On the Coexistence of Money and Bonds*

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Abstract

This paper re-examines the so-called *coexistence puzzle* in terms of a modified version of the legal restrictions hypothesis initially put forth by Bryant and Wallace (1980). The modification is in terms of dropping a questionable assumption in the original hypothesis; i.e., that large denomination government bonds cannot be intermediated by private banks. This restriction is replaced by one that is arguably more palatable; i.e., that the intermediated monetary instruments created by private banks are not universally acceptable as payment for all exchanges (unlike government money). The friction that gives rise to this latter restriction is one that is commonly employed in monetary models where fiat money is essential for exchange.

1 Introduction

The principle of *no-arbitrage* asserts that any two assets with identical risk characteristics should earn identical rates of return, if they are to be held willingly in the wealth portfolios of individuals. As is well known, this stark prediction appears to be inconsistent with the rate of return differential that normally exists between government-issued money and other types of financial instruments that may conceivably be used as payment instruments.

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This discrepancy between theory and observation is referred in what follows as the *coexistence puzzle*.

The coexistence puzzle is sometimes framed in terms of (fiat) money *vis-à-vis* higher-return assets in general (presumably with similar risk characteristics), including capital or titles to capital; e.g., Wallace (2003).[1] While no private security shares *exactly* in the risk characteristics of government money, some securities appear to come sufficiently close; for example, the demand deposit liabilities of modern chartered banks, which are typically redeemable (at par) in government money (and largely insured by the government). Of course, demandable bank liabilities, which these days take the form of electronic credits, do 'circulate' (from account to account) as the main payment instrument in any well-developed economy. As well, this type of money typically pays interest. Nevertheless, government money (which, in paper form, pays no interest) continues to coexist with bank money. Understanding why this might be the case is an interesting question (and is addressed below); but such an understanding would not constitute full answer to the coexistence puzzle.

The more challenging dimension to the coexistence puzzle is in terms of explaining the coexistence of government money and government bonds. Or, to put it more precisely, the coexistence of two debt instruments, each of which is issued by the same government (ignoring the fact that separate government agencies may be involved), each with (virtually) identical nominal risk characteristics, but with only one of the two instruments yielding interest. On the surface at least, bonds appear to weakly dominate money in every dimension. And yet, like bank money, bonds are not universally (or even widely) accepted in payment for goods and services. Why is this the case?

The common explanation for the coexistence puzzle is that money is a 'special' type of asset. In particular, money provides nonpecuniary 'liquidity' services that makes it a preferred method of payment relative to other types of assets. This is the basic idea behind any model that generates a demand for money by assuming that money enters into the utility (or shopping time) function or by assuming that some purchases are subject to a cash-in-advance constraint. While these 'short-cut' methods have their uses, they are ill-suited for the question at hand since they essentially assume away the

[1] Wallace (2003) credits Hicks (1935) with being the first to recognize the issue at hand. But this is not quite right, at least if the coexistence question is framed in terms of two assets with identical risk characteristics. In Hick's (1935) analysis, the risk characteristics of capital appears to play an important role in determining the demand for money.

coexistence puzzle. Here, I take the view that any satisfactory explanation should be couched in terms of a model with a physical environment that renders money *essential* for trade; i.e., see Kocherlakota (1998).

An early attempt at explaining coexistence is the 'legal restrictions' hypothesis put forth by Bryant and Wallace (1980) and Wallace (1983). This hypothesis has been attacked on the basis of the empirical validity of its underlying assumptions (which presumably accounts for why the theory appears to have fallen out of favor). But I argue below that a modified version of this hypothesis can provide a compelling explanation for coexistence. The modification is in terms of dropping a questionable assumption in the original hypothesis; i.e., that large denomination government bonds cannot be intermediated by private banks. This restriction is replaced by one that is arguably more palatable; i.e., that the intermediated monetary instruments created by private banks are not universally acceptable as payment for all exchanges (unlike government money). The friction that gives rise to this latter restriction is one that is commonly employed in monetary models where fiat money is essential for exchange.

