Monetary and Fiscal Policy Interactions: Some Empirical Evidence in the Euro-Area

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Abstract

The interaction of monetary and fiscal policies is a recurring theme in macroeconomics and has also been a crucial issue in a highly integrated area like the European Union. Monetary policy may be accommodative to fiscal policy or counteractive. This problem seems more important for the Euro-area than for other economies, since the member states of the EMU have individual fiscal authorities, but the monetary policy is pursued by a single monetary authority, the ECB. We first undertake some tests of fiscal regimes with a VAR model and find that a non-Ricardian fiscal policy has been implemented. We also undertake some Granger-Causality tests and find that the fiscal policy does not seem to Granger-cause the inflation, but the inflation Granger-causes the fiscal policy to some extent. In order to estimate the time-varying interactions between the two policies, we estimate a State-Space model with Markov-switching. There seem to be some regime changes in the monetary and fiscal policy interactions in France and Germany, but the results are somewhat different for the two countries. Finally we explore the forward-looking behavior in the two policy interactions with the conclusion that expectation seems to have played little role.
Keywords: Fiscal Regime, VAR Model, Granger-Causality, State-Space Model, GMM

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1 Introduction

The nature of the interdependence between monetary and fiscal policies is a recurring theme in macroeconomics and has also been a crucial issue in a highly integrated economic area as the European Union. Fiscal policy might affect the chances of success of monetary policy in various ways: via its impact on general confidence in monetary policy, via short-run effects on demand and by modifying the long-term conditions for economic growth and low inflation. On the other hand, monetary policy may be accommodative to fiscal policy or counteractive. The traditional analysis of monetary and fiscal policy interactions focuses on the optimal policy mix when both policy instruments are under the control of a single policy maker. With the widespread shift to a separation of powers between fiscal and monetary authorities, the question arises of how the two policies interact when the policy makers' objectives differ. The problem seems more important for the Euro-area than for other economies, since the member states of the EMU have individual fiscal authorities but the monetary policy is pursued by a single monetary authority, the ECB. Therefore, this paper is devoted to the analysis of monetary and fiscal policy interactions of the Euro-area.

The remainder of this paper is organized as follows. In Section 2 we discuss the recent literature of monetary and fiscal policy interactions. In Section 3 we undertake VAR estimation of the fiscal regime and Granger-Causality tests of the monetary and fiscal policy instruments. In Section 4 a State-Space model with Markov-switching is employed to estimate the time-varying interactions of monetary and fiscal policies for France and Germany. Section 5 explores monetary and fiscal policy interactions with forward-looking behavior considered. Section 6 concludes.

2 Recent Literature on Monetary and Fiscal Policy Interactions

Though there are numerous studies on the interactions of monetary and fiscal policies, we may divide the literature into four directions according to their focuses of research.

The Fiscal Theory of the Price Level Determination The "Fiscal Theory of the Price Level" (FTPL) was mainly developed by Leeper (1991), Sims (1994, 1997 and 2001a) and Woodford (1994, 1995, 1998 and 2000) and has attracted much attention. This approach studies the impact of a fiscal policy that has been termed "non-Ricardian", which specifies the time paths of government debt, expenditure and taxes without respecting the government's intertemporal solvency constraint such that in equilibrium the price level has to adjust in order to ensure government solvency. The introduction of this non-Ricardian fiscal policy into an otherwise standard New Keysian monetary sticky price model has been shown to alter the stability conditions associated with the central bank's interest rate policy. Benhabib et al. (2001), for example, characterize conditions under which interest-rate feedback rules that set the nominal interest rate as an increasing function of the inflation rate, induce aggregate instability. They find that these conditions are partly affected by the monetary-fiscal regime as emphasized in the fiscal theory of the price level. We will present the FTPL briefly below.

Woodford (1995) states that the fiscal policy affects the equilibrium price level for a simple reason. An increase in the price level reduces the real value of the net (outside) assets of the private sector, or equivalently, the net government liabilities. The reduction of private-sector wealth naturally reduces private-sector demand for goods and services through a straightforward wealth effect. As a result, there will be only one price level that results in aggregate demand that equals aggregate supply. Changes in expectations regarding future government budgets have similar wealth effects that require an offsetting change in the price level in order for equilibrium to be maintained. One thus arrives at a theory of price-level determination in which fiscal policy plays the crucial role, both because the effects of price-level changes on aggregate demand depend on the size of the outstanding nominal government debt and because of the wealth effects of expected future government debt.

Let p_t denote the price level at date t, W_t the nominal value of beginning-of-period wealth, g_t government purchases in period t, T_t the nominal value of net taxes paid in period t, R_t^b the gross nominal return on bonds held from period t to t+1 and R_t^m the gross nominal return on the monetary base and define further the following variables:

$$\begin{aligned}
\tau_t &= T_t/p_t, \quad (real\ tax) \\
\triangle_t &= (R_t^b - R_t^m)/R_t^b, \quad (\text{``}price\text{''}\ of\ holding\ money) \\
r_t^b &= R_t^b(p_t/p_{t+1}) - 1, \quad (real\ rate\ of\ return\ on\ bonds) \\
m_t &= M_t/p_t. \quad (real\ balances)
\end{aligned}$$

The equilibrium condition in Woodford (1995) that determines the price level p_t at date t, given the predetermined nominal value of net government liabilities W_t and the expectations at date t regarding the current and future values of the real quantities and relative prices, can be expressed as

$$\frac{W_t}{p_t} = \sum_{s=t}^{\infty} \frac{(\tau_s - g_s) + \triangle_s m_s}{\prod_{j=t}^{s-1}(1 + r_j^b)}. \tag{1}$$

Assuming long-run price flexibility, although prices may be sticky in the short run, Woodford (1995) gives a simple interpretation to the mechanism by which the price level adjusts to satisfy (1). Briefly speaking, an increase in the nominal value of outstanding government liabilities, or in the size of the real government budget deficits expected at some future dates, is inconsistent with equilibrium at the existing price level. Either change causes households to believe that their budget set has expanded and so they demand additional consumption immediately. The consequence would be an excess demand for goods and the price level will therefore be forced up, to the extent that the capital loss on the value of net outside assets restores households' estimates of their wealth to ones that just allow them to purchase the quantity of goods that the economy can supply. Woodford (1995) emphasizes that in one special case, namely the so-called "Ricardian" policy regime, the fiscal considerations referred to fail to play any role in the price-level determination. The FTPL has attracted much attention and quite a lot research has been undertaken to discuss monetary and fiscal policy interactions under this framework. Woodford's work has in particular been very important for the Euro-area countries where the Masstricht criteria have restricted the member states' deficit by 3% and the debt by 60% of the GDP. These criteria would make sense if one expects, as the fiscal theory of the price level suggests, that fiscal policy has price effects. Further discussion on the FTLP has been developed, for example, by Ljungqvist and Sargent (2000, ch. 17) and Linnemann and Schabert (2002).

Despite its popularity, the FTPL, however, has been criticized on logical and empirical grounds. Buiter (2001), for example, points out that FTPL confuses two key building blocks of a model in a market economy: Budget constraints, which must be satisfied identically, and market clearing or equilibrium conditions. Canzoneri, Cumby and Diba (2000) undertake some empirical research to test whether the "Ricardian" or "non-Ricardian" regime can be obtained in time series data for a particular country. With the U.S. data of 1951-1995, they conclud that the U.S. fiscal regime seems to have been a "Ricardian" rather than a "non-Ricardian" one, and find that the conclusion is robust to different subperiods of data.

