Can we consider the policy instruments as cyclical substitutes? Some Empirical Evidence

Sylvie Duchassaing and Laurent Gagnol

BETA – theme

Résumé

Le principal objectif de cet article est d'étudier les interactions entre les banques centrales et les autorités budgétaires. Il semble, en effet, utile de préciser si les deux autorités choisissent des stratégies complémentaires ou substituables. A partir d'un modèle simple de policy mix, nous estimons les fonctions de réaction budgétaires et monétaires par la méthode des données de panel. Nos résultats principaux montrent que durant la période 1975-1997, les instruments de politique économique semblent complémentaires. De plus, même si les banques centrales deviennent de plus en plus indépendantes durant la période, les estimations soulignent que les fonctions de réaction des banques centrales tiennent compte encore de l'activité économique et que les gouvernements continuent à observer le taux d'inflation.

Abstract

The main objective of this article is to study how central banks and fiscal authorities interact when they conduct the economic policy. Specially, it seems very helpful to specify if this two policymakers act under complementary or substitutability strategy. Our methodology is based on a simple model of policy-mix that is estimated by panel data method. Our main results show that for seven OECD countries and during the period 1975-1997, the two policy instruments seem to be complementary. Moreover, even if the central banks become more and more independent during this period, the estimates underline that the reaction functions of central banks depend on output and the governments have continued to care about inflation rate.

JEL Classification : E58, E60, E63

Keywords : monetary policy, fiscal policy, policy coordination, public debt

Introduction

Many questions raise about the behaviour of monetary and fiscal authorities under EMU. Indeed, the organisation of economic policies in EMU is original and without historical precedent: the monetary policy is decided at the European level whereas the budget policies remain led at the national level. This European monetary union is not an optimal monetary area according to the criterion of Mundell. The loss of the instrument of the exchange rate can not be compensated by an increased mobility of production factors, in particular of the labour factor, in case of asymmetrical shocks. Moreover, fiscal criteria of the Maastricht Treaty and the recent Pact for Stability have limited the possibility of a Member State to use fiscal instrument in order to stabilise the economy in case of a asymmetrical shock.

Following Artis and Winkler (1997), the main function of this Stability Pact is to restrain the ability of national fiscal authorities to threaten the stability orientation of economic policy of the Euro-Area. Despite the design of its statutes, the effective independence of the ECB is insufficiently guaranteed and that it needs the additional protection of the Pact. This willingness to have an independent central bank explicitly focused on price stability considers that a loose fiscal policy promotes loose monetary policy. Sargent and Wallace (1981) have introduced such viewpoint. They have underlined the importance of the government budget constraint: if government debt accumulates rapidly enough, seignoriage revenues must rise sooner or later. The monetary authority loses monetary control. That is why the degree of political independence of the central bank is really important.

More recent studies have confirmed this point of view by introducing the question of credibility in anti-inflationary monetary policy (Barro and Gordon, 1983; Rogoff, 1985): if fiscal policy is loose, tight monetary policy becomes incredible and time-consistency requires an increase of inflation. The Maastricht treaty has been built on a such point of view. In case of a monetary union, all member governments will be able to borrow on a broader capital at lower interest rates. The governments with a lack of fiscal discipline will probably engage in looser fiscal policy and will produce pressures for expansionary monetary policy in the monetary union as a

whole. In that case, fiscal and monetary policies can be considered as complementary goods: a looser monetary policy leads to a looser fiscal policy.

Another point of view underlines that the unpleasant monetary arithmetic of deficit spending has little practical significance: facing an expansionist fiscal policy, adjustments in taxes can be made without an increase on seigniorage and tax revenues. Moreover markets tend to anticipate government propensities to inflate and to move the economy to a position where surprise inflation no longer serves official interests. Missale and Blanchard (1994) mention the adaptations in the indexation and the currency composition of the debt as a way to protect against inflationist pressures. Fiscal authorities do not seem to make pressure on the monetary authorities in order to inflate more even in presence of high deficits and debt. In that case, fiscal and monetary policies are substituable: a tighter monetary policy leads to a looser fiscal policy.

