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Nominal Bonds and Budgetary Discipline in a Currency Union

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I. Introduction

The Maastricht treaty has stimulated strong controversies about costs and benefits of a currency union. The policy debate concentrated on the sense resp. nonsense of the fiscal convergence criteria, which create the strongest hurdle for countries willing to join the EMU. These criteria have been motivated by the fear that a currency union will aggravate the risk of a monetary or fiscal bail-out of highly indebted countries (countries with a low stability culture). Behind this fear is the argument that a currency union may give rise to negative effects on budgetary discipline, capital markets being not able to take into account adequately country specific risks. (For a detailled discussion of the criteria, see *Buiter/Corsetti/Roubini* (1993)).

In contrast, the theoretical discussion emphasized that one of the main advantages of a currency union (apart from savings in transaction costs and the elimination of speculative currency risk) is exactly that it would give weak countries the chance to profit from a transfer of reputation (cf. *Ploeg* (1990)). By joining the union, a country lacking credibility due to the problem of dynamic inconsistency could make a credible commitment to a policy of low inflation without having to incur adjustment costs. For countries with high nominal debt, this argument is of special relevance. Those countries are likely to be faced with inefficiently high inflation: capital markets anticipate the government's incentive to reduce the burden of debt via a surprise inflation and thus form high inflationary expectations. Applying the logic of *Giavazzi/Pagano* (1988), *Ploeg* (1990) argues that those countries would profit most by joining a currency union with reputation for stability.

This argument supposes that within a monetary union, an automatic, costless transfer of reputation would be possible. The present paper shows that even under such an assumption, the transfer of reputation

can make sense only if the union is an optimum currency area with respect to shocks on government spending. Even in that case, however, a transfer of reputation can work smoothly only if not only monetary but also budgetary policy is centrally coordinated. The intuition behind these results is the following. In principle, there exists a simple mechanism for establishing a credible commitment in the context of government debt: the indexation of government debt would eliminate any incentive to carry out a surprise inflation. So the consistency problem of nominal debt can be analysed only in a model which makes indexation costly. In the present paper, nominal debt serves as a smoothing device, since moral hazard problem arising from imperfect information about budgetary discipline make state contingent real contracts infeasible. Nominal debt, however, creates a moral hazard problem of its own, namely the incentive for a surprise inflation. Consequently, there is a potential gain out of reputation.

But in a currency union, monetary policy responds to union wide shocks. Thus, the union imposes a loss in flexibility unless it is an optimum currency area, that is, unless the shocks are strongly correlated. In addition, the moral hazard problem with respect to budgetary discipline creates externalities within the union if fiscal policy is not centrally coordinated. Thus, the paper analyses, under which conditions monetary and fiscal policy should be organised centrally or decentralised. *Von Hagen / Süppel* (1994) analyse the impact of federalism on monetary policy in the context of *Barro / Gordon's* natural rate model. They model a public choice problem, which drives a wedge between social welfare and the central bank's governers preferences. In contrast, the problem of dynamic inconsistency considered here arises from the incentive to tax bond holders. Frictions are caused by informational asymmetries. As shown, fiscal and monetary policy should be coordinated on the same level, if moral hazard is affecting budgetary discipline.

In addition to the policy implications, the paper contributes to the theoretical analysis of optimal indexation of debt. *Henning Bohn* (1988) was the first to show that in a stochastic economy, nominal debt can be welfare improving, provided risk markets are not perfect. Nominal debt allows to transfer the burden of adjustment to shocks at least partially to a risk neutral capital market. In case of negative shocks (high government cost), actual inflation will be above expected, thus taxing capital owners, and the other way round in case of positive shocks. Bohn shows that full indexation of government debt is not optimal even when government lacks reputation for not resorting to surprise inflation.

Obviously, this form of risk sharing can work more efficiently in a regime with *reputation*. *Calvo/Guidotti* (1992/1993) argue that even perfect risk sharing could be obtained in a regime with reputation. They suggest that the government could then approximate the first best solution by issuing an infinite amount of nominal debt in exchange against real claims. This argument seems to indicate that lack of reputation is the underlying reason for inefficiency. The present paper shows that this conclusion is false. The reason why in Calvo/Guidotti's model the first best solution can be obtained is that there the frictions underlying the incompleteness of risk markets are not modelled. There, nonexistence of risk markets is simply assumed. As will be shown, even in case of reputation a first best solution cannot be obtained, when the frictions causing the incompleteness of risk markets are taken into account. Then, the optimal level of nominal debt is finite also in the regime with reputation.

The model is based on a simple moral hazard problem. In contrast to the literature, the level of government spending is not taken to be exogenous. The cost for producing public goods can be reduced by incurring effort for budgetary discipline. In addition, however, costs are affected by exogenous shocks. In an economy with perfect information risk neutral capital markets would insure perfectly against exogenous risk. If, however, only total cost for government spending can be observed, capital markets cannot distinguish whether high costs are due to negative shocks or low effort. As an example, without detailled knowledge it is hard to judge whether subsidies paid are an efficient response to bad luck of recipients or are result of loose fiscal discipline.

This asymmetric information creates a moral hazard problem. Now, there is a trade off between optimal incentives for cost efficiency and efficient risk sharing. Therefore, some degree of self insurance is required. The capital market does not provide contracts with state-contingent real interest rates due to high monitoring costs involved in observing the degree of self insurance and the state of nature. Nominal debt serves as a substitute for infeasible real contingent contracts. When monetary policy responds to shocks, the capital market participates in risk sharing. The share of indexed bonds serves as a credible, publicly observable commitment to the degree of self insurance, borne by the government. Again, there is an incentive to renege on the promise of repayment, now via excessive inflation. Actual inflation being costly, nominal contracts impose a self discipline on the government: The incentive to tax capital owners via surprise inflation is limited because high inflation imposes welfare losses itself, thus providing countervailing incentives.

