Nominal Debt as a Burden on Monetary Policy*

Javier Díaz-Giménez **Giorgia Giovannetti**
Ramon Marimon **Pedro Teles**†

This version: October 7, 2003

Abstract

This paper explores the roles played by indexed debt and nominal debt when monetary policy is designed sequentially. In our model, with indexed debt the optimal monetary policy is time consistent, resulting in constant interest rates and debt levels. In contrast, with nominal debt, the incentive to reduce the stock of debt, through unanticipated inflation, creates the standard time-inconsistency problem. This leads us to study the optimal sequential choice of monetary policy in the absence of a commitment technology. In the rational expectations equilibrium the incentive to generate unanticipated inflation increases the cost of the outstanding debt even if there are no unanticipated inflation episodes. The optimal policy is to progressively deplete the outstanding stock of debt until the (extra) liability costs vanish. We conclude that nominal debt is indeed a burden on monetary policy, not only because the debt must be serviced, but also because it distorts interest rates.

1 Introduction

Fiscal discipline has often been seen as a precondition to sustain price stability. Such is, for example, the rationale behind the Growth and Stability Pact of the European Union. More precisely, it is understood that an economy with large stock of nominally denominated government debt can benefit from inflation surprises that reduce the need for distortionary taxation in the future. This means that the optimal monetary policy under full commitment (the Ramsey policy) can be time inconsistent. In other words, if a government with the ability to commit were to re-optimize at a later date, it may choose to deviate from the policy originally announced. In this context, a constraints on the level of debt may reduce the impact of such time-inconsistency distortions. However, while the argument is known it is less understood how severe the time-inconsistency problem is and, in particular, what is the monetary policy when there are outstanding

*We would like to thank Jośe-Victor Ríos-Rull, Juan Pablo Nicolini and Isabel Correia for their comments, as well as the participants in seminars and conferences where this work has been presented.

†**J. Díaz-Giménez:**Universitad Carlos III; **G. Giovannetti**: Università di Firenze; **R. Marimon**: Universitat Pompeu Fabra, CREi, CEPR and NBER, and **P. Teles**: Federal Reserve Bank of Chicago and CEPR.

debts and a limited ability to commit. The purpose of this paper is to address these issues. In particular, to study the effects of nominal debt on the optimal sequential choice of monetary policy. To this aim, we identify the mechanisms at work in a simple general equilibrium monetary model. By pursuing model simplicity we not only can provide a sharp characterization of the potential effects of nominal debts on monetary policy and prices, but we also gain powerful insights on the characterization of optimal sequential policies in recursive equilibria.

Our benchmark model economy is a cash-in-advance economy with indexed debt. We characterize the optimal monetary policy in this economy and we compare it with the optimal policies that obtain when the debt is nominal, (i) under full commitment, and (ii) when the government is unable to fully commit to its announced policy. In this case we restrict our attention to the Markov perfect equilibrium.

The structure of the optimal taxation problems that we solve is the following: we assume that the government has to finance both a given constant flow of expenditures with revenues levied using only seigniorage. To solve these optimal taxation problems, the government chooses the paths on seigniorage that maximize the household's utility subject to the implementability and budget constraints. Unexpected inflation is costly, because we assume that the consumption good must be purchased with cash carried over from the previous period, as in Svensson (1985). This timing of the cash-in-advance constraint implies that, if the government decided to surprise the household with an unexpected increase in inflation in any given period, the household's consumption would be smaller than planned because its predetermined cash balances would be insufficient to purchase the intended amount of consumption. When considering whether or not to carry out such a surprise inflation, the government compares the reduction in the household's current utility that results from this lower level of consumption with the increase in the household's future utility that results from the reduction in future seigniorage. After introducing the economy in Section 2, in Section 3 we characterize this time-inconsistency problem of the optimal policy with full commitment, when the government has a stock of outstanding nominal debt. We show that interest rates are kept constant from period one on, but that the initial interest rate is higher, corresponding to the partial monetization of the inherited stock of nominal debt.

