

EFFICIENT FISCAL POLICY RESTRICTIONS IN A CUSTOMS UNION

Very preliminary draft

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Abstract

We study the interactions of monetary and fiscal policies in the context of monetary union. Tensions over fiscal policies has become one of the key issues in the operation in the European Union. We analyze restrictions on public debt in monetary union in which a patient central bank plays a one-shot Stackelberg game against a number of impatient fiscal authorities in a simple environment without uncertainty. The non-cooperative outcome of this game is excessive borrowing relative to the planning optimum. It will drive up inflation target as the central bank attempts to minimize the impact of higher yields on borrowing member nations.

Fiscal borrowing constraints on member nations improve economic coordination by bringing public deficits more in line with household desire levels, in turn reducing the pressure on the central bank to inflate its way to lower real yields. We show, in particular, that there exists fiscal constraints supporting the cooperative allocation as a Stackelberg equilibrium.

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1 Introduction

The early success of the Economic and Monetary Union (EMU) since 1999 is now more than five years and the euro has gained widespread international acceptance. However, tensions over fiscal policies of member nations have cast doubts on the successful operation of EMU. The larger members like Germany and France are unwilling to accept any serious interference with their sovereignty over national fiscal policy and tend to ignore the restrictions imposed by the stability pact. What will be the impacts if Germany and France continue to ignore the fiscal restrictions imposed by the European Stability Pact, 2002? The Dutch government is cautious on the decision by France and Germany to ride roughshod over the euro's stability pact rules on budget deficit. Is the Dutch government correct in insisting that *all* member nations have to adhere these restrictions and constitution for all times? This paper provides efficiency arguments for defining public debt limits in a simple monetary union in which consumption smoothing is not an important consideration for any decision maker.

We envision instead an environment in which the public sector deficits of any member nation causes a *pecuniary externality* for all other members by raising the average costs of loans in the monetary union. This externality is particularly relevant if fiscal authorities are less patient than the representative household or the common central bank. Those fiscal authorities are willing to borrow excessively against their own future income. In this situation, the central bank is forced to raise its target rate of inflation, and distort real economic activity, in an attempt to contain the upward pressure of real interest rates. When the member nations in the monetary union set deficits non-cooperatively, the central bank is forced to choose between low inflation and real yields. If the common central bank decides to have both, as the households would desire, it has to coordinate fiscal policies more efficiently. Fiscal constraints turn out to be a substitute for policy coordination: they limit the national governments to go into excessive debt, control the pecuniary externality from fiscal competition, and provide incentives for the central bank to choose an inflation target that strikes the balance between real economic activity and real costs of capital.

It is worth noting that the argument *against* debt limits is based on the need to smooth consumption against uninsurable idiosyncratic (i.e. country-specific) risks. Member nations may encounter severe adverse outcome on the economies such that they may require excessive

borrowing beyond the agreed limits in the monetary union for a certain periods and repay it with the future income. We assume all agents are risk averse in the paper.

Chari and Kehoe (2002) is the closest literature related to this paper. They study the design of monetary unions and argue that the time inconsistency problem in monetary policy leads to a free-rider problem in the setting of fiscal policies. Our paper shares similar to Chari and Kehoe (2002) in the model setup in which there are non-cooperative fiscal authorities, competitive agents and a benevolent monetary authority that chooses inflation. In their framework, the free-rider problem occurs when the actions of fiscal authorities affect the common inflation rate and therefore the payoffs to individual member nations.

Our research paper is also related to the literature on the interactions of fiscal policy with monetary policy, including Giovannini and Spaventa (1991), Uhlig (2002), Cooper and Kempf (2001), and Dixit and Lambertini (2003). In particular, Cooper and Kempf (2001) and Uhlig (2002) study the fiscal policies in the context of monetary union. They emphasize the potential gain to the common central bank in conducting policy with commitment in the monetary union. Their studies find that a lack of commitment and free-rider problems tend to reduce the social gain in setting up the monetary union. On the other hand, Dixit and Lambertini (2003) emphasize differences in the objectives or preferences between monetary and fiscal authorities. They consider a model that the two authorities have different inflation and output targets in a static framework. Cooper and Kempf (2004) explores the presence of the trade-off and find that there will not be welfare improvement in case of monetary policy only and low correlation of national shocks. Fiscal interventions by member nations, combined with the policy conducted by the central bank provide a commitment on the monetary policy. In equilibrium, such a monetary union will be welfare improving for any correlation of shocks.

There are two key issues here. The first issue is whether there is externality on other member nations in conducting fiscal policy from a particular fiscal authority. External effects like free-rider problems may favor the monetary union to reach some optimal cooperative outcomes that are not feasible in the non-cooperative environment. The second issue is to examine the channels of the externality. In case of Chari and Kehoe, the actions of individual fiscal authorities affect the common inflation rate, and thus affect the payoffs of other nations. On the other hand, our paper focuses on the effect on the borrowing costs. The bor-

rowing of individual fiscal authorities may push up the interest costs for all the member nations in the monetary union. Hence, the externality comes in and affect the payoffs of other nations. Given the external effects, whether in case of driving up the common inflation rate or the costs of borrowing, the noncooperative equilibrium may not be social optimal. We consider simple fiscal constraints with a borrowing limit and find that, by carefully choosing the constraints, the social optimal can be decentralized under the non-cooperative environment.