The paper proceeds as follows. In Section 2, I briefly review the original legal restrictions hypothesis and critically evaluate the objections put forth against it. In Section 3, I lay out the basic framework of my own model without government bonds to highlight the role played by money in this environment and to provide an explanation for the coexistence puzzle between money and private assets. Section 4 then introduces government bonds and examines the conditions under which coexistence prevails between money and bonds. Section 5 discusses the general results and relates them to some recent competing explanations. Section 6 concludes.

2 Legal Restrictions

One of the first explanations for the coexistence puzzle is the 'legal restrictions' hypothesis put forth by Bryant and Wallace (1980) and Wallace (1983). In the overlapping generations model that they consider, money and bonds naturally earn the same rate of return. However, the authors highlight two features of the environment that may prevent this from happening. First, negotiable bearer bonds tend to be issued in very large denominations. Second, legal restrictions prevent banks from issuing low denomination banknotes, which prevents the intermediation of large denomination government debt.

The large denomination property of government debt is only a necessary and not sufficient condition. In particular, a profit maximizing bank could exploit an existing arbitrage opportunity by issuing its own small denomination notes that are fully backed by large denomination government bonds. Competition among banks would presumably drive the return on private banknotes in line with the return on bonds (with perhaps a small differential to cover the costs of intermediation). For any strictly positive interest rate, the demand for non-interest bearing money should then fall to zero. The legal restriction on the issuance of private banknotes is what prevents this from happening.

The legal restrictions hypothesis has been challenged by those who question the empirical validity of its two underlying assumptions. First, numerous authors have pointed out the fact that historically, many governments have attempted to circulate 'small' denomination interest-bearing bonds. For example, over the period 1915–27, the government of France issued *bons* (interest-bearing treasury debt) in denominations as low as 100 Francs; see Makinen and Woodward (1986). Despite their many attractive features, *bons* did not drive Bank of France notes out of circulation. Makinen and Woodward argue that the *bons* episode in France provides evidence that overturns one of the underlying assumptions of the legal restrictions hypothesis.

But there is reason to doubt this claim. Evidently, the lowest denomination *bon* was 100 Francs, which by my own calculation is equivalent to roughly 100 USD today. Other indirect evidence suggesting that the *bon* was a larger denomination note is the fact that it was readily used in larger transactions (e.g., real estate). Thus, I do not believe that one can conclude, as Makinen and Woodward claim, that *bons* were suitable for 'everyday exchange.' The same can be said of the 'low' denomination interest bearing treasury bills issued by both the Northern and Southern governments in the United States during the civil war; see Burdekin and Weidenmier (2002). During this episode, the minimum denomination interest-bearing note issued was $5, which again is approximately the equivalent of 100 USD today.

Let me dwell for a moment on the issue of denomination, since it plays an important role in my own explanation. First, there appears to be no compelling evidence to suggest that governments have ever issued interest-bearing currency in the range of denominations that were available in their non-interest-bearing counterparts. Thus, to the extent that individuals find low denomination money convenient, it is not surprising to learn that the issuance of interest-bearing money in 'intermediate' denominations did not

drive non-interest-bearing money out of circulation. On the other hand, a somewhat subtler issue remains. In particular, why does it appear that interest-bearing money coexisted with non-interest-bearing notes of *identical* denomination? I will return to this question in the sequel; but for now will conclude that the assertion of large denomination bond-issue appears to be an empirically valid assumption.

The more problematic feature of the legal restrictions hypothesis is the assertion that banks are legally prohibited from issuing their own small denomination notes, thereby preventing them from intermediating large denomination bonds. We know of historical episodes in which this assumption appears, on the surface at least, to be invalid. For example, during the so-called 'free-banking' era in the United States (1836–63), most states passed laws making it relatively easy to establish a state bank and issue 'low' denomination notes.[2] While banks did intermediate government bonds, the notes they issued (redeemable in specie) generally did not pay interest. Similarly, during the Scottish free banking system (1716–1864), while Scottish banks were not prohibited from issuing 'low' denomination interest bearing notes (again, redeemable in specie), they evidently chose not to (although they did pay interest on demand deposit accounts); e.g., see White (1987). The fact that zero interest notes (and specie) coexisted with higher yielding securities in these eras of relatively free banking casts some doubt on the legal restrictions hypothesis. On the other hand, Rolnick and Weber (1982) and Cowan and Kroszner (1989) forcefully point out that these so-called 'free-banking' eras operated in highly regulated regimes. For example, Scottish banks were prohibited from issuing notes in denominations lower than £1 (worth approximately 200 USD today).