The ex ante optimal policy is not dynamic consistent. But since the monetary policy announced depends on observable variables (and thus cheating can be detected in principle), institutional rules (such as delegation of monetary policy) may be devised, creating an incentive for not yielding the temptation to use a surprise inflation.

II. The basic model

In this section, monetary policy of an independent country is analysed. The model is an extension of the approach used by *Calvo/Guidotti* (1992). Government expenditure (consisting of spending on public goods g and the repayment of government debt $(1+r)\,d_0$) has to be financed with taxes (at the tax rate τ) and seigniorage. Money demand is taken to be interest inelastic, that is $k = M/P \cdot Y > 0$ is constant. Thus, in an economy without growth, seigniorage amounts to $\pi \cdot k$. Both taxation and actual inflation cause welfare losses which are increasing in the resp. rate. As is common in the literature, social welfare is approximated by a quadratic loss function. The government produces a given level g of public goods. Production costs are normalised to g, except for exogenous random shocks ε with $E(\varepsilon) = 0$ and $\mathrm{Var}(\varepsilon) = \sigma^2$. In contrast to standard models, however, government spending can be controlled to some extent by budgetary discipline: Higher effort e increases efficiency for the production of public goods. For a given level of public goods g, an increase in effort e reduces costs. Thus, total cost for producing g are: $g + \varepsilon - e$. That is, total government expenditure amounts to:

$$g + \varepsilon - e + (1+r) \cdot d_0 = Z + \varepsilon - e \geq 0 \quad \text{with} \quad Z = g + (1+r)\,d_0$$

Government chooses effort e for budgetary discipline before knowing the cost shock ε. e should be interpreted as all government activities which increase efficiency of production and thus help to minimize the cost of public projects. To what extent such measures are taken, however, cannot be observed perfectly by the capital market. It is difficult to verify whether costs are high because of negative shocks or low effort e. To simplify, it is assumed that only total cost $g + \varepsilon - e$ can be observed publicly. Take the case of subsidies: they may be paid as an efficient response to bad luck, or they may be a result of lack of fiscal discipline.

For the government, effort for budgetary discipline is costly: Thus, measures to increase cost efficiency cause welfare losses for the society as well (for instance, measures to enforce fiscal discipline are likely to

create some degree of social tensions). Just as the distortions caused by inflation and the tax rate, these costs are again approximated by a quadratic loss function. Then, total social loss is:

$$L = E[e^2 + \pi^2 + \tau^2] \tag{1}$$

The government's objective is to minimise total losses subject to the budget constraint:

$$\tau + k\pi = Z + \varepsilon - e \tag{2}$$

Since high effort imposes social costs, the socially optimal effort level e^* is finite. Let e^* be the effort level which would obtain in the case of perfect insurance and no moral hazard. For that case, the solution is characterised by:

$$e^* = \tau = \frac{1}{2+k^2} Z; \quad \pi = \frac{k}{2+k^2} Z; \quad L = \frac{1}{2+k^2} Z^2 \tag{3}$$

Perfect insurance, however, is not feasible when effort e cannot be observed and so insurance contracts cannot be made contingent on the level of efficiency e. If ε and e cannot be observed separately, an insurance contract can specify payments only as a function of total spending $Z + \varepsilon - e$ resp. of $\varepsilon - e$. Under full insurance, there would be no incentive at all to invest in cost reducing effort e. Once such insurance contracts have been signed, it would always be optimal to choose $e = 0$ and claim that an unexpectedly high spending shock occured. This moral hazard problem creates a trade off between risk insurance and efficient budgetary discipline. The reason is that part of the benefit of budgetary discipline accrues to the insurance market, whereas the cost of effort has to be borne fully by the government. Then, due to moral hazard effort e will be less than socially efficient: $e < e^*$.

As a consequence, perfect risk markets no longer work. If state contingent real contracts are infeasible, the only way to insure against spending shocks is to sell nominal government bonds to risk neutral investors on the capital market. Variation of the actual inflation rate makes the real return of nominal bonds state dependent[1]. Of course, by varying the actual inflation rate, nominal debt, in principle, works in the same way

[1] *Bohn* (1988) analysed the smoothing role of nominal debt in a stochastic economy. He, however, assumed the nonexistence of risk markets without discussing the moral hazard problem of endogenous government spending.

as contingent real debt. Thus, again, there is an incentive to default, now via a policy of high inflation. But since inflation itself imposes welfare losses, a countervailing incentive prevents excessive use of this default device.

The following sections analyse to what extent nominal government bonds may serve as a substitute for insurance markets and characterise deviations from the efficient outcome.

1. Nominal debt: The case of commitment

Nominal bonds make the effective rate of return $r + \pi^e - \pi$ a function of government spending, in an indirect way. When government spending is high, the increase in inflation reduces the investor's rate of return. So, part of the adjustment cost is borne by the capital market, thus smoothing variations in inflation and tax rate. The higher the share of nominal bonds, the more insurance is provided by the capital market.

When buying nominal government bonds, capital investors anticipate that the moral hazard problem becomes more severe the higher the effective insurance rate, that is the higher the share of nominal debt. Thus, inflationary expectations rise with the share of nominal debt (or, more generally, with an increase in maturity of nominal bonds). For a given θ, inflationary expectations are determined such that the average rate of return of nominal government bonds is equal to the real interest rate r, with rational expectations about the level e chosen by the government.

Inflationary expectations give an indirect incentive to reduce government spending. Higher inflationary expectations have to be accommodated by monetary policy. Thus, the higher π^e, the higher the marginal cost of inflation, reducing the benefit of buying more insurance. Effectively, the capital market disciplines the government via inflationary expectations: In order to prevent the welfare losses caused by a rise in π^e, the government abstains from issuing an excessive share of nominal bonds. The publicly observable degree of indexation serves as a credible commitment signalling the degree of self insurance undertaken by the government.