Strategic Interactions between Monetary and Fiscal Policies Some researchers have tried to explore monetary and fiscal policy interactions from a strategic perspective. Examples include Catenaro (2000), van Anarle, Bovenberg and Raith (1995), Buti et al. (2000), Wyplosz (1999), and van Anarle, Engwerda and Plasmans (2002). van Aarle, Bovenberg and Raith (1995), for example, extend the analysis of Tabellini (1986) and reconsider the interaction between fiscal and monetary authorities in a differential game framework. Explicit solutions of the dynamics of the fiscal deficit, inflation and government debt in the cooperative and Nash open-loop equilibria are derived. van Anarle et al. (2002), however, discuss three alternative policy regimes in a stylized dynamic model of the EMU: Noncooperative monetary and fiscal policies, partial cooperation and full cooperation both in symmetric and asymmetric settings.

Empirical Research on Monetary and Fiscal Policy Interactions Though most of the research on monetary and fiscal policy interactions is theoretical, some empirical work can also be found. Besides the empirical research by Canzoneri, Cumby and Diba (2000), who study the fiscal regime of the U.S. with VAR models, some other researchers have also explored how monetary and fiscal policies may have interacted in reality. Examples include Mélitz (1997 and

2000), van Aarle et al. (2001), Muscatelli et al. (2002) and Smaghi and Casini (2000). Mélitz (1997), for example, uses pooled data for 15 member states of the EU except Luxembourg and 5 other OECD countries to undertake some estimation and finds that coordinated macroeconomic policy existed–easy fiscal policy leads to tight monetary policy and easy monetary policy to tight fiscal policy. Muscatelli et al. (2002) estimate VAR models with both constant and time-varying parameters for the G7 countries and find that while monetary and fiscal policies are increasingly used as strategic complements, the responsiveness of fiscal policy to the business cycle has decreased since the 1980s and that the strategic interdependence between fiscal and monetary policy can be captured using Bayesian VAR models. Smaghi and Casini (2000), however, undertake an investigation on the cooperation between the monetary and fiscal institutions. They compare the situations prior to EMU and in the first year of EMU and find that something has been lost when the Euro-area countries moved into the EMU. In particular there is some scope for further improving the dialogue and cooperation between budgetary and monetary authorities in the EMU.

Monetary and Fiscal Policy Interactions in Open Economies The analysis of monetary and fiscal policy interactions has also been extended to open economies and examples include Leith and Wren-Lewis (2002), Mélitz (2000), van Aarle et al.(2002), Sims (1997), Chamberlin et al. (2002), Clausen and Wohltmann (2001) and Beetsma and Jensen (2002). The monetary and fiscal policy interactions between two or more countries, especially between the member states of EMU are usually the focuses of this research. This problem seems quite crucial for the Euro-area, since the member states have their own fiscal authorities but the monetary policy is pursued by a single monetary authority, the ECB.

3 Basic Evidence of Monetary and Fiscal Policy Interactions in the Euro-Area

In this section we will undertake some empirical research on the monetary and fiscal policy interactions in the Euro-area employing a VAR model. Two problems are to be tackled. First, following Canzoneri, Cumby and Diba (referred to as CCD hereafter), we want to test whether the fiscal regime of the Euro-area has been "Ricardian" or "non-Ricardian", so that we can judge whether the assumption for the FTPL holds in reality. Second, we will refer to van Aarle et al. (2001) and Muscatelli et al. (2002) to see how monetary and fiscal policies in the Euro-area have interacted.

3.1 Tests of the Fiscal Regime

CCD test the interactions between the two variables, surplus and government liabilities. We will undertake a similar test only for France and Germany because the data are unavailable for other states of the EMU. Government liability is

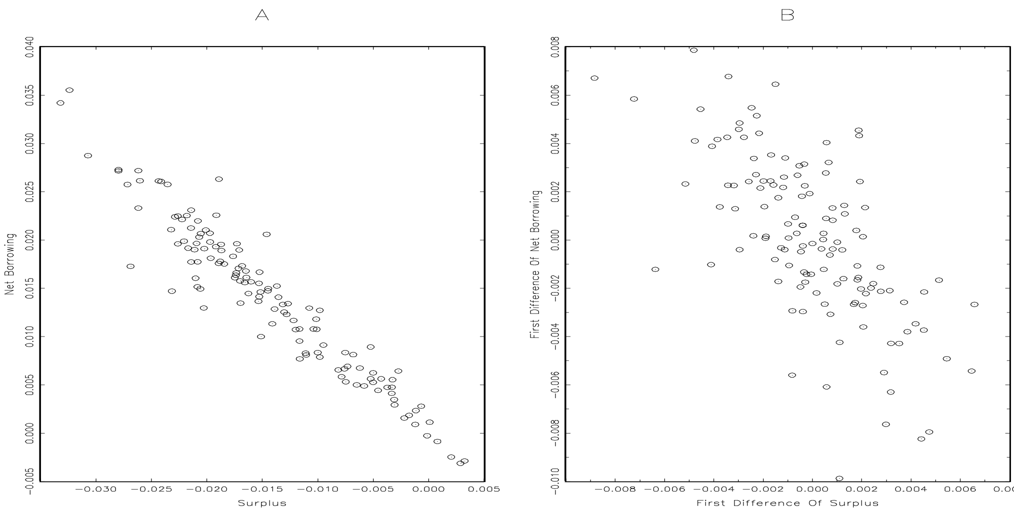

Figure 1: Surplus and Liability (Net Borrowing) of Germany

measured by net borrowing. Both surplus and liability are scaled by dividing the current GDP. Some preliminary view on this matter can be obtained from the surplus and liability of Germany in Figure 3.1A. In Figure 3.1B we show the first differences of the two variables.[1] Figure 3.1A indicates that there exists a significant negative correlation between the surplus and liability of Germany with the correlation coefficient being -0.952. This suggests that the net borrowing does not decrease when the surplus decreases, on the contrary, it increases when the surplus decreases. This seems to indicate that some kind of non-Ricardian fiscal policy is at work. From Figure B we get similar results. The correlation coefficient of the first differences of the two variables is -0.657.

Next we undertake a VAR estimation for the two variables. Before undertaking the VAR estimation, we must make sure that the variables in the VAR model are stationary. Therefore we will first undertake an ADF unit-root test for the surplus and liability. In case that the variables are non-stationary, we have to use the detrended variables or the differences of the variables for the estimation. With four lagged differences in the ADF tests, we find that the ADF test statistic (-2.20) of the German surplus is larger than the MacKinnon critical values for rejection of hypothesis of a unit root of 1% (-3.48), 5% (-2.88) and 10% (-2.58). We get similar results in the tests of the liability: the ADF test statistic is -2.45, larger than the MacKinnon critical values for rejection of hypothesis of a unit root of 1%, 5% and 10% . Therefore we can not reject a

[1]The quarterly data covers 1967.1-1998.4 and the data source is the International Statistics Yearbook 2000.