In my view, however, perhaps the clearest evidence that contradicts the second assumption of the legal restrictions hypothesis is to be found in modern economies with well-developed electronic payment systems. While banks do not issue low denomination payment instruments in paper form (either willingly or by legal restriction), they can and do issue highly divisible interest-bearing demand deposits that these days are essentially the electronic equivalent of privately issued interest bearing paper notes. Unlike the banknotes of old, which were made redeemable for specie, the electronic bank money of today is made redeemable for government-issued zero interest paper notes (cash). Thus, in the context of present day economies, the coexistence puzzle may be framed as asking why cash continues to coexist with

[2] Shortly after the National Banking Act of 1863, a 10% tax was imposed on banknotes and they quickly disappeared from circulation.

what appears to be a dominant monetary instrument (i.e., interest-bearing demand liabilities that are safely backed, in part, by government bonds).

In the model I develop below, I maintain the assumption that government interest bearing debt is issued in large denominations, making it unsuitable for 'everyday' payments. But I dispense with the assumption that legal restrictions prevent banks from intermediating large denomination bonds. In the model below, banks can and do intermediate bonds by issuing a highly divisible 'electronic' interest bearing payment instrument. I replace the legal restriction with what is arguably a more plausible assumption: That there is a less than complete public record of individual trading histories. This assumption implies that privately-issued debt instruments are not universally accepted for all types of payments–a restriction that makes fiat money essential for trade. Efficiency in this environment entails the emergence of banks whose assets constitute cash, bonds and loans; and whose interest-bearing liabilities must be made redeemable on demand for cash. Bonds earn interest because they must compete with capital in the wealth portfolios of individuals. Non-interest bearing cash is valued for its ability to facilitate exchange in trading opportunities where the seller cannot easily verify the legitimacy of the buyer's bank instrument (e.g., a check drawn on a non-local bank) or where the seller does not have access to a centralized payment system (which prevents a debit-card transaction).

3 The Basic Model

The model developed here is similar to one developed by Smith (2003) and Andolfatto (2003). Consider an economy consisting of two separate 'locations' A and B. Of course, one need not interpret 'locations' literally as being spatially separated. The key assumption is that the trading histories of an agent (or agency) belonging to A are not observable by those agents (or agencies) belonging to B; and vice-versa. This restriction on the environment implies that private liabilities issued in location A are not recognized in location B (and vice-versa). Each location is populated by N_t young agents at date $t = 1, 2, ..., \infty$ who live for two periods. There is an initial old generation N_0 in each location. Let n denote the (gross) rate of population growth.

Each young agent is relocated to the 'other' location with probability $0 < \pi < 1$. One can interpret this event as the probability of being confronted with a trading opportunity in which the buyer and seller (and their

respective banks) are anonymous to each other (so that privately-issued liabilities are not an acceptable form of payment). In what follows, I will refer to π as the probability of a 'liquidity shock.' Assume that this liquidity shock is private information. Since there is no aggregate uncertainty, π also represents the fraction of young agents making a transition to a 'foreign' location. Hence, the young (in location A) have an expected utility function:

$$U = (1-\pi)u(c_A) + \pi u(c_B), \tag{1}$$

where $u' > 0 > u''$ and c_j denotes consumption in location $j = A, B$ (the young in location B have similar preferences).

Young individuals are endowed with $y > 0$ units of output. There is an investment technology that takes k units of current output and delivers xk units of future output, where $x > n$. The investment choice must be made before the realization of the liquidity shock. Assume that capital is too costly to scrap so that it cannot be transported across locations. As well, assume that capital depreciates fully after yielding its return. Young agents only care about consumption when old (so that they save their entire endowment).

Since capital cannot be scrapped and since private liabilities are not accepted in foreign locations, there is a role for fiat money. Assume that the initial old of each location are endowed with a stock of fiat money M. The supply of money is held constant over time, so that it earns a real (gross) return equal to n. Note that money will be valued (for its insurance properties) despite being dominated in rate of return.