This paper is organized as follows. Section 2 describes the economic environment, defines non-cooperative equilibria and social optimum. Sections 3 and 4 show that an optimum allocation of resources be achieved as a competitive equilibrium only through the use of fiscal constraints. Conclusions and policy implications are discussed in section 5.

2 Environment

We consider a monetary union with a common independent central bank and $i = 1, \dots, N$ member states/nations with fiscal authorities. Each state or nation has a great deal of independence in setting fiscal policies, subject to mild restrictions. All nations share a central monetary authority which sets a single monetary policy, and a common inflation rate, for all member states of the union. The monetary union tends to impose a certain restrictions on the borrowing from the member states. Chari and Kehoe (2002) suggest that fiscal constraints prevent a free-ride problem from arising in monetary unions of forward-looking agents. In their model, individual fiscal policies affect the common inflation rate and thus indirectly the payoff to other governments. A change in individual fiscal policies alters agents' expectation of future inflation across the member states and thus change all of their current actions.

This section presents a simple model of differences in payoffs to analyze the interactions between fiscal and monetary policies in the context of monetary union. We study an exchange economy that consists of a number of impatient national fiscal authorities, $i = 1 \dots N$, and a patient common central bank. Time extends for two periods denoted as $t = 1, 2$.

a) Fiscal Authority (FA) and Households

Each nation consists of an autarkic household with pre-tax endowment income $w_i = (y_1^i, y_2^i(\pi))$. The index i is used interchangeably to

refer fiscal authority and the agent in each member nation. Endowments are exogenous in the first period, but it is a decreasing function of the inflation rate at the second period.¹ This means that inflation in our simple environment imposes a deadweight loss on real output, i.e.

$$y_2'(\pi) < 0 \text{ and } y_2''(\pi) < 0 \quad \forall i \text{ and } \pi \geq 0$$

For simplicity, we assume the households have a common linear preference with utility function,

$$U^i = c_1^i + \beta c_2^i \quad , \beta > 0$$

Each national fiscal authority (FA) has a payoff with a lower discount factor δ similar to the households

$$V^i = c_1^i + \delta c_2^i \quad , \beta > \delta > 0$$

In other words, fiscal authorities are less patient than individual households. This creates a disagreement over what actions are best for households and for fiscal authorities. We assume each fiscal authority $i = 1, \dots, N$ pays a subsidy to households at $t = 1$, levies a tax τ^i at $t = 2$ which repays the debt with interests in the second period. Fiscal policy is then the vector (b^i, τ^i) . We define $b^{-i} = (b^1, b^2 \dots b^{i-1}, b^{i+1}, \dots, b^N)$ to denote the borrowing of by all nations, other than nation i . Budget constraints for the households are as follows:

$$\begin{aligned} c_1^i &= y_1^i + b^i \\ c_2^i &= y_2^i(\pi) - \tau^i \end{aligned}$$

where $b^i > 0$ indicates borrowing or subsidy by fiscal authority i . Households have no access to any foreign loan market. A key assumption in our model is that nations do not take as given the cost of foreign loans. The cost of borrowing is low if borrowing per nation is at or below a critical value $B(\pi)$ which depends on the common inflation rate, otherwise it is higher for all borrowing in excess of that threshold value. In particular, we write the household after-tax endowment as $\tilde{w}^i = (y_1^i + b^i, y_2^i(\pi) - \tau^i)$ where loan repayment is

¹The first period endowment is assumed to be exogenous for simplicity. It may also be written as a function of an anticipated inflation rate. This will not change the results in our subsequent analysis. In particular, we can always normalize the first period endowment and express the second period endowment as the growth rate of the economy.

$$\begin{aligned}
\tau^i &= R_L B(\pi) + R_H \left(\frac{1}{N} \sum_{i=1}^N b^i - B(\pi) \right) \quad \text{if } \sum_{i=1}^N b^i > NB(\pi) \\
&= R_L b^i \quad \text{if } \sum_{i=1}^N b^i \leq NB(\pi)
\end{aligned} \tag{1}$$

where R_H and $R_L < R_H$ are the thigh and low yields on loans respectively.

