# Essential Interest-Bearing Money

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September 7, 2007

**Abstract**

In this paper, I provide a rationale for why money should earn interest; or, what amounts to the same thing, why risk-free claims to non-interest-bearing money should trade at discount. I argue that interest-bearing money is essential when individual money balances are private information. The analysis also suggests one reason for why it is sufficient (as well as necessary) for interest to be paid only on large money balances; or equivalently, why bonds need only be issued in large denominations.

## 1 Introduction

In his essay *The Optimum Quantity of Money*, Friedman (1969) argues that an optimal monetary policy entails setting the nominal interest rate to zero. This policy prescription, which is surprisingly robust across a wide class of models, is commonly known as the Friedman rule.

There are, by now, several papers that argue why deflating at the Friedman rule is not necessarily an optimal policy. Some authors have argued that efficient risk-sharing arrangements in fact require some inflation; see, for example, Levine (1991) and Molico (2006). Others have argued that some inflation is necessary to mitigate the distortions induced by search and bargaining frictions; see, for example, Lagos and Rocheteau (2005) and Rocheteau and Wright (2005). Elsewhere, I have argued that while deflating at the Friedman rule may be a desirable policy, an *ex post* rationality constraint may prevent such a policy from being implemented; see Andolfatto (2007). Finally, some authors have argued that it is desirable (and essential) from a social perspective to render government bonds illiquid, so that they trade at discount; see Kocherlakota (2003) and Shi (2007).

In this paper, I abstract entirely from the considerations highlighted in the literature cited above. In particular, I employ a version of Lagos and Wright (2005), so that inflation has no benefit in terms of improving risk-sharing. I

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also employ a competitive market structure, so that inflation is not desirable for the purpose of mitigating any search and bargaining frictions. Moreover, I restrict preferences in a manner that implies *ex post* rationality is always satisfied. Finally, in the environment I consider, an illiquid bond is inessential; at least, if one permits interest to be paid on money. I ask whether paying interest on nominal government debt may nevertheless be an essential component of an optimal monetary policy. I find that this departure from the Friedman rule is in fact essential when individual money balances are private information.

The logic underpinning this result can be expressed simply as follows. Let $r > 0$ denote the real interest rate that would prevail in a world free of any trading frictions. In the environment I consider, there are frictions that prevent an economy from achieving this optimal interest rate; and these same frictions imply an essential role for nominal government debt. Let $i$ denote the nominal interest rate that is paid on government debt; and let $\pi$ denote the rate of inflation. If $i$ and $\pi$ are policy instruments, then an optimal policy entails setting $(i - \pi) = r$. That is, if one permits interest to be paid on money balances, there exists a continuum of policies $(i, \pi)$ that are consistent with efficiency.

The Friedman rule asserts that $i = 0$ is desirable; so that $\pi = -r < 0$. One way to achieve the requisite rate of deflation is to contract the money supply by way of lump-sum taxes on money balances.[1] I assume, quite reasonably I think, that observable money balances are taxable. If this is so, then as $(i, \pi) = (0, -r)$ falls within the class of efficient policies, I argue that interest-bearing money is inessential when money balances are observable.

I then consider the case in which private money balances are private information. When this is so, money balances may be 'hidden' for the purpose of evading a nominal tax. If money balances can be hidden with impunity, then lump-sum taxation (and hence, deflation) is necessarily ruled out. I demonstrate below that this also prevents any policy $(i, \pi \geq 0)$ from implementing the efficient allocation. In this latter case, there is a constrained-efficient policy $(i, \pi \geq 0)$ that satisfies $(i - \pi) = 0 < r$. But as $(i, \pi \geq 0) = (0, 0)$ is one such policy, I argue that this is also a case in which interest-bearing money is inessential.