In order to have a benchmark against which to evaluate the role played by nominal debt, we study, in Section 4, the same economy assuming that government debt is indexed. Our results paraphrase those of Nicolini (1998) who shows that, when the utility function is logarithmic in consumption and linear in leisure and the government debt is indexed, the optimal monetary policy, in an economy similar to ours, is to abstain from the inflation surprises; a result that follows from applying optimal taxation principles. This implies that, in this model economy, the solution to the Ramsey problem is time consistent. Furthermore, as we show, since the solution to this problem is stationary, there is a unique interest rate that balances the government budget. This interest rate is higher than in the Ramsey solution with nominal debt since, with indexed debt, the government can not benefit from the lump-sum reduction of the initial debt by increasing the initial price.

Having these regimes as reference, we turn then in Section 5 to the main results of the paper. We study the optimal policy that obtains in the absence of commitment.

In this case, we restrict our attention to the Markov perfect equilibrium. We call this equilibrium recursive as in Cole and Kehoe (1996) and Obstfeld (1997). Two interesting features of the optimal policy that obtains under this recursive equilibrium are that the optimal inflation tax is non-stationary and that it converges to the inflation tax that obtains when there is no government debt. This result arises because in the recursive equilibrium it is optimal for the government to deplete the stock of nominal government debt to zero. An implication of these results is that, in this economy, the optimal nominal interest is initially higher than the one that prevails when debt is indexed but in the limit it is lower. This decreasing path for the nominal interest rate is another indication that nominal debt is indeed a burden for monetary policy. It not only has to be serviced, but it distorts interest rates, being part of the optimal policy to asymptotically monetize the debt eliminating such distortions. In Section 6 we carry out a numerical example and we describe our findings comparing the different regimes.

The relationship between fiscal and monetary policy is also the focus of the literature on the unpleasant monetarist arithmetic of Sargent and Wallace (1981), and the fiscal theory of the price level of Sims (1994) and Woodford (1996). In these approaches, however, policies are taken to be exogenous. This is not the case both in our analysis, and the related work of Chari and Kehoe (1999), Rankin (2000) and Obstfeld (1997).

Chari and Kehoe (1999) focus on the policy debate showing the time-inconsistency problem Obstfeld (1997) discusses the time consistency of optimal monetary policy when government debt is indexed. In his benchmark model economy inflation surprises are not costly and the Markov perfect equilibrium is non-monetary. This leads him to impose an *ad hoc* cost of unanticipated inflations. This new feature of his model creates the incentive for the government to deviate from the original policy path and to surprise the economy with a finite inflation. The time inconsistency of this optimal taxation problem leads him to study the Markov perfect equilibrium of this economy. In this case, the Ramsey government accumulates real assets until they earn enough interest to finance all future government expenditures. In the limit, the taxation problem disappears and so does the time inconsistency problem. Our analysis differs from Obstfeld's in that we consider nominal debt and that in our model economy the cost of unanticipated inflation arises from the timing of the cash-in-advance constraint rather than being imposed ad-hoc. In a similar framework, Rankin (2000) shows that the size of the initial debt matters for the direction of the time inconsistency problem, without providing a full characterization of the resulting dynamic equilibrium.

Our work is also very closely related to the recent work of Krusell, Martín and Ríos-Rull (2003) who also characterize recursive equilibria in the context of an optimal labor taxation problem. In their model the source of the time-inconsistency problem is, as in Lucas and Stokey (1983), due to the incentives to manipulate real interest rates in order to reduce the service of the real debt.

2 The model economy

The economy is made up of a government sector and a private sector. We assume that the government in this economy issues currency, M^g, and nominal debt, B^g, to finance an exogenous and constant level of public consumption, g. We abstract from all other sources of public revenues. In each period $t \geq 0$ the government budget constraint is the following:

$$M_{t+1}^g + B_{t+1}^g \leq M_t^g + B_t^g(1+i_t) + p_t g, \tag{1}$$

together with a no-Ponzi games condition. i_t is the nominal interest rate paid on nominal bonds lent by the government at time $t-1$, p_t is the price of one unit of the date t composite good, and M_0^g and B_0^g are given. A government policy is therefore a specification of $\{M_{t+1}^g, B_{t+1}^g, g\}$ for $t \geq 0$.