Since the young save their entire endowment, the only relevant choice is over the composition of their savings; i.e., money (q) or capital (k). Since the portfolio decision must be made before an agent experiences a liquidity shock, the young have incentive to form a coalition (which I will call a *bank*). The bank takes deposits y, which it uses to purchase money (from the old), investing the remainder in the location specific capital project. The private information friction is easily circumvented by making bank deposits redeemable in fiat money *on demand*. Thus, the bank's balance sheet will consist of government money (cash) and private loans (capital investment) on the asset side; and demandable liabilities on the liability side.

Formally, the bank's choice problem is to maximize (1) subject to:

$$\begin{aligned} (1-\pi)c_A + \pi c_B &\leq xk + nq; \\ \pi c_B &\leq nq; \end{aligned}$$

where $q + k = y$.

Since $x > n$, the second constraint will bind (since there is no aggregate uncertainty, the bank's cash reserves can be chosen so that they are just sufficient to meet expected withdrawals). In this case, the equilibrium real demand for money balances q^* is characterized by:

$$xu'\left(\frac{x(y-q^*)}{1-\pi}\right) = nu'\left(\frac{nq^*}{\pi}\right).$$

Note that the nominal interest rate is positive; i.e. $(x/n) > 1$. Andolfatto (2003) demonstrates that holding the stock of money constant is an optimal monetary policy (from the perspective of a representative young generation). In other words, the Friedman rule is not optimal in this environment.[3] The intuition is straightforward. While generating a deflation to equate the return on capital and money (i.e., the Friedman rule) has the benefit of providing full insurance, this gain is more than offset by the implied contraction in capital spending (as the high rate of return on money induces banks to divert deposits away from business loans and into fiat money).

The model developed above provides a partial answer to the coexistence puzzle; i.e., when the puzzle is framed in terms of non-interest-bearing money and capital (or titles to capital in the form of fully backed bank liabilities). But the more challenging aspect of the coexistence puzzle pertains to the coexistence of government money and bonds. The next section introduces government bonds and demonstrates the conditions under which the coexistence of these two financial instruments may occur.

4 Government Bonds

There is an outstanding stock of nominal government bonds B that are in the hands of the initial old. Assume that these bonds have no maturity date, but that they are transferable (across generations) and pay a nominal (gross) interest rate R. The government's policy is to maintain a fixed bond/money ratio $\theta \equiv (B/M)$. Interest payments on debt are financed with a lump-sum tax on bond-holders.

Let b denote the real bond holdings per young agent. Then the bank's choice problem is to maximize (1) subject to:

[3] At least, from a class of policies that expands/contracts the supply of money at some constant rate and injected/withdrawn with lump-sum transfers/taxes.

$$\begin{aligned}(1-\pi)c_A + \pi c_B &\leq xk + Rnb + nq - \tau;\\ \pi c_B &\leq nq;\\ q + k &= y.\end{aligned}$$

where τ is a lump-sum tax. Note that this specification assumes that government bonds are issued in sufficiently large denominations that prohibit bank money from being redeemable in government bonds (when I go to the bank machine, the ATM spits out non-interesting bearing cash, not small denomination notes of interest-bearing government debt).[4]

If bonds are to compete with capital, the nominal interest rate must be such that $R^* = (x/n) > 1$. Note that since the equilibrium price level falls at rate n, both bonds and capital earn the same real return x. In this case, the bank is indifferent between bonds and capital, so that $s \equiv b + k = y - q$. As well, since money is dominated in rate of return, we have $\pi c_B = nq$.The the bank's choice problem is therefore given by:

$$\max_q (1-\pi)u\left(\frac{x(y-q)-\tau}{1-\pi}\right) + \pi u\left(\frac{nq}{\pi}\right).$$

The demand for real money balances is characterized by:

$$xu'\left(\frac{x(y-q^D)-\tau}{1-\pi}\right) = nu'\left(\frac{nq^D}{\pi}\right). \tag{2}$$

From the government's budget constraint:

$$\tau = (x-1)b.$$

Since $\theta \equiv b/q$, we can alternatively write this constraint as:

$$\tau = (x-1)\theta q.$$

Substituting this constraint into condition (2) yields a condition that characterizes the equilibrium real money balances:

$$xu'\left(\frac{xy - [x + (x-1)\theta]q^*}{1-\pi}\right) = nu'\left(\frac{nq^*}{\pi}\right).$$

[4] If bonds are issued in small denominations, then the second constraint would be given by:

$$\pi c_B \leq xb + nq.$$

In this case, money would be driven out of circulation.

