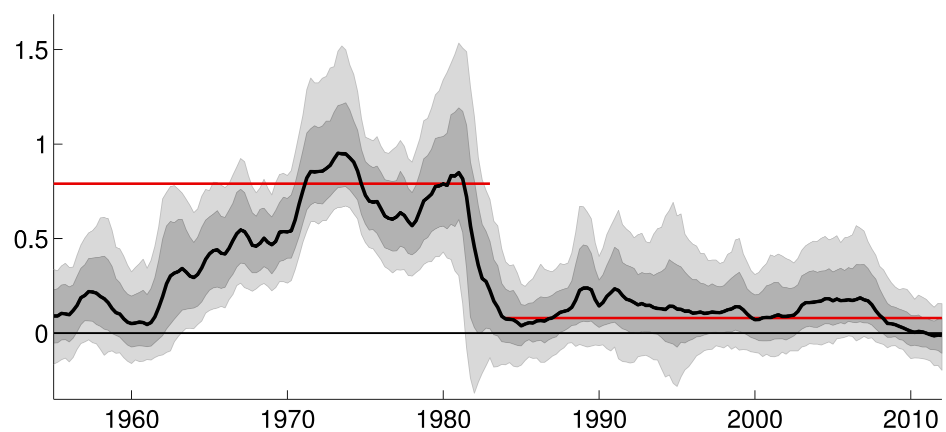
The U.S. evidence on a change in the monetary-fiscal interaction presented in Figure 1(c) is striking. The low-frequency relationship between deficits and inflation is high during the 1960s and 1970s, with a prevalent nexus between fiscal financing and monetary expansion. This link falls apart when Paul Volcker enters the scene, establishing an anti-inflationary policy that is backed by the U.S. government.



(a) $\hat{b}_f$ for Germany



(b) $\hat{b}_f$ for Italy



(c) $\hat{b}_f$ for the U.S.

Figure 1: The black line represents the median and the dark shaded area indicates the 16th and 84th percentiles and the light shaded area the 5th and 95th percentiles of the posterior probability mass of the time-varying regression coefficient of inflation on deficits over debt. Red lines depict slopes of the scatter plots which are based on the OLS regression coefficient of the filtered data in Section C.

In Figure 1, the red horizontal line represent the results we obtain using the Lucas filter applied to particular sub-samples. Given the robustness of the Lucas filter it is quite reassuring that our TVP-VAR estimates for the low-frequency relationship are always in the ballpark of the Lucas-filter estimates for the selected sub-samples. Further evidence on the robustness of the time-varying low-frequency relationship between deficits and inflation can be found in Kliem et al. (2015).

To summarize, the estimation results exactly confirm our expectations for the low-frequency relationship, which we have derived from the narrative account. In a next step, we decompose the low-frequency relationship into policy and non-policy structural shocks.

3.3 Structural decomposition

In this section, we decompose the low-frequency relationship into policy and non-policy shocks. We identify two policy shocks, one monetary policy and one fiscal policy shock. Both shocks are identified using a Cholesky decomposition of the reduced form variance-covariance matrix. The order of the variables implies the following identifying assumptions. The variable which captures the fiscal stance does not respond to other shocks within the first period. This assumption follows the identification scheme proposed by Blanchard and Perotti (2002). The monetary policy shock is identified as in (Sims, 1992; Christiano, Eichenbaum, and Evans, 1996). We assume that output growth and inflation respond with a one-period lag to a monetary policy shock, while the monetary aggregate responds immediately.

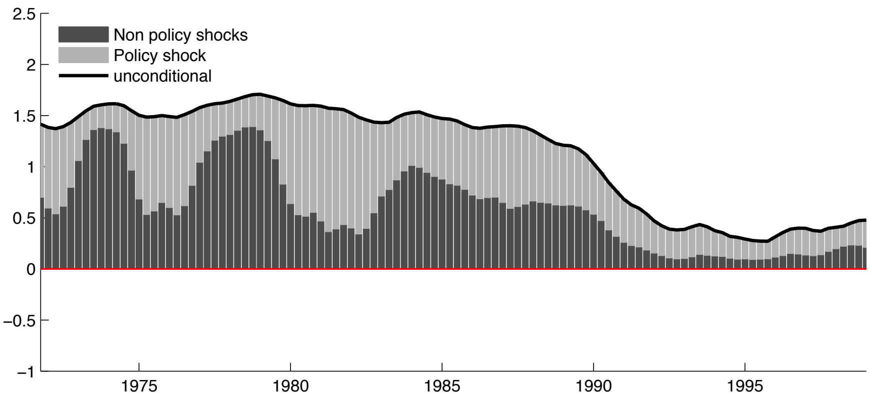
We denote the Cholesky decomposition of the variance-covariance matrix by $\tilde{\mathbf{B}}$ and re-write the state-space system in the following way:

$$\begin{aligned} \mathbf{X}_t &= \hat{\mathbf{A}}_{t|T}\mathbf{X}_{t-1} + \tilde{\mathbf{B}}_{t|T}\epsilon_t \\ \mathbf{y}_t &= \hat{\mathbf{C}}_{t|T}\mathbf{X}_t \ . \end{aligned} \tag{11}$$