We assume the borrowing limit $B(\pi)$ is an increasing, concave function of the inflation rate. Thus, the central bank can use inflation to lower the average real cost of loans to member nations, but inflation matters more at low levels than at high ones.² If the debt at current period is below the borrowing limit $B(\pi)$, the nation will borrow at a lower costs of interest (R_L), otherwise, any amount beyond the limit will be subject to a higher interest cost at R_H . Each fiscal authority chooses only b^i taking as given the interest costs (R_L, R_H) and common inflation rate (π). The free-rider problem considered in Chari and Kehoe (2002) also exists in this setting, as any excessive borrowing from a particular nation will drive up the interest costs to all other member nations, taking the inflation rate given. In particular, it changes the intertemporal marginal rate of substitution and reduces the resources available for consumption in an exchange economy.

b) Central Bank

We assume the common monetary authority has a social welfare function identical to households in the member nations, with a weight assigned on each nation in the monetary union. This means that the central bank chooses the common inflation rate that maximizes the function

$$W(\pi) = \sum_{i=1}^N \lambda^i U^i = \sum_{i=1}^N \lambda^i [c_1^i + \beta c_2^i] \quad \text{with fixed weights } \lambda^i \geq 0$$

We sum up and interpret some technical assumptions on the endowment and the borrowing limits before defining the equilibrium. The

²Here in the paper we assume the borrowing limit depends only on the common inflation rate set by the monetary union. In other words, all nations face the same borrowing limit $B^i(\pi) = B(\pi) \forall i$. The borrowing limit may be better perceived as a ratio of the total output, to be in line with the constraint in case of European Union.

functions $(y_2^i(\pi), B(\pi))$ are monotone in π for any given $\pi \in [0, \bar{\pi}]$. In particular,

- inflation distorts real output, i.e., $y_2^i(\pi)$ is decreasing and concave in π for all $\pi \geq 0$.
- inflation reduces the cost of borrowing by raising the borrowing limit, i.e. $B(\pi)$ is increasing and concave in π for all $\pi \in [0, \bar{\pi}]$.
- negative inflation is not distortive on real output, and any inflation higher than $\bar{\pi}$ does not affect the cost of borrowing

$$y_2'(0) = B'(\bar{\pi}) = 0$$

- there are two levels of yields on loans (R_H, R_L) such that the households face a lower yield R_L if the borrowing is within the limit $B(\pi)$, otherwise, any excess amount beyond the limit will be charged with a higher yield R_H . We assume the following

$$R_H > 1/\beta > R_L > 1/\delta$$

This condition implies that each fiscal authority cares only about current consumption and borrows against all future income. The households in each nation will do the same if the borrowing limit is sufficiently large such that they face a lower yield on their loans. On the other hand, if they face a tight borrowing limit, they will choose at the kink on the budget line. In that case, household will consume in both periods.

Figure 1 illustrates the last assumption in the two cases defined by $y_2(\pi) - R_L B(\pi) \leq 0$, and $y_2(\pi) - R_L B(\pi) > 0$. Given (π, R_L, R_H) , the fiscal authority and the household choose the same consumption vector in the former case, but different in the latter case.

Figure 1a. Slack credit market $y_2(\pi) - R_L B(\pi) \leq 0$

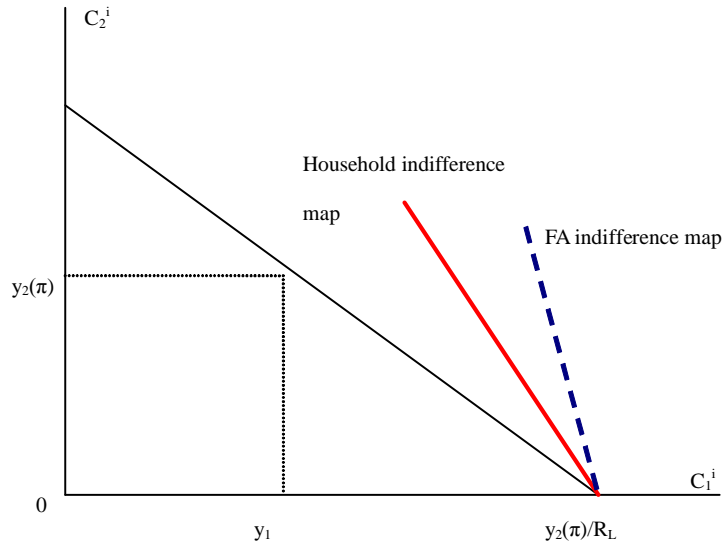
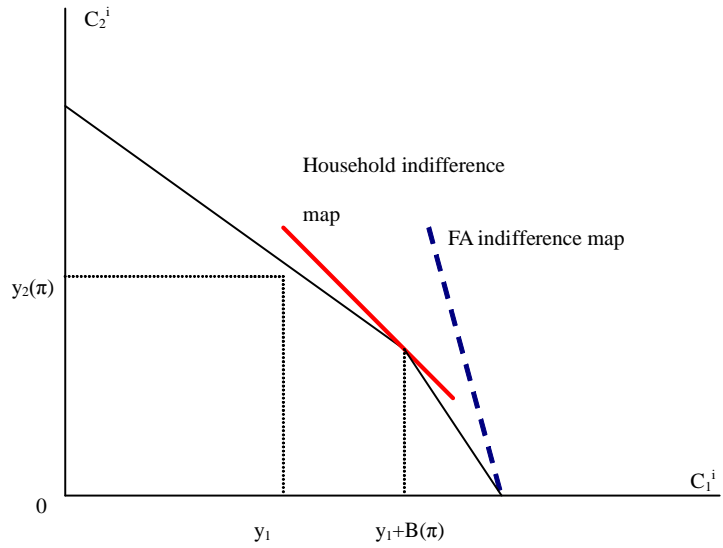