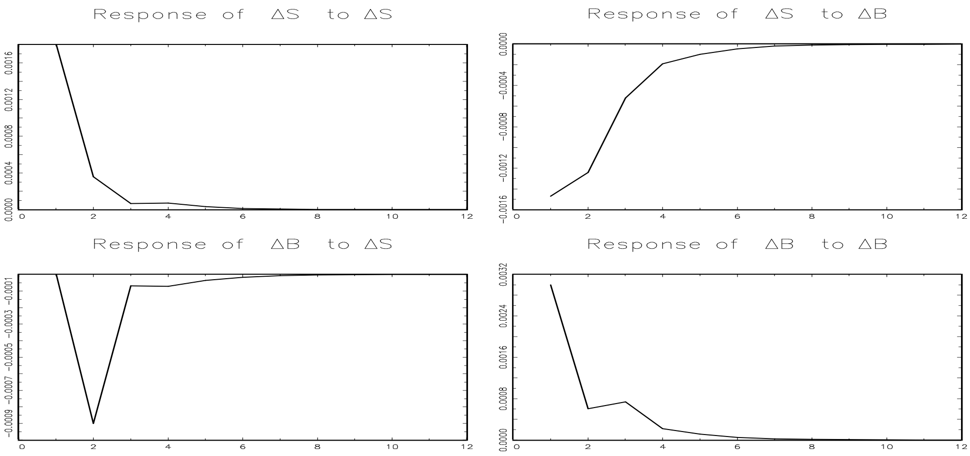

Figure 2: Response to One S.D. Innovation (Germany) with Ordering ΔB_t, ΔS_t

unit root in the data and use the first differences of the surplus and liability in the VAR estimation. With two lags of variables in the VAR estimation, we get the following results for Germany:

$$\Delta S_t = \underset{(0.026)}{5.45 \times 10^{-6}} + \underset{(1.775)}{0.208}\Delta S_{t-1} - \underset{(1.481)}{0.164}\Delta S_{t-2} - \underset{(3.438)}{0.304}\Delta B_{t-1} - \underset{(1.148)}{0.104}\Delta B_{t-2}$$

$$\Delta B_t = \underset{(0.043)}{-1.20 \times 10^{-6}} - \underset{(3.342)}{0.523}\Delta S_{t-1} + \underset{(0.285)}{0.042}\Delta S_{t-2} - \underset{(0.450)}{0.053}\Delta B_{t-1} + \underset{(0.499)}{0.061}\Delta B_{t-2}$$

$$R^2 = 0.277,$$

where ΔS_t and ΔB_t denote the first difference of surplus and liability respectively. The estimation tells us that there exists a significant negative correlation between the two variables. Next we simulate the impulse responses for the two variables. The results are presented in Figure 2 and 3 with different ordering.

Both Figure 2 and 3 indicate that one S.D. innovation in ΔS_t causes a negative response of ΔB_t and similarly, one S.D. innovation of ΔB_t also induces a negative response of ΔS_t. This is just what the non-Ricardian fiscal regime implies. If we include more lags (four lags for example) of ΔS_t and ΔB_t into the estimation, we get similar results. All the evidence above seems to confirm a non-Ricardian fiscal regime in Germany in the period covered.

Now we come to the case of France. The quarterly data cover 1971.1-1998.4 with the same data source as used for Germany. The surplus and liability and their first differences are shown in Figure 4. In Figure 4A we observe a significant negative correlation between the surplus and liability with the correlation coefficient being -0.864, and in Figure 4B we also see a significant negative correlation between the first differences of the two variables. This seems to suggest that a non-Ricardian fiscal policy has been implemented in

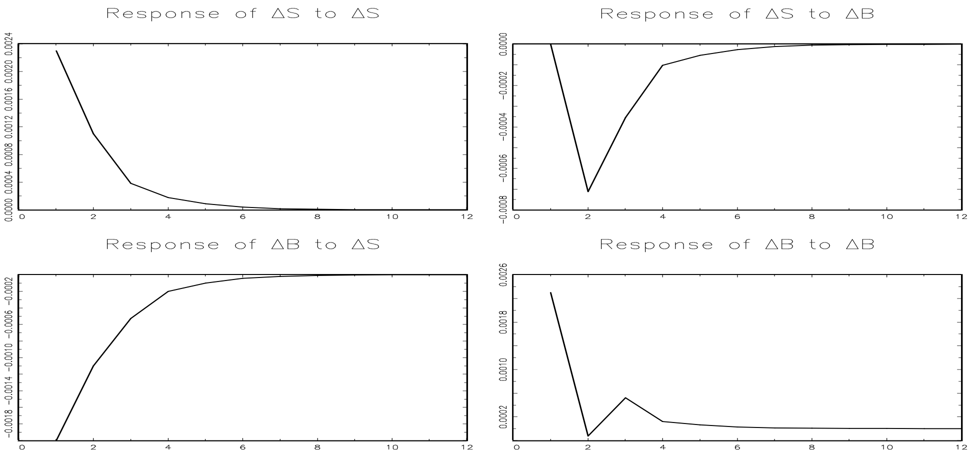

Figure 3: Response to One S.D. Innovation (Germany) with Ordering ΔS_t, ΔB_t

France. Before coming to the final conclusion, we must resort to more analysis. The ADF tests of the surplus and liability indicate that we can not reject a unit root in the two series. The ADF test statistic of the surplus is -2.650, larger than the Mackinnon critical values for rejection of hypothesis of a unit root of 1% (-4.037), 5% (-3.448) and 10% (-3.149). The ADF test of the liability series is -2.625, also larger than the three critical values above. Therefore we will use the detrended series of the surplus and liability for the VAR estimation. The result of the VAR estimation reads as

$$\Delta S_t = \underset{(0.203)}{0.0001} + \underset{(9.569)}{0.942}\Delta S_{t-1} - \underset{(1.995)}{0.209}\Delta S_{t-2} - \underset{(1.840)}{0.190}\Delta B_{t-1} + \underset{(2.206)}{0.220}\Delta B_{t-2}$$

$$\Delta B_t = \underset{(0.120)}{-6.14 \times 10^{-5}} - \underset{(3.894)}{0.392}\Delta S_{t-1} + \underset{(1.288)}{0.138}\Delta S_{t-2} + \underset{(4.354)}{0.459}\Delta B_{t-1} + \underset{(0.027)}{0.003}\Delta B_{t-2}$$

$$R^2 = 0.671,$$

where ΔS_t and ΔB_t denote the detrended series of the surplus and liability respectively. The estimation indicates some negative correlation between ΔS_t and ΔB_t. We show the impulse responses in Figure 5 and 6 with different ordering. From Figure 5 and 6 we find that one S.D. innovation of ΔS_t always induces a negative response of ΔB_t. This is similar to the case of Germany. Figure 5 and 6 indicate that one S.D. innovation of ΔB_t induces a negative response of ΔS_t in the first 5 quarters and an insignificant positive response after the sixth quarter. Therefore, for France too, our tests seem to indicate that the fiscal regime has been a non-Ricardian rather than a Ricardian one.