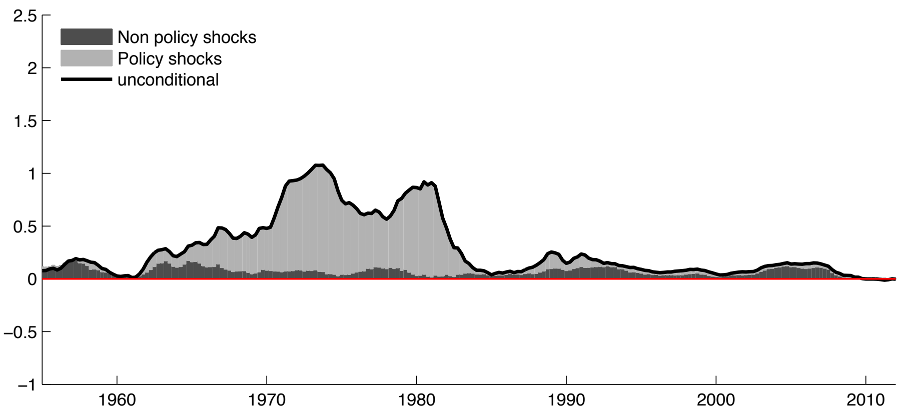
Furthermore, denote the i-th column in the matrix $\tilde{\mathbf{B}}$ by $\tilde{\mathbf{B}}^{\mathbf{i}}$. The temporary spectrum conditional on the i-th structural shock at time t is given by:

$$S^i_{Y,t|T}(\omega) = \hat{\mathbf{C}}_{t|T}\left(I - \hat{\mathbf{A}}_{t|T}e^{-i\omega}\right)^{-1}\tilde{\mathbf{B}}^i_{t|T}(\tilde{\mathbf{B}}^i)'_{t|T}\left(I - \hat{\mathbf{A}}'_{t|T}e^{i\omega}\right)^{-1}\hat{\mathbf{C}}'_{t|T} \tag{12}$$

Since the structural shocks are independent, we know that the unconditional spectrum in equation (12) is the sum of spectra conditional on each structural shock (see, e.g., Gambetti and Galí, 2009; Gambetti, Pappa, and Canova, 2008; Mertens, 2010). Consequently, the unconditional low-frequency measure can be written as the sum of weighted conditional



(a) Structural decomposition for Italy



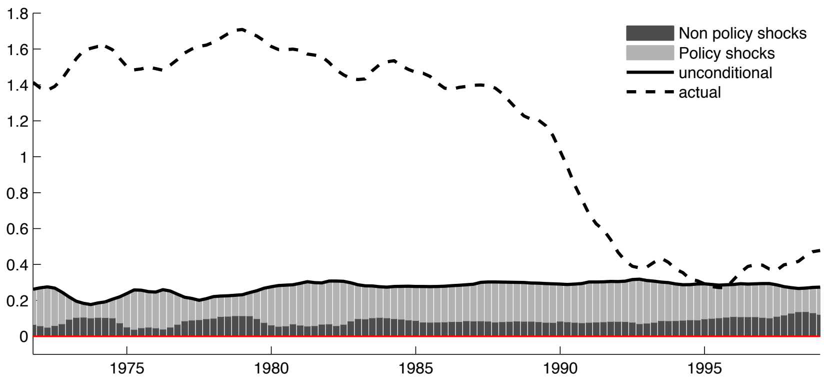
(b) Structural decomposition for the U.S.

Figure 2: Structural decomposition of the low-frequency relationship into policy and non-policy shocks.

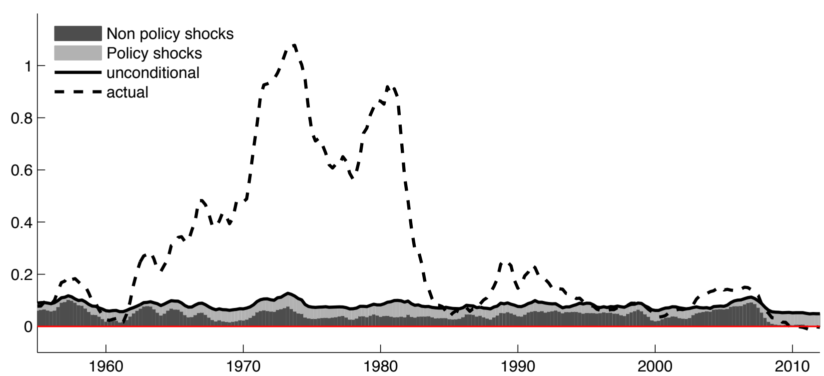
low-frequency measures

$$\hat{b}_{f,t|T} = \frac{S^m_{d,t|T}(0)}{S_{d,t|T}(0)}\hat{b}^m_{f,t|T} + \frac{S^f_{d,t|T}(0)}{S_{d,t|T}(0)}\hat{b}^f_{f,t|T}\sum_{i=1}^{3}\frac{S^i_{d,t|T}(0)}{S_{d,t|T}(0)}\hat{b}^i_{f,t|T}\ , \tag{13}$$