Figure 1b. Tight credit market: $y_2(\pi) - R_L B(\pi) > 0$



3 Social Optimum and Equilibria

We define equilibria and optimum for the policy vectors (b^1, \dots, b^N, π) . First, we consider a non-cooperative equilibrium of the Stackelberg type

with the central bank leading. The fiscal authorities in each nation choose the amount borrowed at the given inflation rate, while the common central bank chooses the inflation rate given the best response of fiscal authorities to the common inflation rate.

Definition 1 *An unconstrained Nash equilibrium is a vector $(b^1, \dots, b^N, \tau^1, \dots, \tau^N, \pi)$ with the following properties:*

- i. each fiscal authority (FA) chooses (b^i, τ^i) to maximize $V^i = y_1^i + b^i + \delta(y_2^i - \tau^i)$ subject to the budget constraint (1), and to $y_1^i + b^i \geq 0$, $y_2^i(\pi) - \tau^i \geq 0$ for a given (b^{-i}, τ^{-i}, π)*
- ii. the central bank chooses a common inflation rate π to maximize the social welfare function $W(\pi) = \sum_{i=1}^N \lambda^i U^i = \sum_{i=1}^N \lambda^i [y_1^i + b^i + \beta(y_2^i(\pi) - \tau^i)]$ subject to $y_1^i + b^i \geq 0$, $y_2^i(\pi) - \tau^i \geq 0$ for given (b^1, \dots, b^N) and (τ^1, \dots, τ^N) .*
- iii. the goods market clears at every period, i.e. $c_1^i = y_1^i + b^i$ and $c_2^i = y_2^i(\pi) - \tau^i$*

In case of fiscally constrained Nash equilibrium, there is an additional constraint on fiscal authorities

- iv. $b^i \leq X^i \forall i$, where X^i is exogenously fixed.*

We may derive the best response function for each fiscal authority and the central bank respectively. Given the assumption on time preference, it is clear that the fiscal authority will borrow against all future income $y_2^i(\pi) = \tau^i \forall i$, regardless of the inflation rate chosen by the central bank. So, the best response function for each fiscal authority is to choose $b^i = y_2^i(\pi)/R$ where R is defined according to equation (1). In this sense, the social welfare function of the central bank is reduced to $W(\pi) = \sum_{i=1}^N \lambda^i [y_1^i + b^i]$, which is not a function of inflation rate π . This means that the central bank has no power of optimization with its inflation instrument, and the best response function for the central bank is not well-defined. The unconstrained Nash equilibrium consists of a policy vector (b^1, \dots, b^N, π) such that each fiscal authority borrows against all its own future income but the inflation rate is not well defined.

Definition 2 *An unconstrained Stackelberg equilibrium with the monetary authority moving first consists of a policy vector $(b^1, \dots, b^N, \tau^1, \dots, \tau^N, \pi)$ with the following properties:*

- i. each fiscal authority (FA) chooses (b^i, τ^i) to maximize $V^i = y_1^i + b^i + \delta(y_2^i - \tau^i)$ subject to the budget constraint (1), $y_1^i + b^i \geq 0$, $y_2^i(\pi) - \tau^i \geq 0$ for a given (b^{-i}, τ^{-i}, π)*
- ii. the central bank chooses a common inflation rate π to maximize the social welfare function $W(\pi) = \sum_{i=1}^N \lambda^i U^i = \sum_{i=1}^N \lambda^i [y_1^i + b^i + \beta(y_2^i(\pi) - \tau^i)]$*

subject to $y_1^i + b^i \geq 0$, $y_2^i(\pi) - \tau^i \geq 0$ and taking as given the best response (b^i, τ^i) of each fiscal authority to the inflation choice π .

iii. the goods market clears at every period, i.e. $c_1^i = y_1^i + b^i$ and $c_2^i = y_2^i(\pi) - \tau^i$

In case of fiscally constrained Stackelberg equilibrium, there is an additional constraint

iv. $b^i \leq X^i \forall i$, where X^i is exogenously fixed.

The case of Stackelberg equilibrium is different from Nash equilibrium. The best response of the central bank on the strategies from fiscal authorities is well defined. The inflation rate chosen (π^S) maximizes the social welfare function taking fiscal responses as given. That means

$$\pi^S \in \arg \max_{\pi} \sum_{i=1}^N \lambda^i [y_1^i + b^i + \beta(y_2^i(\pi) - \tau^i)]$$

(b^i, τ^i) are best response of fiscal authority i to π , X_i and all other policies (b^{-i}, τ^{-i}) . In addition, we define consider the cooperative social optimum among all fiscal authorities and the central bank.

