Interest on Reserves and Inflation[1]

by

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Discussion Paper No. 2005.03
February 2005

[1] Forthcoming in the Journal of Development Economics.
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Abstract

The payment of interest on reserves was common practice in inflationary economies such as those in Latin America and Israel. This policy may appear as paradoxical since it implies returning part of the seigniorage that was generated by the inflation process, which presumably was initiated by the government in order to obtain inflationary finance for the deficit. In this paper we argue that the motivation for paying interest on reserves in the high inflation economies can be captured by the model of the discretionary regime, where the policymakers' policies have to react to adverse expectations of the public (see Barro-Gordon 1983). In this environment the policymaker is concerned with the erosion of real liquidity by inflation, which is in part beyond his control, therefore he is willing to subsidize liquidity by paying interest on reserves. However, using the same analytical framework, we show that paying interest on reserves is an unlikely outcome for industrial economies, which are presumably closer to the rules (commitment) regime.

The payment of interest on reserves was common practice in inflationary economies such as those in Latin America and Israel[1]. The policy of paying interest on reserves may appear as paradoxical, since it implies returning part of the seigniorage that was generated by the inflation process, which presumably was initiated by the government in order to obtain inflationary finance for the deficit. The motivation for paying interest on money in high inflation economies was obviously different from the Friedman proposal (1960) for paying interest on money. Friedman's proposal was intended to avoid *negative* inflation, while maintaining real liquidity at the satiation level[2]. This scenario does not fit (by definition) the case of the high inflation economies as Latin America and Israel who paid interest on money to protect the economy against the shrinking of the stock of real money balances, which was being eroded by inflation[3].

In this paper we argue that the motivation for paying interest on reserves in the high inflation economies can be captured by the model of the discretionary regime, where the policymakers' policies have to react to adverse expectations of the public (see Barro-Gordon 1983). In this environment the policymaker is concerned with the erosion of real liquidity by inflation, which is in part beyond his control, therefore he is willing to subsidize liquidity by paying interest on reserves. However, using the same analytical framework, we show that paying interest on reserves is an unlikely outcome for industrial economies, which are presumably closer to the rules (commitment) regime.

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[1] In the height of the inflation process in Israel the interest on reserves reached 0.8% of GDP. (Bank of Israel Annual Report 1984).

[2] In practice, Friedman's proposal has not been implemented in the US nor in other industrial countries. Although the suggestion of paying interest on money has been viewed favorably by many economists, there were doubts about its practicality because of the fiscal cost of the proposal, its initial distributional burden (Smith 1991) and because of possible indeterminacies which it may entail (Sargent and Wallace 1985).

[3] For this reason the recent literature on the optimality of the Friedman rule, for example, Correia and Teles (1998), Chari et. al (1996) and Kimbrough (1986), is not very relevant for our problem.

We assume that in the discretionary regime the central bank is not totally incapable of any commitment. Experience shows that the central bank can commit credibly on its announced nominal rate of interest on reserves; this is in contrast to its inability of making a binding commitment on inflation in the discretionary regime. This is consistent with experience in inflationary economies. Thus, the discretionary central bank cannot guaranty the real interest rate on reserves but it can guaranty the nominal rate.

Our analytical framework is conceptually similar to the model of Poterba and Rotemberg (1990)[4] (PR) in the sense that it is based on a loss function of the government which allows a distinction between discretion and rules. There is, however, a basic difference. While the loss function in PR is based on two arguments, actual inflation and the tax rate, our model has an additional argument in the form of the deviation of real balances from their target. The additional argument, which represents the concern of the authorities with the liquidity position, is essential for the justification of the payment of interest on reserves in the discretionary regime. In fact, the PR model is not optimal (or rational) if the policymaker has the option of paying interest on reserves and does not use it. We show that in the framework of this model the payment of interest on reserves is associated with the option for surprise inflation. If we remove this option then interest on reserves will not be paid in equilibrium, except for the reason of avoiding negative inflation. In order to exclude the latter case (so as to rule out the Friedman motivation for paying interest on reserves) we assume that the real interest rate is zero, which is perfectly legitimate in the context of a one (or finite) period equilibrium model.

[4] Which is similar in many respects to Mankiw (1987).

At the empirical level there is no doubt that the policymakers in inflationary economies were concerned with the liquidity position. For example, in Israel the level of M_1 shrank from around 15% of GDP in the beginning of the inflationary process (in the early seventies) to around 3% in its end (towards the mid eighties). On the theoretical level the question is whether the addition of the liquidity motive in the loss function is not redundant in view of the fact that it includes already a term representing inflation. We will show that if we add the liquidity motive in the PR model, then it is optimal to pay interest on reserves in the discretionary regime.