where the low-frequency relationship conditional on the monetary policy shock and the fiscal policy shock is given by $\hat{b}^m_{f,t|T}$ and $\hat{b}^f_{f,t|T}$ respectively. The weight in front of $\hat{b}^m_{f,t|T}$ and $\hat{b}^f_{f,t|T}$, $\frac{S^m_{d,t|T}(0)}{S_{d,t|T}(0)}$ and $\frac{S^f_{d,t|T}(0)}{S_{d,t|T}(0)}$ denote the fraction of the unconditional spectrum at frequency zero explained by the corresponding spectrum conditional on the monetary and fiscal policy shock. We refer to the sum of these two shocks as policy shocks. The sum of the remaining shocks is denoted non-policy shocks. Figures 2(a) and 2(b) display the unconditional low-frequency relationship and its decomposition into policy and non-policy policy shocks of the counterfactual experiments. Both figures show that a substantial part of the low-frequency relationship is driven by the transmission of policy shocks. This is especially true for the US in the period between 1965 and 1979. While the low-frequency relationship in Italy is mostly driven by the long-lasting effects of policy, parts of it are due to non-policy shocks. In the next step, we therefore investigate wether these long-lasting effects are due to the systematic behavior of the economy.



(a) Counterfactual for Italy



(b) Counterfactual for the U.S.

Figure 3: Historical decomposition and counterfactuals of the median of the unconditional low-frequency relationship between deficits over debt and inflation. The counterfactual experiments illustrate the historical decomposition of the median $\hat{b}_f$ for fixed VAR model coefficients $\mathbf{A}_t$ and $\mathbf{B}_t$ at t equal to 1995:q1.

More precisely, we perform a counterfactual analysis for the US and Italy. We investigate whether the movements of the low-frequency relationship are due to changes in the volatilities of the shocks or whether the changes in the low-frequency relationship can be attributed to changes in the systematic behavior of the economy. We thus fix the systematic behavior of the economy (the matrices $\mathbf{A}_t$ and $\mathbf{B}_t$ of the VAR model in eq. (1)) in a counterfactual experiment to the first quarter of 1995. This time coincides to a period of a low-frequency relationship between deficits and inflation in the US and in Italy. More precisely, we fix the systematic behavior of the economy to be $\mathbf{A}_{1995.1}$ and $\mathbf{B}_{1995.1}$ at each point in time. The results are shown in Figure 3(a) and Figure 3(b). In both figures we also plot the estimated low-frequency relationship.

For the US, when contrasting figures 2(b) and 3(b) it is quite apparent that the drop in the in the low-frequency relationship between deficits and inflation during the 90's is mainly due to changes in the transmission mechanism in fiscal and monetary policy. Had the economy always been in the same state as in 1995Q1, the low-frequency relationship before the 80's would have been around zero and the long-run impact of policy shocks would have almost invisible. The counterfactual analysis for Italy reveals a similar pattern. The low-frequency relationship between inflation and deficits is reduced drastically. If Italy had been always in the same state as 1995, it would have never experienced periods with such a high low-frequency relationship. We interpret these counterfactuals across the three different countries we have considered as strong evidence in favor of theories which consider different regimes of interaction between monetary and fiscal policy.

4 Conclusion

Is there empirical evidence for inflationary fiscal policy? In this paper, we show there is. In the past monetary and fiscal interactions have had consequences for long-run inflation and, therefore, have contributed to a sustained higher level of inflation. In this regard, we conclude, that in times of permanent negative real interest rates, coordinated policy actions might be a way out.

Following the theories on the interaction of monetary and fiscal policy, our hypotheses is that fiscal deficits are associated with inflation under two conditions. First, the fiscal authority does not back the outstanding government debt by discounted future primary surpluses and second the monetary authority accommodates the behavior of the fiscal authority. In order to investigate the hypothesis, we have considered data for three industrialized countries between 1970 and 1999: Germany, Italy and the U.S. All countries have been subject to the same technological change. However, we argue they all had a different evolution of the interaction between fiscal and monetary policy.

For Germany, we argue that the fiscal and monetary interaction was such that the monetary authority dominated. Consequently, we estimate that fiscal deficits are not associated with inflation at low frequencies. From the narrative account, we determine for Italy a regime with fiscal dominance in the 1970s, a gradual process towards an independent central bank and an fiscal authority which is able to repay its debt with future primary surpluses. This process is not successfully completed until the Maastricht treaty is signed in 1991. In line with this narrative account we estimate a very high low-frequency relationship in the 1970s, which moves during the 1980s gradually towards zero. After the entry into the European Monetary Union the low-frequency relationship remains stable at much lower values than in the 1970s and 1980s. For the U.S. we estimate a high low-frequency relationship between public deficits and inflation in the 1970s, which is lower than the one we estimate for Italy. This is in line with the narrative account of a monetary and fiscal interaction dominated by the fiscal authority. The low-frequency relationship breaks down with Paul Volcker taking office in 1979. Afterwards, the low-frequency relationship between the two variables remains stable around zero.