Definition 3 *An optimum allocation is a cooperative choice of the policy vector $(b^1, \dots, b^N, \tau^1, \dots, \tau^N, \pi)$ that maximizes the social welfare function $W(\pi) = \sum_{i=1}^N \lambda^i U^i = \sum_{i=1}^N \lambda^i [y_1^i + b^i + \beta(y_2^i(\pi) - \tau^i)]$ subject to the budget constraint (1), $y_1^i + b^i \geq 0$, and $y_2^i(\pi) - \tau^i \geq 0$ for all member nations.*

Note that in the optimal allocation, the weighted household utility in the monetary union is maximized given the cooperative choice of the policy vector $(b^1, \dots, b^N, \tau^1, \dots, \tau^N, \pi)$. However, this is generally unachievable in a non-cooperative equilibrium because fiscal authorities have a different rate of discount factor for future consumption. This creates a divergence between the goals of fiscal authorities and the one of the central bank. Since the central bank shares the same utility function as the households, the social optimal allocation is the outcome chosen by the central bank if it was in charge of all policies, including both fiscal and monetary sides

Without much loss of generality, we restrict the analysis on symmetric equilibria, in which the households and fiscal authorities are the

same across nations. Each one has the same endowment process, time preference and therefore chooses the same amount borrowed from the international credit market, i.e. $b^i = b$. Furthermore, we analyze "equal-treatment" optima where each country has the same weight $\lambda^i = \lambda$ in the social welfare function. The notation i indicating each nation is dropped from the variables in the equal-treatment optimal allocation. From definition 2, the policy vector in a symmetric equal-treatment optimum consists of (b, τ, π) that maximizes

$$\begin{aligned} W(b, \pi) &= y_1 + b + \beta [y_2(\pi) - \tau] \\ \text{subject to } b &\geq -y_1 \quad ; \quad \tau \leq y_2(\pi) \\ \tau &= R_L b && \text{if } b \leq B(\pi) \\ &= R_L B(\pi) + R_H(b - B(\pi)) && \text{if } b > B(\pi) \end{aligned}$$

It is easy to see from Figure 1b that the optimal consumption puts the household at the kink in its budget set, that is,

$$\begin{aligned} c_1 &= y_1 + B(\pi) \\ c_2 &= y_2 - R_L B(\pi) \end{aligned}$$

Therefore, the optimal choice for inflation rate is

$$\begin{aligned} \pi^* &\in \arg \max W^*(\pi) \\ \text{where } W^*(\pi) &\equiv y_1 + \beta y_2(\pi) + (1 - \beta R_L)B(\pi) \end{aligned} \quad (2)$$

Note that the first term $y_2(\pi)$ in $W^*(\pi)$ is decreasing in π , while the second term $B(\pi)$ is increasing in π from above. By the technical assumptions listed earlier, we also know that $W^*(\pi)$ is a concave function with a positive derivative at inflation rate $\pi = 0$ and a negative derivative at $\pi = \bar{\pi}$. Hence, there exists a unique $\pi^* \in (0, \bar{\pi})$ that maximizes $W(\pi)$. That π^* is the optimum rate of inflation. An optimum puts the consumers at the kink of the budget set defined for $\pi = \pi^*$. At the kink we have

$$(b^*, \pi^*, R^*) = (B(\pi^*), \pi^*, R_L) \quad (3)$$

The key question is that if the social optimal allocation is achievable in a decentralized setting. A quick comparison indicates that the optimal

allocation (b^*, π^*, R^*) is different from the Nash equilibrium in definition 1 simply because $R = R_H$ at any Nash equilibrium. In the following section, we will examine if the fiscal constraint at Stackelberg equilibrium helps to achieve the optimal allocation.

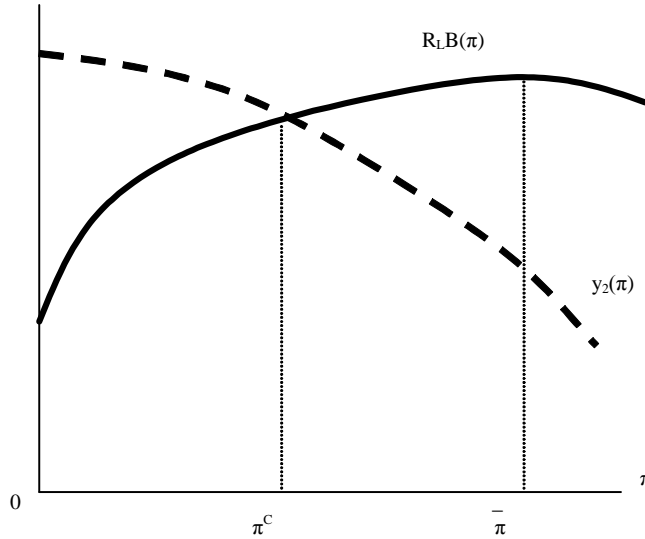
4 Equilibrium without Fiscal Constraints