Of course, the fact that private money balances can be hidden does not necessarily imply that they will be. In particular, agents can be expected to reveal their money balances, if it is in their interest to do so. I argue below that the only way to ensure incentive-compatibility is to pay interest on money. That is, when money pays interest, agents that hold money must reveal them in order to collect interest. Moreover, once money is displayed it is observable; and hence, by assumption, taxable. If the interest return (weakly) exceeds the tax cost, then agents will find it in their interest to reveal their money balances. I demonstrate below that this condition is met if and only if $\pi \geq 0$. In this case then, I find that a policy $(i, \pi \geq 0)$ together with a lump-sum tax on those who

[1] Cole and Kocherlakota (1998) demonstrate that there are, in fact, many different ways to implement a desirable zero interest rate policy.

present money for redemption can implement the efficient allocation. In fact, any such policy with $(i - \pi) = r$ will suffice. But as $\pi \geq 0$ is necessary for implementation, it follows that $i > 0$ is absolutely essential for this policy to work.

The model I consider has one other interesting implication; namely, that it is both necessary and sufficient for interest to be paid only on 'large' money balances. I also find that if one restricts the payment of interest on money-tokens, then optimal policy requires the issuance of nominal interest-bearing (illiquid) bonds. Combined with the fact that interest need only be paid on 'large' money holdings, this suggests one possible explanation for why government bonds are typically only issued in large denominations.

# 2 The Environment

The environment is similar to that described in Andolfatto (2007); itself a version of Lagos and Wright (2005) absent any search frictions.

The economy is populated by a mass of *ex ante* identical agents, distributed uniformly on the unit interval. Each period $t = 0, 1, 2, ..., \infty$ is divided into two subperiods which, for convenience, are labeled 'day' and 'night.' All agents have an opportunity to produce or consume during the day. At night, agents have an equal probability $0 < \pi \leq 1/2$ of realizing either an opportunity to produce or a desire to consume; and with probability $(1 - 2\pi)$ they simultaneously have no opportunity to produce nor any desire to consume. Label these agents consumers, producers, and nonparticipants.

Let $x_t(i) \in \mathbb{R}$ denote the consumption of output during the day at date $t$ for agent $i$; where $x_t(i) < 0$ is interpreted as production. Similarly, let $c_t(i) \in \mathbb{R}_+$ and $y_t(i) \in \mathbb{R}_+$ denote consumption and production at night, respectively. Let $u : \mathbb{R}_+ \to \mathbb{R}$ and $g : \mathbb{R}_+ \to \mathbb{R}_+$; where $u(c)$ denotes the flow utility of consumption and $-g(y)$ denotes the flow utility of production (the utility flow associated with nonparticipation is normalized to zero). Assume that $u'' < 0 < u'$, $u'(0) = +\infty$, $u(0) = -\infty$ and $g' > 0$, $g'' \geq 0$.

Hence, preferences for representative agent $i \in [0, 1]$ are given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ x_t(i) + \pi \left[ u(c_t(i)) - g(y_t(i)) \right] \right\};$$

where $0 < \beta < 1$. As all goods are nonstorable, the economy-wide resource constraints are given by:

$$\begin{aligned} \int x_t(i) di &= 0; \\ \pi \int c_t(i) di &= \pi \int y_t(i) di; \end{aligned}$$

for all $t \geq 0$.

Weighting all agents equally, the planning problem reduces to choosing a $y$ that maximizes *ex ante* utility:

$$W(y) = \left(\frac{\pi}{1-\beta}\right)[u(y) - g(y)]. \qquad (1)$$

Clearly, the function $W$ is strictly concave and achieves a unique maximum at $y^*$ satisfying $u'(y^*) = g'(y^*)$.

In short, the planner assigns $c_t^*(i) = y^*$ and $y_t^*(i) = 0$ if $i$ is a consumer during the night; and $c_t^*(i) = 0$ and $y_t^*(i) = y^*$ if $i$ is a producer during the night. Observe that as $x_t(i)$ enters linearly in preferences, any lottery over $\{x_t(i) : t \geq 0\}$ that satisfies $E_0 x_t^*(i) = 0$ would satisfy the resource constraint and entail no *ex ante* welfare loss.

