Economics Department

Central Bank Independence and Public Debt Convergence in an Open Economy Dynamic Game

POMPEO DELLA POSTA

ECO No. 97/28

EUI WORKING PAPERS

EUROPEAN UNIVERSITY INSTITUTE

EUROPEAN UNIVERSITY INSTITUTE, FLORENCE

ECONOMICS DEPARTMENT

EUI Working Paper **ECO** No. 97/28

Central Bank Independence and Public Debt Convergence in an Open Economy Dynamic Game

POMPEO DELLA POSTA

BADIA FIESOLANA, SAN DOMENICO (FI)

©Pompeo Della Posta
Printed in Italy in October1997
European University Institute
Badia Fiesolana
I – 50016 San Domenico (FI)
Italy

Central Bank Independence and Public Debt Convergence in an Open Economy Dynamic Game

Pompeo Della Posta

Department of Economics
European University Institute
I-50016 San Domenico di Fiesole (FI), Italy
E-Mail: dellapos@datacomm.iue.it
and
Dipartimento di Scienze Economiche
Via Ridolfi, 10
I-56124 Pisa, Italy
E-Mail: peoposta@ec.unipi.it

July 1997

Abstract

A realistic objective function for the atomistic central Bank and Treasury of a country adhering to a fixed exchange rate agreement like the EMS, would contain the public debt level, to be minimized for example to meet one of the requirements contained in the Maastricht Treaty, and foreign reserves, that cannot go beyond a lower limit if the country does not want to renege on the exchange rate commitment. Both the Treasury and the Central Bank will then aim to reduce the level of debt, attempting to leave the burden of the adjustment on the others, while at the same time caring about the foreign reserves level. We assume that each authority decides optimally the variable under its own control by taking into account the decision rule of the others (Feedback-Nash equilibrium), so that we obtain a subgame perfect, and therefore time consistent, solution.
Recent work on the subject has suggested the importance of independence of the Central Bank in order to increase the probability of success of a stabilization plan. Other contributions, however, argue that monetary independence may not be sufficient to induce fiscal discipline. In this paper we put forward a new argument leading to the conclusion that Central Bank independence might not be necessary to induce fiscal discipline: for this to be true it is enough that the fiscal authority assigns a high weight to the loss produced by foreign reserves variations. In the absence of "perverse" capital inflows, even with a dependent Central Bank, ready to inflate away part of the debt, the fiscal authority will act in a disciplined way to compensate the capital outflow produced by the monetary laxity.

Some keywords: Central Bank independence, public debt convergence, dynamic game, Feedback-Nash equilibrium.

JEL Classification: E52, E58, E61, E62, F41

1. Introduction*

A realistic objective function for the atomistic Central Bank and Treasury of a country adhering to a fixed exchange rate agreement like the EMS, would contain the public debt level, to be minimized for example to meet one of the requirements contained in the Maastricht Treaty or, in more general terms, to avoid any possible risk of financial crisis, and foreign reserves, that cannot go beyond a lower limit if the country does not want to renege on the exchange rate commitment. At the same time both the Central Bank and the Treasury will want to minimize the loss resulting from the deviations of their respective control variables from a given target**. Both the Treasury and the Central Bank will then aim to reduce the level of debt, attempting to leave the burden of the adjustment on the others, while at the same time caring about the foreign reserves level, given the adhesion to the exchange rate mechanism and the degree of financial and/or commercial openness of the economy. The simple closed economy conclusion that a budget deficit increases the level of the public debt while a monetary expansion reduces it, becomes complicated by recognising the implications that follow from the openness of an economy. The incentive to run a monetary expansion to reduce the level of outstanding public debt is therefore modified when the monetary authority is constrained by the level of foreign reserves. It is easy to understand that by charging the monetary authority with this additional objective, a tighter monetary policy might become the optimal outcome because a divergent monetary expansion that would reduce the public debt level, in presence of free capital movements would also cause a capital outflow and hence a reduction in reserves that increases the probability that the exchange rate will not be defended. The likely effect of a fiscal expansion on foreign reserves also has to be considered. The experience of the eighties in Europe suggests that the predictions of the simple Mundell-Fleming model might hold true: a domestic fiscal expansion in a fixed exchange rate system with free capital inflow leads to an increase in foreign reserves, due to the resulting higher domestic interest rates. If this is the case the negative effect on reserves of an expansionary monetary policy is compensated for by the

---

* Chapter 4 of the Ph.D. thesis "Fiscal Convergence, Expectations and Speculative Attacks in the European Monetary System", to be defended in October, 1997. Revised version of the paper presented at the II "Colloquia on Economic Research" held at IGIER, Abbazia di Mirasole on May, 1994 and at the VIII Convegno di Teoria dei Giochi held in Genova on November 16/17, 1993.

** I wish to thank the Conferences' participants for their reactions and comments. Many thanks to my supervisor, prof. Mark Salmon for having provided the initial stimulus for this paper and for his helpful suggestions. I gratefully acknowledge financial support from MURST.

effects of fiscal policy, so that the former could even be more expansionary than in the closed economy case. By considering different foreign responses to fiscal and monetary expansions in a strategic setting, however, it will be shown that even in the presence of a very accomodative, non-independent Central Bank, an exchange rate commitment directly involving the fiscal authority might be enough to bring about disciplined fiscal behaviour, the reason being that the foreign exchange reserves outflow caused by a divergent monetary policy will have to be compensated by a disciplined fiscal stance capable of attracting foreign capital. This is an apparently odd result, above all if interpreted in the light of the recent literature on Central Bank independence that suggests the need for an increasing degree of independence of the monetary authority in order to force the fiscal authority to follow a disciplined fiscal behaviour. As will become clearer in the rest of the paper, it is crucially dependent both on the assumption that no "perverse" capital outflow takes place i.e. that the market assigns the appropriate risk premia to the debt issued by a divergent fiscal authority and on the assumption that the latter itself assigns a high weight to the loss produced by a renegement of the exchange rate commitment.

The paper is organized as follows. Section 2 contains a brief survey of the main conclusions reached in the existing literature on strategic games between a Central Bank and a Treasury; special emphasis is assigned to the Italian case. Section 3 considers a simple normal form static game providing the main result of the paper: when the Treasury assigns high preferences to exchange rate stability (i.e. prevents foreign exchange reserves from falling below a given threshold), the presence of an accomodative, expansionary Central Bank induces disciplined behaviour by the fiscal authority. Section 4 considers instead a similar open economy dynamic game also leading to the same conclusion. Section 5 contains the numerical simulation and 5.1 comments on the results obtained. Some final remarks are presented in section 6.

2. The strategic game between Central Bank and Treasury

Several authors have examined the strategic game between a monetary and a fiscal authority to minimize the public debt variability[1]. Tabellini (1986) analyses a closed economy dynamic game between a monetary and a fiscal authority (M and F respectively); each selecting the value of their own control variable, monetary creation (m) and fiscal deficit (f) to minimise their loss

[1]Petit (1991) also considers a strategic game between a domestic Central Bank and a domestic Treasury using the econometric model in continuous time developped by Gandolfo and Padoan (1984). Unfortunately their results are of no help in the case that we are considering here because the model they use ignores public debt.

functions subject to the common dynamic constraint represented by the growth of debt over time. The loss functions are composed of the squared deviation of their control variable from a given target and of the squared value of the public debt weighted by a parameter expressing the relative importance of the two components. He compares different solution concepts: Feedback-Nash, Cournot-Nash and Cooperative. In the first case each authority minimizes its own loss function by taking into account the reaction rule of the other authority. The optimal solution therefore is not only time consistent but also subgame perfect. In the Cournot-Nash case instead each authority precommits to a given (open loop) future behaviour and each player minimizes its loss function by taking as given the path of the current and future actions of the other. In the Cooperative case the two players jointly optimize a common objective function to which appropriate weights are assigned, reflecting the relative importance of the objectives of the two authorities[2]. The results obtained by Tabellini (1986), using the different solution concepts indicate that: the Cooperative solution implies the highest speed of adjustment and the lowest steady state public debt level while the Cournot-Nash solution produces a faster adjustment and a lower steady state public debt than the Feedback-Nash. The intuition is that in the Feedback-Nash equilibrium each authority takes into account the reaction of the other authority to a given debt level, and thereby reduces its own optimal adjustment effort. In the Cooperative case, on the other hand, each authority optimizes by considering the opponent's objective partly as its own objective, so the individual optimal adjustment effort is reinforced. When increasing the degree of monetary independence in the Cournot-Nash case, the reaction of the monetary authority to a given public debt level is reduced while the fiscal authority's reaction is increased, but in such a way that a lower speed of adjustment and a higher steady state debt level results. In the Feedback-Nash case, instead, a higher degree of monetary independence produces ambiguous steady state results depending on the parameter values while causing a slower speed of adjustment. This contribution, then, suggests that a likely result of increasing the degree of Central Bank monetary independence, is a higher steady state public debt level because the lower adjustment effort produced by the monetary institution (that refuses to monetize the public debt in order to prevent inflation), is less than compensated for by the higher effort imposed on the fiscal authority.

[2] The Feedback-Nash solution seems to represent the institutional setting of a country like Italy in which neither the Treasury, nor the Central Bank seem to be able to precommit to a given course of action but rather reoptimize period after period. On the other hand, the Cournot-Nash case might depict the situation of a country like Germany, where the Bundesbank's current and future actions can be considered as given, due to the institutional constraints imposed on it.

Opposite conclusions are reached by Mourmuras and Su (1993) who, using a dynamic game version of the model proposed by Dornbusch (1991) show that a higher degree of monetary independence ("dominance" in their words) increases the probability of public debt stabilization. They conclude therefore in favour of the prescriptions contained in the Maastricht Treaty regarding the independence of a European Central Bank. Not surprisingly, they also show that a high degree of polarization, i.e. a high marginal cost of fiscal adjustment, implies a higher segniorage and causes inflation. Their result, however, seems to rely heavily on the equation representing the dynamics of the probability of stabilization failure: only fiscal adjustment increases the probability of success, while no role is assigned to even partial and limited debt monetization or to output growth[3].

Bruni and Monti (1992) also evaluate the possible disciplinary effect of Central Bank independence on the fiscal authority. Although there is little theoretical or empirical conclusive evidence of such an effect in the literature, Tabellini (1987) observes that the 1981 Italian monetary reform, the so called "divorce" between Banca d'Italia and Treasury, was undertaken in the hope to bring about a more moderate fiscal policy and a less accomodative monetary policy. Fiscal policy, however, showed very limited signs of moderation, although the Central Bank had to act in a very restrictive way in order to establish a reputation for being "tough", given the initial uncertainty about its true nature. The inevitable result was a growing public debt.