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A Convergence statistics of the TVP-VARs

To check the convergence of our sampler for three countries, we have used visual inspections as convergence diagnostics. The visual inspections illustrate how the parameters move through the parameter space, thereby allowing us to check wether the chain gets stuck in certain areas. To visualize the evolution of our parameters, we use running mean plots and trace plots. For lack of space, we present only running mean plots and trace plots for the trace of the variance covariance matrices $\mathbf{Q}$, $\mathbf{W}$ and $\mathbf{S}$. As can be seen in Figure 4- 9 running mean plots and trace plots both show that the mean of the parameter values stabilize as the number of iterations increases and that the chains of the different TVP-VARs are mixing quite well.

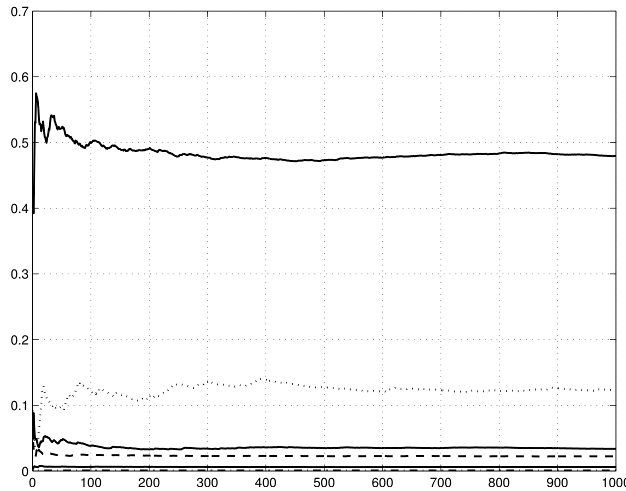


Figure 4: Running Mean Plot for Germany.

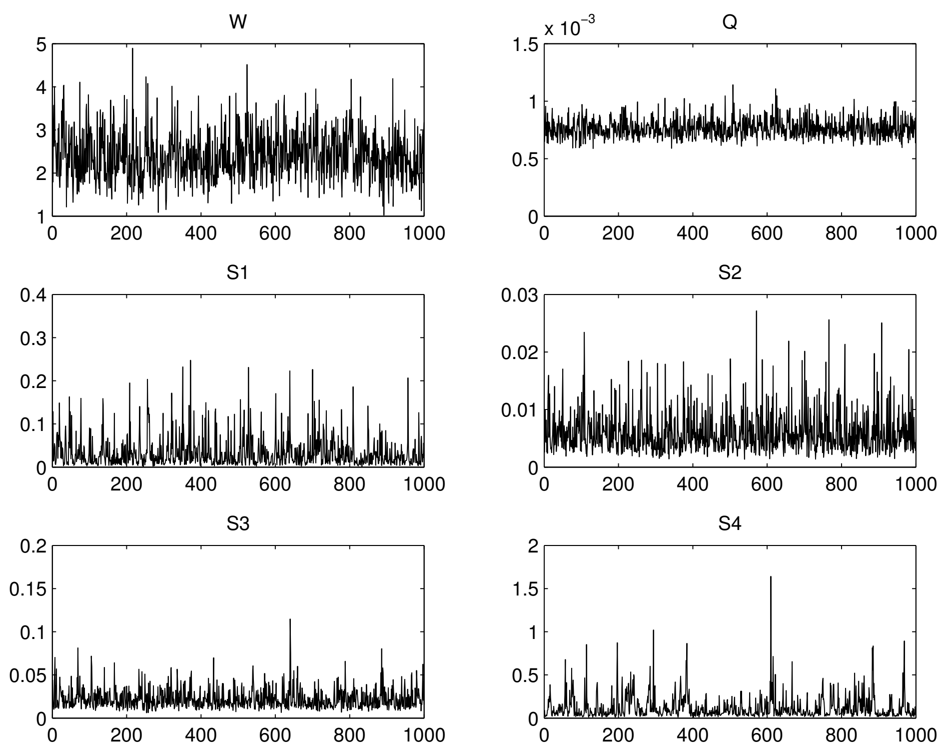


Figure 5: Trace Plot for Germany.