I assume that agents lack commitment and that private trading histories are unobservable. I also assume that agent types (whether producer, consumer, or nonparticipant) are private information. Given these frictions, it is known that social welfare can be improved with the introduction of tokens, commonly referred to as *money.* Note that money can only be created by society; and not by private agents. Assume that tokens are perfectly durable and divisible.

Assume that trade occurs on a sequence of competitive spot markets involving *quid-pro-quo* exchanges of money for output. These markets open in the day and in the night; let $(v_d, v_n)$ denote the value of money in the day and night markets, respectively. I also allow society to pay interest on money and/or make lump-sum money transfers at the beginning of each day market. Thus, society can commit to making nominal payments in relation to its outstanding nominal debt (money); while individuals cannot commit to repay loans at all.

I also allow society to impose *nominal* penalties on individuals.[2] Whether these nominal penalties are feasible or not will depend critically on whether individual money balances in the day-market are private information or not. In what follows, I will consider each case in turn, as my conclusion rests heavily on the nature of this information structure.

# 3 Observable Money Balances

## 3.1 Individual Decision-Making

Let $R$ denote the (gross) nominal interest rate and let $\tau$ denote a nominal lump-sum transfer (or tax, if $\tau$ is negative). I begin my analysis by assuming that individual money balances (at the beginning of each day) $z$ are observable

[2] In particular, I do not allow society to impose real penalties; for example, by forcing agents to produce output.

and that society has the power to tax these nominal balances. Because money balances are observable, it is feasible to condition interest payments and tax obligations on money holdings.

As is well-known, the assumption of quasi-linear preferences admits an analytical solution for the equilibrium beginning-of-period money balances. In the present context, this distribution will be massed over three points $\{0, z_L, z_H\}$, with $z_L < z_H$. In what follows, I assume that only agents with $z \geq z_H$ are entitled to receive interest and money transfers (or obliged to pay a nominal tax, if the transfer is negative). As it turns out, this assumption is made without any loss of generality.

#### 3.1.1 The Day-Market

Let $m$ denote money carried forward into the night-market. For agents with $z \geq z_H$, the day-market choice problem can be stated as follows:

$$D(z) \equiv \max_{m} \{v_d (Rz + \tau - m) + N(m)\}; \tag{2}$$

where $N(m)$ is the value associated with carrying the money $m$ into the night-market (note that there is no discounting between subperiods). The associated FOC is given by:

$$v_d = N'(m). \tag{3}$$

In addition, we have the envelope result:

$$D'(z) = Rv_d. \tag{4}$$

For all agents with $z < z_H$, the choice problem is the same as above, except with $R = 1$ and $\tau = 0$. Hence, the only modification required for these agents is in terms of the envelope condition (4); which is given by:

$$D'(z) = v_d. \tag{5}$$

#### 3.1.2 The Night-Market

**Consumers** Let $C(m)$ denote the value associated with being a consumer, entering the night-market with money balance $m$. The choice problem can be stated as follows:

$$C(m) \equiv \max_{y,,z^+} \left\{u(y) + \beta D(z^+) : z^+ \geq 0,\ m \geq v_n^{-1} y\right\};$$

where $z^+ = m - v_n^{-1} y$. Here, I make an educated guess that:

$$y = v_n m; \tag{6}$$

so that $z^+ = 0$. In this case, the value function is given by:

$$C(m) \equiv u(v_n m) + \beta D(0). \tag{7}$$

By the envelope theorem:

$$C'(m) = v_n u'(y). \tag{8}$$

**Producers** Let $P(m)$ denote the value associated with being a consumer, entering the night-market with money $m$. The choice problem can be stated as follows:

$$P(m) \equiv \max_{y,z^+} \left\{ -g(y) + \beta D(z^+) : z^+ \geq 0 \right\}$$

where $z^+ = m + v_n^{-1} y$. Clearly, the constraint $z^+ \geq 0$ will not bind, so that the problem can be restated as:

$$P(m) \equiv \max_{y} \left\{ -g(y) + \beta D(m + v_n^{-1} y) \right\}. \tag{9}$$

The associated FOC is given by:

$$v_n g'(y) = R\beta v_d^+; \tag{10}$$

where use has been made of (4). In addition, we have the envelope result:

$$P'(m) = R\beta v_d^+; \tag{11}$$

where again, use has been made of (4).