The issue of nominal bonds creates an additional moral hazard problem, namely the problem of dynamic inconsistency. After the realization of the spending shock ε, there is a strong incentive to reduce tax distortions via a surprise inflation, taxation of capital being ex post no longer

distortionary. The dynamic consistent solution is characterized in section 2.2. First, however, we analyse the case that the central bank can commit to not yielding to this temptation. Since the central bank's policy depends on observable variables, deviations from the announced path could, in principle, be punished. Therefore, commitment for not deviating is feasible. That means, the central bank can act as a Stackelberg leader against both the capital market and the tax authorities: the capital market adjusts inflationary expectations to the policy announced by the central bank, and the tax authorities set their tax rate anticipating the rate of inflation set by the central bank[2].

Whereas the central bank can influence inflationary expectations due to its reputation, the government, when deciding about effort e, has no impact on inflationary expectations. e being not observable, there is no way to commit to a specific level of effort. Since deviation cannot be detected, punishment would not be feasible. Consequently, the optimisation problem is a three-step procedure: Initially, the optimal degree of indexation $(1-\theta)$ is chosen in the first step. Then, in the second step, effort e is determined, taking inflationary expectations as given. In the final step, with a given share of nominal debt θ and given effort e, the optimal combination between tax and inflation is determined in a credible way.

The problem has to be solved backwards. In the last stage, for given θ and e, welfare loss is minimized. That is,

$$L = E(\pi^2 + \tau^2) \tag{4}$$

is minimized subject to the constraints

$$\tau + \pi k = Z + \varepsilon - e + (\pi^e - \pi)\,\vartheta\, d_0 \tag{5}$$

$$\pi^e = E\pi \tag{6}$$

This gives the Lagrange-function

$$\text{Min } L = [Z + \varepsilon - e + \pi^e\,\vartheta\, d_0 - (k + \vartheta\, d_0)\,\pi]^2 + \pi^2 + \lambda\,[E\pi - \pi^e] \tag{7}$$

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[2] In case an independent central bank could observe effort e for a budgetary discipline of the fiscal department more precisely than the capital market, there would be an additional advantage out of reputation. In the following, however, it will be assumed that the central bank cannot observe e either.

with the first order conditions

$$-\tau\,[\vartheta d_0 + k] + \pi + \lambda = 0 \tag{8}$$

$$\bar{\tau}\,\vartheta d_0 = \lambda \tag{9}$$

They can be summarized as

$$\tau k + \vartheta d_0\,[\tau - \bar{\tau}] = \pi \tag{10}$$

with average rates: $\bar{\pi} = E\,\pi$ and $\bar{\tau} = E\,\tau$. Taking expected values, one gets:

$$\bar{\tau} = \frac{1}{k}\,\bar{\pi} \tag{11}$$

Inserting 11 in 10 gives the relation

$$\tau - \bar{\tau} = \frac{\pi - \bar{\pi}}{k + \vartheta d_0} \tag{12}$$

Inserting this condition into the budget constraint 5 gives the optimal fluctuation of inflation and tax rate as a function of ε:

$$\pi - \bar{\pi} = \frac{k + \vartheta\,d_0}{1 + (k + \vartheta\,d_0)^2}\,\varepsilon\,;\quad \tau - \bar{\tau} = \frac{1}{1 + (k + \vartheta\,d_0)^2}\,\varepsilon \tag{13}$$

Since the capital market participates in the risk sharing only via variation of the inflation rate, fluctuations of the inflation rate bear a larger share of the burden of adjustment as compared to the tax rate. Effort is determined in stage 2 by minimizing the loss function

$$\text{Min } e^2 + \frac{k^2 + 1}{k^2}\,\bar{\pi}^2 \quad \text{bei} \quad e + \frac{k^2 + 1}{k}\,\bar{\pi} = Z + (\pi^e - \bar{\pi})\,\vartheta\,d_0 \tag{14}$$

Effort decreases with an increasing share of nominal bonds (an increase in θ):

$$e_R = \alpha\,\bar{\tau}_R = \frac{\alpha}{k}\,\bar{\pi}_R \quad \text{with} \quad \alpha = \frac{1 + k^2}{1 + k^2 + k\,\vartheta\,d_0} \tag{15}$$

Effort is a proportion α of the tax rate. Only in case of full indexation ($\vartheta = 0$ resp. $\alpha = 1$), there would be no efficiency losses for the choice e.

Average inflation and tax rate are decreasing with the degree of indexation, whereas effort is increasing.

$$(16) \qquad \bar{\pi}_R = \frac{k}{1+k^2+\alpha} Z; \quad \bar{\tau}_R = \frac{1}{1+k^2+\alpha} Z; \quad e_R = \frac{\alpha}{1+k^2+\alpha} Z$$

In the absence of indexation (choosing $\theta = 1$), in principle, the efficient mix between π, τ and e could be realized on average (compare equation 16 with 3), but only at the cost of high overall variability being larger: there is a trade off between efficient incentives and insurance via indexation.

$$(17) \qquad L_R = \frac{1+k^2+\alpha^2}{(1+k^2+\alpha)^2} Z^2 + \sigma_\varepsilon^2 \frac{1}{1+(k+\vartheta d_0)^2} \text{ resp.}$$

$$(18) \qquad L_R = \frac{(1+k(k+\vartheta d_0))^2 + 1 + k^2}{(1+k^2)(2+k(r+\vartheta d_0))^2} Z^2 + \sigma_\varepsilon^2 \frac{1}{1+(k+\vartheta d_0)^2}$$

Total loss depends on two components: First, the loss out of financing average spending $Z = g + (1+r) d_0$ (call this part L_Z). Second, the loss due to the variation in inflation and tax rate (call this part L_σ). Welfare loss increases with increasing g, d_0 and σ^2. An increase in nominal debt θ reduces the welfare loss L_σ since with increasing θ an increasing proportion of the fluctuations is borne by the capital market. On the other hand, higher nominal debt imposes also costs: L_Z increases because of the negative incentives on budgetary discipline. For $\theta \to \infty$ budgetary discipline tends to $e \to 0$.