a) *The credit market is not tight*

Suppose first that $y_2(\pi) \leq R_L B(\pi)$, or equivalently that $\pi \in [\pi^C, \bar{\pi}]$ where $y_2(\pi^C) = R_L B(\pi^C)$ as shown in Figure 3 below. In this case, the amount borrowed is less than the present value of future income and the fiscal authority can borrow at the low interest yield. The credit market is slack with a sufficiently large borrowing limit $B(\pi)$. As shown in Figure 1a, the budget set at any symmetric equilibrium do not have a *kink* and therefore we can state the amount borrowed in a simple form:

$$b = y_2(\pi)/R_L < B(\pi) \quad (4)$$

Figure 3. Critical inflation rates



From the diagram, it is clear that the best response of the fiscal authority coincides with the household choice in the Stackelberg equilibrium. At the low interest yield R_L , both the household and the fiscal authority will borrow against all the future income $y_2(\pi)$ and consume

at the current period. Equation 4 indicates that the consumption choices are

$$c_1 = y_1 + y_2(\pi)/R_L \quad ; \quad c_2 = 0$$

The result is based on our linear utility for both household and fiscal authority, and the assumption that $1/\beta > R_L > 1/\delta$. The household wants to borrow as much as possible at the low interest yield, while the fiscal authority always wants to borrow against all future income regardless of the interest yield. We can also derive the payoffs to the symmetric fiscal authority and the central bank respectively as follows:

$$\begin{aligned} FA : \quad V(\pi) &= c_1^i + \delta c_2^i \\ &= y_1 + y_2(\pi)/R_L \\ MA : \quad W(\pi) &= \sum_{i=1}^N \lambda^i [c_1^i + \beta c_2^i] \\ &= y_1 + y_2(\pi)/R_L \\ &\leq y_1 + B(\pi) \quad \text{for } \pi \in [\pi^C, \bar{\pi}] \end{aligned} \tag{5}$$

The central bank achieves maximal payoff at the lowest feasible value of π in the interval $[\pi^C, \bar{\pi}]$, i.e. at $\pi = \pi^C$.

b) The credit market is tight

Suppose next that inflation rate $\pi \in [0, \pi^C)$ is sufficiently low to have $y_2(\pi) - R_L B(\pi) > 0$. In this scenario, the budget set has a interior kink at $B(\pi)$ and the credit market is relatively tight with a borrowing cost higher than R_L . Figure 1 shows that there is a divergence between the choice of the households and the fiscal authorities in this case. In a symmetric equilibrium, the fiscal authority (FA) always wants to borrow as much as possible against all future income. Its best response is to have zero future consumption regardless of the interest yield, because $R_H > R_L > 1/\delta$. We work out the best response on the amount borrowed from the international credit market

$$b = \frac{y_2(\pi) + (R_H - R_L)B(\pi)}{R_H}$$

which implies the consumption vector

$$c_1 = y_1 + \frac{y_2(\pi) + (R_H - R_L)B(\pi)}{R_H} \quad ; \quad c_2 = 0$$

On the other hand, the household's optimal choice is always at the kink position given $R_H > 1/\beta > R_L$. The household wants to borrow up to the limit $B(\pi)$ at the low interest yield R_L . The payoff to the household in the symmetric Stackelberg equilibrium is identical to the central bank, that is,

$$\begin{aligned} W(\pi) &= \sum_{i=1}^N \lambda^i [c_1^i + \beta c_2^i] \\ &= y_1 + \frac{y_2(\pi) + (R_H - R_L)B(\pi)}{R_H} \end{aligned} \quad (6)$$

We obtain different payoffs to the central bank at the social optimal (equation 2), at the slack credit market (equation 5), and at the tight credit market (equation 6). The three different payoffs to the central bank allows us to compare the alternative allocations and measure the deviation of the decentralized scenario from the social optimal. We can write them as follows:

The social optimal when the planner chooses the amount borrowed b is:

$$W^*(\pi) \equiv y_1 + \beta y_2(\pi) + (1 - \beta R_L)B(\pi)$$

The Stackelberg equilibrium with the fiscal authority choosing b in a slack credit market:

$$W(\pi) = y_1 + y_2(\pi)/R_L \quad \text{if } \pi \geq \pi^C$$

The Stackelberg equilibrium with the fiscal authority choosing b in a tight credit market:

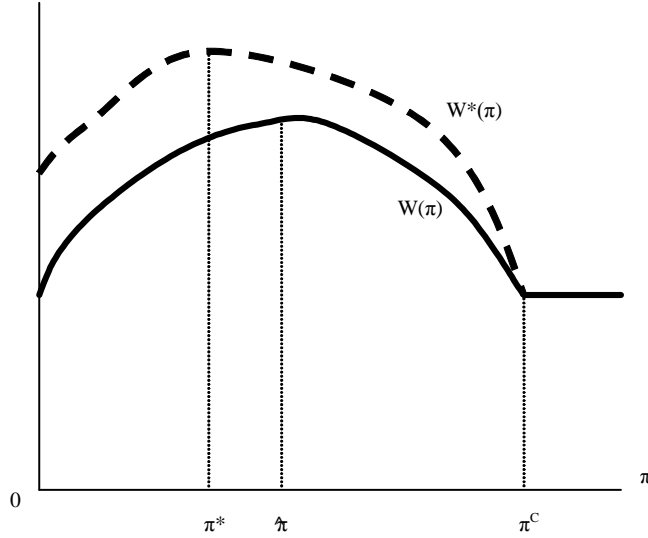
$$W(\pi) = y_1 + \frac{y_2(\pi) + (R_H - R_L)B(\pi)}{R_H} \quad \text{if } 0 < \pi < \pi^C$$