A satisfactory explanation for the dramatic growth of public debt considers the role of what Bruni and Monti (1992) call "perverse" capital inflows, resulting from the predictions of the Mundell-Fleming model. Such capital inflows make monetary management more difficult and imply the need to sterilize the effects of money created through the foreign channel, but above all assure the financing of the budget deficit, although at the price of higher interest rates. According to Bruni and Monti (1992), however, growing interest rates should still provide a decisive incentive for the Treasury to reduce the budget deficit, were the intertemporal discount rate not too high. If no such intertemporal constraint is felt, as they suggest is the case in many instances, the higher future taxes necessary to repay the existing debt are simply ignored.

Bruni and Giavazzi (1987), also stress the role of interest rates when considering the effect of a financial liberalization or repression on the budget deficit. Their point is that financial repression, i.e. the imposition of controls on capital outflows, allows the Treasury to lower the interest rate to be paid on the public debt so as to produce an expansionary fiscal bias. Only exposure to

[3] The particular values assigned to the parameters of their model might also partly justify the result they obtain.

foreign competition when capital movements are liberalized, causes the Treasury to offer higher interest rates reflecting the higher risk premium to be paid on the domestic public debt. Capital liberalization, then, by causing an interest rate rise, should tighten the government budget constraint and therefore produce a fiscal adjustment. As explained above, in presence of a high intertemporal discount rate, the conclusion reached by Bruni and Giavazzi (1987) can be questioned. Moreover, further doubts have to be raised on the likely effects of a financial liberalization, given that it is uncertain whether the financial market will apply the appropriate risk premium on the public debt of heavily indebted countries. It is worth stressing that it is exactly this fear that motivated the imposition within the Maastricht Treaty of direct fiscal constraints on the public finances of those countries wishing to adhere to the European Monetary Union.

In this paper we argue that there is a different way through which financial liberalization may induce a disciplinary fiscal effect: a divergent domestic monetary expansion in a country adhering to a fixed exchange rate agreement causes a reserves loss if capital is allowed to flow freely across countries and in turn a constant reserves depletion would cause the collapse of the fixed exchange rate. It is easy to see, then, that it would be enough to make the Treasury concerned about the effect of its actions on the exchange rate or at least to increase the cost of reneging on the exchange rate commitment, to induce a disciplined behaviour on the fiscal authority even in presence of an accomodating Central Bank. One further condition, however, has to be added: that no "perverse" capital inflows, induced only by the higher fiscal deficits and interest rates should occur. When the financial markets assign confidence to virtuous countries with sound finances, it is easy to conclude that the incentive for disciplined behaviour is strongly felt. If markets, on the other hand, behave in such a way that a higher interest rate is enough to attract capital, ignoring the presence of any repudiation risk, and/or assigning more confidence to a highly indebted country for example just because its membership has been accepted by the sound countries participating to a monetary union, such an incentive is hardly present. The conclusion to draw, then, is that with free capital mobility, in which both fiscal expansion and monetary expansion cause capital outflows, increasing the weight that the Treasury assigns to the loss produced by the reduction in foreign reserves might be enough to induce a disciplinary effect on the fiscal authority. Alternatively, and more significantly, one can say that Central Bank dependence (i.e. Treasury dominance), will not induce budgetary laxity because of the fiscal authority's serious commitment to mantain the fixed exchange rate agreement.

If this argument follows, the conclusion reached by Bruni and Monti (1992) that Central Bank independence is a necessary but not a sufficient condition for fiscal discipline has to be modified. It might well be that even in

the presence of a non independent Central Bank devoted to debt reduction through monetization rather than to price stability, a disciplinary effect on the fiscal authority would result as a consequence of the exchange rate commitment and of the destabilizing consequences of a divergent monetary expansion. Central Bank independence would then be neither a necessary nor a sufficient condition for fiscal discipline. The prescription contained in the Maastricht Treaty, that in order to move to phase Three no realignments should have taken place in the two preceding years, can be seen as an institutional way of increasing the weight that the Treasury assigns to foreign reserves and a disciplinary effect on the Treasury should therefore result.

Less clearcut conclusions, however, are reached when moving from a fixed exchange rate system to a monetary union. In the latter case the foreign constraint is no longer necessarily felt by a domestic country, so the incentive to run expansionary fiscal policies might arise in the presence of a dependent central bank, ready to monetize the budget deficit. If Central Bank independence were seen as sufficient to induce fiscal discipline, however, the public finance prescriptions contained in the Maastricht Treaty would not be necessary. The fact that both central bank independence and public finance rules (together with "no bail-out" clauses) are contained in the Maastricht Treaty, then, can only be interpreted as a sign of pessimism as to the likely effects of monetary autonomy: Central Bank independence, as suggested by Bruni and Monti (1992), is not seen in the Maastricht Treaty as sufficient to induce fiscal discipline.

3. A simple normal form static game

A very simple normal form static game between a monetary (M) and a fiscal (F) authority, both of whom have the option to expand (E) or to contract (C) their control variable, will help understand the main conclusions reached in this paper. Such an approach is by construction rather ad hoc (see also Giavazzi and Carraro (1992)) but it does provide well defined answers as to the equilibria reached when the relative importance attached to one or the other objective of the authorities' loss function is unambiguously defined.

We assume that F's loss function is composed of the deviations from a given target for fiscal deficit and of the variability in public debt. If preferences are assumed to be lexicographic, with priority given to the first objective (for example because of a high degree of polarization), then F's pay-offs will be as shown in Table 1, where the best outcome is (E,E) with fiscal expansion and no debt, the second best is (C,E) with fiscal expansion and debt, the third preferred is (E,C), no fiscal expansion but money growth and the worst outcome is (C,C) with neither fiscal nor monetary expansion. In this and in the following tables, the higher the number the higher the loss; the first number refers to the pay-off

for the monetary authority while the second number refers to the pay-off for the fiscal authority. Assuming that M is not independent from F, so that it is obliged to finance the budget deficit created by the fiscal authority and only at a second stage will it care about low inflation, its highest preference will be for a no debt situation and no monetary expansion, so (C,C) will be ranked first. The other possibility to avoid debt creation is (E,E) where the fiscal expansion obliges M to monetize the debt. (C,E) is the third preferred pay-off and (E,C) is the fourth. As a result, not surprisingly, the only Nash-equilibrium is given by (E,E) which might represent the Italian pre-"divorce" situation fairly well, in which the high rate of inflation produced by a dependent Central Bank allowed the government to avoid the debt growth.

When the Central Bank becomes more independent so that priority is assigned to low inflation and therefore low monetary growth (for example because of the adhesion to the EMS) which dominates the commitment to satisfy the needs of the Treasury (thanks to a monetary reform like the "divorce") the unique Nash-equilibrium becomes (C,E) (see Table 2) and it's easy to conclude that a debt explosion will result. This is the situation observed in Italy during the eighties, when no incentive to reduce the budget deficit was felt by the Treasury, most possibly due to institutional and political reasons, to its high intertemporal discount rate and to the above mentioned "perverse" capital inflows. This situation is close to the one shown by Tabellini (1986).

When, on the other hand, in the presence of an independent Central Bank, external constraints are put on the fiscal authority, so that as a consequence priority has to be assigned to fiscal discipline (the public finance prescriptions contained in the Maastricht Treaty are one obvious cause of such a change in preferences), the Treasury pay-offs are different and, as shown in Table 3, the outcome (C,C) becomes the unique Nash-equilibrium. Although for different theoretical reasons this is the outcome obtained by Mourmours and Su (1993) and considered as possible when certain conditions occur by Bruni and Monti (1992) and Bruni and Giavazzi (1987).

If we now let the Central Bank preferences be as in Table 1, corresponding to a case of fiscal dominance (i.e. of monetary dependence with a very low weight assigned to reserves variability) but we still assume that F cares about foreign reserves (for example because of the high cost of abandoning the fixed exchange rate agreement) so that only after the variability in foreign reserves has been minimized does it care about public debt, the resulting outcome will also be (C,C), as in the case of monetary dominance (see table 4).

We can also consider a different situation, in which the monetary authority prefers high to low monetary growth (for example because by doing this it reduces the public debt level), while it doesn't really care about foreign

reserves. If this is the case, the payoffs may be as indicated in table 5 and the first best for the monetary authority will be (E,C). In this situation, in which the Treasury's preferences are assumed to be as in the previous case, the only resulting Nash equilibrium will be one in which the monetary authority follows an expansionary monetary policy, while the Treasury, in view of the exchange rate commitment follows a restrictive fiscal policy to compensate the effect on foreign reserves of the monetary laxity (see table 5). Although apparently odd, the situations described in tables 4 and 5 might represent the case of a government that uses the external constraint as a way to impose a credible, disciplined behaviour on itself. The Italian pre-EMS crisis situation, for example, can be interpreted as one in which the Government assigned a high weight to the loss caused by a reserves depletion or to the renegement of the exchange rate commitment. By doing so the restrictive monetary stance of the Banca d'Italia was reinforced by a strong commitment to reduce the public debt level through a serious fiscal adjustment.

This issue we now explore in the context of a dynamic game.

		F	
		C	E
M	C	1,4	3,2
	E	4,3	2,1

Table 1: monetary dependence and fiscal discipline

		F	
		C	E
M	C	1,4	2,2
	E	3,3	4,1

Table 2: monetary independence and fiscal indiscipline

		F	
		C	E
M	C	1,2	2,3
	E	3,4	4,1

Table 3: monetary independence and fiscal discipline

		F	
		C	E
M	C	1,1	3,2
	E	4,3	2,4

Table 4: monetary dependence and fiscal discipline (with different Treasury preferences for foreign reserves variability)

		F	
		C	E
M	C	3,1	4,2
	E	1,3	2,4

Table 5: Monetary laxity and fiscal discipline

4. The Open Economy Dynamic Game Between a Fiscal and a Monetary Authority

Moving to a dynamic situation, M and F are now considered to minimize the following intertemporal loss functions:

(1) $$V_M = \frac{1}{2}\int_t^{\infty}[\eta_M(m_s-\bar{m})^2+\tau_M(D_s-\bar{D})^2+\zeta_M(R_s-\bar{R})^2]e^{-\rho(s-t)}ds$$

(2) $$V_F = \frac{1}{2}\int_t^{\infty}[\eta_F(f_s-\bar{f})^2+\tau_F(D_s-\bar{D})^2+\zeta_F(R_s-\bar{R})^2]e^{-\rho(s-t)}ds$$

subject to the same dynamic constraints:

(3) $$\dot{D} = rD+f-m$$

(4) $$\dot{R} = r'_e R+\psi f-\delta m-\chi\pi$$

where

(5) $$\pi = \alpha m+\beta f+\varepsilon\dot{R}$$

The loss function of the monetary (fiscal) authority is composed respectively of the deviations in monetary growth (fiscal deficit), public debt and foreign reserves from their respective target, each weighted by a parameter expressing the relative importance of the different objectives[4].

Debt growth over time (equation (3)), depends on the interest rate (assumed to be constant for simplicity), on the fiscal deficit and on the monetary growth optimally chosen by F and M.