Even though our methodology is to present the argument in the framework of a one period model, nevertheless we show that this model is capable of capturing the basic features of the PR model, and in addition is able of taking account of all the essential elements of the payment of interest on money in a relatively simple manner.

The paper is organized as follows. We first present an extended version of the PR model, which includes the liquidity motive and interest on reserves. We show that interest on reserves will not be paid in the equilibrium of the commitment regime but *will* be paid in the discretionary regime. We conclude with remarks on remaining problems.

An extended PR model

The main feature of the PR model is that both ordinary taxes and the inflation tax will move together when there are changes in revenue needs (say because of changes in public expenditures). The authors show that this result holds regardless of whether the regime is one of discretion or rules (commitment). For this purpose they use a loss function based on inflation and ordinary tax rates (which are distortionary, or undesirable in some sense). These taxes are connected by a budget constraint, that includes bonds, which are carried over from one period to the next. However, the main features of the model can be derived in a much simpler, one period model, by omitting bonds, which are not essential for the problem. We extend the PR model by adding to it a liquidity motive.

As noted earlier, the main conceptual difference between our approach and that of PR is in the deviation (m^d-m*) where m^d is the demand for real money balances (identical with the monetary base) and m* is the liquidity target, which is needed to motivate (potentially) the payment of interest on reserves in the discretionary regime. We may, but need not, interpret m* as the (finite) satiation level of real balances, which correspond to the Friedman rule (where the marginal utility of holding money is zero)[5]. We assume for simplicity that the interest on reserves is paid directly on the monetary base, which is identical with the money supply (i.e. there is only deposit money with a 100% reserve ratio)[6]. Hence we regard m^d as being a negative function of the interest differential i-v, where i is the market nominal interest rate (which equals expected inflation π^e by our earlier assumption) and v is the rate of interest paid by the central bank to money holders (through the reserves of the commercial banks). We may then write the demand for money as $m^d(x^e)$, where $x^e = \pi^e - v$.

Using the definitions $x = (\pi - v)$ and $x^e = (\pi^e - v)$ we obtain that net seigniorage is given by NS=x $m^d(x^e)$, where m^d is decreasing in x^e. Surprise inflation may raise x above x^e, and thus increase NS in the discretionary regime in a non-distortionary manner, but it is checked by the aversion to inflation as reflected by the first term in the loss function below. In equilibrium we have of course NS=x $m^d(x)$.

Let the one period loss function be given by

$$S=[(\alpha/2)\pi^2+(\gamma/2)\theta^2]+(\beta/2)(m^d-m^*)^2 \qquad (1)$$

[5] We ignore here the costs of enforcing compliance of ordinary taxes.
[6] This model can be generalized to a fractional reserve system, without affecting the main conclusions.

where the expression in the square brackets is the PR loss function and $(\beta/2)(m^d\text{-}m^*)^2$ is our addition of the liquidity motive (all parameters are positive). Here π and θ represent the (actual) inflation rate and the tax rate respectively. The budget constraint is given by

$$\psi(\theta) + xm^d = g \qquad (2)$$

We assume equilibrium in the money market so that $m^d = m$. $\psi(\theta)$, $[\psi'(\theta)>0, \psi''(\theta)<0]$, represents the total tax bill, which is the product of national income and the tax rate (the former is assumed to depend negatively on the latter with an elasticity less than one). We assume that θ is credible in both regimes, whereas π is credible only under rules. We consider real government expenditures (g) as exogenous. This completes the derivation of the basic structure of the extended (and simplified) PR model.

The commitment case

The basic aspect of the commitment regime is that it assumes full credibility of government's announcements about inflation, so $\pi = \pi^e$ identically.

It is intuitive that paying interest on money is not optimal under rules in the above framework. Take the usual case where NS is positive so that $\pi > v$. Suppose that v is positive. In this case it is possible to reduce both π and v by equal amounts, so as to leave $m^d(x)$ and θ intact and reduce the term $(\alpha/2)\pi^2$, which enables a reduction in the loss function. As long as the above conditions prevail, it is optimal <u>not</u> to pay interest on reserves, and NS will be based only on inflation. So in this case $x = \pi$.