Calvo/Guidotti (1992) argue that under commitment, the first best solution can be obtained by $\theta \to \infty$. They take government spending as exogenous. The present analysis shows that their result is due to neglecting the reasons for the incompleteness of the capital markets, namely the moral hazard problem with respect to budgetary discipline. With $\theta \to \infty$, the outcome deviates more and more from the efficient mix between the three ways of financing expenditure Z, that is inflation, tax and budgetary discipline.

A change in e cannot affect inflationary expectations directly. Effort is reduced with rising θ since part of an increase in budgetary discipline goes – as an external effect – to the capital investors. In order to prevent cheating about e, the capital market adjusts it's inflationary expectations with a change in θ. Consequently, with increasing θ the cost of average inflation increases. Total loss 17 is minimized by determining the degree of indexation in an optimal way. On the margin, cost and benefit of re-

ducing the share of indexed bonds must be equal. As shown in appendix 1, the optimal degree of nominal debt is positive, but finite: $0 < \theta < \infty$. Even if the central bank has reputation, the moral hazard problem prevents the attainment of a first best solution by issuing nominal debt in exchange for real claims. The comparative static analysis shows, that the share of nominal bonds is increasing with an increase in variance (the marginal benefit of risk sharing increasing), whereas it decreases with an increase in g and d_0.

2. *The dynamic consistent solution without commitment*

In the last section it was assumed that the central bank can guide inflationary expectations in a credible way when deciding about the optimal mix between tax and inflation rate. The solution characterised in the last section, however, is not dynamically consistent. Once inflationary expectations are given, it would be optimal to carry out a surprise inflation. The dynamic consistent solution is obtained when inflationary expectations are taken as given even when deciding about the tax rate. Again, the problem has to be solved as a three stage optimization problem. In the last stage, for given e and θ, welfare losses are minimized:

$$\text{Min } E(\pi^2 + \tau^2) \quad \text{with} \quad k\pi + \tau = Z - e + \varepsilon + (\pi^e - \pi)\vartheta d_0 \tag{19}$$

with the optimal mix:

$$\tau = \frac{1}{k + \vartheta d_0}\,\pi\,; \quad \tau - \bar{\tau} = \frac{1}{k + \vartheta d_0}\,(\pi - \bar{\pi}) \tag{20}$$

Yielding

$$\pi = \bar{\pi} + \frac{k + \vartheta\, d_0}{1 + (k + \vartheta\, d_0)^2}\,\varepsilon\,; \quad \tau = \bar{\tau} + \frac{1}{1 + (k + \vartheta\, d_0)^2}\,\varepsilon \tag{21}$$

Variability of inflation and tax rate correspond to the variability in the commitment solution (compare 21 with equation 13). Average tax rate, however, now is lower and average inflation rate higher as compared to the case of reputation. In the second stage, expected welfare losses are minimized by choosing the optimal mix beetwen e and $\bar{\pi}$:

$$\text{Min } e^2 + \frac{(k + \vartheta d_0)^2 + 1}{(k + \vartheta d_0)^2}\,\bar{\pi}^2 \tag{22}$$

subject to the constraint

$$e = Z + \pi^e \vartheta d_0 - \left(k + \vartheta d_0 + \frac{1}{k + \vartheta d_0}\right) \bar{\pi} \tag{23}$$

This gives as dynamic consistent solution:

$$\bar{\pi}_d = \frac{k + \vartheta d_0}{2 + k (k + \vartheta d_0)} Z \tag{24}$$

$$e_d = \tau_d = \frac{1}{2 + k (k + \vartheta d_0)} Z \tag{25}$$

with a welfare loss

$$L_d = \frac{2 + (k + \vartheta d_0)^2}{(2 + k (k + \vartheta d_0))^2} Z^2 + \frac{1}{1 + (k + \vartheta d_0)^2} \sigma_\varepsilon^2 \tag{26}$$

As shown in appendix 2, for the same degree of indexation, inflation rate is higher and tax rate lower as compared to the case of reputation, whereas effort e is the same. That is:

$$\pi_d > \pi_R ; \quad \tau_d < \tau_R ; \quad e_d = e_R, \; L_d > L_R . \tag{27}$$

Lack of commitment implies larger welfare losses, since the mix between π, τ and e deviates even further from the efficient mix. As derived in appendix 2, part of this loss will be absorbed via a higher degree of indexation (lower θ)[3] and thus, higher effort.

III. Monetary policy and fiscal externalities in a currency union

Comparing equation 26 with 18 shows that a central bank with reputation for stable policy creates welfare gains. Since monetary policy depends on publicly observable variables, cheating can be detected and by designing adequate contracts, commitment may be feasible. But establishing a reputation can be costly. One of the arguments in favour of a currency union is exactly the idea that such a union allows a costless transfer of reputation (cf. *Giavazzi/Pagano* (1988) and *Ploeg* (1990)). In this section, we analyse optimal monetary policy within a union and

[3] In an economy without shocks ($\sigma = 0$) the welfare loss is minimal with complete indexation ($\theta = 0$). In this case, the dynamic consistent solution coincides with the case of commitment.

its implications for fiscal policy. Essentially, we are concerned with a question of mechanism design for federalism: On what level (central coordination or decentralisation) should decisions be taken? In principle, one could think of a huge variety of institutional arrangements. The paper concentrates on the issue, whether a centralized monetary policy requires coordination of fiscal policy as well. The gain of a monetary union is assumed to be a costless transfer of reputation. Consequently, throughout it will be assumed that the union's central bank can credibly commit to not carrying out a surprise inflation. That is, it can influence inflationary expectations on the capital market.