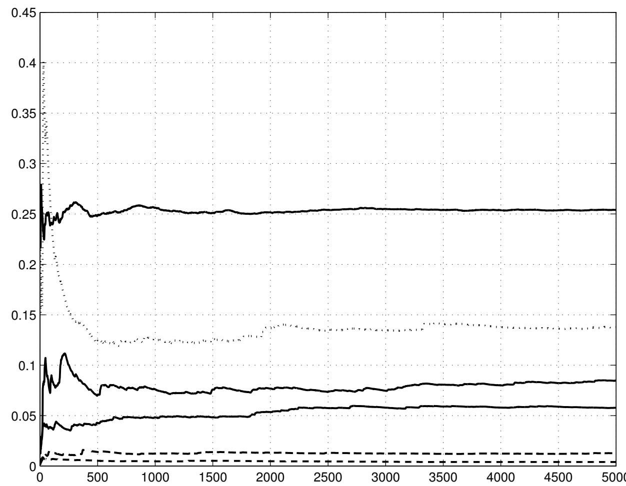


Figure 6: Running Mean Plot for Italy.

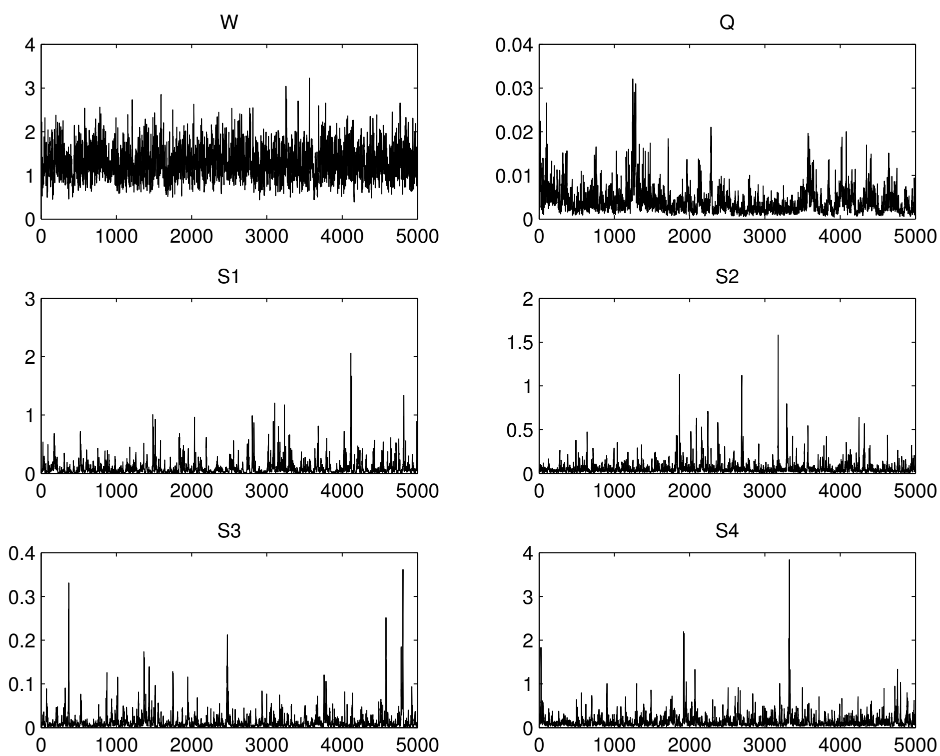


Figure 7: Trace Plot for Italy.

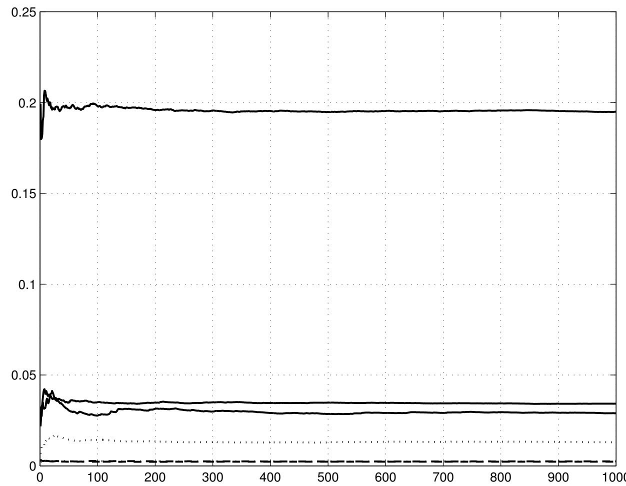


Figure 8: Running Mean Plot for the U.S..