The dynamics of the foreign exchange reserves (equation (4)), on the other hand, is determined by flow of capital and of the current account: fiscal expansion, by inducing a higher interest rate favours a capital inflow while monetary expansion, having an opposite effect on r causes a capital outflow. As we will see, different conclusions follow when a fiscal expansion causes capital outflows because of credibility problems. The current account is assumed to be determined by the domestic inflation rate that undermines the international competitiveness of the country: the higher the inflation rate, the higher the current account deficit produced by lower exports and higher imports.

The inflation rate (equation (5)) is assumed to result from internal causes (monetary growth and fiscal expansion) and external causes (reserves variation),

[4] Of course, one parameter is redundant.

with the latter depending on the degree of sterilization expressed by the parameter ε[5].

By substituting (5) into (4) our second dynamic constraint becomes:

$$\dot{R} = \frac{r_e' R + (\psi - \beta\chi) f - (\delta + \alpha\chi) m}{(1 + \varepsilon\chi)} \tag{6}$$

which we write as:

$$\dot{R} = r_e'' R - \delta'' m + \psi'' f \tag{7}$$

where the new coefficients have obvious interpretations.

As already mentioned the solution concept that we are going to consider is the Feedback-Nash (that approximates better the Italian situation), in which both authorities minimize their loss function by taking into account the opponent's optimal reaction rule to the state of the system. Without loss of generality, the reaction function of the fiscal authority may be expressed as:

$$f = \theta_0 + \theta_1 D + \theta_2 R \tag{8}$$

where θ_1 and θ_2 capture F's reaction to the debt level and to the reserves level respectively. The analogous equation for M can be expressed as:

$$m = \gamma_0 + \gamma_1 D + \gamma_2 R \tag{9}$$

Using (8) and (9) both in the loss functions and in the state equations we obtain the following Hamiltonians:

$$H^M = \frac{1}{2}[\eta_M (m_s - \bar{m})^2 + \tau_M (D_s - \bar{D})^2 + \zeta_M (R_s - \bar{R})^2] e^{-\rho t} + \lambda_1^M [rD + (\theta_0 + \theta_1 D + \theta_2 R) - m] + \lambda_2^M [r_e'' R + \psi''(\theta_0 + \theta_1 D + \theta_2 R) - \delta'' m] \tag{10}$$

$$H^F = \frac{1}{2}[\eta_F (f_s - \bar{f})^2 + \tau_F (D_s - \bar{D})^2 + \zeta_F (R_s - \bar{R})^2] e^{-\rho t} + \lambda_1^F [rD + f - (\gamma_0 + \gamma_1 D + \gamma_2 R)] + \lambda_2^F [r_e'' R + \psi'' f - \delta''(\gamma_0 + \gamma_1 D + \gamma_2 R)] \tag{11}$$

[5] Monetary growth, fiscal deficit, public debt and foreign reserves can all be thought of as GDP ratios, with GDP growth equal to zero.

where

(12) $$\lambda_1^M = \mu_1^M e^{-\rho t}$$

and the same relationship applies for the other shadow values.

The first order conditions turn out to be:

$$-\dot{\lambda}_1^M = [\frac{\partial H^M}{\partial D} + \frac{\partial H^M}{\partial f}\theta_1]e^{-\rho t}$$

i.e.

(14) $$\dot{\mu}_1^M = -\tau_M(D_s - \overline{D}) + (\rho - r - \theta_1)\mu_1^M - (\psi''\theta_1)\mu_2^M$$

$$-\dot{\lambda}_2^M = [\frac{\partial H^M}{\partial R} + \frac{\partial H^M}{\partial f}\theta_2]e^{-\rho t}$$

i.e.

(16) $$\dot{\mu}_2^M = -\zeta_M(R_s - \overline{R}) - (\theta_2)\mu_1^M + (\rho - r''^e - \psi''\theta_2)\mu_2^M$$

$$-\dot{\lambda}_1^F = [\frac{\partial H^F}{\partial D} + \frac{\partial H^F}{\partial m}\gamma_1]e^{-\rho t}$$

i.e.

(18) $$\dot{\mu}_1^F = -\tau_F(D_s - \overline{D}) + (\rho - r + \gamma_1)\mu_1^F + (\delta''\gamma_1)\mu_2^F$$

$$-\dot{\lambda}_2^F = [\frac{\partial H^F}{\partial R} + \frac{\partial H^F}{\partial m}\gamma_2]e^{-\rho t}$$

i.e.

(20) $$\dot{\mu}_2^F = -\zeta_F(R_s - \overline{R}) + \gamma_2\mu_1^F + (\rho - r_e'' + \delta''\gamma_2)\mu_2^F$$

(21) $$\frac{\partial H^M}{\partial m} = -\mu_1^M - \delta''\mu_2^M + \eta_M m - \eta_M \bar{m} = 0$$

(22) $$\frac{\partial H^F}{\partial f} = \eta_F f + \mu_1^F + \psi''\mu_2^F - \eta_F \bar{f} = 0$$

The usual transversality conditions apply.

5. The Computer Simulation

The model is solved numerically, given that no analytical solution is possible, due to the presence of the two dynamic constraints, by making use of SADDLEPOINT (Buiter and Austin, 1982) as modified by Mark Salmon to allow for Feedback-Nash solutions[6].

In the simulations, D and R are treated as predetermined state variables, μ_1^M, μ_2^M, μ_1^F, μ_2^F, the Lagrange multipliers are treated as non predetermined state variables, m and f are output variables and $\bar{D}$, $\bar{R}$, $\bar{m}$, $\bar{f}$ are exogenous variables[7].

Given the first order conditions seen above, then, the model can be represented in state space[8] as follows, by considering separately the 6 dynamic state ((3) and (7)) and costate ((14), (16), (18) and (20)) equations and the 2 output equations ((21) and (22)):

---

[6] See Miller and Salmon (1985) for a complete technical description of the solution method and Cesar and Della Posta (1990) for a practical guide to the modifications to be operated to the open loop model in order to get the Feedback-Nash solution.

[7] See Buiter (1983) for the distinction between predetermined and non predetermined state variables, output variables and exogenous variables.

[8] See Petit (1990) for an explanation of the state space representation of a system and Van der Ploeg and Markink (1989) for applications and use of the computer program PSREM that solves open loop dyamic models without allowing however, to calculate Feedback-Nash solutions.

(23)
$$E_1\begin{bmatrix} D \\ R \\ \mu_1^M \\ \mu_2^M \\ \mu_1^F \\ \mu_2^F \end{bmatrix} + E_2\begin{bmatrix} \dot{D} \\ \dot{R} \\ \dot{\mu}_1^M \\ \dot{\mu}_2^M \\ \dot{\mu}_1^F \\ \dot{\mu}_2^F \end{bmatrix} + E_3\begin{bmatrix} m \\ f \end{bmatrix} + E_4\begin{bmatrix} \bar{D} \\ \bar{R} \\ \bar{m} \\ \bar{f} \end{bmatrix} - 0$$

(24)
$$E_5\begin{bmatrix} D \\ R \\ \mu_1^M \\ \mu_2^M \\ \mu_1^F \\ \mu_2^F \end{bmatrix} + E_6\begin{bmatrix} \dot{D} \\ \dot{R} \\ \dot{\mu}_1^M \\ \dot{\mu}_2^M \\ \dot{\mu}_1^F \\ \dot{\mu}_2^F \end{bmatrix} + E_7\begin{bmatrix} m \\ f \end{bmatrix} + E_8\begin{bmatrix} \bar{D} \\ \bar{R} \\ \bar{m} \\ \bar{f} \end{bmatrix} - 0$$

where:

$$E_1 - \begin{bmatrix} r & 0 & 0 & 0 & 0 & 0 \\ 0 & r_e'' & 0 & 0 & 0 & 0 \\ -\tau_M & 0 & (\rho - r - \theta_1) & -\psi''\theta_1 & 0 & 0 \\ 0 & -\zeta_M & -\theta_2 & (\rho - r_e'' - \psi''\theta_2) & 0 & 0 \\ -\tau_F & 0 & 0 & 0 & (\rho - r + \gamma_1) & \delta''\gamma_1 \\ 0 & -\zeta_F & 0 & 0 & \gamma_2 & (\rho - r_e'' + \delta''\gamma_2) \end{bmatrix}$$

$$E_2 = \begin{bmatrix} -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 \end{bmatrix}$$

$$E_3 = \begin{bmatrix} -1 & 1 \\ -\delta'' & \psi'' \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

$$E_4 = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ \tau_M & 0 & 0 & 0 \\ 0 & \zeta_M & 0 & 0 \\ \tau_F & 0 & 0 & 0 \\ 0 & \zeta_F & 0 & 0 \end{bmatrix}$$

$$E_5 = \begin{bmatrix} 0 & 0 & -1 & -\delta'' & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & \psi'' \end{bmatrix}$$

$$E_6 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$E_7 = \begin{bmatrix} \eta_M & 0 \\ 0 & \eta_F \end{bmatrix}$$

$$E_8 = \begin{bmatrix} 0 & 0 & -\eta_M & 0 \\ 0 & 0 & 0 & -\eta_F \end{bmatrix}$$

As seen in equations (10) and (11), γ_1 is the reaction coefficient of the monetary authority to debt variability; γ_2 is the reaction coefficient of the monetary authority to reserves variations; θ_1 is the reaction coefficient of the fiscal authority to debt variations and θ_2 is the reaction coefficient of the fiscal authority to reserves variations.

The results obtained in our simulations indicate substantial sensitivity to the parameter values. Given the value assigned to δ or to ψ, expressing the reserves reaction induced respectively by monetary or fiscal policy, for example, well defined saddlepoint solutions are only obtained with particular parameter values reflecting the preferences for the monetary and/or the fiscal authority. In some cases no convergence is found in calculating the fixed point[9]. The stable saddlepath results obtained with suitably chosen parameters however, are perfectly in line with economic reasoning and shows that, when a fiscal expansion attracts capital and monetary expansion does not cause reserves depletion, a greater Central Bank dependence can provide the government with more flexibility. On the contrary, when a monetary expansion causes capital outflow and credibility effects are at work so that a fiscal consolidation attracts

[9] See Markink and Van der Ploeg (1989) and Buiter (1983) for a systematic analysis and interpretation of the cases in which no convergence is achieved.

foreign reserves, Central Bank dependence does not modify the adjustment effort undertaken by the fiscal authority.