In this paper, we study how central banks and fiscal authorities interact when they conduct the economic policy. We try to estimate if monetary and fiscal reaction functions could be considered as complementary or substituable goods. Our methodology is based on a simple model of policy-mix that is estimated by panel data method. Our main results show that for seven OECD countries and during the period 1975-1997, the two policy instruments seem to be complementary: it confirms the unpleasant monetary arithmetic of deficit spending. The plan of the paper is as follows. A survey of the literature is presented in Section II. Section III develops the theoretical model which is estimated in section IV. Finally, concluding remarks are given in Section V.

II. Survey of the empirical studies

Some papers have tried to estimate empirically the monetary policy reaction functions as Taylor (1993) or Clarida and al (1998) but there are few empirical studies about the behaviour of fiscal and monetary authorities. Melitz (1997) uses pooled data for 19 OECD countries (all the members of the European Union except Luxembourg and four other countries: Australia, Canada, Japan and the United States). The chosen instrument of monetary policy is the intervention rate of the monetary authorities on the money market. The fiscal policy instrument

is the primary surplus as a percentage of potential output. Concerning the fiscal variables, Melitz distinguishes government consumption and transfer payments on the one side and tax receipts minus investment spending on the other.

The main results concern the responses to public debt, the interactions between monetary and fiscal policy and the responses to the business cycle. First, taxes rise and expenditures fall in response to a higher debt burden. Second, fiscal and monetary policy tend to move in opposite directions in the OECD countries: loose fiscal policy does not promote loose monetary policy and tight monetary policy induces the fiscal authorities to choose an expansionary fiscal policy. According to the empirical results, the fiscal policy responds through spending rather than taxes.

The decomposition between consumption and transfer payments suggests that the fiscal authorities tend to increase transfers to firms in order to protect them from tight monetary policy. An example is the Swedish fiscal authorities that lowered tax rates and offered special assistance to financial firms in difficulty because the Bank of Sweden practised a very tight monetary policy to defend the kroner in 1992. Third, the monetary policy and tax receipts have stabilising responses face to deviations from potential output but the government spending has a pro-cyclical behaviour: the automatic stabilisation is lower than usually assumed.

Debrun and Wyplosz (1999) adopt a panel data approach. The short-term interest rate is the instrument of monetary policy and the primary budget surplus is the fiscal policy instrument. The main results are the following. First, it seems that central banks take care of cyclical conditions because they care both inflation and output. Second, central banks do not seem to react to fiscal policy. But after 1992, there is evidence that central banks choose monetary policy as a cyclical substitute to fiscal policy. A negative sign is observed between the lagged primary budget deficit and the interest rate. The instruments are used as cyclical substitutes: the central bank has a tendency to react to higher deficits by tightening monetary policy.

Concerning the estimations of fiscal reaction function, the unemployment rate and the current account have no significant role in the results. Like central banks, governments are sensitive to

both inflation and cyclical conditions. But governments are not keynesian activists: they react to cyclical fluctuations but little. Increases in interest rates are followed by fiscal relaxation: there is a strategic substitutability between fiscal and monetary policy. A last result is that debt level exerts a moderating influence on the primary surplus. In conclusion, the reaction functions reveal strategic substitutability among the monetary and fiscal authorities. These results are very similar to those obtained by Melitz (1997).

III. The theoretical Model

1- A simple model of Policy-mix

Our main objective is to specify determinants of the economic decisions from central banks and governments, which can be stylised by a simple model of policy-mix. Our model represents an aggregate demand function for an open economy, under hypothesis of adaptive expectations. Short term interest rate and taxes are under control, receptively, of central bank and government and represent the two instruments of economic policy.

$$y_t = -a_1 r_t + a_2 Z_t + a_3 g_t , \qquad a_1, a_2, a_3 > 0 \qquad (1)$$

where y_t represents the aggregate demand, which is function of r_t, the short term interest rate, Z_t the current account and g_t the government expenditures. We also introduce a simple specification of the budget constraint (see appendix for calculus details):

$$g_t - t_t = gb_{t-1} + gr_t , \qquad g < 0 \qquad (2)$$

Equation (2) implies that the primary deficit depends on the debt of period *t-1*. g_1 and g_2 are negative because if debt or interest rate increases, the government faces to a stronger budget constraint and has to limit primary deficit to satisfy its solvability.