Let $b_{t+1} = B_{t+1}/p_t$ be the real value of the end-of-period stock of debt. Then the government budget constraint, (**??**), can be written as

$$\frac{M_{t+1}}{p_t} + b_{t+1} = \frac{M_t}{p_t} + b_t(1+i_t)\frac{p_{t-1}}{p_t} + g \tag{2}$$

We assume that the economy is inhabited by a continuum of identical infinitely-lived households whose preferences over infinite sequences of consumption and labor can be represented by the following utility function:

$$\sum_{t=0}^{\infty} \beta^t [u(c_t) - \alpha n_t] \tag{3}$$

where $c_t > 0$ denotes consumption at time t, n_t denotes labor at time t, and $0 < \beta < 1$ is the time discount factor. The utility function is assumed to satisfy standard assumptions, of being strictly increasing and strictly concave, and, for reasons that will become clear below, for most of the paper we assume that it is logarithmic, $u(c) = \log(c)$, .

We assume that consumption in period t must be purchased using the currency carried over from period $t-1$ as in Svensson (1985). Notice that this timing of the cash-in-advance constraint implies that, when solving its maximization problem, the representative household takes both M_0 and B_0 as given.[1] Specifically, the cash-in-advance constraint faced by the representative household for every $t \geq 0$ is the following:

$$p_t c_t \leq M_t \tag{4}$$

To simplify the productive side of this economy we assume that, each period, labor can be transformed into either the private consumption good or the public consumption good on a one-to-one basis. Consequently, the competitive equilibrium real wage can be trivially shown to be $w_t = 1$ for all $t \geq 0$, and the economy's resource constraint is

$$c_t + g \leq n_t \tag{5}$$

for every $t \geq 0$.

Therefore, in each period $t \geq 0$ the representative household also faces the following budget constraint:

$$M_{t+1} + B_{t+1} \leq M_t - p_t c_t + B_t(1+i_t) + p_t n_t \tag{6}$$

where M_{t+1} and B_{t+1} denote, respectively, the nominal money balances and the nominal government debt that the household carries over from period t to period $t+1$. Finally we assume that the representative household faces a no-Ponzi games condition.

[1] In the Lucas and Stokey (1983) timing both M_0 and B_0 can be chosen by the household.

2.1 A competitive equilibrium

Definition 1 *A competitive equilibrium for this economy is a government policy,* $\{M^g_{t+1},$ $B^g_{t+1}, g, \}_{t=0}^{\infty}$*, an allocation* $\{M_{t+1}, B_{t+1}, c_t, n_t\}_{t=0}^{\infty}$*, and a prices,* $\{p_t, i_t\}_{t=0}^{\infty}$*, such that:*

(i) given M^g_0 *and* B^g_0*, the government policy and prices satisfy the government budget constraint described in expression (**??**);*

(ii) when households take M_0*,* B_0 *and prices as given, the allocation maximizes the problem described in expression (**??**), subject to the cash-in-advance constraint described in expression (**??**), the household budget constraint described in expression (**??**), and the no-Ponzi games condition; and*

(iii) markets clear, that is: $M^g_t = M_t$*,* $B^g_t = B_t$*, and* g *and the allocation satisfies the economy's resource constraint described in expression (**??**), for every* $t \geq 0$*.*

Given our assumptions on the utility function u, it is straightforward to show that the competitive equilibrium allocation of this economy satisfies both the household budget constraint (**??**), and the economy's resource constraint (**??**) with equality, and that the first order conditions of the Lagrangean of the household's problem are both necessary and sufficient to characterize the solution to the household's problem. Furthermore, it is also straightforward to show that, when $i_{t+1} > 0$, the cash-in-advance constraint (**??**) is binding, and that the competitive equilibrium allocation of this economy is completely characterized by the following conditions that must hold for every $t \geq 0$:

$$\frac{u'(c_{t+1})}{\alpha} = 1 + i_{t+1} \tag{7}$$

$$1 + i_{t+1} = \beta^{-1}\frac{p_{t+1}}{p_t} \tag{8}$$

$$c_t = \frac{M_t}{p_t} \tag{9}$$

the government budget constraint (**??**) and the resource constraint (**??**).