With the evidence above, the VAR estimation following CCD seems to favor the conclusion that, different from the case of the U.S. tested by CCD, Germany

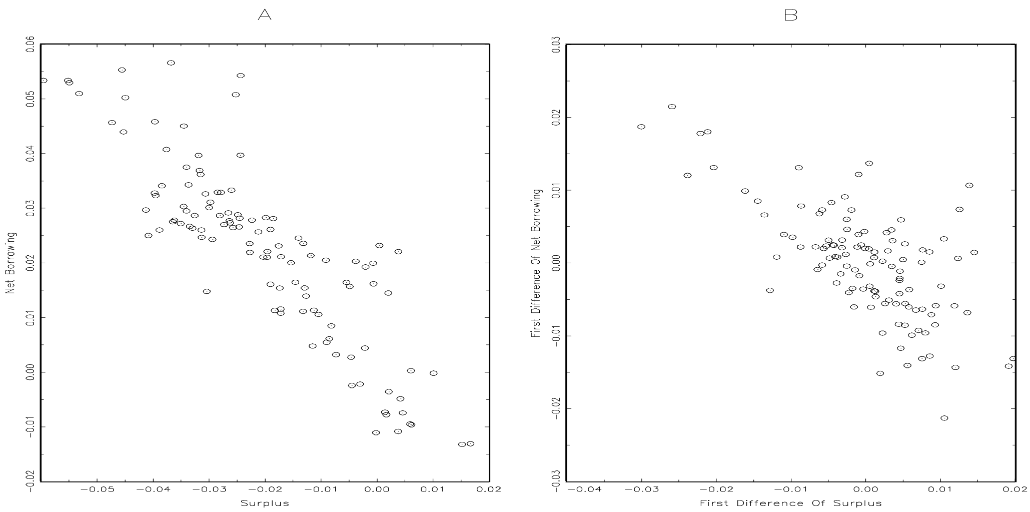

Figure 4: Surplus and Liability (Net Borrowing) of France

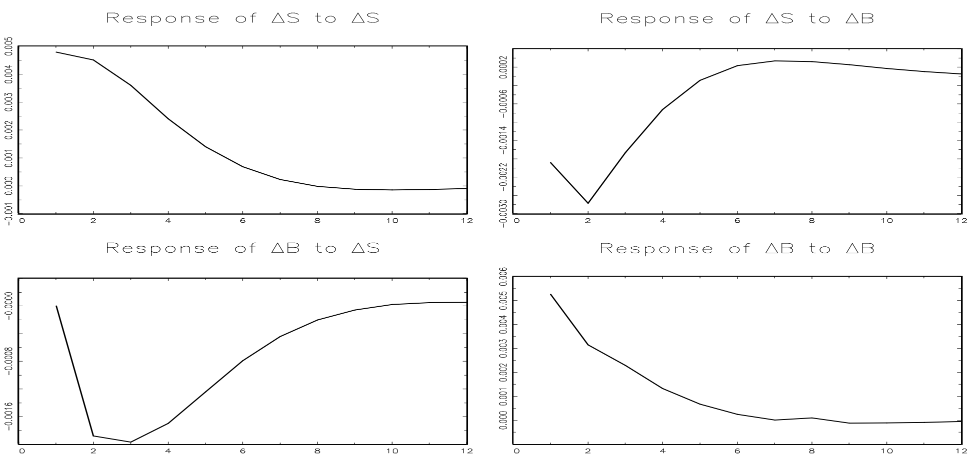

Figure 5: Response to One S.D. Innovation (France) with Ordering ΔB_t, ΔS_t

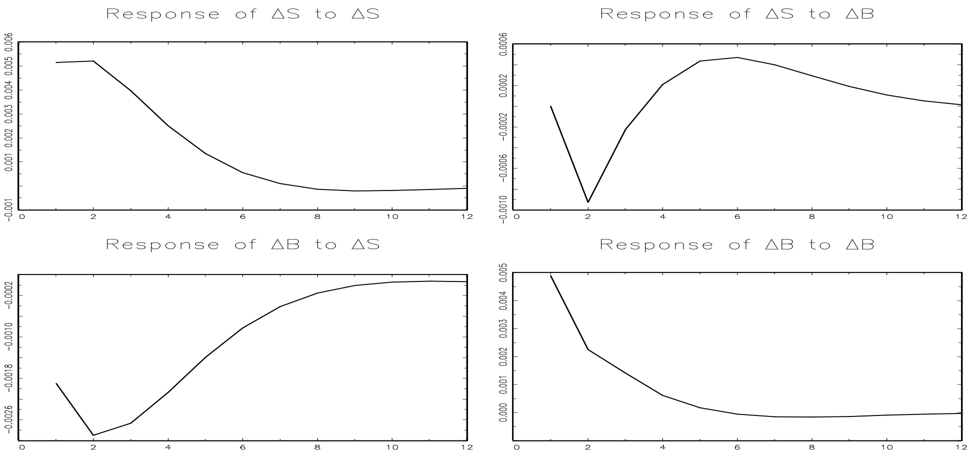

Figure 6: Response to One S.D. Innovation (France) with Ordering ΔS_t, ΔB_t

and France seem to have implemented a non-Ricardian rather than Ricardian fiscal policy in the past decades. In his fiscal theory of the price level, Woodford (1995) maintains that the non-Ricardian rather than the Ricardian fiscal regime seems to be the common case. He considers the Ricardian fiscal regime only as a special case, in which the fiscal policy plays little role in the price level determination. The evidence of Germany and France seems to confirm, to some extent, the statement of Woodford (1995).

Next we come to another important question: How did the monetary and fiscal policies interact in the Euro-area? We will first undertake the Granger-Causality test for the monetary and fiscal policy instruments and then refer to some evidence of monetary and fiscal policy interactions in the Euro-area from Muscatelli et al. (2002).

In the research below we take the surplus and the short-term interest rate as the fiscal and monetary policy instruments respectively. The countries to study include France, Germany and Italy. Because the short-term interest rate of Italy is unavailable, we take the official discount rate instead. The Italian surplus data are unavailable for 1991.4-1995.1. In order to approximate the surplus of Italy during this period, we compute the growth rate of the government debt for this period first. Assuming that the government debt has grown in a similar manner as the government expenditure, we compute the government expenditure growth for this period with the debt growth rate and then compute the surplus by subtracting the government expenditure from the government revenues. The short-term interest rates of France and Germany are measured by the 3-month treasury bill rate and the German call money rate respectively.[2]

[2]The data source is the International Statistics Yearbook 2000.

Country	$\Delta S \to \Delta R$	$\Delta R \to \Delta S$	$\Delta S \to \Delta\pi$	$\Delta\pi \to \Delta S$
Germany	$No^* \ No^{**}$	$No^* \ Yes^{**}$	$No^* \ No^{**}$	$No^* \ No^{**}$
France	$No^* \ No^{**}$	$No^* \ Yes^{**}$	$No^* \ No^{**}$	$Yes^* \ No^{**}$
Italy	$No^* \ No^{**}$	$No^* \ Yes^{**}$	$No^* \ No^{**}$	$Yes^* \ Yes^{**}$

Table 1: Granger-Causality Tests at 5% Significance Level (1970.1-98.4). Here $*$ denotes tests with 4 lags and $**$ with 8 lags.

The goal of the Granger-Causality test is to explore whether there exists Granger-Causality between the short-term interest rate and the surplus in the three countries. Before undertaking the Granger-Causality test, we undertake the ADF unit root test for these variables and find that with four lags included into the estimation, the ADF test statistics of all variables are larger than the 1%, 5% and 10% critical values, except the German interest rate, the ADF test statistic of which is larger than the 1% critical value, but smaller than the 5% and 10% critical values. We use first differences of these variables for the estimation below.