Parameter values are chosen so as to simulate different economically relevant situations: the different capital mobility cases are considered by assigning different values to the δ coefficient: δ=0.01 (from case 1 to 6) reflects a situation of almost no capital mobility; with δ=0.1 we consider a case of limited capital mobility (from case 7 to case 11) while with δ=0.2 we analyze a situation (from case 12 to 15) of higher capital mobility (20% of the domestic credit creation is assumed to be returned to the Central Bank in exchange for foreign reserves). ψ is the coefficient expressing the effect of a fiscal expansion on reserves. We have considered ψ=.1 (cases from 1 to 11) to reflect a situation of "perverse" capital inflows following a fiscal expansion and ψ=-0.1 (cases from 12 to 15) to simulate a situation in which efficient markets produce as a result the fact that a fiscal expansion causes a capital outflow rather than inflow. τ_M, the parameter expressing the weight that the monetary authority assigns to the loss caused by public debt variability, is assumed to take up values included between 0.1 and 0.5, reflecting different degrees of monetary independence (the lower this value the higher the degree of independence of the Central Bank). Different values of comparable size are considered for τ_F, ζ_M and ζ_F so as to simulate different situations in which the monetary authority dominates or is dominated by the fiscal authority. The interest rate level r is assigned a "reasonable" 5% value. ρ is assumed to have value 0.06 to reflect a situation in which the intertemporal discount rate is only slightly higher than the interest rate. A value for ρ=1.06 is also considered so as to simulate instead a case in which the future is heavily discounted. The parameter expressing the weight η_M and η_F assigned to the loss produced when moving away from the target for the fiscal and monetary instrument is assumed to be higher than the cost caused by debt and reserves variations: monetary and fiscal authority have a relevant target, determined by economic and social constraints ($\bar{m}$=5% and $\bar{f}$=5%). We can think of this and of the other values as GDP percentages. $\bar{D}$ is the public debt target that we have assumed to be 0.6 (the public debt/GDP ratio suggested in the Maastricht Treaty as the maximum ratio to be admitted to the monetary union). The target reserves level $\bar{R}$ is assumed to be 0.2 (again to be interpreted as foreign reserves/GDP=20%). The initial debt/GDp level, D_0 is assumed to be 1 (think about the italian situation in which the debt/GDP ratio is even higher than that), while the initial reserves level R_0 is assumed to be the same as the target, so that the monetary and fiscal authority tries to stick as much as possible to the initial reserves level[10]. As for the remaining coefficients, their values

[10] This is to stress the fact that reserves do represent a constraint imposed on the national economic authorities. They are assumed to have no access to special financing channels like

have been chosen so as to represent a "reasonable" scenario ($\chi=\varepsilon=\beta=0.1$, $\alpha=0.8$, $r''_e=0$).

5.1 The Simulation Results

The simulation results allow us to quantify the different conclusions obtained when assuming different institutional situations or market behaviours (see tables 1, 2 and 3 and the graphical representations that follow).

Simulation n° 1 can be taken as a basic reference with which to compare the other results. We assume almost no capital mobility ($\delta=.01$) so that a monetary expansion causes a reserves reduction only because of the current account worsening produced by the resulting loss of competitiveness due to the higher inflation ($\delta''=.0833$). The monetary authority is assumed to be relatively independent and therefore public debt variations from the target ($\bar{D}=.6$) are not highly weighted in its loss function ($\tau_M=.1$); a higher weight is assigned to foreign reserves variations from a given threshold ($\bar{R}=.2$) instead ($\zeta_M=.3$). The monetary authority is assumed to assign a high weight to its own monetary target ($\eta_M=1$). As for the fiscal authority it is assumed to be rather undisciplined and therefore it doesn't care much about public debt and foreign debt variations ($\tau_F=.1, \zeta_F=.1$), while the primary deficit target has a comparatively higher weight ($\eta_F=1$), reflecting a high degree of polarization. The reaction coefficient of the monetary authority with respect to public debt turns out to be $\gamma_1=.1936$, while with respect to foreign reserves $\gamma_2=-.0097$. The reaction coefficients of the fiscal authority on the other hand turn out to be: $\theta_1=-.1873$, $\theta_2=-.0132$. A positive public debt implies a primary surplus to reduce it and positive foreign reserves induce the same behaviour on the fiscal authority. As a result, the optimal monetary policy at the origin will be .1406 falling to .0713 at time 10; the adjustment effort of the fiscal authority remains rather low ($f_0=-.0334$, $f_{10}=.0349$). In spite of a relatively high degree of monetary independence, public debt convergence (from 1 to .6391 at time 10) is obtained by a significant monetary accomodation. This result approximates the solution obtained in table 2 contained in section 3[11].

When increasing the weight that the fiscal authority assigns to public debt

---

the non-credible ones defined in the Basle-Nyborg agreement, established in 1987 to resiste speculative attacks on some weaker countries adhering to the EMS.

[11] It should be considered that differently from the cases analyzed with the normal form static game in section 3, the results here obtained refer to a Feedback-Nash equilibrium, so that a relatively independent Central Bank takes into account that the fiscal authority's low sensitivity to public debt variations and reacts accordingly in order to counterbalance the effects of the undisciplined behaviour of the Treasury.

deviations from a given target (in simulation n.2 τ_F=.3), the public debt reaction coefficient is dramatically increased and, as a result of the greater consideration by the fiscal authority (f_0=-.1598), M can follow a more restrictive stance (m_0=.0952). This situation is close to the result of table 3 in section 3.

An opposite result is obtained when the monetary authority cares more about debt than the fiscal authority (simulation n.3). This result approximates the one obtained in table 1 of section 3.

Case 4 is comparable with case 1: by increasing the weight that the monetary authority assigns to reserves variability, the initial monetary stance gets tighter than case 1 (m_0 moves from .1406 in case 1 to .0891 in case 4) but the adjustment effort undertaken by the fiscal authority increases dramatically (f_0=-.1572 in case 4 and f_0=-.0334 in case 1): given the remaining parameter values, a very independent Central Bank forces the fiscal authority to stand a heavy adjustment effort.

When a limited capital outflow is introduced (δ=.1) as a consequence of a monetary expansion, intuition suggests that monetary policy would become more restrictive to avoid a reserves reduction: in simulation 7 the same preferences as in case 2 are considered, but δ'' =.1782. As expected monetary policy becomes tighter (m_0=.0576) and fiscal policy has to stand most of the adjustment effort (f_0=-.1966).

Simulation 9 produces a relatively more expansionary monetary policy, due to the lower ζ_M. As a result of the higher monetary expansion fiscal policy becomes relatively less restrictive with respect to case 7. In case 11, τ_M=.2 and the monetary policy becomes even more accomodative. Still, this is a situation in which, although the monetary authority is not completely independent, its monetary policy is not very expansionary (m_0=.1207), while fiscal policy still remains rather contracted. This situation is close to the equilibrium described in table 4 of paragraph 3.

In case n. 8 τ_M=.2 but τ_F=.1, so that the debt reduction is mainly obtained through debt monetization and the fiscal authority does not make any adjustment effort.

In case 10 the monetary authority assigns a high weight to the loss caused by reserves variability, so it follows a rather restrictive monetary stance that obliges the fiscal authority to adjust dramatically.

Case 12, compared to 13 and 14 shows the main point of the paper, i.e. that when the fiscal authority is highly sensitive to reserves variations from their target a progressively higher degree of fiscal dominance (implied by a higher τ_M) doesn't cause any significant relaxation of fiscal discipline because of the crucial assumption that virtuous fiscal behaviour attracts foreign capital thanks to the higher credibility gained by the fiscal authority (ψ''=-.1089), (f_0 moves from -.1986 to -.1615 to -.1428 when τ_M moves respectively from .1 to .3 to .5):

N	1	2	3	4	5	6
τ_M	.1		.2	.1		.5
ζ_M	.3			.5	.3	
τ_F	.1	.3	.1	.3		
ζ_F	.1				.5	
ρ	.06					
r	.05					
η_M	1					
η_F	1					
δ	.01					
ψ	.1					
δ''	.0833					
ψ''	.0891					
χ	.1					
ε,β	.1					
α	.8					
$\bar{m}$	.05					
$\bar{f}$	.05					
$\bar{D}$	.6					
$\bar{R}$	.2					
D_{10}	.6391	.6110	.6190	.6103	.6097	.6112
R_{10}	.1403	.1385	.1410	.1386	.1385	.1418
m_0	.1406	.0952	.2145	.0891	.0949	.2782
m_{10}	.0713	.0562	.0791	.0588	.0560	.0774
f_0	-.0334	-.1598	-.0023	-.1572	-.1621	-.0496
f_{10}	.0349	.0246	.0460	.0272	.0245	.0466
γ_1	.1936	.1032	.3564	.1059	.1034	.5227
γ_2	-.0097	-.0196	-.0075	-.0319	-.0230	-.0405
θ_1	-.1873	-.4710	-.1252	-.4686	-.4720	-.2395
θ_2	-.0132	-.0201	-.0119	-.0299	-.0398	-.0549

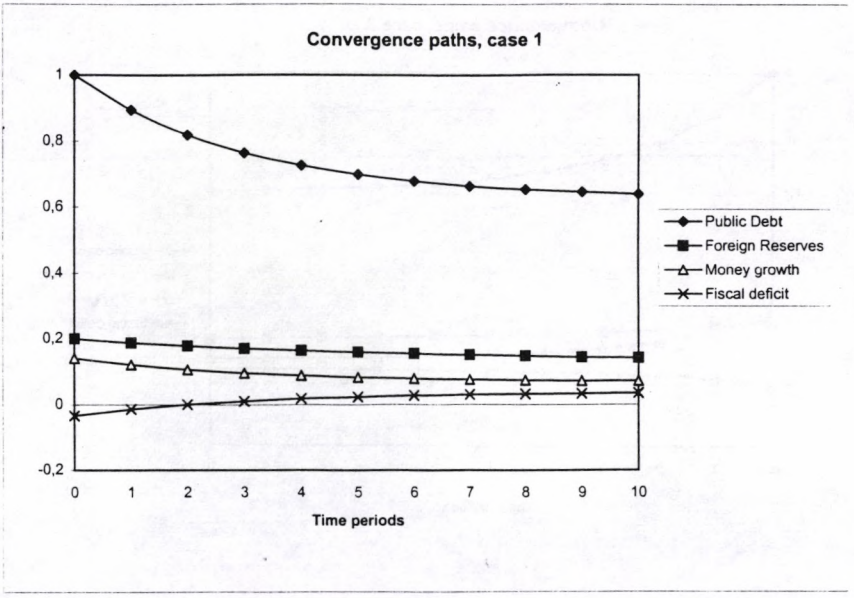
Table 1: Different Central Bank and Treasury preferences for public debt and reserves variability.