If debt is indexed, then condition (**??**) will be replaced by

$$1 + i_t = \beta^{-1}\frac{p_t}{p_{t-1}},\ t \geq 0 \tag{10}$$

The fact that debt is indexed means that, given p_{t-1}, the government policy must be such that i_t adjusts to p_t so that the fisherian equation holds for every $t \geq 0$.

3 Optimal policy with nominal debt and full commitment

Let us first analyze the full commitment, Ramsey (R), solutions to the government maximization problem in the case of nominal non zero debt. We solve the problem from some date $t = 0$ on. If the government was able to re-optimize at time $t = 0$, and was able to commit to its policies from there on, then it would want to choose a policy that would differ from the ones obtained before. However, if this had been anticipated it would have to be the case that the ex-ante interest rate equals the ex-post rate. This is the exercise performed by Chari and Kehoe (1999).

In order to build the implementability conditions we replace $1+i_{t+1}$, $\frac{p_{t+1}}{p_t}$ and $\frac{M_t}{p_t}$, $t \geq 0$, from (??), (??) and (??) in (??) to obtain

$$u'(c_{t+1})\, c_{t+1}\frac{\beta}{\alpha} + b_{t+1} = c_t + b_t\beta^{-1} + g,\ t \geq 1 \tag{11}$$

$$u'(c_1)\, c_1\frac{\beta}{\alpha} + b_1 = c_0 + b_0\beta^{-1}\frac{\overline{p}_0}{p_0} + g \tag{12}$$

where $\overline{p}_0$ is defined as

$$(1+i_0)\frac{p_{-1}}{\overline{p}_0} \equiv \beta^{-1} \tag{13}$$

Notice that in our benchmark case of logarithmic utility function $u'(c_t)\, c_t = 1$. Let $\overline{c}_0 = \frac{M_0}{\overline{p}_0}$.

Definition 2 *The Ramsey solution is a sequence of quantities and prices such that the government maximizes:*

$$Max \sum_{t=0}^{\infty} \beta^t \left[\log(c_t) - \alpha(c_t + g)\right] \tag{14}$$

subject to the implementability conditions

$$\frac{\beta}{\alpha} + b_{t+2} - c_{t+1} - \beta^{-1}b_{t+1} - g = 0,\ t \geq 0 \tag{15}$$

$$\frac{\beta}{\alpha} + b_1 - c_0 - c_0 b_0\frac{\beta^{-1}}{\overline{c}_0} - g = 0 \tag{16}$$

The solution of this problem is described by

$$c_{t+1} = c,\ t \geq 0 \tag{17}$$

$$\frac{\frac{1}{c_0} - \alpha}{\left[1 + b_0\frac{\beta^{-1}}{\overline{c}_0}\right]} = \left[\frac{1}{c} - \alpha\right] \tag{18}$$

If $b_0 > 0$, then $c_0 < c$.

If we impose that the equilibrium must satisfy the consistency condition

$$c_0 = \overline{c}_0, \tag{19}$$

corresponding to an indexation of the ex-post interest rate at time zero -non internalized by the government– then we have

$$\frac{\frac{1}{c_0} - \alpha}{\left[1 + b_0\frac{\beta^{-1}}{c_0}\right]} = \left[\frac{1}{c} - \alpha\right] \tag{20}$$

We can also describe the path of interest rates by rewriting (**??**) as

$$\frac{\frac{1}{c_0}-\alpha}{\left[1+\beta^{-1}\frac{p_0}{p_{-1}}\frac{B_0}{M_0}\right]}=\left[\frac{1}{c}-\alpha\right] \tag{21}$$

and by defining

$$1+i_0^R \equiv \frac{u'(c_0)}{\alpha}=\beta^{-1}\frac{p_0}{p_{-1}} \tag{22}$$

Then

$$\frac{i_0^R}{1+\frac{(1+i_0^R)B_0}{M_0}}=i^R \tag{23}$$

The Ramsey solution is characterized by an ex-post interest rate in period 0 that is higher than the one in the solution to the maximization problem with real debt -discussed in the next section– and a lower rate onwards. The reason is that the government aims at taking advantage of the lump-sum character of monetizing the outstanding nominal debt since there is no time zero indexation that the government must internalize. The government, in fact, has the perception, at time zero, that it can surprise the agents and reduce the real value of the nominal liabilities. However, if there is explicit period zero indexation, the government cannot effectively deplete the debt.