According to the FTPL, the fiscal regime plays a certain role in the price level determination. Therefore, we will also undertake a Granger-Causality tests for the surplus and inflation to see whether there exists any Granger-Causality between these two variables. Since the ADF tests of the inflation rates of the three countries can not reject a unit root, we use the first difference of the inflation rate for the estimation. The results of the Granger-Causality tests are presented in Table 1, where ΔS, ΔR and $\Delta\pi$ denote the changes in the surplus, interest rate and inflation rate respectively and "$\rightarrow$" stands for "Granger-causes". "Yes" indicates that one variable Granger-causes the other and "No" indicates that one variable does not Granger-cause the other. From Table 1 we find that, for all three countries the change in the surplus does not Granger-cause the change in the short-term interest rate no matter whether 4 or 8 lags are included in the tests, and ΔS does not Granger-cause $\Delta\pi$ either. The change in the short-term interest rate does not Granger-cause the surplus change when only 4 lags are used for estimation. It does Granger-cause ΔS when 8 lags are used in the estimation. The answer to the question of whether the change in the inflation rate Granger-causes ΔS is different among the three countries. $\Delta\pi$ does not Granger-cause ΔS in the case of Germany. $\Delta\pi$ Granger-causes ΔS in the case of France when 4 lags are used for the estimation, while in the case of Italy, $\Delta\pi$ Granger-causes ΔS no matter whether 4 or 8 lags are used for the estimation. It should be noted that the results may be sensitive to the periods covered. Therefore we also try the test with different subperiods and find that the results are robust to the samples. Only the results of France seem to show some sensitivity to the samples. For the period 1980.1-90.4, for example, we find that ΔS does Granger-cause $\Delta\pi$.

In short, the Granger-Causality tests indicate that the causality between the surplus, interest rate and inflation rate is asymmetric: The surplus does not Granger-cause the interest rate and inflation, while the interest rate and inflation may, to some extent, Granger-cause the surplus. This suggests that the fiscal policy is in some degree affected by the monetary policy.

The Granger-Causality tests tell us whether there exists any causality between the fiscal and monetary instruments. The next problem is to explore how these variables may have interacted in the Euro-area. Muscatelli et al. (2002) undertook some structural (time-varying and Bayesian) VAR tests of monetary and fiscal policy interactions for the G7 countries. The endogenous variables used include the output gap, inflation rate, fiscal stance and the call money rate. Another similar VAR estimation has been undertaken by van Aarle et al. (2001). The endogenous variables they use include the inflation rate, output growth, change in the short-term interest rate, real government revenue growth and real government spending growth. Aarle et al. (2001) explore the cases of Japan, the U.S. and the member states of EU and the aggregate economy of the Euro-area. Muscatelli et al. (2002) find that for the whole period the form of interdependence between monetary and fiscal instruments is asymmetric and differs across countries. Whereas in the U.S. and U.K. interest rates fall significantly in the first quarter after the fiscal expansionary shock, in the cases of Italy, Germany and France, there seems to be no significant monetary reaction. If anything in the German case, there are some signs that the monetary policy tends to offset fiscal policy shocks, yet the results from the estimation for the pre- and post-1980 subperiods are somewhat different. There is strong evidence that post-1980 monetary policy is used as a complement to fiscal shocks, yet with Germany as a notable exception.

4 Time-Varying Monetary and Fiscal Policy Interactions

Using pooled data for a number of OECD economies, Mélitz (1997) finds that fiscal and monetary policies tend to move in opposite directions to each other. Muscatelli et al. (2002) take advantage of a VAR model to explore the monetary and fiscal policy interactions in the Euro-area. Another interesting study is undertaken by von Hagen et al. (2001). They set up a macroeconomic model and estimated it with three-stage least squares. The goal of that model is to explore the interaction between fiscal policy and real output, and the interaction between the fiscal policy and monetary conditions. The three endogenous variables used are fiscal policy, monetary policy and real GDP growth. In this section, we will undertake some estimation of time-varying monetary and fiscal policy interactions.

Different from the methods applied by other researchers, we resort to a State-Space model with Markov-switching. The goal of applying this kind of model is to explore whether there are regime changes in the monetary and fiscal policy interactions and if yes, how they may have changed. This goal is similar to Muscatelli et al. (2002), who apply a State-Space VAR model to explore the regimes of monetary and fiscal policy interactions. The difference of our method from theirs is that, we assume Markov-Switching in the variance of the shocks and the drifts of time-varying parameters in the State-Space model. The problem of a traditional State-Space model with no Markov-switching is that the changes of the time-varying parameters may be exaggerated. This problem has been recognized by Sims (2001b) in a comment on the paper of Cogley and Sargent (2001). A reasonable choice of our study here is to set up a VAR model with the fiscal policy, monetary policy, output gap and inflation rate as endogenous variables and then estimate time-varying parameters in a State-Space model with Markov-Switching. In doing this we have to estimate a large number of parameters and the efficiency of the results may be reduced. Therefore, we will only estimate a single equation below, this should not affect the conclusion much, since we are mainly interested in the interactions between the monetary and fiscal policy variables.

As in section 3, we measure the monetary policy with the short-term interest R and the fiscal policy with the surplus S. Since we have found some Granger-Causality of the short-term interest rate affecting the surplus, we will just estimate the following simple equation :

$$S_t = \alpha_{1t} + \alpha_{2t}S_{t-1} + \alpha_{3t}R_{t-1} + \epsilon_t, \tag{2}$$

where ϵ_t is a shock with normal distribution and zero mean. In fact, the surplus may also be affected by the inflation rate and output gap, but as mentioned above, we ignore these effects just to reduce the number of parameters to be estimated. Note that we assume α_i (i=1...3) are time-varying and moreover, we assume the variance of the shock ϵ_t is not constant but has Markov-switching property. Define X_t and ϕ_t as

$$X_t = (1\ S_{t-1}\ R_{t-1}),$$
$$\phi_t = (\alpha_{1t}\ \alpha_{2t}\ \alpha_{3t})',$$

equation (2) can be rearranged as

$$S_t = X_t\phi_t + \epsilon_t.$$

Recall that we assume the shock ϵ_t has Markov-switching variance. Following Kim (1993) and Kim and Nelson (1999), we simply assume that ϵ_t has two states of variance with Markov property, namely

$$\epsilon_t \sim N(0, \sigma^2_{\epsilon,SS_t}),$$

with

$$\sigma^2_{\epsilon,SS_t} = \sigma^2_{\epsilon,0} + (\sigma^2_{\epsilon,1} - \sigma^2_{\epsilon,0})SS_t, \;\; \sigma^2_{\epsilon,1} > \sigma^2_{\epsilon,0},$$

and

$$Pr[SS_t = 1|SS_{t-1} = 1] = p,$$
$$Pr[SS_t = 0|SS_{t-1} = 0] = q,$$

where $SS_t = 0$ or 1 indicates the states of the variance of ε_t and Pr stands for probability. The time-varying vector ϕ_t is assumed to have the following path

$$\phi_t = \bar{\Phi}_{SS_t} + F\phi_{t-1} + \eta_t,\ \eta_t \sim N(0, \sigma^2_{\eta,SS_t}), \tag{3}$$

where $\bar{\Phi}_{SS_t}$ (SS_t =0 or 1) denotes the drift of ϕ_t under different states, $\bar{\Phi} = (\bar{\alpha_1}\ \bar{\alpha_2}\ \bar{\alpha_3})$. F is a diagonal matrix with constant elements. η_t is a vector of shocks of normal distribution with zero mean and Markov-switching variance too. σ^2_{η,SS_t} is assumed to be a diagonal matrix.[3] Moreover, we assume $E(\epsilon_t\eta_t) = 0$. The State-Space model of Markov-switching can now be presented as

$$S_t = X_t\phi_t + \epsilon_t,\ \epsilon_t \sim N(0, \sigma^2_{\epsilon,SS_t}), \tag{4}$$
$$\phi_t = \bar{\Phi}_{SS_t} + F\phi_{t-1} + \eta_t,\ \eta_t \sim N(0, \sigma^2_{\eta,SS_t}). \tag{5}$$

Let Y_{t-1} denote the vector of observations available as of time t−1. In the usual derivation of the Kalman filter in a State-Space model without Marko-Switching, the forecast of ϕ_t based on Y_{t-1} can be denoted by $\phi_{t|t-1}$. Similarly, the matrix denoting the mean squared error of the forecast can be written as

$$P_{t|t-1} = E[(\phi_t - \phi_{t|t-1})(\phi_t - \phi_{t|t-1})'|Y_{t-1}],$$

where E is the expectation operator.