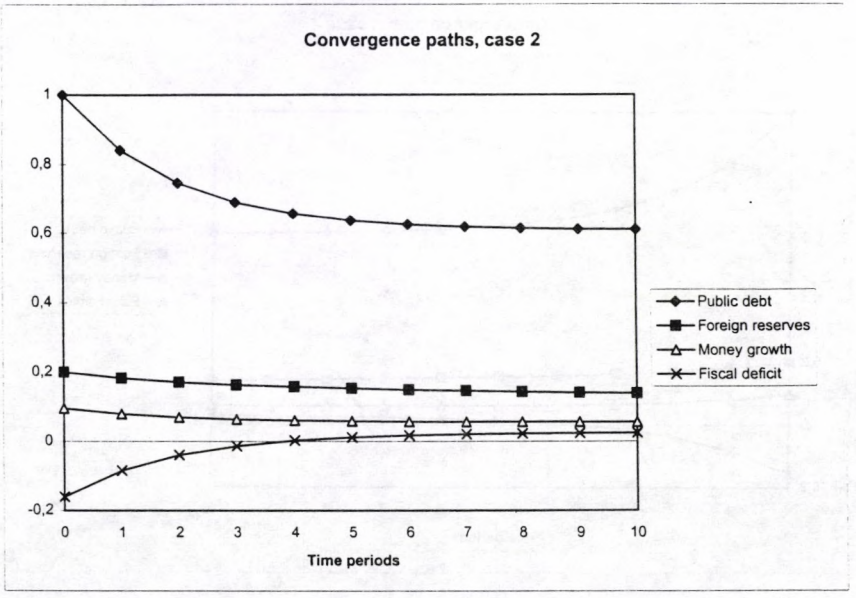
N	7	8	9	10	11
τ_M	.1	.2	.1		.2
ζ_M	.3	.1		.5	.1
τ_F	.3	.1	.3		
ζ_F	.1				
ρ	.06				
r	.05				
η_M	1				
η_F	1				
δ	.1				
ψ	.1				
δ''	.1782				
ψ''	.0891				
χ	.1				
ε,β	.1				
α	.8				
$\bar{m}$	.05				
$\bar{f}$	.05				
$\bar{D}$	.6				
$\bar{R}$	.2				
D_{10}	.6206	.6179	.6074	.6113	.6125
R_{10}	.1198	.0675	.1010	.1324	.0919
m_0	.0576	.1860	.0743	.0455	.1207
m_{10}	.0046	.0419	.0270	.0100	.0303
f_0	-.1966	-.0324	-.1841	-.2154	-.1456
f_{10}	-.0296	.0009	-.0043	-.0413	-.0009
γ_1	.0734	.3344	.0881	.0613	.1978
γ_2	.3137	.1228	.1285	.4705	.1269
θ_1	-.4986	-.1481	-.4880	-.5155	-.4061
θ_2	.2426	.1140	.1189	.3887	.1177

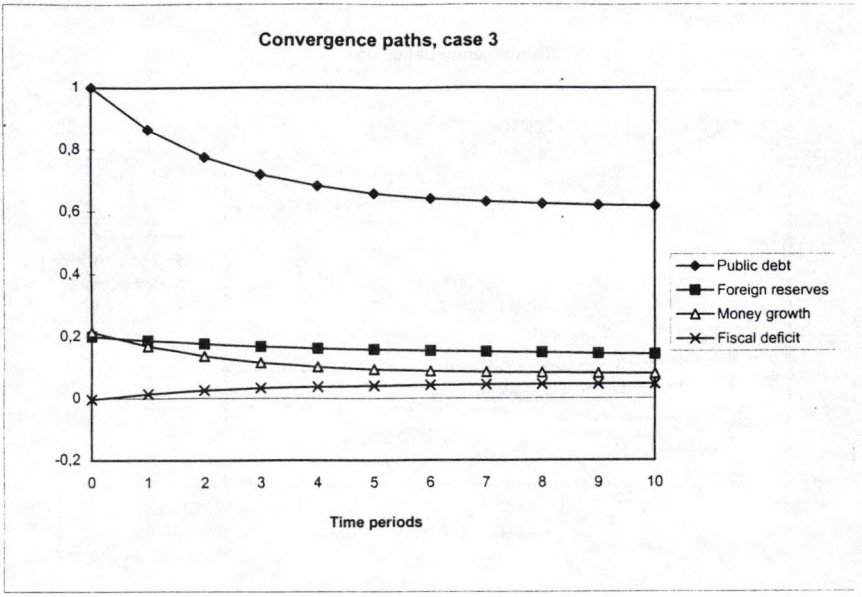
Table n.2: Different Central Bank and Treasury preferences for public debt and reserves variability.

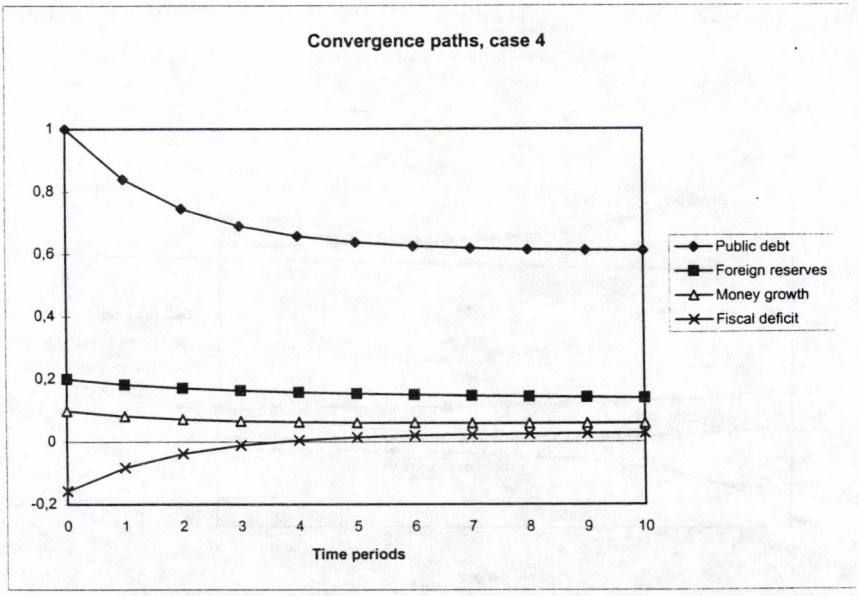
N	12	13	14	15	16
τ_M	.1	.3	.5	.1	.5
ζ_M	.3				
τ_F	.3				
ζ_F	.5				
ρ	.06			1.06	
r	.05				
η_M	1				
η_F	1				
δ	.2				
ψ	-.1				
δ''	.2772				
ψ''	-.1089				
χ	.1				
ε,β	.1				
α	.8				
$\bar{D}$	.6				
$\bar{R}$	.2				
$\bar{m}$	.05				
$\bar{f}$	.05				
D_{10}	.6029	.6012	.6000	.7265	.6537
R_{10}	.1844	.1738	.1700	.1140	.0231
m_0	.0701	.1459	.2108	.0579	.1583
m_{10}	.0117	.0073	.0052	.0322	.0372
f_0	-.1986	-.1615	-.1428	-.0668	-.0447
f_{10}	-.0192	-.0230	-.0248	-.0098	.0026
γ_1	.1298	.3182	.4794	.0686	.3091
γ_2	.4382	.4449	.4617	.0802	.0796
θ_1	-.4682	-.3781	-.3328	-.2277	-.1765
θ_2	.4195	.4722	.5045	.0608	.0780

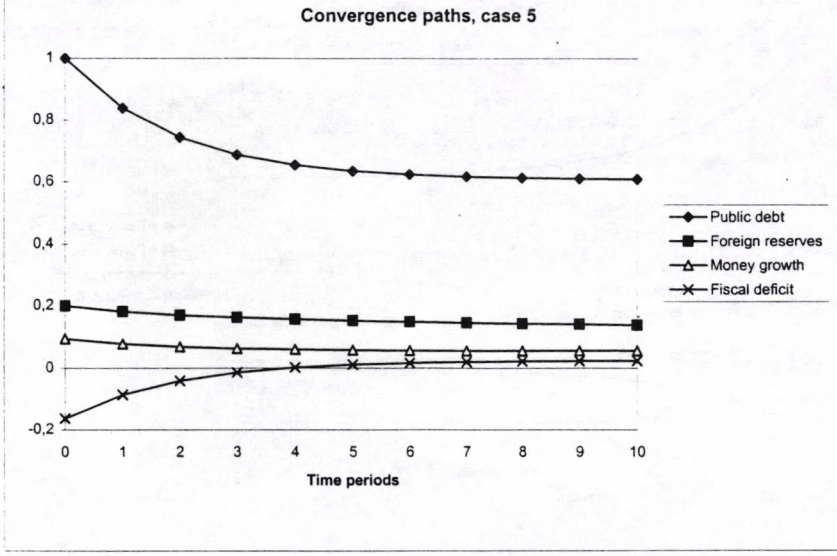
Table n.3: Different Central Bank and Treasury preferences for public debt and reserves variability and different intertemporal discount rate.