Against this gain, possible losses have to be weighed, which arise due to externalities created within the union. Decentralized fiscal policy creates scope for seigniorage externalities. Since they are consequence of flexible monetary policy, they could be ruled out from the beginning, provided the monetary authority is obliged to follow a fixed rule. In the next section, however, it will be shown, that such a fixed rule would be worse than no union at all, even if that would mean loss of reputation.

Then, the implication of organizing fiscal decisions in different ways will be analysed. There are two issues involved in the design of fiscal policy: (a) tax policy; (b) budgetary discipline (effort e). As in section 2, the problem will be solved in several steps. In section 3.2 it is assumed that budgetary discipline e_i is given for each state. Given e, the optimal mix between tax and inflation rate is analysed under the assumption that tax rates are set on the state level by independent authorities. It is shown that under accommodating monetary policy (tax rates are set first, then the central bank follows) an inefficient Nash equilibrium arises due to seigniorage externalities. In contrast, if the central bank has commitment power against tax authorities (central bank acts first, then tax authorities adjust), an efficient mix between inflation and tax rates can be achieved even though taxes are set on the state level. Since the central bank's policy is oriented by union wide shocks, full gains of reputation can be achieved only if shocks are perfectly correlated among states.

As shown in section 3.2.3, because of the endogenous choice of budgetary discipline, an efficient outcome requires coordination of effort by central authorities. If each state's effort is controlled on the local level, central monetary policy on its own cannot cope with this kind of externality.

We consider the following model: There are two completely symmetric countries 1 and 2, with identical loss functions and the same level of

government debt d_0. The countries differ only in the following sense: country 1 has a central bank with reputation for not using surprise inflation, whereas country 2 does not; furthermore, the country's specific spending shocks ε_1 and ε_2 need not be perfectly correlated. After merging both countries, monetary policy is centralized. The common central bank establishes immediate reputation; it minimizes aggregate welfare losses giving both countries equal weight of one half. This symmetric objective models the best case for transfer of reputation. In a more general approach, the country with established reputation may have stronger bargaining power. Later on, this will be taken into account by allowing the central bank to put more weight on responding to specific shocks of one country.

A social planer minimizes welfare losses according to

$$L = \frac{1}{2} E(\pi^2 + \tau_1^2 + e_1^2) + \frac{1}{2} E(\pi^2 + \tau_2^2 + e_2^2) \tag{28}$$

subject to the following constraints:

$$\begin{aligned} \tau_1 + e_1 + S_1 &= Z + (\pi^e - \pi)\,\theta_1\, d_0 + \varepsilon_1 \\ \tau_2 + e_2 + S_2 &= Z + (\pi^e - \pi)\,\theta_2\, d_0 + \varepsilon_2 \\ \pi &= \frac{1}{2k}(S_1 + S_2);\quad \pi^e = E\pi, \text{ given } e \end{aligned} \tag{29}$$

Depending on the institutional arrangements, inadequate incentives for budgetary discipline may give rise to a variety of fiscal externalities. One way to rule out such externalities from the beginning would be to bind the central bank to a policy of fixed inflation, not reacting to any shocks. It is easy to see that such a policy would be worse than flexible monetary policy of independent countries.

1. A central bank with fixed rule

If the central bank pursues a strict monetary policy with fixed inflation rate, variations of tax rates would have to bear the whole adjustment costs. Under such conditions not only the capital market would not participate in risk sharing, but also smoothing of tax and inflationary rate would be infeasible. It is obvious that such a fixed rule would be inferior to the case of independent monetary policy: It would be worse

than indexation, since indexation at least allows for smoothing of seigniorage. Of course it would give correct incentives for budgetary discipline. A strict policy of $\pi = \bar{\pi}$ for instance, would require adjustment of national tax rates according to

$$\tau_i = \bar{\tau} + \varepsilon_i \tag{30}$$

yielding total welfare loss for country i

$$L_{\pi=\bar{\pi}} = \frac{1}{2+k^2} \; Z^2 + \sigma^2_{\varepsilon_i} \tag{31}$$

The loss exceeds the loss of indexation ($\alpha = 1$, $\theta = 0$) in equation 26, since shocks can no longer be smoothed by variation of the inflation rate. Complete indexation, on the other hand, is inferior relative to partial nominal debt even in case of lack of reputation: As shown in section 2.3, in the presence of shocks it is always optimal to have some nominal debt.

2. *Optimal policy in a union*

The optimal stochastic policy has to be solved as a three stage optimization process as in section 2. It is assumed that the central bank does not pursue a redistribution policy on its own by redistributing seigniorage income according to the realization of national shocks ε_i. That is, whereas the inflation rate may depend on observed shocks, seigniorage income is distributed proportionally to both countries. Initially we will solve for stage 3, taking e_i and e_j as given. Using the symmetry, we consider the case $e_1 = e_2$. Even if the central bank has reputation for not giving in to the temptation for surprise inflation, the outcome in a union with decentraliced fiscal tax authorities depends on the degree of independence of the central bank relative to the national governments.

a) The optimal mix between tax rates and inflation

In this section, we analyse the final stage, once effort for budgetary discipline has been fixed. First it is shown that an accommodating monetary policy creates seigniorage externalities. This is the case, when tax rates are determined on the state level, before the central bank acts. Each state minimizes the loss function

$$\frac{1}{2}\, E\, (\tau_1^2 + \pi^2)$$

$$s.t.\, \tau_1 = Z - e + (\pi^e - \pi)\, \theta_i\, d_0 + \varepsilon_i - S_i \tag{32}$$

$$\pi = \frac{1}{2k}\, (S_1 + S_2);\ \pi^e = E\pi$$

taking S_j as given. If a reduction in the state's tax rate is accommodated by monetary policy, the traditional seigniorage externality arises. Tax rates are inefficiently low relative to seigniorage finance. The symmetric Nash equilibrium is characterized by the first order conditions

$$\theta\, d_0\, (\tau_i - \bar{\tau}_i) + 2\, k\, \tau_i = \pi \quad \text{with} \quad \bar{\tau}_i = \frac{1}{2\, k}\, \bar{\pi} \tag{33}$$