4 Optimal policy with indexed debt

We address the case of indexed (real) debt as a benchmark, mainly to contrast it with the case we are interested in, i.e. when the debt is in nominal terms.

Definition 3 *For any given level of government expenditures, g, and initial values of currency, M_0, and government debt, B_0, an optimal government policy is a government policy, an implied allocation, and an implied price vector, such that: (a) the household utility is maximized, and (b) the government policy, the allocation and the price vector are a competitive equilibrium.*

The problem of the government is to maximize (**??**) subject to the implementability condition

$$u'(c_{t+1})\,c_{t+1}\frac{\beta}{\alpha}+b_{t+1}=c_t+b_t\beta^{-1}+g,\; t\geq 0 \tag{24}$$

This problem is recursive only when $u(c_t)=\ln(c_t)$. This is the result in Nicolini (1998), that when the price elasticity is one the Ramsey solution with real debt is time consistent. In this case, the problem can be written recursively as

$$V(b)=\max_{c,b'}\{\log(c)-\alpha(c+g)+\beta V(b')\} \tag{25}$$

subject to

$$b'=c+\beta^{-1}b+g-\frac{\beta}{\alpha}. \tag{26}$$

The marginal condition for c is:

$$\frac{1}{c} - \alpha = -\beta V_{b'} \tag{27}$$

where V_b denotes $\frac{\partial V}{\partial b}$. The marginal gain of consumption is equal to the marginal cost of one unit of future debt.

Using the envelope theorem, we have

$$V_b = V_{b'} \tag{28}$$

Thus, we have

$$\frac{1}{c} - \alpha = \frac{1}{c'} - \alpha \tag{29}$$

so that consumption is constant

$$c^* = \frac{\beta - \alpha g}{\alpha} - \frac{1-\beta}{\beta} b_0 \tag{30}$$

where the initial debt b_0 becomes the stationary value of the real debt.

The value of the constant nominal interest rate is, therefore,

$$1 + i^I = \frac{1}{\beta - \alpha g - \alpha b_0 \frac{1-\beta}{\beta}}. \tag{31}$$

The fact that the debt is indexed implies that it is not optimal for the government to surprise the economy with an initial inflation tax and, consequently, that this problem is time consistent.

We have solved a very simple problem: the government has in every period only one tax (i.e. the inflation tax). Notice, however, that a model with other taxes may have more interesting features but a central feature of our model will prevail: with log utility optimal taxation requires taxing equally current and future consumptions. With alternative tax revenues, the solution of the maximization problem is a constant interest rate, at the Friedman rule. What happens here is that the government internalizes the fact that it cannot default on the debt, by surprising the agents with inflation. In the following section we analyze the equilibrium with nominal debt and no commitment.

5 Optimal policy with nominal debt and no commitment

In each period the government decides the price level according to a policy function $p_t = p(b_t, M_t)$. Households have rational expectations and take as given the government policy function. Furthermore their expected future prices, $\bar{p}_t$, are formed in period $t-1$, and they are the same function of the state of the economy at the beginning of period t, i.e. $\bar{p}_t = p(b_t, M_t)$.

Consequently, in this case the nominal interest rate will satisfy the following version of Fisher's equation:

$$1 + i_t = \frac{\overline{p}_t}{\beta p_{t-1}} = \frac{p(b_t, M_t)}{\beta p_{t-1}} \tag{32}$$

The implementability conditions can be written as

$$\frac{\beta}{\alpha} + b_{t+1} = c_t + b_t(1 + i_t)\frac{p_{t-1}}{p_t} + g \tag{33}$$

From (??), we have

$$\frac{\beta}{\alpha} + b_{t+1} = c_t + b_t\beta^{-1}\frac{\overline{p}_t}{p_t} + g \tag{34}$$

Since $c_t = M_t/p_t$ and $\overline{c}_t = M_t/\overline{p}_t$, (??) takes the form

$$\frac{\beta}{\alpha} + b_{t+1} = c_t + b_t\beta^{-1}\frac{c_t}{\overline{c}_t} + g \tag{35}$$

Notice that the problem reduces to a problem with a single state variable b_t. The problem of the government is then to find $c = C(b)$ that solves

$$V(b) = \text{Max}\{\log(c) - \alpha(c + g) + \beta V(b')\} \tag{36}$$

s.t.

$$b' \leq c + b\beta^{-1}\frac{c}{\overline{C}(b)} + g - \frac{\beta}{\alpha} \tag{37}$$

with $C(b) = \overline{C}(b)$.