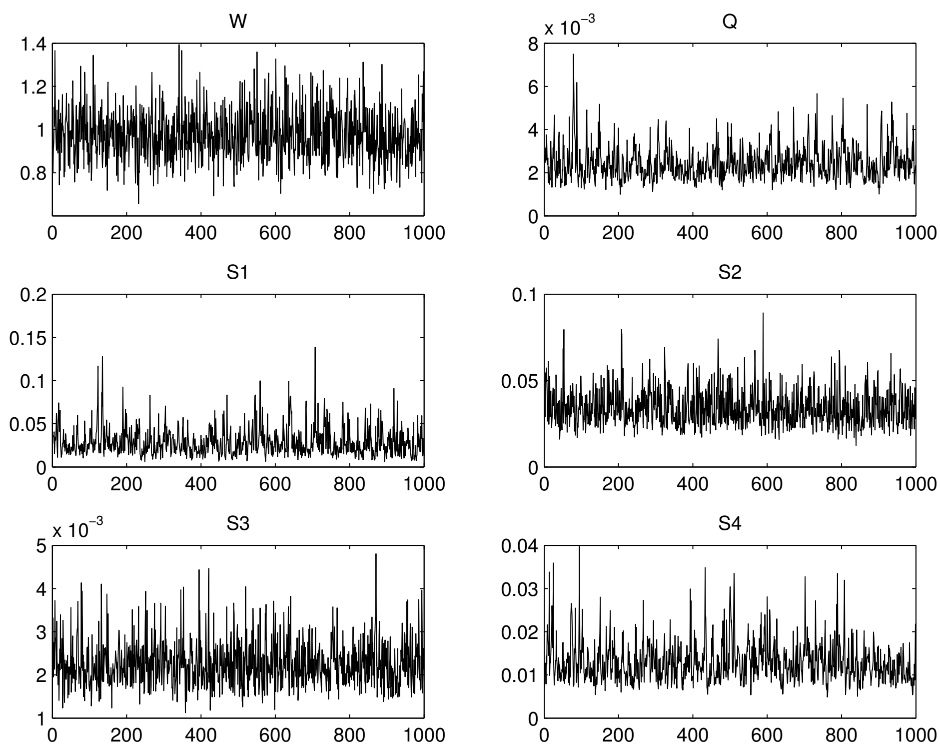
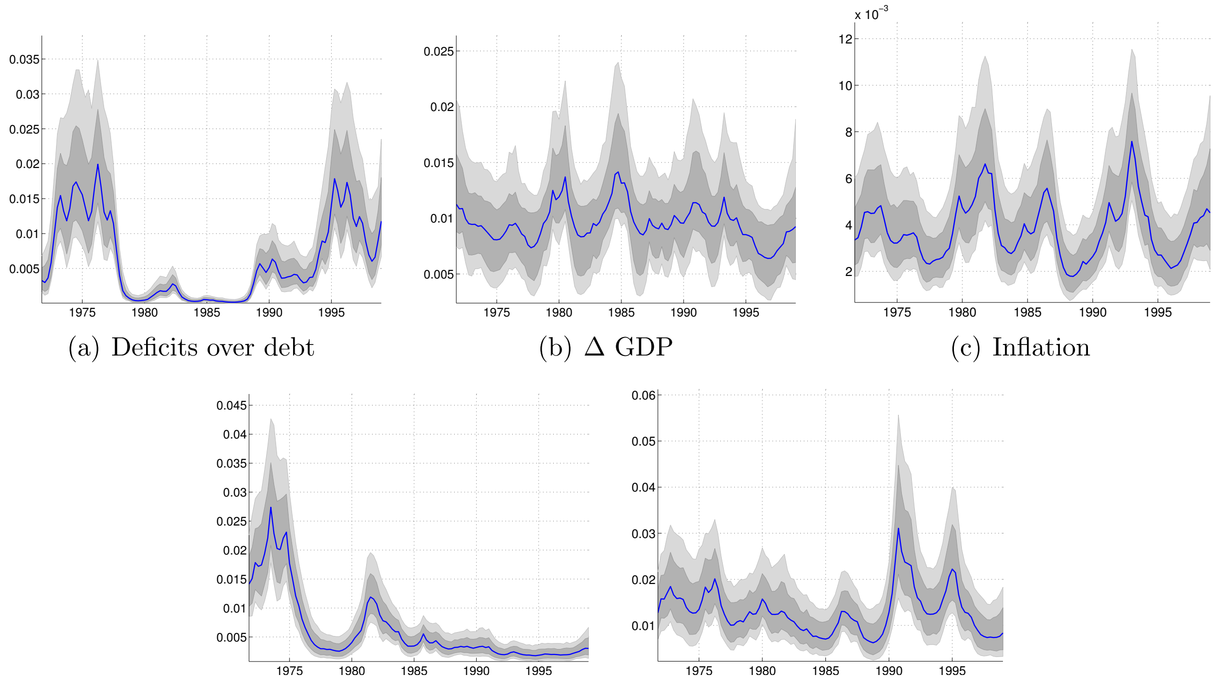


Figure 9: Trace Plot for the U.S.

B Stochastic volatilities



(a) Deficits over debt (b) Δ GDP (c) Inflation

(d) Interest rate (e) Δ Money

Figure 10: Square roots of stochastic volatility for Germany.