The strict rule in the Maastricht treaty not to finance government spending via central bank credits, can be interpreted as commitment for the central bank to act as a Stackelberg leader, with the state's authorities to follow. In that more interesting case, central bank determines the inflation rate first; seigniorage income is distributed proportional to the states and the state's tax rates are adjusted so as to finance the remaining expenditures. The central bank minimizes the loss function

$$\alpha E\, (\tau_1^2 + \pi^2) + (1 - \alpha)\, E\, (\tau_2^2 + \pi^2) \tag{34}$$

subject to

$$\begin{aligned} &1)\ \tau_1 = Z - e + (\pi^e - \pi)\, \theta\, d_0 - \pi\, k + \varepsilon_1 \\ &2)\ \tau_2 = Z - e + (\pi^e - \pi)\, \theta\, d_0 - \pi\, k + \varepsilon_2 \\ &3)\ \pi^e = E\pi \end{aligned} \tag{35}$$

α measures the relative weight given to fluctuations in state 1 in the central bank's payoff. The higher α, the more responsive is the central bank to shocks in state 1. This allows to take into account different bargaining power of the states, given that state 1 already has established a central bank with reputation. The first order conditions are

$$(\tau - \bar{\tau})\, \theta + \tau\, k = \pi \quad \text{with} \quad \tau = \alpha\, \tau_1 + (1 - \alpha)\, \tau_2 \tag{36}$$

using the symmetry of the model and the fact that $\bar{\tau}_1 = \bar{\tau}_2 = \bar{\tau}$. On average, the optimal mix between tax and inflation rate is:

$$\bar{\tau} = \frac{1}{k}\,\bar{\pi}; \quad \bar{\pi} = \frac{k}{1+k^2}\,[Z-e] \tag{37}$$

Thus, commitment of the central bank can avoid the seigniorage externality discussed above. The response of the central bank to stochastic shocks is guided by the union wide shock parameter η, being a mixture between the state's shocks. Consequently, variations in national tax rates have to smooth out national shocks. The stochastic terms are characterized by the following equations

$$\pi - \bar{\pi} = \frac{\theta\, d_0 + k}{1 + (\theta\, d_0 + k)}\,\eta \quad \text{with} \quad \eta = \alpha\,\varepsilon_1 + (1-\alpha)\,\varepsilon_2$$

$$\tau - \bar{\tau} = \frac{1}{1 + (\theta\, d_0 + k)^2}\,\eta \tag{38}$$

$$\tau - \bar{\tau} = \varepsilon_i - \frac{(\theta\, d_0 + k)^2}{1 + (\theta\, d_0 + k)^2}\,\eta$$

The lower the correlation between the national shock ε_i and the union parameter η, the higher the fluctuations in the tax rate as compared to the case of a national monetary policy with commitment (equation 13). Only with perfect correlation ($\varepsilon_i = \varepsilon_2$), shocks can be smoothed in the same way as a national monetary policy in equation 13.

b) Incentives for budgetary discipline

Up to now, the optimal monetary policy has been analysed taking e_i as given. In fact however, e_i is observable neither by the capital market nor by the central bank. Thus, monetary policy is constrained to be a function of observable variables only, that is: $x_i = Z + \varepsilon_i - e_i$. Having expectations e^e about e_i, the central bank announces a policy

$$\pi\,(x_1,\, x_2) \;=\; \pi\,(\varepsilon_1,\, \varepsilon_2,\, e_1^e,\, e_2^e) \tag{39}$$

After observing x_i, the policy is carried out as announced and seigniorage is distributed proportional to each state. Total seigniorage will be equal to the excess of expenditure over each state's tax income and each state's cost reduction due to budgetary discipline. Since e_i cannot be observed by the central bank, it will distribute to each state

$$\pi k = \frac{1}{2}\left[Z_1 - e_1^e + \theta_1 d_{01}(\pi^e - \pi) + \varepsilon_1 + e_1^e - e_1 - \tau_1\right] + \frac{1}{2}\left[Z_2 - e_2^e + \theta_2 d_{02}(\pi^e - \pi) + \varepsilon_2 + e_2^e - e_2 - \tau_2\right] \tag{40}$$

Using the definition of tax rates according to equation 38, this reduces to

$$\bar{\pi} k = \bar{Z} - \bar{\tau} + (\pi^e - \bar{\pi})\,\bar{\theta}\,\bar{d}_0 - \frac{1}{2} e_1 - \frac{1}{2} e_2 \quad \text{with}$$
$$\bar{Z} = \frac{1}{2} Z_1 + \frac{1}{2} Z_2;\ \bar{\tau} = \frac{1}{2}\bar{\tau}_1 + \frac{1}{2}\bar{\tau}_2;\ \bar{\theta}\,d_0 = \frac{1}{2}\theta_1 d_{01} + \frac{1}{2}\theta_2 d_{02} \tag{41}$$

Given the central bank's expectations about e_i, a reduction in effort will increase average inflation, but only half of the burden is shared by the state i.