**Nonparticipants** Let $I(m)$ denote the value associated with being 'idle' (a nonparticipant), entering the night-market with money $m$. This type of agent faces no choice problem; so that:

$$I(m) \equiv \beta D(m); \tag{12}$$

and

$$I'(m) = \beta v_d^+; \tag{13}$$

where here, use has been made of (5).

### 3.1.3 Gathering Restrictions

The *ex ante* value function associated with entering the night-market with money balances $m$ is given by:

$$N(m) = \pi C(m) + \pi P(m) + (1 - 2\pi) I(m). \tag{14}$$

Therefore,

$$N'(m) = \pi v_n u'(y) + \pi R\beta v_d^+ + (1-2\pi)\beta v_d^+; \tag{15}$$

where use has been made of (8), (11), and (13).

Combining (3) and (15),

$$v_d = \pi v_n u'(y) + \pi R\beta v_d^+ + (1-2\pi)\beta v_d^+.$$

As $v_n g'(y) = R\beta v_d^+$ by condition (10), the expression above can be written as:

$$v_d = v_n \left[\pi u'(y) + \pi g'(y) + (1-2\pi)R^{-1}g'(y)\right].$$

Multiplying both sides by $R\beta$ and updating one period yields:

$$R\beta v_d^+ = R\beta v_n^+ \left[\pi u'(y^+) + \pi g'(y^+) + (1-2\pi)R^{-1}g'(y^+)\right].$$

Now, from (10), $R\beta v_d^+ = v_n g'(y)$. Combining this with the expression above yields:

$$v_n g'(y) = R\beta v_n^+ \left[\pi u'(y^+) + \pi g'(y^+) + (1-2\pi)R^{-1}g'(y^+)\right].$$

In what follows, I restrict attention to a steady-state in which $y = y^+$ and $(v_n^+/v_n)$ is equal to some constant. Hence, for a given $R$ and $(v_n^+/v_n)$, we can rewrite the condition above as:

$$g'(y) = R\beta \left(\frac{v_n^+}{v_n}\right) \left[\pi u'(y) + \pi g'(y) + (1-2\pi)R^{-1}g'(y)\right]. \tag{16}$$

## 3.2 Equilibrium

Government policy is described by a triplet $(R, \tau, \mu)$ where $\mu$ is the (gross) rate of growth in the money supply $M$; i.e., $M = \mu M^-$.

In equilibrium, $m = M$, so that, by condition (6), the night value of money satisfies:

$$v_n = \frac{y}{M}.$$

Hence, in a steady-state we have:

$$\left(\frac{v_n^+}{v_n}\right) = \left(\frac{1}{\mu}\right).$$

Combining this with equation (16), the equilibrium level of output in the night-market $\hat{y}$, conditional on policy $(R, \mu)$ satisfies:

$$u'(\hat{y}) = \left[\frac{1 - \pi\Delta - (1-2\pi)R^{-1}\Delta}{\pi\Delta}\right] g'(\hat{y}); \tag{17}$$

where,

$$\Delta \equiv \left( \frac{R\beta}{\mu} \right). \tag{18}$$

Observe that if $\pi = 1/2$, then $\hat{y} = y^*$ iff $\Delta = 1$. But in general, an optimal policy $(R, \mu)$ must satisfy:

$$\mu = \beta \left[ 1 + (R-1)2\pi \right]. \tag{19}$$

Observe that $\mu = \beta$ if $R = 1$.