The Lagrangian function is then

$$L = [(\alpha/2)\pi^2 + (\gamma/2)\theta^2] + (\beta/2)[m^d(\pi) - m^*]^2 - \lambda[\psi(\theta) + \pi\, m^d(\pi) - g] \qquad (3)$$

And the first order conditions w.r.t. θ, π and λ are

$$(\partial L/\partial \pi) = \alpha\pi + \beta[m^d(\pi) - m^*]\, m^{d\prime}(\pi) - \lambda\, \varphi'(\pi) = 0 \qquad (m^{d'} < 0) \qquad (4)$$

$(\partial L/\partial \theta)= \gamma\theta-\lambda\psi'(\theta)=0$ (5)

$(\partial L/\partial \lambda)= \psi (\theta)+ \pi m^d (\pi)-g=0$ (6)

where $\varphi(\pi)= \pi m^d(\pi)$=seigniorage. We assume that $\varphi'(\pi)=m(1- \eta$[7]$) >0$ and $\varphi''(\pi)<0$ which tends to result in π and θ moving both upward when g increases. This result, which is immediate for $\beta =0$ (the PR case), can be easily seen in the extended PR model ($\beta >0$) if $m^d(\pi)$ is linear (but it holds also under more general conditions).

The optimal interest on reserves under discretion.

In the discretionary regime real money balances may be eroded by inflation beyond the desirable level of the policy maker. To counteract the effect of inflation on liquidity, the central bank may be interested in subsidizing money holdings through payment of interest on money, in spite of its fiscal costs.

Following the standard procedure in optimization of the discretionary regime, we take π^e as given and minimize (1) w.r.t. θ, v and π subject to (2) and then equate π with π^e. For this purpose we form the Lagrangian function:

$L= [(\alpha/2)\pi^2+(\gamma/2)\theta^2]+ (\beta/2)[m^d(x^e)-m^*]^2 -\lambda[\psi (\theta)+ x\, m^d (x^e)-g]$ (7)

which yields, upon optimization, the following first order conditions:

$(\partial L/\partial \pi)= \alpha \pi - \lambda m^d (x^e)=0$ (8)

$(\partial L/\partial \theta)= \gamma\theta-\lambda\psi'(\theta)=0$ (9)

$(\partial L/\partial v)= \beta(m^d-m^*) m^{d'}-\lambda m^d (1-\eta)=0$, $(m^{d'}<0)$ (10)

$(\partial L/\partial \lambda)= \psi (\theta)+ x\, m^d (x^e)-g=0$ (11)

where the elasticity η is evaluated at the equilibrium point, where $x =x^e$. It can be verified from the first two conditions that θ and π move together in equilibrium (where $\pi= \pi^e$) for a given v, which is consistent with the main result of PR (where β=0). Moreover, it follows from these equations that x (the cost of holding money)

[7] where η is the elasticity of m with respect to is argument

and θ tend to move in equilibrium in the same direction as a result of an increase in g in the discretionary regime. This is easily seen in the case when the demand function is linear[8].

Note that if the discretionary policymaker has the option of paying interest on money, and does not use it, he does not minimize his loss function, that is, he does not behave optimally.

If we assume, as usual, that $\eta<1$, we see from (10) that in equilibrium real liquidity falls short of its target, $m^d<m^*$,which (potentially) provides a justification for the central bank to pay interest on reserves. This motivation is constrained by the fiscal cost of this policy, as represented by the term $\lambda m^d (1-\eta)$.

Concluding remarks

a. Implications of the Friedman rule.

According to the Friedman rule if we set r=0, as we did in the previous analysis, there is no motivation to pay interest on reserves in the rules regime. However, there is a motivation for paying interest on reserves in the ***discretionary regime***, as stated above. This holds even in a long-term discretionary model, as we show in a separate article[9].

b. The erosion of real balances by inflation

In the foregoing model, the payment of interest on reserves in the discretionary regime offsets completely the effect of a rise in inflation on real liquidity. This is in contrast to the well-known fact that high inflation economies suffer from low real liquidity. Thus, it seems that the payment of interest on reserves does not fully offset

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[8] By (11) if g rises either θ or x must rise in equilibrium. Suppose, without loss of generality, that θ rises, and hence by (9) λ rises as well. If $m^{d'} = -a<0$ (a is a positive constant), then by (10) $m^d [\beta a+ \lambda(1-\eta)]= \beta a m^*$. Suppose that x decreases, then m^d increases and $[\beta a+ \lambda(1-\eta)]$ must decrease. However, η decreases with x, so that $\lambda(1-\eta)$ increases, which leads to a contradiction. By the same argument we can rule out the case where x remains constant. Hence x and θ must move together.

[9] Liviatan and Frish (2003).

the effect of inflation on real liquidity. However this problem can be handled by some modification of the original model; we did it by means of a two-stage procedure where the interest on reserves is announced first (the proof is available from the authors by correspondence).

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