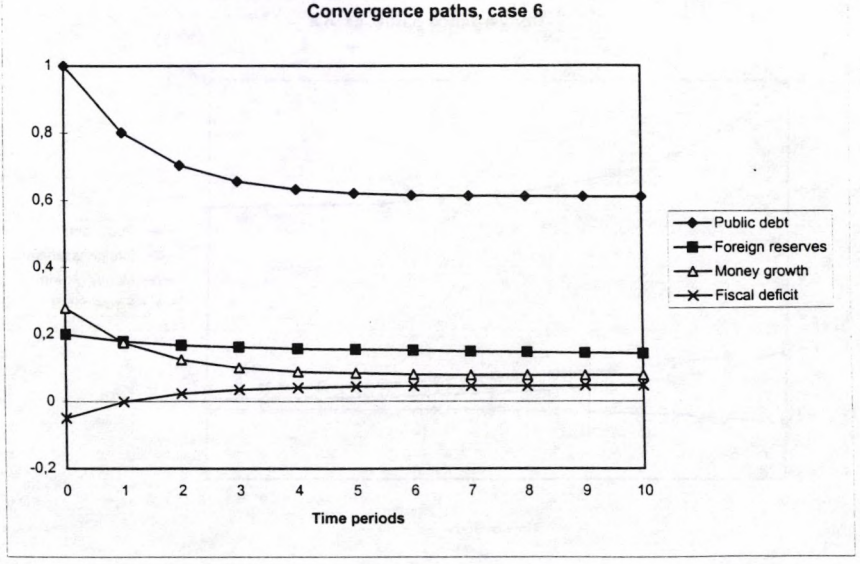


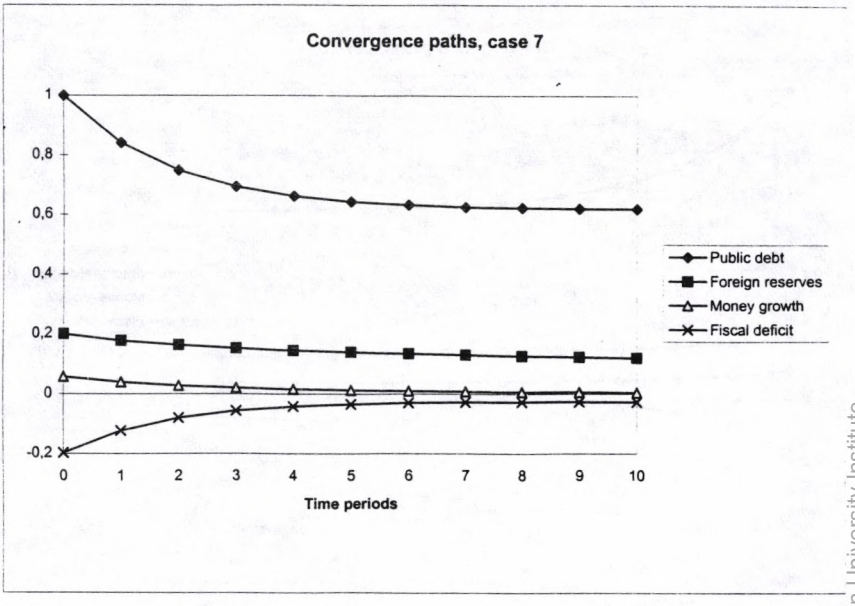


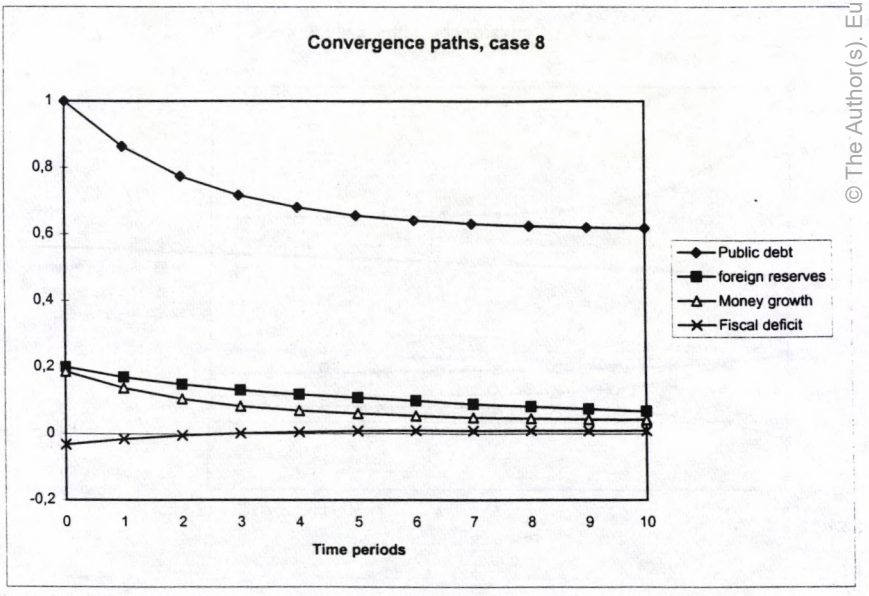


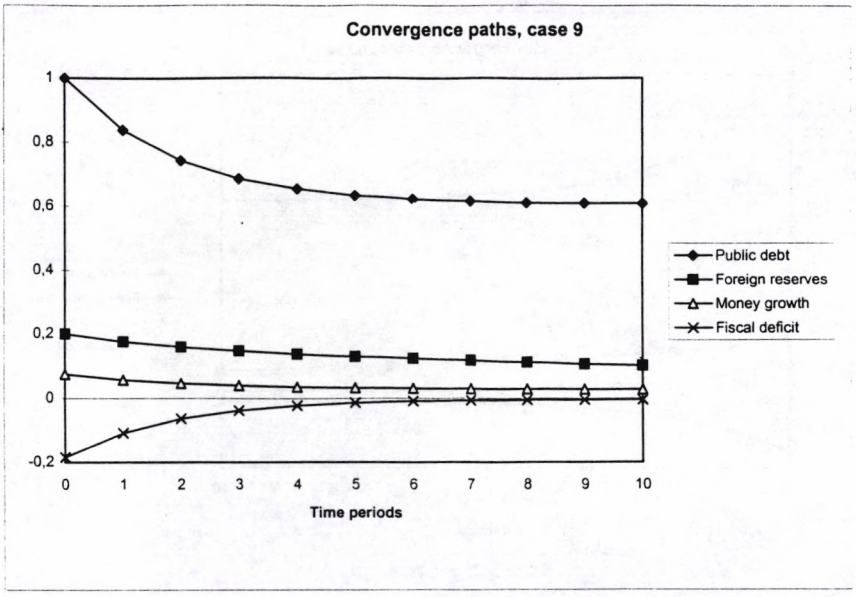


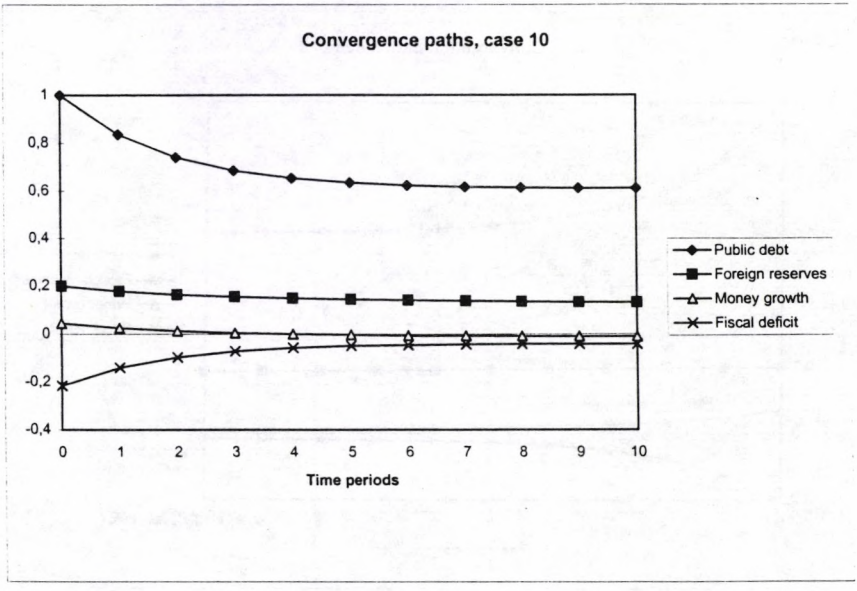


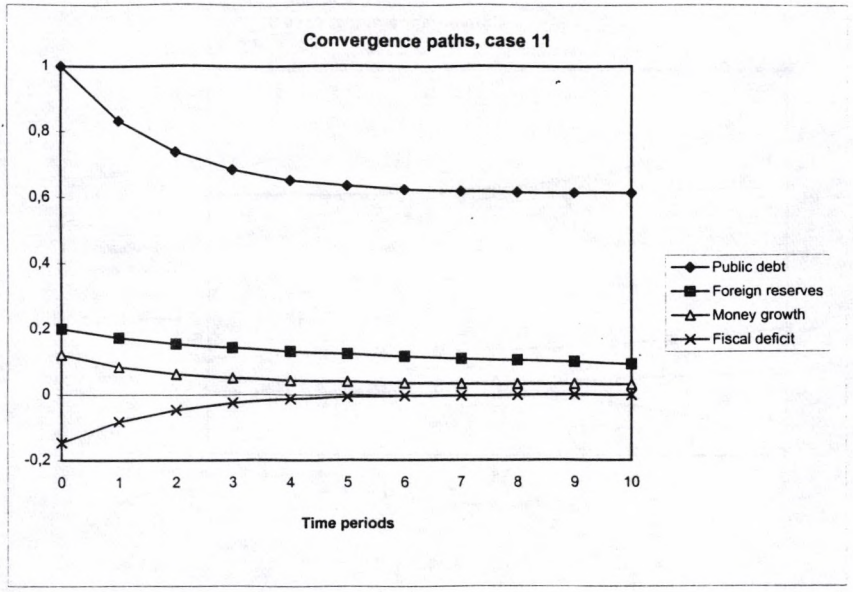


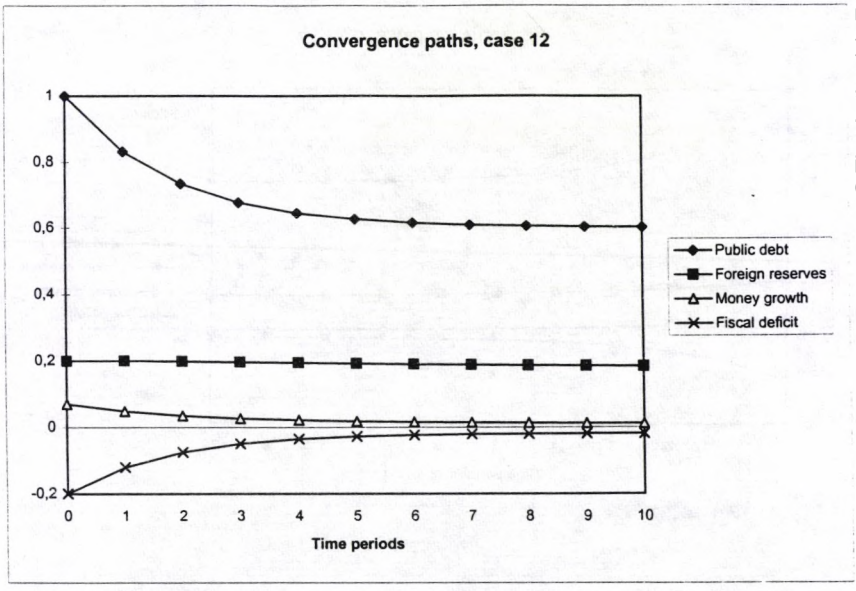


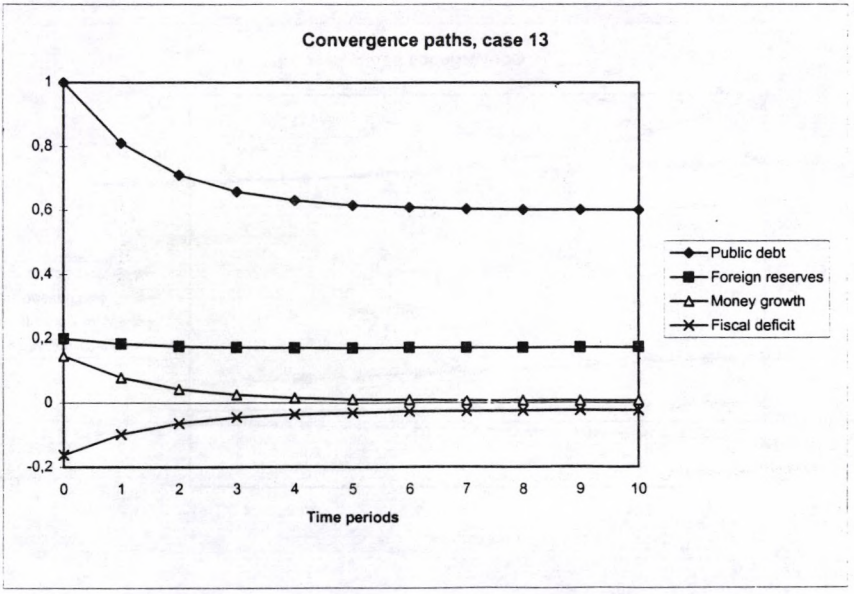


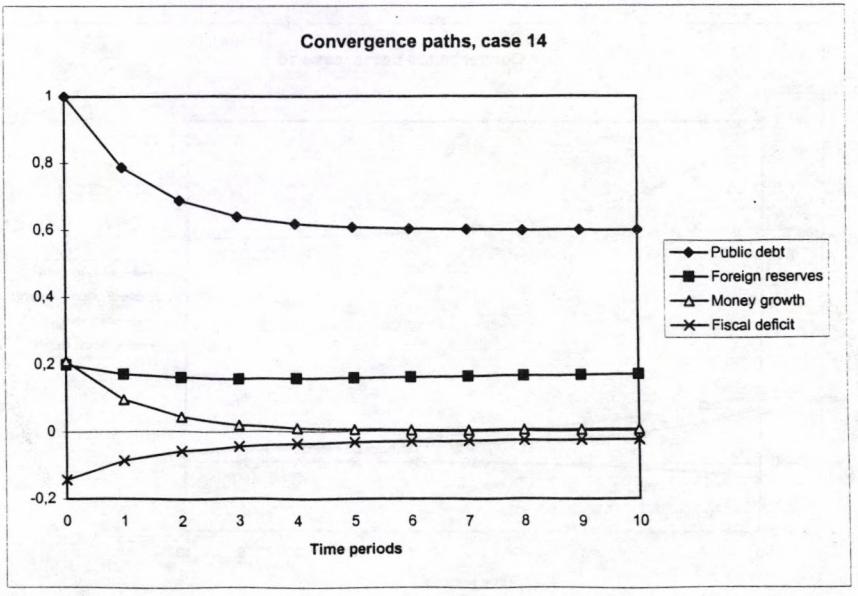


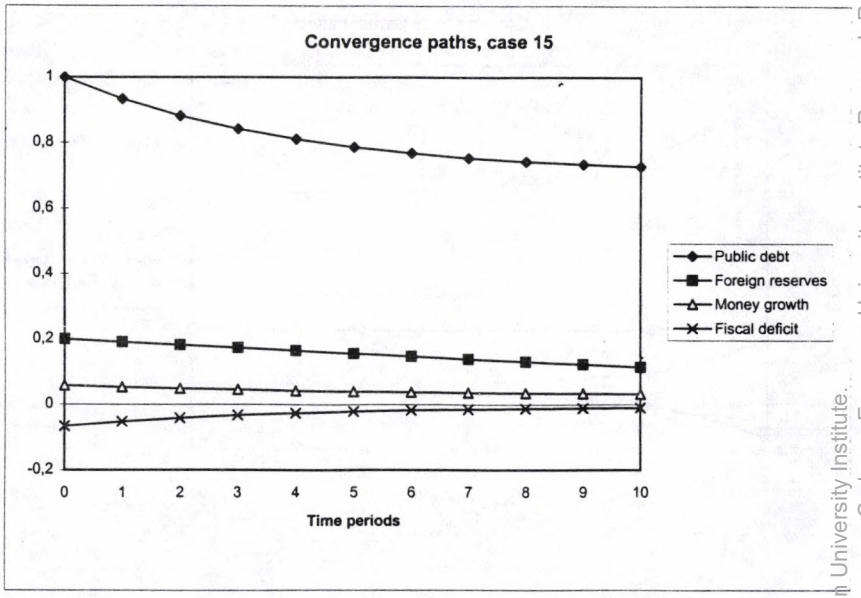


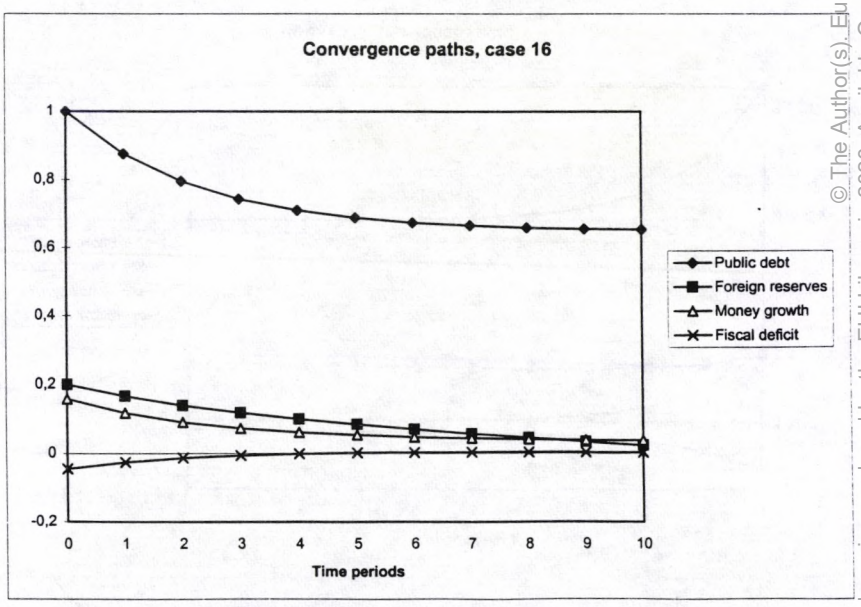












the threat of attacking the currency and therefore depleting the foreign reserves, exercised by the financial markets induces fiscal discipline even in presence of a non independent central bank. This is the situation represented in table 5 of paragraph 3. To better appreciate this point this conclusion can be compared to the case with almost no capital mobility, in which a fiscal expansion attracts foreign capital. It is easy to see that in such a situation, contrary to that just observed for the no "perverse" capital mobiity case) when moving from case 5 (τ_M=.1) to case 6 (τ_M=.5) the change of the fiscal authority's reaction is dramatic (f_0=-.1621 in the former case while f_0=-.0496 in the latter): when the monetary authority cares about public debt variability (i.e. it is willing to monetize the public debt), the fiscal authority reduces dramatically its adjustment effort.

A final interesting case is the one with a much higher intertemporal discount rate (ρ=1.06) (simulations n. 15 and n. 16). In this case both the monetary and the fiscal authority assign a much lower weight to future foreign reserves variations and public debt accumulation so that a less contractionary monetary policy and a less restrictive fiscal policy are obtained as a result of the optimization process. Only in the later stages will the two policymakers realize that the cumulated effects of such relatively more expansionary fiscal and monetary policies have produced a higher reserves and debt variability, so as to induce relatively tighter behaviour. As a result of such low intertemporal responsability the public debt only gets reduced from the initial level of 1 to .7265 at period 10: a substantial public debt convergence is only obtained when the public sector correctly considers the future effects of the current actions.

6. Conclusions

We have considered in this paper how the burden of adjustment might be shared between a monetary and a fiscal authority for example when the adhesion to a fixed exchange rate regime implies the acceptance of public finance rules like those contained in the Maastricht Treaty aimed at the convergence of the public debt to GDP ratio to well defined targets. The debt to GDP ratio could be reduced either through a primary surplus, obtained by cutting expenditure or by raising taxes, or through monetization. Assuming that the Treasury and the Central Bank are two distinct decision bodies, as is the case in many European countries, it is possible to consider the existence of decision rules for each institution with respect to public debt and foreign reserves in which each authority optimizes the variable under its own control by considering the decision rule of the others (Feedback-Nash equilibrium). The optimal fiscal adjustment, the optimal monetary growth and their effect on public debt and foreign reserves then, provide a subgame perfect, therefore time consistent, solution.