$$p_t = s\,(y_t - \bar{y}) + p_t^e , \qquad s > 0 \qquad (3)$$

We introduce a simple form of Phillips curve, which depends on the output gap $(y_t - \bar{y})$ and on the expected inflation rate for period t. These expectations are taken as following:

$$p_t^e = p_{t-1} - m(p_{t-1} - p_{t-1}^e) \qquad 1 \geq m \geq 0 \tag{4}$$

Equation (4) specifies adaptive expectations on the inflation rate for period t, which depends on the inflation rate from period (t-1) and the error made for expecting inflation for period (t-1).

From (1) and (2), we can derive the aggregate demand and inflation rate expression[1] as functions of r_t, Z_t, b_{t-1}, t_t, $\bar{y}$ and p_{t-1}.

$$y_t = \Theta r_t + a_2 Z_t + a_3 g b_{t-1} + a_3 t_t \tag{5}$$

$$p_t = s\Theta r_t + a_2 s Z_t + a_3 g s b_{t-1} + a_3 s t_t - s\bar{y} + p_{t-1} \tag{6}$$

with $\Theta = a_3 g - a_1 < 0$. Those two equations (5) and (6) represent the structure of our economy and the variables controlling by the central bank and the government.

2- The optimal policy-mix

The monetary authority and the government use their economic policy instruments, i.e. the interest rate and the taxes, to minimise their loss functions:

$$L^i = \frac{1}{2}\left[(y_t - \hat{y}_t)^2 + d_i (p_t - \hat{p}_t)^2\right], \quad \text{with } d > 0 \tag{7}$$

where $i = M$ *or* F to denote monetary or fiscal authority. d_i represents the relative weight

[1] This expression is obtained by supposing a myopic comportment when economic agents formulate their expectations $(m = 0)$.

between the two components of the lost function. The economic authorities face a trade-off between inflation and unemployment. First, $(y_t - \hat{y}_t)$ is the gap between the effective growth rate in economy and a target $\hat{y}_t$, which is superior to the natural growth rate ($\hat{y}_t = \bar{y} + k$, with $k > 0$). The second term of the loss function denotes the gap between the effective inflation rate and its target. For convenience, we suppose the authorities want to pursue a zero inflation policy, this condition lets us to fix $\hat{p}_t = 0$.

The monetary and fiscal authorities act without any coordination and minimise their loss functions to choose, respectively, the interest rate and the taxes.

Combining equations (1) to (4) and solving the model, we can express the two following reaction functions:

$$r_t = \Phi_1 Z_t + \Phi_2 b_{t-1} + \Phi_3 t_t + \Phi_4 \bar{y} + \Phi_5 p_{t-1} \qquad (8)$$

$$t_t = \Phi'_1 Z_t + \Phi'_2 b_{t-1} + \Phi'_3 r_t + \Phi'_4 \bar{y} + \Phi'_5 p_{t-1} \qquad (9)$$

where $\Phi_1 = \frac{-a_2}{\Theta} > 0$, $\Phi_2 = \frac{-a_3 g}{\Theta} < 0$, $\Phi_3 = \frac{-a_3}{\Theta} > 0$, $\Phi_4 = \frac{1}{\Theta} < 0$, $\Phi_5 = \frac{-ds}{\Theta(1+s^2 d)} > 0$

and $\Phi'_1 = \frac{-a_2}{a_3} < 0$, $\Phi'_2 = -g > 0$, $\Phi'_3 = \frac{-\Theta}{a_3} > 0$, $\Phi'_4 = \frac{1}{a_3} > 0$, $\Phi'_5 = \frac{-ds}{a_3(1+s^2 d)} < 0$.

Equations (8) and (9) explain us that according our model:

i) the central bank reacts positively to an increase of the variation of current account, taxes and expected inflation rate, but negatively to debt ratio and potential output growth rate;

ii) The government reacts positively to an increase of debt ratio, short interest rate and potential output growth rate but negatively to the variation of current account and expected inflation rate.

Those brief theoretical results express that monetary and fiscal policies play a complementary strategy when they decide of their policymaking. In another words, that means that a restrictive (laxist) monetary policy leads to a restrictive (laxist) fiscal policy.