In the State-Space model with Markov-switching, the goal is to form a forecast of ϕ_t based not only on Y_{t-1} but also conditional on the random variable SS_t taking on the value j and on SS_{t-1} taking on the value i (i and j equal 0 or 1):

$$\phi^{(i,j)}_{t|t-1} = E[\phi_t|Y_{t-1}, SS_t = j, SS_{t-1} = i],$$

and correspondingly the mean squared error of the forecast is

$$P^{(i,j)}_{t|t-1} = E[(\phi_t - \phi_{t|t-1})(\phi_t - \phi_{t|t-1})'|Y_{t-1}, SS_t = j, SS_{t-1} = i].$$

Conditional on $SS_{t-1} = i$ and $SS_t = j$ ($i, j = 0$, 1), the Kalman filter algorithm for our model is as follows:

$$\phi^{(i,j)}_{t|t-1} = \bar{\Phi}_j + F\phi^i_{t-1|t-1}, \tag{6}$$
$$P^{(i,j)}_{t|t-1} = FP^i_{t-1|t-1}F' + \sigma^2_{\eta,j}, \tag{7}$$
$$\xi^{(i,j)}_{t|t-1} = S_t - X_t\phi^{(i,j)}_{t|t-1}, \tag{8}$$
$$\nu^{(i,j)}_{t|t-1} = X_tP^{(i,j)}_{t|t-1}X'_t + \sigma^2_{\epsilon,j}, \tag{9}$$
$$\phi^{(i,j)}_{t|t} = \phi^{(i,j)}_{t|t-1} + P^{(i,j)}_{t|t-1}X'_t[\nu^{(i,j)}_{t|t-1}]^{-1}\xi^{(i,j)}_{t|t-1}, \tag{10}$$
$$P^{(i,j)}_{t|t} = (I - P^{(i,j)}_{t|t-1}X'_t[\nu^{(i,j)}_{t|t-1}]^{-1}X_t)P^{(i,j)}_{t|t-1}, \tag{11}$$

[3]Theoretically, the elements of F may also have Markov-switching property, but since there are already many parameters to estimate, we just ignore this possibility to improve the efficiency of estimation. Note that if the elements of F are larger than 1 in absolute value, that is, if the time varying parameters are non-stationary we should abandon the assumption of eq. (3) and assume a random walk path for the time-varying vector ϕ_t.

where $\xi_{t|t-1}^{(i,j)}$ is the conditional forecast error of S_t based on information up to time t−1 and $\nu_{t|t-1}^{(i,j)}$ is the conditional variance of the forecast error $\xi_{t|t-1}^{(i,j)}$. It is clear that $\nu_{t|t-1}^{(i,j)}$ consists of two parts $X_t P_{t|t-1}^{(i,j)} X_t'$ and $\sigma_{\epsilon,j}^2$. When there is no Markov-Switching property in the shock variance, $\sigma_{\epsilon,j}^2$ is constant. In order to make the Kalman filter algorithm above operable, Kim and Nelson (1999) developed some approximations and managed to collapse $\phi_{t|t}^{(i,j)}$ and $P_{t|t}^{(i,j)}$ into $\phi_{t|t}^{j}$ and $P_{t|t}^{j}$ respectively.[4]

On the basis of the theoretical background of the State-Space model with Markov-switching, we will undertake the estimation for France and Germany below. With the French data 1967.1-1998.4, we obtain the following results (S.E. in parentheses):

$$\sigma_{\eta,0} = \begin{pmatrix} \underset{(0.001)}{0.005} & 0 & 0 \\ 0 & \underset{(0.577)}{0.000} & 0 \\ 0 & 0 & \underset{(0.025)}{0.000} \end{pmatrix}, \sigma_{\eta,1} = \begin{pmatrix} \underset{(0.0003)}{0.0007} & 0 & 0 \\ 0 & \underset{(0.028)}{0.083} & 0 \\ 0 & 0 & \underset{(0.005)}{0.041} \end{pmatrix},$$

$$F = \begin{pmatrix} \underset{(0.135)}{-0.100} & 0 & 0 \\ 0 & \underset{(0.174)}{0.593} & 0 \\ 0 & 0 & \underset{(0.158)}{-0.114} \end{pmatrix}, \bar{\Phi}_0 = \begin{pmatrix} \underset{(0.005)}{-0.021} \\ \underset{(0.168)}{-0.320} \\ \underset{(0.042)}{0.096} \end{pmatrix}, \bar{\Phi}_1 = \begin{pmatrix} \underset{(0.0004)}{0.0009} \\ \underset{(0.161)}{0.383} \\ \underset{(0.009)}{-0.013} \end{pmatrix},$$

$$P = \underset{(0.031)}{0.940},\ q = \underset{(0.172)}{0.733},\ \sigma_{\epsilon,0} = \underset{(0.004)}{0.000},\ \sigma_{\epsilon,1} = \underset{(0.002)}{0.006},$$

with the maximum likelihood function being −472.0. The fact that the elements of F are all smaller than 1 in absolute value indicates that the time-varying parameters are stationary. This justifies our adoption of eq. (3). The differences of $\bar{\Phi}$, σ_η and σ_ϵ under states 0 and 1 are quite significant. The two important parameters in $\sigma_{\eta,1}$ are relatively large (0.083 and 0.041) compared to their values in $\sigma_{\eta,0}$. The difference between $\bar{\Phi,}0$ and $\bar{\Phi,}1$ is also obvious. This confirms our adoption of the Markov-switching model.

Next we present the time-varying paths of the coefficients in Figure 7.[5] Figure 7A presents the time varying path of α_2 under different states. $\alpha_{2,0}$ is the path of α_2 under state 0 and $\alpha_{2,1}$ the path of α_2 under state 1. We also present the expected path of α_i (i=2,3) in Figure 7, which is computed as the weighted sum of $\alpha_{i,0}$ and $\alpha_{i,1}$ with the probability as weights, namely,

$$\alpha_i = Pr[SS_t = 0|Y_t]\alpha_{i,0} + Pr[SS_t = 1|Y_t]\alpha_{i,1}.$$

[4]As for the details of the State-Space model with Markov-Switching, the reader is referred to Kim and Nelson (1999, ch. 5). The program applied below is based on the Gauss Programs developed by Kim and Nelson (1999).

[5]In order to kick out the effects of the initial startup idiosyncracies of the Kalman filter algorithm, we present the paths of the time-varying parameters from t=8 on. The time-varying path of α_1 is not presented here.