The fiscal authorities choose their optimal effort, antizipating the announced policy of the central bank. So monetary policy is a function

$$\pi(\varepsilon_1, \varepsilon_2, e_1, e_2, e_1^e, e_2^e) \tag{42}$$

Of course, since the central bank cannot observe deviations, lack of fiscal discipline cannot be sanctioned effectively. In a rational expectation equilibrium, the optimal effort choosen by the fiscal authorities has to be equal to the expected level: $e_i^e = e_i$. In a rational expectation equilibrium, monetary policy reduces to a function $\pi(\varepsilon_1, \varepsilon_2)$. Again, the optimal choice of e depends on the institutional setting. Incentives for budgetary discipline are analysed a) in a regime with centrally coordinated fiscal policy and b) in a regime with fiscal policy carried out on the state level.

c) Centralized budgetary policy

If fiscal policy is organized on the central level, the central agency is able to control both e_1 and e_2. In that case the central agency will internalise the externalities arising from lack of budgetary discipline. It minimizes the loss function 28 subject to the symmetric budget constraint 40 which hold for each country. Using the optimal mix between inflation and tax rate (equation 37) this gives the first order condition:

$$e_i = \frac{\frac{k^2+1}{k}}{k^2+1+\theta d_0 k} \pi \tag{43}$$

The welfare loss for country i depends on the correlation between this country's and the union wide shocks. It is:

$$L_{K_i} = \frac{(1+k(k+\theta d_0))^2+1+k^2}{(1+k^2)(2+k(r+\theta_0))^2} Z^2 + \sigma_{\varepsilon_i}^2 - 2\frac{(k+\theta d_0)^2}{1+(k+\theta d_0)^2} \sigma_{\varepsilon_i} \sigma_\eta \rho + \frac{(k+\theta d_0)}{[1+(k\theta+d_0)^{22}]} \sigma_\eta^2 \tag{44}$$

with

$$\rho = \frac{\operatorname{cov}(\varepsilon_i, \eta)}{\sigma_{\varepsilon_i} \sigma_\eta} \tag{45}$$

Even if all fiscal externalities are internalised, the loss for each country in a monetary union with reputation may exceed the loss of independent monetary policy without reputation (compare equation 26 with equation 44), unless shocks are strongly correlated. Obviously, countries with existing reputation will loose flexibility (they have to give up an optimal adjustment mechanism) unless the unions monetary policy is biased in favour of smoothing this country's specific shocks. Of course, the more responsive the union policy is to this country's shocks (the higher the weight α in equation 34), the lower the value out of a transfer of reputation to the other country. This shows that the idea of transfer of reputation can justify a currency union only to a very limited extent: Such a transfer is working exactly under conditions of an optimum currency area. Otherwise, the union's monetary policy has to be supplemented by a transfer policy.

In this section, we considered the best case for monetary union: the central fiscal authority can control perfectly budgetary effort of both countries. In reality, of course, there would be also a principal agent problem between central authority and the state level. In the next section, independent budgetary policy of each state is analysed, and the intermediate case (central coordination with agency problems) is discussed.

d) Decentralized budgetary policy

If budgetary discipline is choosen on the national level, each fiscal authority, anticipating the announced monetary policy, is facing the fol-

lowing trade off: on the one hand, fiscal discipline reduces disutility of effort, but on the other hand it increases average inflation and tax rates. Even though the fiscal agency is aware that e_i cannot be observed, it knows that, once x_1 and x_2 have been realized, the central bank is committed to a preannounced policy, which determines the state's tax rates as well. The choice of e_i, however, affects the distribution across x_i and so has an impact the average expenditures within the union. An increase in e_i increases average inflation and tax rate. The central bank forms rational expectations about e_i to avoid misinterpreting a higher realization of x_i as a higher realization of ε_i

$$\hat{\varepsilon}_i = \varepsilon_i + e_i^e - e_i \tag{46}$$

and consequently carry out a policy of higher inflation and taxes. This increase lowers the welfare of country i but part of the increase has to be born by the other country. To some extent, the increase in the inflation rate leads to a loss of capital owners holding bonds of this country, reducing government expenditures. Since this reduction is only partly to the benefit of country i, it reduces effort only by the weight $1/2\ \theta_i d_0$. On the other hand, half of the advantage of the reduced expenditures in country j due to a devaluation of their real value of debt is to the benefit of country i. Using the knowlegde about optimal tax policy after realization of x_1, x_2, country i minimizes its loss function

$$L = e_i^2 + \frac{k^2+1}{k^2}\ \bar{\pi}^2 \tag{47}$$

subject to the effect of e_i's choice on π, determined by:

$$e_i = \frac{1}{2}\left[\bar{Z} + \frac{1+k^2}{k}\bar{\pi} + (\pi^e - \bar{\pi})\,\bar{\theta}\,d_0\right] - e_2 \tag{48}$$

The fiscal agent, apart from taking the central bank's policy as given, takes also budgetary effort of country j as given. The symmetric Nash equilibrium is characterized by:

$$e_i = \frac{1}{2}\left[\frac{\frac{k^2+1}{k}}{1+k^2+\frac{1}{2}\theta_1 d_0 + \frac{1}{2}\theta_2 d_0}\right]\pi \tag{49}$$

The externality arising from the nonobservability of budgetary effort increases both inflation and tax rate relative to budgetary discipline.

The analysis shows that centralized monetary policy runs into troubles when fiscal policy is decentralized. In a completely different set up, analysing social insurance problems, *Persson/Tabellini* (1996), come to a similar conclusion, namely that horizontal economic ordering should be combined with horizontal political control. They state *"when allocating a particular task to a particular level of collective decision making, it is necessary to consider the spill-over effects on incentives in other areas of policy"*.

Of course, centralizing fiscal policy would not help if contrary to what was supposed in the last section, the coordinator is facing informational frictions as well and cannot observe the effort undertaken in each country. If that is the case, subsidiarity would be superior – implying, in this context, that monetary policy should be organized on a state level as well.