IV. The Econometric Methodology

1- The Data Sources

The data used in this paper are, for most of them, issued from the European Communities databases (EUROSTAT), except for the short term interest rate and the growth rate of the output gap which are extracted from OECD Outlook databases. The studied period goes from 1975 to 1997 under annual step.

Our main objective is to specify the reaction functions of central banks and governments of six European countries and the United States in order to explore the interactions between these two separate authorities. That's why, we choose to integrate the main economic variables like, current balance, output gap, rate of inflation, short term interest rate and two fiscal variables which capture fiscal decisions of governments.

Notice that all those variables are expressed in percent of GDP (except the short-term interest rate and output gap). Reasons are quite simple: first, it is easily to interpret results (like elasticity value), second, percents of GDP give homogenised data, which were initially expressed on national moneys.

For statistical reasons and to preserve the homogeneity of data, we choose only six countries in Europe: Germany, France, Italy, Netherlands, United Kingdom, Spain and we introduce the United States in order to compare the European Policy-mix and the American Policy-mix.

2- The panel data econometrics

The panel data econometrics allows us to control individual heterogeneity among economic policy choices of our seven countries. Following Melitz and Zumer (1998), we consider this model (i = 1,2,...,M; t = 1,2,...,T, with M the number of countries and T the number of periods):

$$\overline{Y_i} = a_d + b_B \overline{X}_i + \overline{e}_i, \qquad (10)$$

$$Y_{it} = a_i + b_{it} X_{it} + e_{it}, \qquad (11)$$

The variable Y_i refers either to r_i, the short term interest rate *i* or t_i, the taxes of country *i.* The variable *X* refers to a vector of K explanatory variables:

i) If Y refers to r, the *K* explanatory variables are the current account (*Z*), the public debt lagged to one period (B_{-1}), the rate of taxation (*t*), the output gap ($\bar{y}$) and the inflation rate lagged to one period (p_{-1}) (cf. equation (8)).

ii) If Y refers to t, the *K* explanatory variables are the current account (Z), the public debt lagged to one period (B_{-1}), the short-term interest rate (*r*), the output gap ($\bar{y}$) and the inflation rate lagged to one period (p_{-1}) (cf. equation (9)).

The variables $\overline{X_i}$ and $\overline{Y_i}$ are the averages over time *T.* h_i and e_{it} are separate disturbances. The a_i terms are the individual effects which are taken to be constant over time *t*. In that case, this is a classical regression model on ordinary least squares provides consistent and efficient estimates of a and b, but if the a_i are not the same across all units, two approaches can be used. The fixed effect approach takes a_i to be a group specific constant term in the regression model (Greene, 1997) and if a_i is a group specific disturbance, the econometric specification is the random effects approach.

Subtracting (10) from (11) gives:

$$Y_{it} - \bar{Y}_i = b_W (X_{it} - \overline{X}_i) + (e_{it} - \bar{e}_i) \qquad (12)$$

In the equation (10), the term b_B is the between estimator and corresponds to a cross section estimate; we can also consider that it corresponds to a long-term approach. The estimator b_W (cf. equation (12)) is the within estimator and corresponds to a time series estimate.

III. The empirical results

1- The main results

i) The results based on monetary reaction functions

Our panel data estimates show us that the fixed effects approach is accepted according the Hausman test[2]. According column 3 of table 1, the within estimator leads to good results. The

[2] The Hausman test is able to distinguish between a specification with fixed or random effects in the estimate. It

current account is the only variable not significant. A one percent increase of the output gap leads to an increase by 23 basis points of the interest rate. Facing an expansion of the activity, the central banks try to control the inflationary pressures by increasing the interest rate. The same interpretation can be applied to an increase of the inflation rate: if the inflation rate grows to 1 percent, the central banks react by increasing the short term interest rate by 48 basis point. We can notice that, according our results, the inflation rate is the explanatory variable that leads to the most important monetary authorities'reaction. That confirms the fact that central banks have a main objective: the price stability. Notice that, if a long-term approach were retain as significant (i.e. the between estimates), the only variable used to design the monetary policy is the inflation rate.