Recent work on the subject has suggested the importance of a high degree of independence of the Central Bank in order to increase the probability of success of a stabilization plan. Other contributions, however, stress that no empirical or theoretical result allows us to conclude that a higher degree of monetary independence is sufficient to induce fiscal discipline (the case of Italy, whose debt explosion has taken place after the 1981 monetary reform, is self-explanatory).

In this paper we have put forward a new argument leading to the conclusion that under certain conditions Central Bank independence is not necessary to induce fiscal discipline: if the fiscal authority assigns a high weight to the loss produced by foreign reserves variations and in the absence of "perverse" capital inflows even with a dependent Central Bank, ready to inflate away part of the debt, the fiscal authority will act in a disciplined way to compensate the capital outflow produced by the monetary laxity. The no-realignment condition contained in the Maastricht Treaty might be interpreted precisely as an institutional way to increase the weight assigned by the Treasury to the loss produced by reserves variations.

The move from irrevocably fixed exchange rates to a monetary union where the monetary policy is run by a European Central Bank, might destroy the foreign channel through which fiscal discipline is induced. The need for the independence of the future European Central Bank, therefore, is not questioned given the existence of separate national fiscal authorities each of them having the option to run divergent policies in the absence of any direct foreign constraint.

It should be noted, however, that in the Maastricht Treaty even the presence of an independent European Central Bank is not seen as sufficient to induce a fiscal discipline on the national Treasuries. The imposition of explicit budget rules would not be necessary, otherwise. As a matter of fact, the availability of a larger European financial market together with the credibility offered by a strong European Central Bank, might provide the incentive for running expansionary fiscal policies, in the absence of direct and binding constraints like the one given by the foreign reserve dynamics. Future work should study the likely effects of a credible and strong European Central Bank on the incentives of national Treasuries to run divergent fiscal policies so as to find possible justifications for the imposition of binding fiscal rules on the countries adhering to a monetary union.

References

Austin, G.P. and W.H. Buiter (1982) "Saddlepoint: A Programme for Solving Continuous Time Rational Expectations Models", LSE Discussion Paper

no. 82/132, November.

Bruni, F. and M. Monti (1992) "Autonomia della banca centrale, inflazione e disavanzo pubblico: osservazioni sulla teoria e sul caso italiano", in Il ruolo della banca centrale nella politica economica, Arcelli, M. (a cura di), Il Mulino.

Bruni, F. and F. Giavazzi (1987) "Debito pubblico e politica valutaria - debito pubblico, debito estero e protezionismo valutario" in Debito pubblico e politica economica in Italia, Bruni F. (a cura di), Collana Giorgio Rota - Ricerca n. 1, IPI.

Buiter, W. (1982): "Predetermined and non Predetermined Variables in rational expectations models", Economics Letters, 10, pp. 49-54

Cesar, H. and P. Della Posta (1990) "Calculating Feedback solutions with Mark-2", mimeo.

Dornbusch, R. (1991) "Credibility and Stabilization", The Quarterly Journal of Economics, August, pp.837-850.

Gandolfo, G. and Padoan P.C. (1984) " Inflation and Economic Policy in an Open Economy: some simulations with a Dynamic Macroeconometric Model" in **Basar T., Pau L. F. (eds)** Dynamic modelling and control of National Economies 1983 , Pergamon Press, pp.39-46.