Note that it is a property of this quasi-linear model that the characterization of $\hat{y}$ in (17) is independent of how money is injected into (or withdrawn from) the economy. Likewise, $\hat{y}$ is determined independently of other equilibrium variables, for example, $\hat{v}_d$ and $\hat{x}$ (although, the converse is not true). The only thing of relevance to report here in terms of day-market activity are two well-known results:

**R1** At the beginning of the day, the distribution of money balances is a three-point distribution; with measure $\pi$ holding $z_H = 2M^-$ dollars (those who produced in the previous night-market); with measure $(1 - 2\pi)$ holding $z_L = M^-$ dollars (those who were nonparticipants); and with measure $\pi$ holding zero dollars (those who consumed in the previous night-market).

**R2** At the end of the day, the entire population holds an equal amount of money $m = M$.

I conclude by describing the government budget constraint. Recall that only ex-producers are entitled to earn interest and are obliged to pay taxes. Each ex-producer returns to the day-market with $z_H = 2M^-$ dollars. Hence, society bears a net interest cost equal to $(R-1)2M^-$ (per ex-producer). At this point, society can target these agents (excluding all others) as recipients of a transfer of new money $(\mu - 1)2M^-$ (per ex-producer). The transfer that society makes to these agents net of interest cost is therefore given by:

$$\begin{aligned} \tau &= (\mu - 1)2M^- - (R-1)2M^-; \\ &= (\mu - R)2M^-. \end{aligned} \tag{20}$$

## 3.3 Optimality of the Friedman Rule

Condition (19) asserts that the optimal monetary policy involves setting

$$\mu = \beta \left[ 1 + (R-1)2\pi \right].$$

Moreover, this policy is constrained to satisfy (20):

$$\tau = (\mu - R)2M^-.$$

As lump-sum taxation is feasible, then there is a continuum of policies $(\mu, R)$ that implement the first-best allocation. Imagine, for example, that the money supply is held constant, so that $\mu = 1$. Then it is optimal to pay interest on money; i.e., condition (19) then implies:

$$R = \left[ \frac{1 - \beta + \beta 2\pi}{\beta 2\pi} \right] > 1. \tag{21}$$

But interest-bearing money is not essential here. In particular, optimality can also be achieved by setting $R = 1$ and $\mu = \beta < 1$ (Friedman rule). Note that in either case, the optimal policy requires $\tau < 0$.

Of course, this argument in favor of the Friedman rule as an optimal policy explicitly assumes that money balances are observable and taxable. Arguably, this is not an entirely attractive assumption, given that agents in the model acquire and spend their money in anonymous spot market transactions.

One way to bypass the Friedman rule as a prescription for optimal policy is to simply (and crudely) rule out lump-sum taxation altogether; i.e., restrict policy so that $\tau \geq 0$. In this case, a constrained-efficient monetary policy is without loss characterized by $\mu = R$; i.e., see (20). Obviously, one solution here is simply to hold the money supply constant and pay no interest on money. In other words, ruling out lump-sum taxes in this manner does not in any way make interest-bearing money essential here.

Implicit in the restriction $\tau \geq 0$ is the idea that personal money balances can be hidden from society with impunity. But while personal money balances may indeed be private information (and therefore hidden), this does not necessarily imply that they *will* be. In particular, agents will reveal their true money balances if doing so is incentive-compatible. I argue below that paying interest on money is the way society can implement an incentive-compatible allocation.

# 4 Incentive-Compatible Monetary Policy

I now assume that money balances are private information. The question now is whether ex-producers have an incentive to reveal their true money balances $2M^-$ (as all other agents are not subject to tax, incentive-compatibility for them is trivially satisfied). The question boils down to determining whether ex-producers will end up with more money by revealing it or by hiding it.

If ex-producers reveal their money (i.e., report $z = 2M^-$), they end up with

$$R2M^- + \tau$$

dollars. If they instead choose to misrepresent their money balances (i.e., report $z < 2M^-$), they end up with

$$2M^-$$

dollars. Clearly, they will report truthfully iff $R2M^- + \tau \geq 2M^-$. Using condition (20), this incentive-compatibility condition reduces to:

$$\mu \geq 1. \tag{22}$$

Hence, incentive-compatibility precludes a deflationary policy.