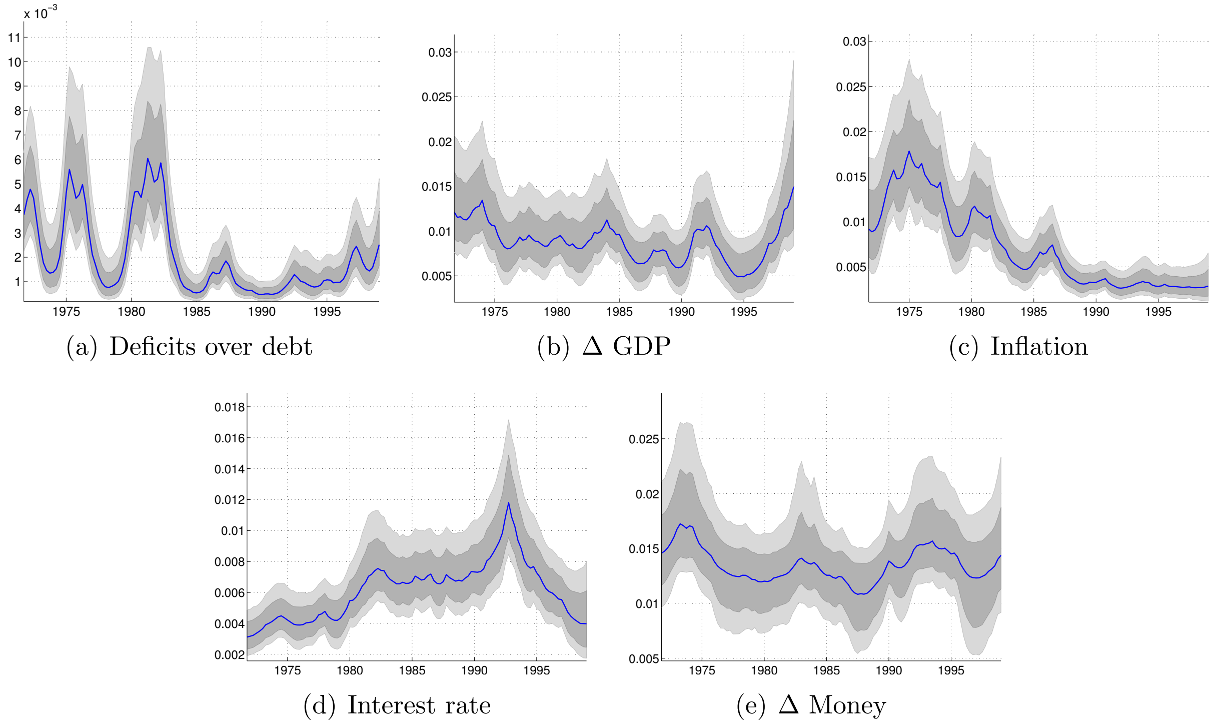


Figure 11: Square roots of stochastic volatility for Italy.