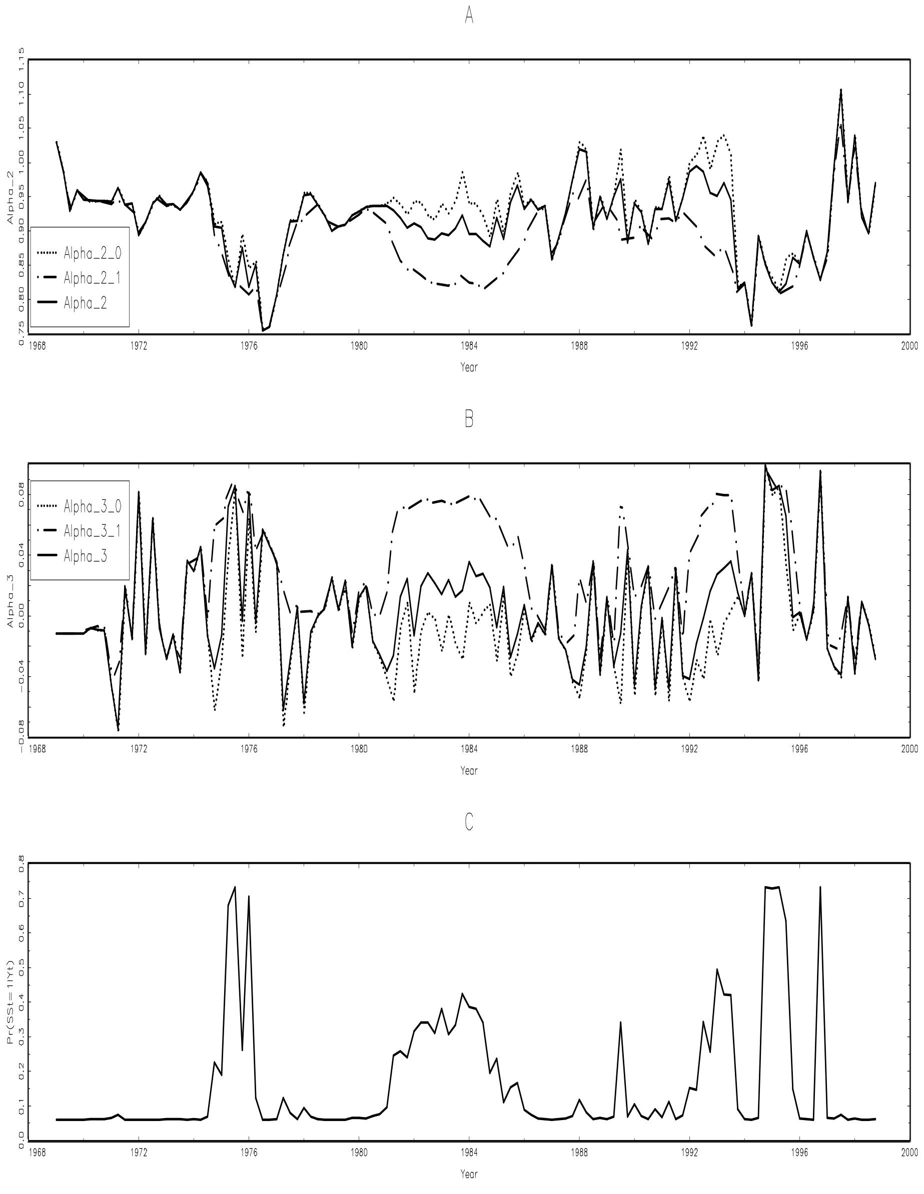

Figure 7: Results of the State-Space Model: France 1969-98

The time-varying paths of α_3 under different states in Figure 7B. Figure 7C represents the probability of being in state 1 given the observation Y_t. There seem to be some significant changes in the time-varying parameters in the first half of the 1970s and 1990s. The switching of α_3 indicates the changes of the monetary and fiscal policy interactions in France. The monetary and fiscal policy interactions are somewhat different under states 1 and 0. The largest difference lies in the first half of the 1980s. α_3 is positive under state 1 and negative under state 0. But the probability of being in state 1 is not very large, between 0 and 0.5. From the expected path of α_3, we can conclude that in the first half of the 1970s, 1980s and 1990s the fiscal policy of France seems to have moved in the same direction as the monetary policy. That is, when a tight monetary policy was implemented, the fiscal policy also tended to be tight. They were accommodative during these periods.

For the German data 1970.1-98.4 we get the following results with S.E. in parentheses:

$$\sigma_{\eta,0} = \begin{pmatrix} \underset{(0.0003)}{0.002} & 0 & 0 \\ 0 & \underset{(0.030)}{0.000} & 0 \\ 0 & 0 & \underset{(0.008)}{0.000} \end{pmatrix}, \sigma_{\eta,1} = \begin{pmatrix} \underset{(0.0005)}{0.0002} & 0 & 0 \\ 0 & \underset{(0.023)}{0.071} & 0 \\ 0 & 0 & \underset{(0.003)}{0.006} \end{pmatrix},$$

$$F = \begin{pmatrix} \underset{(0.244)}{0.282} & 0 & 0 \\ 0 & \underset{(0.049)}{0.894} & 0 \\ 0 & 0 & \underset{(0.214)}{0.502} \end{pmatrix}, \bar{\Phi}_0 = \begin{pmatrix} \underset{(0.001)}{-0.007} \\ \underset{(0.043)}{0.020} \\ \underset{(0.013)}{-0.011} \end{pmatrix}, \bar{\Phi}_1 = \begin{pmatrix} \underset{(0.001)}{-0.003} \\ \underset{(0.039)}{0.130} \\ \underset{(0.009)}{0.011} \end{pmatrix},$$

$$p = \underset{(0.096)}{0.689},\ q = \underset{(0.073)}{0.829},\ \sigma_{\epsilon,0} = \underset{(0.001)}{0.000},\ \sigma_{\epsilon,1} = \underset{(0.003)}{0.0004},$$

with the maximum likelihood function being -500.0. From F we know that all time-varying parameters are stationary. Similar to the case of France, the differences between $\bar{\Phi}$, σ_η and σ_ϵ under states 0 and 1 are relatively obvious.

We present the time-varying paths of the coefficients of Germany in Figure 8. The interpretation of this figure is similar as that of France. The fact that α_3 in Figure 8B lies between -0.02 and 0.03 indicates low correlation between the fiscal and monetary policies in Germany. α_3 evolves at a relatively stable level which is a little lower than zero between 1975 and 1985. This seems to indicate that the monetary and fiscal policies have been more likely to be strategic substitutes than complements during this period. After the middle of the 1980s α_3 switches around zero, indicating that fiscal and monetary policies have been sometimes complementary to each other and sometimes strategic substitutes.