We may, without loss, restrict attention to policies with $\mu = 1$ (the maximum deflation rate allowable). But then, optimal policy requires a strictly positive nominal interest rate; i.e., see (21). By condition (20), the equilibrium transfer is given by $\tau = (1 - \beta^{-1})2M^- < 0$. Because $R > 1$ is absolutely necessary to achieve this result, interest-bearing money is essential.

**Proposition 1** *If money balances are private information, then an optimal incentive-compatible monetary policy requires that money earn a strictly positive net nominal interest rate.*

Let me discuss this result and how it relates to the literature. First note that when lump-sum taxes are ruled out exogenously ($\mu = R$), the monetary equilibrium allocation $\hat{y}$ is inefficient; see condition (17). In this equilibrium, consumers are liquidity/debt constrained; see (6). If types were observable, then policy might rectify this situation by targeting money transfers to consumers in the night-market. But as types are private information, such a policy is infeasible; see also Kocherlakota (2003).

The basic problem then is that the (real) rate of return on money is too low. In the absence of any frictions, the competitive equilibrium real interest rate is $1/\beta - 1 > 0$. In a monetary economy, when $\mu = R$, the real return on money is zero. Of course, this return could, in principle be increased to $1/\beta - 1$ by setting $\mu = \beta$. However, when money balances are private information, such a policy is not incentive-compatible.

The question then is how to increase the real return on money; i.e., how to engineer $R > \mu$? Simply paying $R$ and financing the implied interest charges by printing money at rate $\mu$ will not work; as government budget balance in this case implies that $\mu = R$. One solution is to hold the money supply constant and pay interest $R = \beta^{-1}$ financed by a lump-sum tax on those who present their money to collect interest.[3] The effect of paying interest on money to increase the marginal return to production in the night-market; see (10). That is, producers are more willing to buy cash if it earns them a higher rate of return. This result is similar to that of Berentsen, Camera, and Waller (forthcoming) who introduce an intermediary that pays interest on deposits of money.

Let me conclude this section by highlighting one other interesting result. In particular, observe that (in this environment, at least), an optimal monetary policy need only pay interest on 'large' money balances. In other words,

[3] Under this program, agents are just indifferent between presenting their money and hiding it. I assume here that when indifferent, they choose the former option.

**Proposition 2** *If money balances are private information, then it is both necessary and sufficient for an optimal incentive-compatible monetary policy to pay interest only on 'large' money balances.*

Note that the proposition above does not rule out the possibility that interest might be paid on small money balances; the proposition merely states that doing is inessential (assuming that such a policy is even feasible). What is essential is that 'large' money balances earn interest.

# 5 Money and Bonds

Paying interest on money-tokens is not often viewed as a practical policy. Suppose we exogenously rule out paying interest on money (objects that circulate as a means of payment). In this case, one can then demonstrate how an optimal policy requires the creation of two distinct tokens. One token is non-interest-bearing object that circulates; and hence resembles what most people would call cash. The other token represents a non-circulating sure claim against the non-interest-bearing token; and hence resembles what most people would call a risk-free nominal bond. For convenience, I will refer to these two tokens as money and bonds, respectively.

Trade proceeds as described earlier, but with one modification. That is, in the day and night markets, agents trade output for money as before. However, imagine now that society opens a "discount window" just subsequent to night-market trading. At this window, money can be exchanged for bonds at the discount price $q \leq 1$. That is, a bond pays off $q^{-1}$ units of money immediately the next day. Those who choose to present their bonds for redemption are required to pay a lump-sum fee $-\tau$. Note that this structure effectively imposes a cash-in-advance constraint on goods-market trading (i.e., bonds cannot be used to purchase output; and hence, are illiquid in this sense).