The deviation of the central bank's payoff from the socially optimal allocation can be obtained by

$$\begin{aligned}
W^*(\pi) - W(\pi) &= (1 - \beta R_L) \left[B(\pi) - \frac{y_2(\pi)}{R_L} \right] \quad \text{if } \pi \in [\pi^C, \bar{\pi}] \\
&= \left(\beta - \frac{1}{R_H} \right) [y_2(\pi) - R_L B(\pi)] \quad \text{if } \pi \in [0, \pi^C)
\end{aligned}$$

From these expressions, we can easily prove that $W^*(\pi) - W(\pi) > 0$ for all inflation rates $\pi \in [0, \bar{\pi}]$. We arrive at different inflation choices and payoffs to the central bank in the unconstrained symmetric Stackelberg equilibrium compared to the equal-treatment optimum. Figure 4 presents the social welfare function along different inflation rates. The optimal inflation rate π^* is lower than the symmetric Stackelberg equilibrium at $\hat{\pi}$. The two functions coincide after the critical inflation rate π^C as the fiscal authorities and the households choose the same outcomes at inflation rates beyond π^C . Therefore, we have the following proposition:

Figure 4. Social welfare functions



Proposition 1. The optimal equal-treatment inflation rate π^* is lower than the unconstrained symmetric Stackelberg equilibrium $\hat{\pi}$.

Proof. We prove by contradiction:

Let $\pi^* > \hat{\pi}$, then by previous assumption, it follows that $B'(\pi^*) < B'(\hat{\pi})$ as $B(\cdot)$ is a concave increasing function in inflation. Then, using the first-order condition, we have

$$\begin{aligned} y_2'(\pi) + (1/\beta - R_L)B'(\pi^*) &= 0 \\ y_2'(\hat{\pi}) + (1/\beta - R_L)B'(\hat{\pi}) &= 0 \end{aligned}$$

and conclude that $y_2'(\hat{\pi}) < y_2'(\pi^*)$. This in turn implies $\hat{\pi} > \pi^*$ which is a contradiction to the above. QED ■

Next we describe the policy vector and the interest yield that support the two important allocations. First, at the equal-treatment optimum we have:

$$\begin{aligned} \pi^* &\in \arg \max_{\pi} W^*(\pi) \\ R^* &= R_L \\ b^* &= B(\pi^*) \\ c_1^* &= y_1 + B(\pi^*) \\ c_2^* &= y_2(\pi^*) - R_L B(\pi^*) \end{aligned}$$

Next, the unconstrained symmetric Stackelberg equilibrium satisfies:

$$\begin{aligned} \hat{\pi} &\in \arg \max_{\pi} W(\pi) \\ \hat{R} &= R_H \\ \hat{b} &= \frac{y_2(\hat{\pi}) + (R_H - R_L) B(\hat{\pi})}{R_H} \\ \hat{c}_1 &= y_1 + \hat{b} \\ \hat{c}_2 &= 0 \end{aligned}$$

5 Equilibrium with Fiscal Constraints

We have seen from the above section that the social optimum and the unconstrained Stackelberg equilibrium are different in terms of inflation targets (π^* vs $\hat{\pi}$), interest yield (R_L vs R_H), and consumption allocations. In particular, if the fiscal authorities and the central bank do not cooperate, the difference in objectives will cause deviations from the social optimum. This paper considers the case where the fiscal authorities are less patient than the central bank as an illustrative example. Additional discrepancies may occur if disagreements exist on the value

of public goods, or the value of commitment. Then, a natural question is whether the monetary union can adopt policies that can move the Stackelberg equilibrium closer to the social optimum. The example illustrated above indicates the fiscal authorities tend to undertake borrowing against future income. In the extreme case, the fiscal authorities borrow against all future income to increase current consumption. This section examines if some fiscal constraints imposed by the constitutional mans help to move the decentralized economy to the social optimum. By carefully choosing borrowing constraints, a monetary union may be able to achieve social optimum as a decentralized Stackelberg equilibrium.