Concerning the fiscal variables, a one percent increase of the public debt leads to an decrease of 6 basis points of the interest rate and the most interesting result is an one percent increase of the rate of taxation leads to an increase by 34 points of the interest rate. These results, in coherence with those obtained in our model, mean the central banks take account the situation of public finances and the public debt when monetary decisions are taken. Let us notice however, that even if their reactions vis-à-vis of the past public debt are statistically significant, they remain relatively weak compare to the reactions about the taxes. Concerning the fact that short-term interest rate reacts positively to an increase of taxes can be explained by two ways. First, if we consider the increase of perceived taxes is due to a discretionary fiscal policy, we can consider the two policy instruments are complementary. Second, if we interpret the increase of perceived taxes as an expansion of the activity, the restrictive monetary policy is justified to fight against the potential inflationary pressures.

In order to complete our analysis of the within estimator, it is possible to compare the values of the fixed effects for the seven countries of our sample. Indeed, we can distinguish three groups of countries with similar fixed effects: Germany, France and Netherlands form a first group, Spain and Italy a second one, and UK and US a last one. That suggests the exchange rate regime plays an important role. The first group of countries belongs to the "hard" EMS in which the German monetary policy was predominant. Spain and Italy have followed more

tests the hypothesis H0: random effects versus fixed effects.

laxist monetary policies during the period because of economic difficulties. The United States and the United Kingdom have pursued less constrained economic policies.

The main conclusions of Debrun and Wyplosz (1999) are that central banks do take care for both inflation and output and do not seem to react to fiscal policy. We obtain the same first result but, in our estimate, central banks do seem to react to fiscal policy. The interdependence between fiscal and monetary authorities seems to exist because a one percent increase of the rate of taxation leads to an increase by 33 basis points of the interest rate. The public debt is also significant but in smaller proportions.

The main conclusion is that monetary and fiscal instruments are complementary: both authorities move in the same cyclical direction, e.g. increasing the interest rate and the taxes. However strong fixed effects must be taken into account.

ii) The results based on fiscal reaction functions

The estimated behaviour of governments is reported to table 2. In case of the within estimator, all the variables are significant. The current account has a negative impact on taxes. The fact that the fiscal policy is looser leads to two interpretations. First, if the surplus of the current account is due to an increase of the exports then governments can decide to reduce the taxes facing the expansion of the economy. However, this interpretation is debatable because an expansion leads usually to an increase of the perceived taxes. Another argument is to consider that the surplus of current account is due to a very low imports level that means a low interior demand, so governments could decide to reduce taxes in order to support economic activity.

An interesting result is governments are sensitive to both inflation and cyclical conditions. Debrun and Wyplosz (1999) also obtain this result. Following our estimates, an one percent increase of inflation rate leads to a decrease by 31 basis points of the rate of perceived taxes. This result leads us to provide two explanations: first an increase of the inflation rate can be considered as a looser monetary policy so fiscal authorities choose too a looser fiscal policy in order to reinforce the impact of policy-mix. Second, if we consider that inflation rate is due to an increase of the activity, we can suppose a discretionary fiscal policy which consists to

decrease the taxes. Moreover, the public debt has a positive impact on taxes: an increase of the public debt provokes an increase of taxes in order to finance the debt.

In relation to monetary policy, we find again a complementarily between policies: a one-percent increase of the interest rate leads to an increase by 28 points of the rate of taxation. If central banks increase the interest rate, the payments of interest of the public debt are higher that is why fiscal authorities must increase the rate of taxation. The comparison of the fixed effects leads to same conclusions: the countries have different policy reactions following the exchange rate regime they have adopted.

2- Remarks

We eliminate the United States from our sample in order to focus our analysis on the European countries. Our results are not very different from those obtained above. In case of monetary reaction functions, the comparison between the estimates with or without the United States shows, in the case of fixed effects, that current account becomes significant in the estimate of monetary reaction function (table 3).

The current account can be considered as a measure of the degree of openness. Taking into account the weakness of the trade exchanges between the European countries and the United States, an estimate on the seven countries has strong probabilities to under-estimate the influence of the current account in the monetary reaction. By eliminating the United States, we obtain a homogeneous group of countries that are relatively open the ones to the others, thus reinforcing the impact of the current account.