Obviously, the role of a bond here is simply to replicate what could have been achieved by paying interest on money directly (if doing so was possible). Hence, it should come as no surprise that an optimal (and incentive compatible) policy in this case is to set $(\mu, q) = (1, \beta)$. Moreover, the imposition of a cash-in-advance constraint actually serves to promote social welfare.[4] It is of some interest to note that, in light of proposition 2, an optimal policy here only requires that bonds be issued in 'large' denominations. In doing so, agents with 'small' money balances are discouraged from purchasing bonds. As far as efficiency is concerned, excluding some agents in this manner is fine; as the social problem here lies in encouraging those in a position to accumulate large money balances to produce at efficient levels.[5]

[4] If bonds were allowed to used as a payment device, a simple no-arbitrage argument dictates that they must, in equilibrium, sell at par.

[5] Note that, for the equilibrium described here, even if bonds were offered in small denomi-

What this analysis demonstrates is that if money cannot pay interest, then an illiquid bond is essential. However, as the environment considered here provides no rationale for why money cannot earn interest, the theory falls short of explaining why an illiquid bond is essential in the sense of Kocherkota (2003) and Shi (2007). All that I can conclude here is that interest-bearing money is essential (if money balances are private information), and there are potentially many different trading arrangements that can replicate this result with a combination of non-interest-bearing and interest-bearing assets.

# 6 Conclusion

My paper provides a rationale for why money should earn interest; or, what amounts to the same thing, why risk-free claims to non-interest-bearing money should trade at discount. The rationale is as follows. In monetary economies, efficiency dictates that money earn a positive real rate of return. When individual money balances are observable (and taxable), efficiency can be achieved by deflating at the Friedman rule. But when individual money balances are private information, incentive-compatibility precludes a deflationary policy, so that a strictly positive nominal interest rate (financed by a lump-sum tax) is essential.

Moreover, my paper provides a rationale for why it is sufficient (as well as necessary) to pay interest only on large money balances; or equivalently, why bonds need only be issued in large denominations. The rationale for this is that the point of increasing the real return on money is to encourage those who are in a position to sell output for money to expand their production. In other words, society needs to reward those who add to their money balances (by increasing sales); rather than rewarding those who do not (by remaining idle or spending their money). However, whether this latter result is specific to my environment (where large money balances correlate perfectly with recent production) remains an open question.

nation, agents with small money balances would choose not to purchase them (the redemption fee would outweigh the interest benefit). On the other hand, if redemption fees could be conditioned on money balances presented for redemption, then agents with small money holdings would be indifferent between holding money or exchanging them for bonds. Allowing for this possibility, however, in no way expands the set of implementable allocations.

# References


1. Andolfatto, David (2007). "Incentives and the Limits to Deflationary Policies," Manuscript.

2. Berentsen, Aleksander, Gabriele Camera and Christopher Waller (forthcoming). *Journal of Economic Theory.*

3. Cole, Hal and Narayana Kocherlakota (1998). "Zero Nominal Interest Rates: Why They're Good and How to Get Them," *Federal Reserve Bank of Minneapolis Quarterly Review*, 22(2): 2-10.

4. Friedman, Milton (1969). The Optimum Quantity of Money, in *The Optimum Quantity of Money and Other Essays*, 1–50, Chicago: Aldine.

5. Kocherlakota, Narayana (2003). "Societal Benefits of Illiquid Bonds," *Journal of Economic Theory*, 108: 179–193.

6. Lagos, Ricardo and Guillaume Rocheteau (2005). "Inflation, Output, and Welfare," *International Economic Review,* 46(2): 495–522.

7. Lagos, Ricardo and Randall Wright (2005) "A Unified Framework for Monetary Theory and Policy Analysis," *Journal of Political Economy*, 113: 463–484.

8. Rocheteau, Guillaume and Randall Wright (2005). "Money in Search Equilibrium, in Competitive Equilibrium, and in Competitive Search Equilibrium," *Econometrica*, 73: 75–102.

9. Levine, David (1991). "Asset Trading Mechanisms and Expansionary Monetary Policy," *Journal of Economic Theory*, 54: 495–522.

10. Molico, Miguel (2006). "The Distribution of Money and Prices in Search Equilibrium," *International Economic Review*, 47(3): 701–722.

11. Shi, Shouyong (2007). "Efficiency Improvement from Restricting the Liquidity of Nominal Bonds," Manuscript.