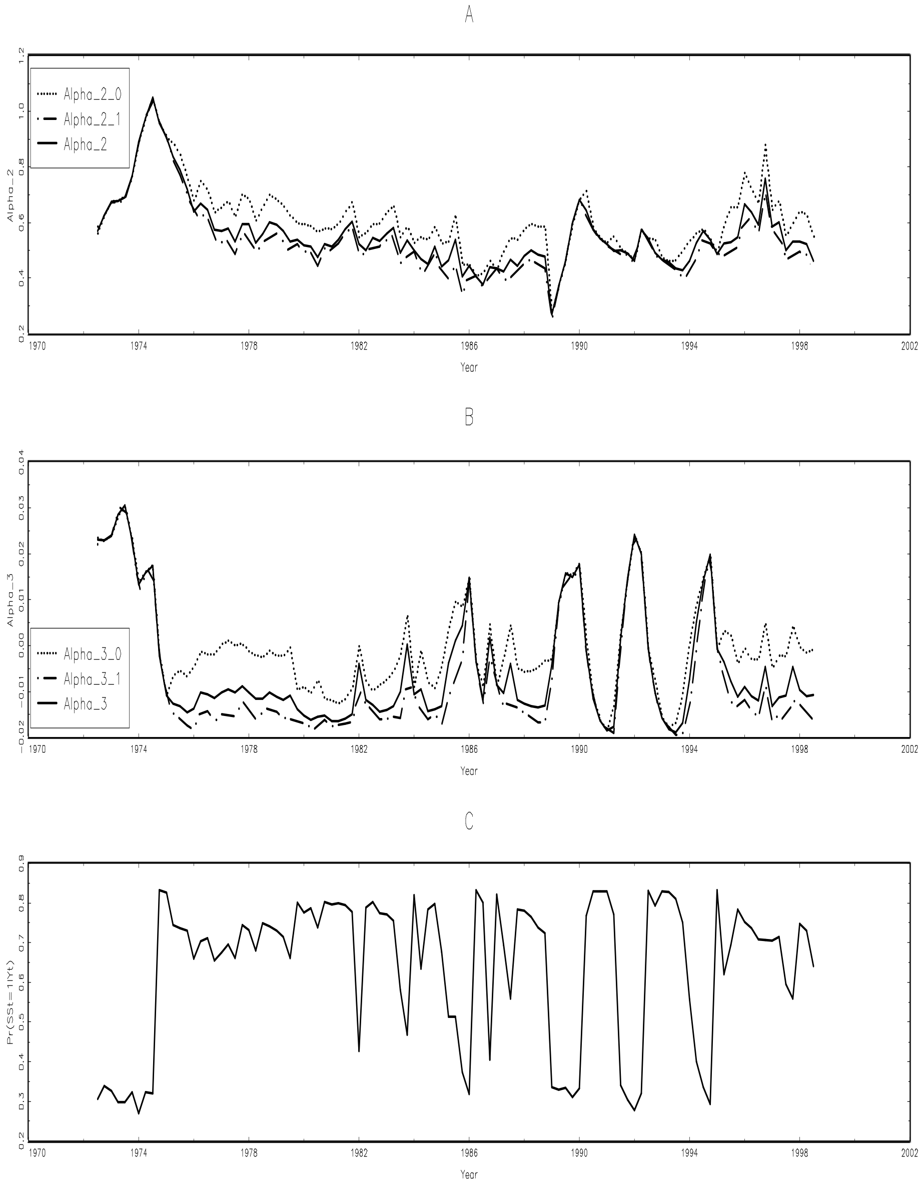

Figure 8: Results of the State-Space Model: Germany 1972-98

5 Evidence of Monetary and Fiscal Policy Interactions with Forward-Looking Behavior

Above we have explored the interactions between monetary and fiscal policies with little attention given to forward-looking behavior. The question concerned is, therefore, whether the fiscal or monetary policy takes into account the future behavior of the other. In order to take into account the forward-looking behavior, we assume that the surplus can be modelled as

$$S_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i S_{t-i} + \alpha_{m+1} y_{t-1} + \alpha_{m+2} E[R_{t+n}|\Omega_t] + \varepsilon_t, \tag{12}$$

where y_t denotes the output gap, E is the expectation operator and Ω_t the information available for the expectation of the future short-term interest rate R_{t+n}. ε_t is iid with zero mean. After eliminating the unobserved forecast variables from the equation above, we have the following equation

$$S_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i S_{t-i} + \alpha_{m+1} y_{t-1} + \alpha_{m+2} R_{t+n} + \eta_t, \tag{13}$$

where $\eta_t = \alpha_{m+2}\{E[R_{t+n}|\Omega_t] - R_{t+n}\} + \varepsilon_t$. Let u_t be a vector of variables within the information set Ω_t for the expectation of the future short-term interest rate. Since $E[\eta_t|u_t] = 0$, equation (13) implies the following set of orthogonality conditions that will be employed for estimation:

$$E[S_t - \alpha_0 - \sum_{i=1}^{m} \alpha_i S_{t-i} - \alpha_{m+1} y_{t-1} - \alpha_{m+2} R_{t+n}|u_t] = 0. \tag{14}$$

We will apply GMM to estimate the unknown parameters for Germany with data 1970.1-98.4. The instruments include the 1-4 lags of the short-term interest rate, output gap, the first difference of the inflation rate and the surplus and a constant. An MA(4) autocorrelation correction is undertaken. The output gap of Germany is measured by the percent deviation of log Industrial Production Index from the HP filtered trend. In the estimation below we take M=2, because lags of S_t with $M > 2$ have insignificant t-statistics. The results with different n are presented in Table 2 with t-statistics in parentheses. We also present the J-statistics to see the validity of the over-identifying restrictions. From Table 2 we find that α_4 has always a positive sign, but the t-statistics are not significant enough. This seems to indicate that the future short-term interest rate does may have affected the current fiscal policy, but not in a significant degree. Note that the coefficient on the output gap has always a negative sign with insignificant t-statistics. This indicates that the fiscal policy is almost unaffected by the output.

Parameter	n = 0	1	2	3
α_0	-0.003 (5.262)	-0.001 (1.880)	-0.002 (2.523)	-0.003 (2.742)
α_1	1.271 (24.058)	1.283 (16.426)	1.324 (17.095)	1.371 (17.928)
α_2	-0.404 (7.206)	-0.351 (4.402)	-0.405 (5.206)	-0.461 (6.095)
α_3	0.008 (0.787)	-0.012 (1.134)	-0.016 (1.419)	-0.014 (1.189)
α_4	0.0004 (0.060)	0.008 (0.729)	0.020 (1.445)	0.022 (1.526)
R^2	0.912	908	0.909	0.910
J-St.	0.118	0.092	0.088	0.086

Table 2: GMM Estimation of Germany 1970.1-98.4

6 Conclusion

This paper explores the monetary and fiscal policy interactions in the Euro-area. We first present the recent literature on this problem and then undertake some estimation with VAR models for France and Germany to test the fiscal regimes. Our results indicate that the two countries have implemented non-Ricardian fiscal policy in the period tested. This is consistent with the so-called fiscal theory of price level, which proposes that the price level has to adjust to ensure the government solvency under a non-Ricardian fiscal regime and that the Ricardian fiscal regime is only a special case. We also undertake some Granger-Causality tests for the fiscal policy and the inflation and find that the fiscal policy does not seem to Granger-cause the inflation, but the inflation Granger-causes the fiscal policy to some extent.

Another important problem we are interested in is how the monetary and fiscal policies have interacted over time. We apply a State-Space model with Markov-switching to estimate the time-varying parameter of a simple model. The evidence indicates that the monetary and fiscal policies have been complementary to each other in France most of the time, especially at the beginning of the 1970, 1980s and the 1990s. For Germany, however, we do not find significant interactions between monetary and fiscal policies, since the time-varying parameter between the two policies has been evolving around zero between 0.03 and -0.02. Between 1975 and 1985 it is a little lower than zero and after the middle of the 1980s, it switches around zero. This indicates that the two policies may have been weak strategic substitutes during the former period and switched between weak complements and substitutes during the latter period.

The last problem we have tackled is whether the fiscal policy has taken into account the expectation of the future monetary policy. That is, we consider the monetary and fiscal policy interactions with the forward-looking behavior. In Germany the future monetary policy does not seem to have affected the current fiscal policy greatly.

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