But the case for centralization is stronger than just suggested, at least if shocks are correlated. Even if the central agency coordinating fiscal policy is facing informational problems about e_i, it may use information about the correlation of shocks in order to discipline local authorities. With perfect correlations, for instance, by designing an appropriate incentive mechanism, the central agency can force the agent of both states to choose the solution which internalize externalities within the union. Of course the central agency has still a self interest to take advantage out of the informational handicap of the capital market. Thus, with perfect correlation, the optimal solution characterized in equation 18 can be obtained in general. Again, this emphazises the importance of conditions for an optimum currency area.

Appendix

Appendix 1 Optimal choice of indexation

Total loss $L(\vartheta)$ is minimized by choosing the optimal share of nominal bonds θ_R^*. From equation (18) it follows:

$$L(0) = \frac{1}{2+k^2} Z^2 + \frac{1}{1+k^2} \sigma_\varepsilon^2$$

$$L(\infty) = \frac{1}{1+k^2} Z^2$$

$$L(0) < L(\infty), \text{ if } \sigma_\varepsilon^2 < \frac{1}{2+k^2} Z^2$$

We assume that this condition holds, that is fluctuations in government spending are small relative to total government expenditure. Welfare loss changes with θ according to

$$L'(\vartheta) = \frac{2k^2 d_0^2 \vartheta}{(1+k^2)(2+k(k+\vartheta d_0))^3} Z^2 - \frac{2d_0(k+\vartheta d_0)}{(1+(k+\vartheta d_0)^2)^2} \sigma_\varepsilon^2$$

since $L(0) < L(\infty)$ and $L'(0) < 0$ we get: $0 < \theta < \infty$.

The first order condition gives

$$\vartheta d_0 \frac{\left[1+(k+\vartheta d_0)^2\right]^2}{(k+\vartheta d_0)(2+k(k+\vartheta d_0))^2} = \frac{1+k^2}{k^2} \frac{\sigma^2}{Z^2}$$

The left hand side gives a relation $\theta d_0 f(\theta d_0)$.

$$\frac{\delta \vartheta}{\delta \sigma} > 0, \frac{\delta \vartheta}{\delta g} < 0 \text{ and } \frac{\delta \vartheta}{\delta d_0} < 0, \text{ if } f + \vartheta f' > 0 \text{ and } f + d_0 f' > 0.$$

This condition holds, since it is equivalent to the condition

$$x(1+x^2)(2+4x) + 6x^2 \vartheta d_0 > 2\vartheta d_0 + 4xk\vartheta d_0 \text{ with } x = k + \vartheta d_0.$$

Appendix 2 Reputation versus dynamic consistent solution

Comparing inflation and tax rate and budgetary effort for the dynamic consistent solution relative to the case of reputation we get:

$$\pi_R = \frac{k + \frac{k^2}{1+k^2} \vartheta d_0}{2 + k(k + \vartheta d_0)} Z < \pi_d$$

$$\tau_r = \frac{1 + \frac{k}{1+k^2} \vartheta d_0}{2 + k(k + \vartheta d_0)} Z > \tau_d$$

$$e_R = \frac{1}{2 + k^2 + k\vartheta d_0} Z = e_d$$

The optimal share of nominal bonds θ_d^* for the dynamic consistent case is derived by the first order condition, minimizing equation 26, which gives:

$$\vartheta d_0 \frac{\left[1+(k+\vartheta d_0)^2\right]}{(k+\vartheta d_0)(2+k(k+\vartheta d_0))^2} \frac{1}{2} \frac{\sigma^2}{Z^2}$$

Since $\frac{1}{2} < \frac{1+k^2}{k^2}$, we get $\vartheta_d^* < \vartheta_R^*$.

When the central bank has no reputation, the share of nominal bonds is lower.

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Summary

Nominal Bonds and Budgetary Discipline in a Currency Union

The paper analyses monetary policy in a stochastic economy with shocks on government spending. Due to a moral hazard problem (efforts for budgetary discipline being not observable), nominal debt serves as a substitute for risk markets. It is shown that the optimal level of debt is finite even in a regime with reputation. A transfer of reputation in a currency union can work smoothly only under conditions of an optimum currency area (strongly correlated spendings shocks). Even in that case, however, budgetary policy has to be centrally coordinated as well, because otherwise incentives for budgetary discipline will be distorted. (JEL E50, E62, H63)

Zusammenfassung

Nominalverschuldung und Budgetdisziplin in einer Währungsunion

Der Aufsatz zeigt, daß ein Transfer von Reputation im Rahmen einer Währungsunion nur dann Vorteile bringen kann, wenn Bedingungen eines optimalen Währungsraumes (stark korrelierte Ausgabenschocks) vorliegen. Selbst unter solchen Bedingungen ist jedoch eine zentrale Koordinierung der Budgetpolitik erforderlich. Die optimale Geldpolitik wird anhand eines Modells analysiert, in dem Staatsausgaben stochastischen Schocks unterliegen. Angesichts von Moral-Hazard-Problemen fungiert Nominalverschuldung dabei als Substitut für fehlende Risikomärkte. Es wird gezeigt, daß fehlende Koordination in einer Währungsunion die Anreize zur Budgetdisziplin reduziert.

Résumé

Endettement nominal et discipline budgétaire dans une union monétaire

Cet article montre qu'un transfert de crédibilité dans le cadre d'une union monétaire ne peut être bénéfique que s'il existe des conditions d'un espace monétaire optimal (des chocs de dépenses fortement corrélés). Même sous de telles conditions, une coordination centrale de la politique budgétaire est pourtant indispensable. La politique monétaire optimale est analysée à l'aide d'un modèle dans lequel les dépenses publiques sont soumises à des chocs stochastiques. Pour ce qu'il en est des problèmes du risque subjectif, l'endettement nominal joue le rôle de substitut pour les marchés à risque manquants. Il est montré ici qu'un manque de coordination dans une union monétaire réduit les incitations à la discipline budgétaire.