Definition 4 *A recursive monetary equilibrium for this economy is a value function $V(b)$, policy functions $\{C^*(b), b^*(b)\}$, and a function $\overline{\mathrm{C}}(b)$ such that*

*(i) Given $\overline{\mathrm{C}}(b)$, the value function, $V(b)$, and the policy, $\{C^*(b), b^*(b)\}$, solve the problem described by expressions (**??**) and (**??**), and*

(ii) $C^*(b) = \overline{\mathrm{C}}(b)$

To characterize the recursive monetary equilibrium notice that the first order conditions of (??)-(??) are, first

$$\frac{1}{c} - \alpha = -\beta V_{b'}\left[1 + b\beta^{-1}\frac{1}{\overline{C}(b)}\right] \tag{38}$$

This condition equates the marginal gain of one unit of consumption to its marginal cost associated with higher debt resulting from the additional debt, as if it was indexed, and the additional debt resulting from a lower price in the current period. Second, using the envelope theorem,

$$V_b = V_{b'} \left[\frac{c}{\overline{C}\,(b)} - \frac{c}{\overline{C}\,(b)} \frac{b\overline{C}'\,(b)}{\overline{C}\,(b)} \right] \tag{39}$$

or, given that in equilibrium $c = \overline{C}\,(b)$,

$$V_b = V_{b'} \left[1 - \epsilon_c(b)\right] \tag{40}$$

That is, one marginal increase of b_t has value V_{b_t}, but the corresponding increase of b_{t+1} has two components, the direct effect of increasing the stock of debt -as in the indexed debt case– and the indirect effect due to the fact that higher values of debt are associated with higher interest rates, $\epsilon_c(b) \leq 0,$ given that with a higher stock of nominal debt the incentive to monetize the debt is higher and, along a rational expectations equilibrium path, these distortions are anticipated.

Using (**??**) we can also express the last condition as

$$\frac{\frac{1}{c} - \alpha}{\beta \left[1 + b\beta^{-1}\frac{1}{c}\right]} = \frac{\frac{1}{c'} - \alpha}{\beta \left[1 + b'\beta^{-1}\frac{1}{c'}\right]} \left[1 - \epsilon_c(b')\right] \tag{41}$$

or

$$\frac{\frac{1}{c} - \alpha}{\left[1 + \frac{(1+i)B}{M}\right]} = \frac{\frac{1}{c'} - \alpha}{\left[1 + \frac{(1+i')B'}{M'}\right]} \left[1 - \epsilon_c(b')\right] \tag{42}$$

Notice that (**??**) shows that, in contrast with the case of indexed debt (**??**) where marginal values of consumption are simply equated, in a recursive monetary equilibrium with nominal debt, marginal values of consumption must be discounted, since a higher consumption means a lower price and therefore higher outstanding and future debt. Furthermore, discounted marginal values of consumption are additionally distorted by the incentive to increase the current price: $\left[1 - \epsilon_c(b_{t+1})\right]$.

Next we further characterize this equilibrium using numerical methods.

6 Numerical solutions

To carry out our numerical example we use the following values for the model economy parameters: $\alpha = 0.45$, $\beta = 0.98$, $b_0 = 0.17865$ and $g = 0.00822$. Notice that our period corresponds to a year and that we choose a very high level of nominal debt in relation to government expenditures. As we will see, the results for lower values of debt can be obtained from our computations. The results that we obtain for the time paths of the stock of debt, consumption, and the nominal interest rate, in the three cases that we analyze in this paper are reported in Figures **??**, **??**, and **??**, respectively.

As we have already mentioned, we find that the optimal monetary policy that obtains when debt is indexed is stationary and that is not the case when debt is nominal (see Figures **??**, **??**, and **??**).