It is straightforward to see this in our symmetric setting. The cooperative outcome is achieved at a borrowing limit $X^i(\pi) = B(\pi)$. Then, the best response for each fiscal authority is to borrow up to the limit $B(\pi)$ that coincides with the optimal outcome from the viewpoint of the household and central bank. We can write down the constrained symmetric equilibrium as the followings:

Definition 4 *An constrained Stackelberg equilibrium with the monetary authority moving first consists of a policy vector (b^1, \dots, b^N, π) with the following properties:*

- i. each fiscal authority (FA) chooses b^i to maximize $V^i = y_1^i + b^i + \delta(y_2^i - \tau^i)$ subject to the budget constraint (1), the fiscal constraint $b^i \leq X^i$, and $y_1^i + b^i \geq 0$, $y_2^i(\pi) - \tau^i \geq 0$ for a given (b^{-i}, X^i, π) .*
- ii. the central bank chooses a common inflation rate π to maximize the social welfare function $W(\pi) = \sum_{i=1}^N \lambda^i U^i = \sum_{i=1}^N \lambda^i [y_1^i + b^i + \beta(y_2^i(\pi) - \tau^i)]$ subject to budget constraint (1), $y_1^i + b^i \geq 0$, $y_2^i(\pi) - \tau^i \geq 0$, and taking as given the best response functions of all fiscal authorities.*
- iii. the goods market clears at every period, i.e. $c_1^i = y_1^i + b^i$ and $c_2^i = y_2^i(\pi) - \tau^i$.*

When the fiscal constraint X^i is the same as the borrowing limit $B(\pi)$, we can easily write down the equilibrium outcomes and payoffs of the fiscal authorities and the central bank. The fiscal authority borrows up to the limit $\tilde{b} = B(\pi)$ and enjoys the low interest yield $\tilde{R} = R_L$. The fiscal constraint is satisfied in the monetary union as $\sum_{i=1}^N b^i \leq NB(\pi)$. The central bank chooses the inflation rate at $\tilde{\pi} = \pi^*$, and gets the same payoff as in the equal-treatment optimum. So, the fiscal constraints can be viewed as a decentralization mechanism to reach the social optimum defined in the previous section.

Fiscal constraints prevent the fiscal authorities in the member nations from acting in ways that raise the cost of borrowing above R_L , thus allowing the central bank to pursue a lower inflation target to minimize the distortions from inflation. This conclusion relies on the greater impatience of the fiscal authorities and will hold in considerably broader circumstances than the simple framework studied in this paper. The result does not depend on the assumed linearity of the utility function, the specification of credit demand schedules, the autarkic nature of households, or the finite time horizon.

Recent European experience shows that large member nations in a monetary union like France and Germany have a tendency to ignore the fiscal constraints in adverse circumstances as they attempt to smooth consumption. We may extend our framework to incorporate idiosyncratic shocks in our environment. The key issue seem to be related to the mechanism design: how a monetary union strikes a balance between consumption smoothing and incentives to adhere to limits on fiscal deficits in face of nation specific shocks.

6 Conclusions

In a simple currency union with linear payoffs, perfect certainty and a finite economic horizon, we have explored how fiscal constraints serve the policy aims of a patient central bank as it deals with the impatient fiscal authorities of member nations. By limiting public debt, fiscal constraints ease the burden on the central bank to keep real interest rates from rising too much, allowing the central bank to lower its inflation target and minimize the economic harm from inflation.

The logic of this argument seems to be robust to the particular assumptions made in our model economy, with two possible exceptions: idiosyncratic income shocks and limited enforcement. Uniform, across-the-board restrictions on deficits and public debt like those envisioned in the European Union Stability Pact limit the ability of fiscal authorities to smooth idiosyncratic shocks to national income by taking long positions in international asset markets. The temptation to ignore agreements on debt limits is strongest when large economies like Germany and France face economic adversity.

Should the European Union scrap the Stability Pact? This paper cannot claim to provide an answer. Doing so would produce concave payoffs that value smooth consumption, and market incompleteness that

makes smoothing hard to attain. But we do have a suggestion on how to enforce whatever fiscal limits are found to be in the best interests of European households. Instead of threatening deviant nations with fines that will prove inadequate or hard to collect, the European Commission should lead the job of enforcing the Stability Pact provisions to the central bank. When the European Central Bank builds up substantial positions in the public debt of member nations, it will have the ability to reward those who observe fiscal constraints and punish those who do not, by repatriating most of the interest income it collects from the former and withholding all interests from the latter.

7 Reference

Cooper, R. and H. Kempf (2004): "Overturning Mundell: Fiscal Policy in a Monetary Union", *Review of Economic Studies*, Vol.71/2 pp. 371 April 2004

Dixit, A., and L. Lambertini (2003): "Interactions of Commitment and Discretion in Monetary and Fiscal Policies", *American Economic Review*, 93

Giovannini, A. and L. Spaventa (1991): "Fiscal Rules in the European Monetary Union: A No-Entry Clause", CEPR Discussion Paper 516, England

Chari, V. and P. Kehoe (2002): "Time Consistency and Free-Riding in a Monetary Union", *Federal Reserve Bank of Minneapolis Staff Report No.308*, September 2002

Uhlig, H. (2002): "One Money, but Many Fiscal Policies in Europe: What are the Consequences?" Manuscript, Humboldt University, Berlin