Table 4 describes the reaction of the European fiscal authorities: all the explanatory variables are significant in case of fixed effects. Even if the inflation rate and output gap still remain significant, the fiscal authorities seem to react more facing a variation of the output than in case of the estimate with the United States.

V. Concluding remarks

Our main objective was to verify if fiscal and monetary policies could be considered as substitutable goods: a tighter monetary policy leads to a looser fiscal policy. Using panel data estimates on a sample of six European countries and the United States, during the period 1975-1997, we obtain the contrary: a tighter monetary policy leads to a tighter fiscal policy. The fixed effects estimates indicate us that the interactions between fiscal and monetary authorities depend on the fact that the European countries belong or not to the “hard EMS”.

Among the possible extensions of this paper, one extension is to introduce more countries in our sample in order to improve the quality of our results and to complete our analysis on the interactions between governments and independent central banks. Another extension is to sharpen fiscal variables by introducing transfers (Melitz, 1997). It would allow us to identify which fiscal variables are manipulated by governments facing an active monetary policy. Finally, some causality tests could examine the dynamic relationship between short-term interest rates and taxes in order to detect bilateral long run causality.

References

Artis M.J. and B. Winckler (1997), "The Stability Pact, Safeguarding the Credibility of the European Central Bank", CEPR Discussion Paper N°1688.

Barro and Gordon (1983), "Rules, Discretion and Reputation in a Model of Monetary Policy", Journal of Monetary Economics, 12, pp. 101-121.

Clarida R., J. Gali and M. Gertler (1997), "Monetary Policy Rules in Practice, Some International Evidence", *European Economic Review*, 42, pp. 1033-1067.

Debrun X. and C. Wyplosz (1999), "La coordination des politiques budgétaire et monétaire , 109 (3), pp. 387-424.

Greene W. H. (1997), *Econometric Analysis*, third edition, Prentice Hall ed.

Missale and Blanchard (1994), "The Debt Burden and Debt Maturity", *American Economic Review*, March, pp. 309-19.

Melitz J. (1997), "Some Cross Country Evidence about Debt, Deficits, and the Behaviour of Monetary and Fiscal Authorities", CEPR Discussion Paper N°. 1653.

Melitz J. and F. Zumer (1998), "Regional Redistribution and Stabilizaton by the Centre in Canada, France, the United Kingdom and the United States: New Estimates based on Panel Data Econometrics", CEPR Discussion Paper N°1829.

Rogoff (1985), "The Optimal Degree of Commitment to an Intermediate Monetary Target", *Quarterly Journal of Economics*, 100, pp. 1169-90.

Sargent T. and N. Wallace (1981), "Some Unpleasant Monetarist Arithmetic *Reserve Bank of Minneapolis Quarterly Review*, Fall, pp.1-17.

Taylor J. (1993), "Discretion versus Policy Rules in Practice", *Carnegie-Rochester Conference on Public Policy* 39, pp. 195-214.

Wyplosz C. (1999), "Economic Policy Coordination in EMU: Strategies and Institutions", Paper presented at the German-French Economic Forum in Bonn, January 12, 1999.

Table 1. Reaction Function of the Central Banks,
Panel data estimation: 7 countries, 1975 - 1997, Dependent variable: short term interest rate

	b_{OLS}	b_B	b_W	b_R
Z_t	-0,57** (-5,44)	0,59 (4,57)	-0,24 (-1,94)	-0,47** (-4,45)
$\bar{y}_t$	0,12 (1,23)	0,006 (0,04)	0,23* (2,55)	0,16 (1,78)
p_{t-1}	0,68** (15,5)	1,12* (30,02)	0,48** (7,48)	0,57** (10,63)
b_{t-1}	0,02* (2,40)	-0,03 (-4,62)	-0,07** (-3,13)	-0,0058 (-0,42)
t_t	0,10** (2,84)	-0,02 (-0,95)	0,33** (3, 73)	0,14* (2,50)
C	-0,14 (-0,08)	4,36 (4,34)		0,21 (0,08)
Adj. R2	0,69	0,99	0,76	0,66

t-value in parentheses
* indicates significance at the 0.5 percentage point level
****** indicates significance at the 0.1 percentage point level