Giavazzi, F. and C. Carraro (1989) "Teoria dei giochi e teoria della politica economica" in La teoria dei giochi e la politica economica, Spaventa, L. (a cura di), Collana della Società Italiana degli Economisti, Il Mulino.

Markink, A.J. and F. van der Ploeg (1989) "Dynamic Policy Simulation of Linear Models with Rational Expectations of Future Events: a Computer Package", Discussion Paper Series CentER no. 8906, Tilburg University.

Miller, M. and M. Salmon (1985) "Policy Coordination and Dynamic Games", in W. Buiter and R. Marston (eds), International Economic Policy Coordination, CUP, Cambridge.

Mourmouras, Iannis A. and Dou-Ming Su (1993) "Central Bank Independence, Policy Reforms and the Credibility of Public Debt Stabilizations", paper presented at the European Economic Association

Conference held in Helsinki, 27-29 August.

Petit, M.L. (1990) Control Theory and Dynamic Games in Economic Policy Analysis, Cambridge University Press.

Petit, M.L. (1990) "Applications of Differential Games", chapter 8 in Control Theory and Dynamic Games in Economic Policy Analysis, Cambridge University Press.

Tabellini, G. (1986) "Money, Debt and Deficits in a Dynamic Game", Journal of Economic Dynamics and Control, no. 10, pp. 427-442, North-Holland.

Tabellini, G. (1987) "Central Bank Reputation and the Monetization of Deficits: the 1981 Italian Monetary Reform", Economic Inquiry, vol. XXV, pp.185-200.

EUI WORKING PAPERS

EUI Working Papers are published and distributed by the
European University Institute, Florence

Copies can be obtained free of charge
– depending on the availability of stocks – from:

The Publications Officer
European University Institute
Badia Fiesolana
I-50016 San Domenico di Fiesole (FI)
Italy

Please use order form overleaf

Publications of the European University Institute

To

The Publications Officer
European University Institute
Badia Fiesolana
I-50016 San Domenico di Fiesole (FI) – Italy
Telefax No: +39/55/4685 636
e-mail: publish@datacomm.iue.it
http://www.iue.it

From

Name .....
Address.....
.....
.....
.....
.....

❒ Please send me a complete list of EUI Working Papers
❒ Please send me a complete list of EUI book publications
❒ Please send me the EUI brochure Academic Year 1998/99

Please send me the following EUI Working Paper(s):

No, Author .....
Title: .....
No, Author .....
Title: .....
No, Author .....
Title: .....
No, Author .....
Title: .....

Date .....

Signature .....

Working Papers of the Department of Economics
Published since 1996

ECO No. 96/1
Ana Rute CARDOSO
Earnings Inequality in Portugal: High and Rising?

ECO No. 96/2
Ana Rute CARDOSO
Workers or Employers: Who is Shaping Wage Inequality?

ECO No. 96/3
David F. HENDRY/Grayham E. MIZON
The Influence of A.W.H. Phillips on Econometrics

ECO No. 96/4
Andrzej BANIAK
The Multimarket Labour-Managed Firm and the Effects of Devaluation

ECO No. 96/5
Luca ANDERLINI/Hamid SABOURIAN
The Evolution of Algorithmic Learning: A Global Stability Result

ECO No. 96/6
James DOW
Arbitrage, Hedging, and Financial Innovation

ECO No. 96/7
Marion KOHLER
Coalitions in International Monetary Policy Games

ECO No. 96/8
John MICKLEWRIGHT/ Gyula NAGY
A Follow-Up Survey of Unemployment Insurance Exhausters in Hungary

ECO No. 96/9
Alastair McAULEY/John MICKLEWRIGHT/Aline COUDOUEL
Transfers and Exchange Between Households in Central Asia

ECO No. 96/10
Christian BELZIL/Xuelin ZHANG
Young Children and the Search Costs of Unemployed Females

ECO No. 96/11
Christian BELZIL
Contiguous Duration Dependence and Nonstationarity in Job Search: Some Reduced-Form Estimates

ECO No. 96/12
Ramon MARIMON
Learning from Learning in Economics

ECO No. 96/13
Luisa ZANFORLIN
Technological Diffusion, Learning and Economic Performance: An Empirical Investigation on an Extended Set of Countries

ECO No. 96/14
Humberto LÓPEZ/Eva ORTEGA/Angel UBIDE
Explaining the Dynamics of Spanish Unemployment

ECO No. 96/15
Spyros VASSILAKIS
Accelerating New Product Development by Overcoming Complexity Constraints

ECO No. 96/16
Andrew LEWIS
On Technological Differences in Oligopolistic Industries

ECO No. 96/17
Christian BELZIL
Employment Reallocation, Wages and the Allocation of Workers Between Expanding and Declining Firms

ECO No. 96/18
Christian BELZIL/Xuelin ZHANG
Unemployment, Search and the Gender Wage Gap: A Structural Model

ECO No. 96/19
Christian BELZIL
The Dynamics of Female Time Allocation upon a First Birth

ECO No. 96/20
Hans-Theo NORMANN
Endogenous Timing in a Duopoly Model with Incomplete Information

*out of print

ECO No. 96/21
Ramon MARIMON/Fabrizio ZILIBOTTI
'Actual' Versus 'Virtual' Employment in Europe: Is Spain Different?

ECO No. 96/22
Chiara MONFARDINI
Estimating Stochastic Volatility Models Through Indirect Inference

ECO No. 96/23
Luisa ZANFORLIN
Technological Diffusion, Learning and Growth: An Empirical Investigation of a Set of Developing Countries

ECO No. 96/24
Luisa ZANFORLIN
Technological Assimilation, Trade Patterns and Growth: An Empirical Investigation of a Set of Developing Countries

ECO No. 96/25
Giampiero M.GALLO/Massimiliano MARCELLINO
In Plato's Cave: Sharpening the Shadows of Monetary Announcements

ECO No. 96/26
Dimitrios SIDERIS
The Wage-Price Spiral in Greece: An Application of the LSE Methodology in Systems of Nonstationary Variables

ECO No. 96/27
Andrei SAVKOV
The Optimal Sequence of Privatization in Transitional Economies

ECO No. 96/28
Jacob LUNDQUIST/Dorte VERNER
Optimal Allocation of Foreign Debt Solved by a Multivariate GARCH Model Applied to Danish Data

ECO No. 96/29
Dorte VERNER
The Brazilian Growth Experience in the Light of Old and New Growth Theories

ECO No. 96/30
Steffen HÖRNIG/Andrea LOFARO/ Louis PHLIPS
How Much to Collude Without Being Detected

ECO No. 96/31
Angel J. UBIDE
The International Transmission of Shocks in an Imperfectly Competitive International Business Cycle Model

ECO No. 96/32
Humberto LOPEZ/Angel J. UBIDE
Demand, Supply, and Animal Spirits

ECO No. 96/33
Andrea LOFARO
On the Efficiency of Bertrand and Cournot Competition with Incomplete Information

ECO No. 96/34
Anindya BANERJEE/David F. HENDRY/Grayham E. MIZON
The Econometric Analysis of Economic Policy

ECO No. 96/35
Christian SCHLUTER
On the Non-Stationarity of German Income Mobility (and Some Observations on Poverty Dynamics)

ECO No. 96/36
Jian-Ming ZHOU
Proposals for Land Consolidation and Expansion in Japan

ECO No. 96/37
Susana GARCIA CERVERO
Skill Differentials in the Long and in the Short Run. A 4-Digit SIC Level U.S. Manufacturing Study

***

ECO No. 97/1
Jonathan SIMON
The Expected Value of Lotto when not all Numbers are Equal

ECO No. 97/2
Bernhard WINKLER
Of Sticks and Carrots: Incentives and the Maastricht Road to EMU

ECO No. 97/3
James DOW/Rohit RAHI
Informed Trading, Investment, and Welfare

*out of print

ECO No. 97/4
Sandrine LABORY
Signalling Aspects of Managers' Incentives

ECO No. 97/5
Humberto LÓPEZ/Eva ORTEGA/Angel UBIDE
Dating and Forecasting the Spanish Business Cycle

ECO No. 97/6
Yadira GONZÁLEZ de LARA
Changes in Information and Optimal Debt Contracts: The Sea Loan

ECO No. 97/7
Sandrine LABORY
Organisational Dimensions of Innovation

ECO No. 97/8
Sandrine LABORY
Firm Structure and Market Structure: A Case Study of the Car Industry

ECO No. 97/9
Elena BARDASI/Chiara MONFARDINI
The Choice of the Working Sector in Italy: A Trivariate Probit Analysis

ECO No. 97/10
Bernhard WINKLER
Coordinating European Monetary Union

ECO No. 97/11
Alessandra PELLONI/Robert WALDMANN
Stability Properties in a Growth Model

ECO No. 97/12
Alessandra PELLONI/Robert WALDMANN
Can Waste Improve Welfare?

ECO No. 97/13
Christian DUSTMANN/Arthur van SOEST
Public and Private Sector Wages of Male Workers in Germany

ECO No. 97/14
Søren JOHANSEN
Mathematical and Statistical Modelling of Cointegration

ECO No. 97/15
Tom ENGSTED/Søren JOHANSEN
Granger's Representation Theorem and Multicointegration

ECO No. 97/16
Søren JOHANSEN/
Ernst SCHAUMBURG
Likelihood Analysis of Seasonal Cointegration

ECO No. 97/17
Maozu LU/Grayham E. MIZON
Mutual Encompassing and Model Equivalence

ECO No. 97/18
Dimitrios SIDERIS
Multilateral Versus Bilateral Testing for Long Run Purchasing Power Parity: A Cointegration Analysis for the Greek Drachma

ECO No. 97/19
Bruno VERSAEVEL
Production and Organizational Capabilities

ECO No. 97/20
Chiara MONFARDINI
An Application of Cox's Non-Nested Test to Trinomial Logit and Probit Models

ECO No. 97/21
James DOW/Rohit RAHI
Should Speculators be Taxed?

ECO No. 97/22
Kitty STEWART
Are Intergovernmental Transfers in Russia Equalizing?

ECO No. 97/23
Paolo VITALE
Speculative Noise Trading and Manipulation in the Foreign Exchange Market

ECO No. 97/24
Günther REHME
Economic Growth, (Re-)Distributive Policies, Capital Mobility and Tax Competition in Open Economies

*out of print

ECO No. 97/25
Susana GARCIA CERVERO
A Historical Approach to American Skill Differentials

ECO No. 97/26
Susana GARCIA CERVERO
Growth, Technology and Inequality: An Industrial Approach

ECO No. 97/27
Bauke VISSER
Organizational Structure and Performance

ECO No. 97/28
Pompeo Della Posta
Central Bank Independence and Public Debt Convergence in an Open Economy Dynamic Game

*out of print