We also find that, when debt is indexed, the stock of debt is time-invariant, and that, when debt is nominal, it is optimal to reduce the initial stock of debt. Under full commitment this debt reduction is only carried out during the first period, and under no commitment the stock of debt is depleted progressively until it is completely cancelled (see Figure **??**).

As far as consumption is concerned, we find that the long-run level of consumption is higher when debt is nominal than when debt is indexed (see Figure **??**), and that, given our specification of preferences, this implies that the long-run level of utility is higher when debt is indexed than when debt is nominal.

Finally, we find that the long-run interest rate that obtains when debt is indexed is higher than those that obtain when debt is nominal, and that, in this case, the long-run interest rate that obtains under full commitment is higher than the one that obtains when there is no commitment (see Figure **??**).

7 Concluding comments

This paper emphasizes the different roles that nominal and real debt have in affecting the sequential decision of optimal monetary policy in a general equilibrium monetary model, where the costs of an unanticipated inflation are accounted for by the specification of the timing of the cash in advance constraint. In particular, as in Nicolini (1998) with logarithmic utility there is no time-inconsistency problem when debt is indexed (real). The solution is stationary and the same optimal monetary policy is implemented with and without full commitment. However, for the same specification of preferences, time inconsistency arises when we consider nominal debt. Then, the government is tempted to inflate away its nominal liabilities. With limited commitment the optimal sequential policy consists on progressively depleting the outstanding debt, converging asymptotically to zero, so that, in the long run, the optimal monetary policy coincides with that of an economy without inherited debt, where time-inconsistency distortions are absent. Correspondingly, interest rate decrease along the path, converging to zero if there is no need to raise seignorage to finance other expenditures. In summary, our analysis suggests that nominal debt is indeed a burden on monetary policy, arising from the absence of a commitment technology that precludes the full commitment Ramsey policy from being implemented. A monetary authority conscious of the implications of following a sequential monetary policy may prefer an institutional arrangement that prevents monetary authorities from having to internalize nominal debts. Constraining fiscal deficits and debts may be a step in this direction.

References

[1] Chari, V.V. and Patrick J. Kehoe. 1997. "On the Need for Fiscal Constraints in a Monetary Union,", mimeo, Federal Reserve Bank of Minneapolis.

[2] Chari, V.V. and Patrick J. Kehoe. 1999. "Optimal Fiscal and Monetary Policy", National Bureau of Economic Research, WP 6891, January.

[3] Cole, Harold and Timothy Kehoe, 1996, "A self-fulfilling model of Mexico's 1994-1995 debt crisis", *Journal of International Economics*, 41, 309-330.

[4] Krusell, Per, Fernando Martín and José-Víctor Ríos-Rull, 2003, "On the Determinantion of Government Debt," work in progress.

[5] Lucas, Robert E., Jr. and Nancy L. Stokey, 1983, "Optimal Fiscal and Monetary Theory in an Economy without Capital", *Journal of Monetary Economics,* 12, 55-93.

[6] Nicolini, Juan Pablo, 1998, "More on the Time Inconsistency of Optimal Monetary Policy", *Journal of Monetary Economics*

[7] Obstfeld Maurice, 1997, "Dynamic Seigniorage Theory", *Macroeconomic Dynamics*, 588-614.

[8] Rankin, Neil, 1999, "Time Consistency, Ability to Commit and Optimal Seigniorage: Further Perspectives on the Inflation Bias Problem", mimeo, University of Warwick.

[9] Sargent, Thomas, J. and Neil Wallace, 1981, "Some Unpleasant Monetarist Arithmetic," *Quarterly Review,* Federal Reserve bank of Minneapolis, 5,3, 1-17. [Reprinted, 1993, in *Rational Expectations and Inflation, 2nd ed.,* New York, Harper Collins].

[10] Svensson, L.E.O., 1985, "Money and Asset Prices in a Cash-in-Advance Economy", *Journal of Political Economy*, 93, 919–944.