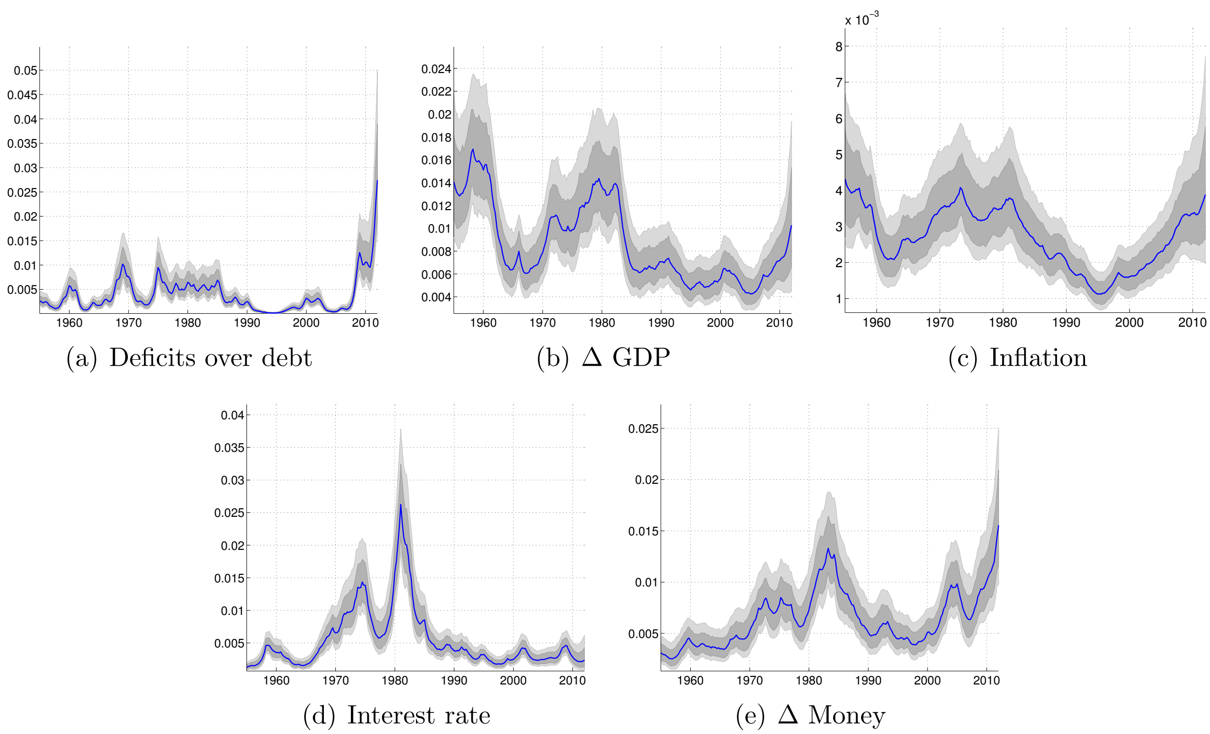
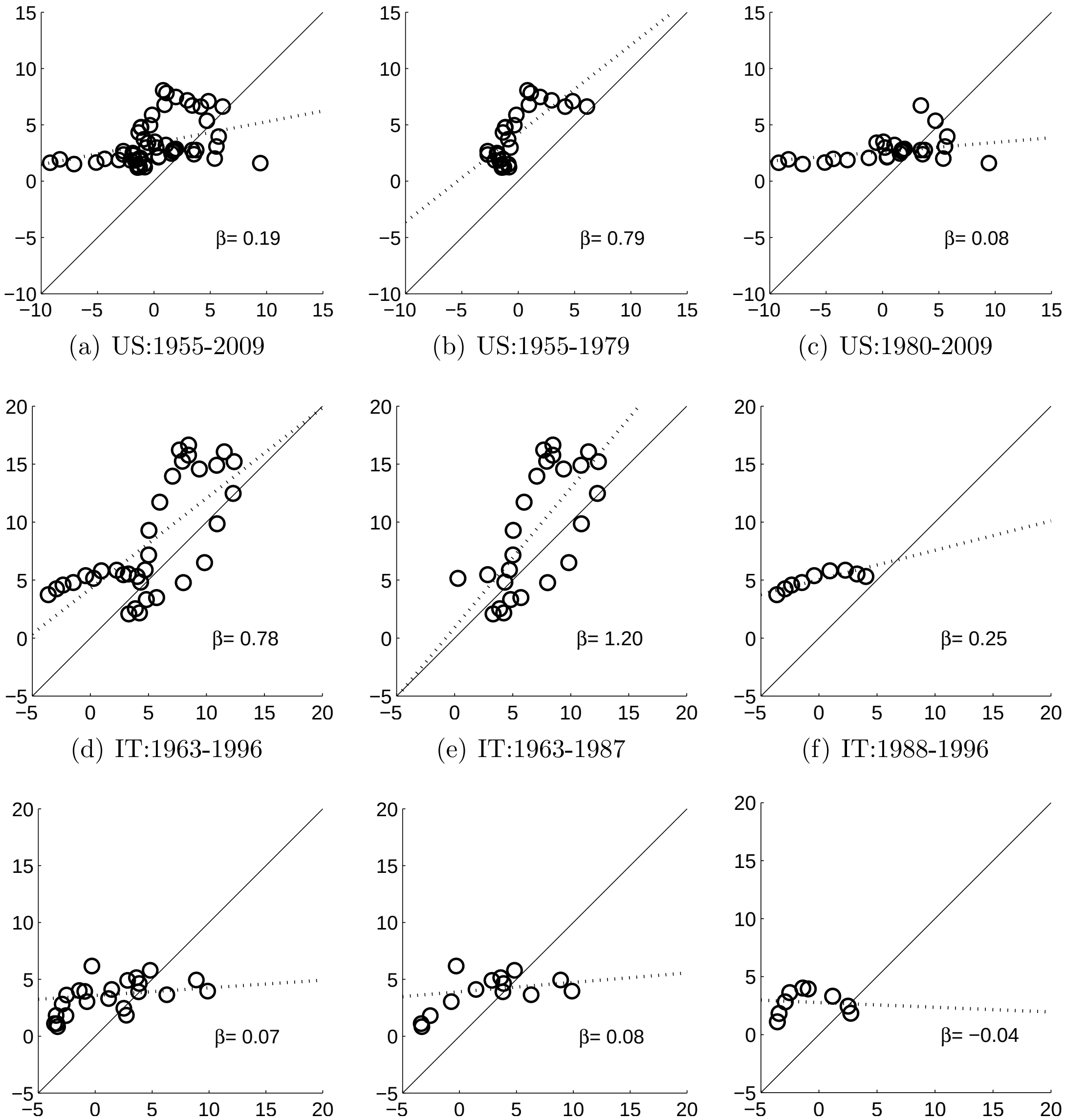


Figure 12: Square roots of stochastic volatility for the U.S.

C Lucas Filter



(a) US:1955-2009 (b) US:1955-1979 (c) US:1980-2009

(d) IT:1963-1996 (e) IT:1963-1987 (f) IT:1988-1996

(g) GER:1963-1996 (h) GER:1963-1987 (i) GER:1988-1996

Figure 13: Scatter plots of filtered time series of inflation and deficits over debt. The dashed line indicates the slope of the scatter (β) and the solid line is the 45° line.