Table 2. Reaction Function of Fiscal Authorities
Panel data estimation: 7 countries, 1975 - 1997, Dependent variable: rate of taxation

	b_{OLS}	b_B	b_W	b_R
Z_t	1,44** (6,16)	15,18 (1,33)	-0,38** (-3,51)	-0,35** (-3,25)
$\bar{y}_t$	0,03 (0,14)	-1,02 (-0,19)	-0,31** (-3,89)	-0,31** (-3,80)
p_{t-1}	-0,87** (-5,92)	24,5 (0,96)	-0,31** (-4,84)	-0,32** (-5,12)
b_{t-1}	0,02 (1,10)	-0,60 (-1,04)	0,13** (7,59)	0,12** (7,45)
r_t	0,53* (2,85)	-21,78 (-0,95)	0,28** (3,73)	0,27** (3,69)
C	41,45** (27,48)	117,50 (1,50)		35,67** (16,17)
Adj. R2	0,45	0,50	0,93	0,08

t-value in parentheses
* indicates significance at the 0.5 percentage point level
****** indicates significance at the 0.1 percentage point level

Table 3. Reaction Function of the European Central Banks,
Panel data estimation: 6 countries, 1975 - 1997, Dependent variable: short term interest rate

	b_{OLS}	b_W	b_R
Z_t	-0,64** (-5,97)	-0,23* (-2,42)	-0,58** (-5,23)
$\bar{y}_t$	-0,10 (1,05)	0,25* (2,42)	0,15 (1,54)
p_{t-1}	0,55** (10,48)	0,46** (7,03)	-0,52** (8,92)
B_{t-1}	0,02* (2,46)	-0,05* (-2,15)	0,008 (0,6)
t_t	0,0063 (0,14)	0,26** (2,76)	0,05 (0,8)
C	5,03* (2,21)		4,1 (1,39)
Adj. R2	0,72	0,76	0,71

t-value in parentheses
* indicates significance at the 0.5 percentage point level
****** indicates significance at the 0.1 percentage point level

Table 4. Reaction Function of European Fiscal Authorities
Panel data estimation: 6 countries, 1975 - 1997, Dependent variable: rate of taxation

	b_{OLS}	b_W	b_R
Z_t	0,69* (2,94)	-0,48** (-3,83)	-0,43** (-3,48)
$\bar{y}_t$	-0,02 (-0,12)	-0,34** (-3,65)	-0,33** (-3,5)
p_{t-1}	-0,76** (-5,86)	-0,29** (-4,21)	-0,32** (-4,7)
B_{t-1}	0,002 (0,12)	0,13** (7,38)	0,12** (6,96)
r_t	0,03 (0,14)	0,24** (2,76)	0,22** (2,6)
C	48,18** (31,04)		37,38** (17,45)
Adj. R2	0,52	0,91	0,044

t-value in parentheses
* indicates significance at the 0.5 percentage point level
****** indicates significance at the 0.1 percentage point level

Appendix

Determination of equation (3):

$$G_t - T_t + i_t B_{t-1} = \Delta M_t + \Delta B_t$$

We suppose that there is no seignoriage in this economy $(\Delta M = 0)$ and the government tries to stabilise its public debt growth $(\Delta B = 0)$. After Taylor's approximation, we obtain the following equation:

$$(G_t - G_0) - (T_T - T_0) = -[(i_t - i_0)B_0 + (B_{t-1} - B_0)i_0]$$

After transformations, we obtain the following equation:

$$G_0 g_t - T_0 t_t = -r_t (r_0 B_0) - b_{t-1}(r_0 B_0)$$

With $g_t = \frac{G_t - G_0}{G_0}$; $t_t = \frac{T_T - T_0}{T_T}$; $r_t = \frac{i_t - i_0}{i_o}$; $b_{t-1} = \frac{B_{t-1} - B_0}{B_0}$.

The government has a balanced budget: $G_0 = T_0$.

Finally, we obtain:

$$g_t - t_t = \left(-\frac{r_0 B_0}{G_0}\right) r_t + \left(-\frac{r_0 B_0}{G_0}\right) b_{t-1}$$

With $g = \frac{r_0 B_0}{B_0}$