[11] Woodford, Michael. 1996. "Control of the Public Debt: A Requirement for Price Stability?", NBER Working Paper 5684

Figure 1: The optimal stocks of indexed debt and of nominal debt with full commitment and with no commitment

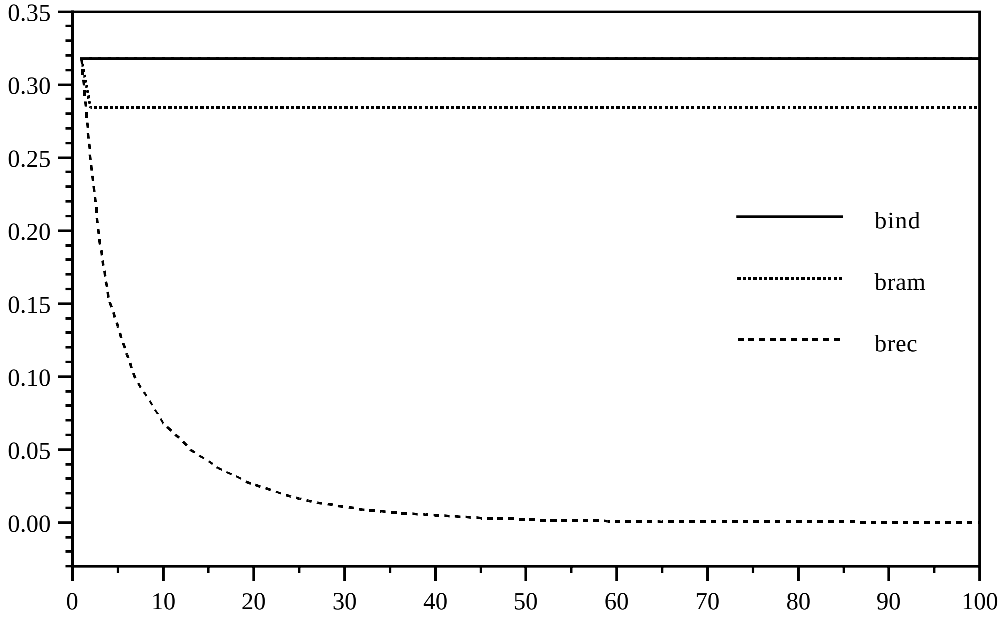

Figure 2: The optimal paths of consumption with indexed debt and with nominal debt with full commitment and with no commitment

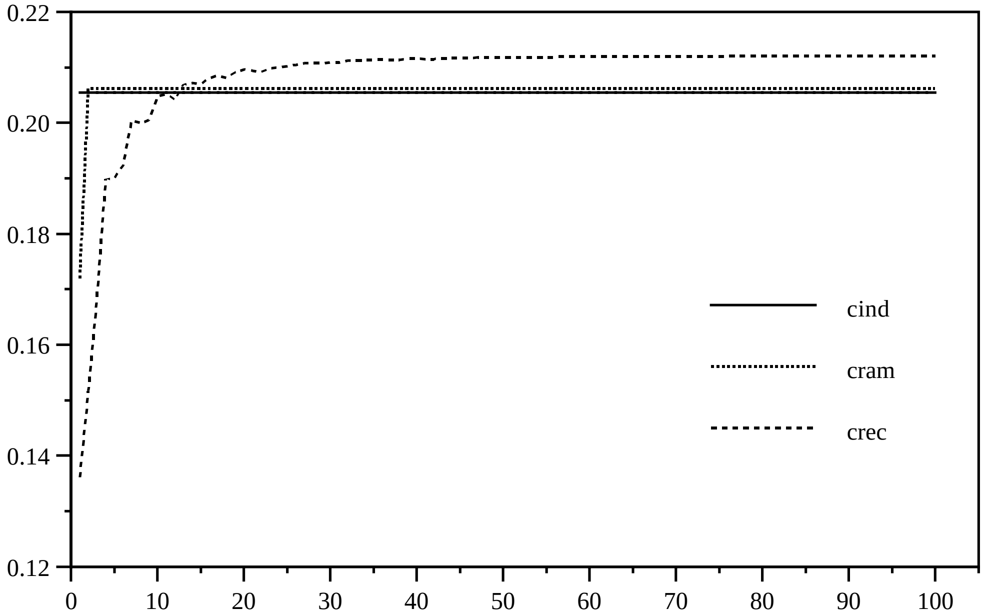

Figure 3: The optimal paths of nominal interest rates with indexed debt and with nominal debt with full commitment and with no commitment