Note that if $\theta = 0$, then the model reduces to the earlier specification.

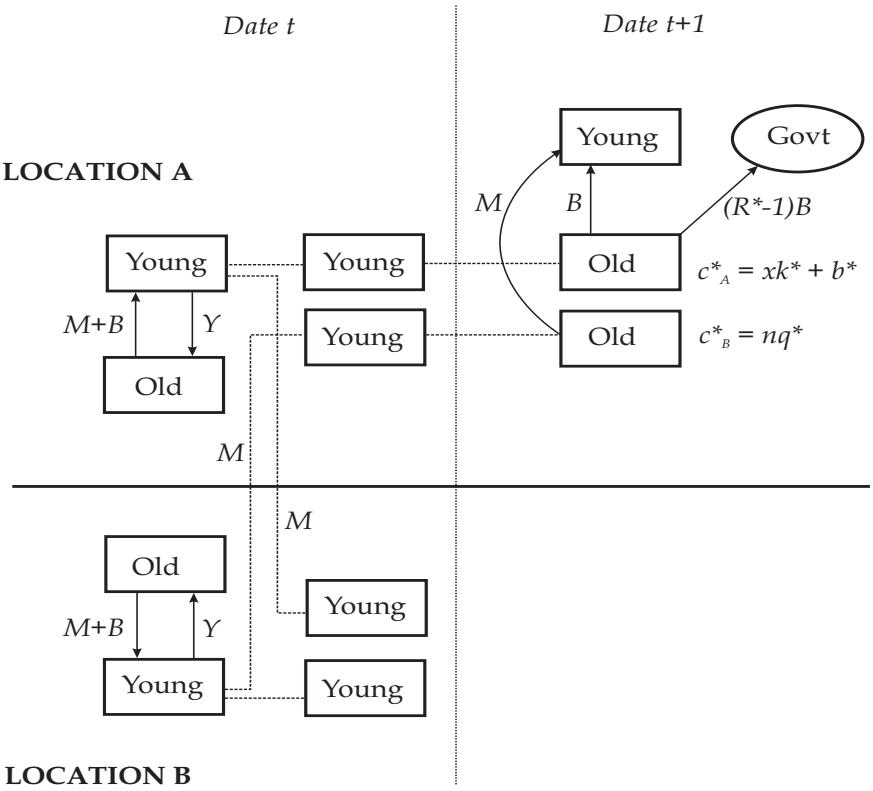
Let me now summarize the pattern of trades in this economy. The 'initial' old are endowed with M dollars of currency and B dollars of interest bearing debt. After paying the lump sum tax (that finances the interest cost of outstanding government bonds), the initial old are left with $M+B$ dollars. Banks collect deposits from each of the initial young (consisting of claims against y). A portion of these claims are used to purchase the $M+B$ dollars of government debt instruments from the old. (Notice here that both money and bonds 'circulate' as equivalent payment instruments at this stage). The remainder of these claims are used to finance capital investment.

Thus, on the asset side of its balance sheet, the bank holds government cash, government bonds, and private loans (claims against the economy's capital stock). Efficiency dictates that the liability side of the bank's balance sheet consist of demandable debt (demand deposits). One can think of demandable debt consisting of electronic transactions balances that can be redeemed on demand for government cash. These demandable debt instruments serve as a private money instrument. If depositors choose to exercise the redemption option (i.e., withdraw funds early), then they receive government cash but earn no interest on their savings. Depositors who carry their savings at the bank into the future period use the principal and interest to purchase future output.

After the realization of individual liquidity shocks in the current period, the bank's cash balances are drained entirely by those who need to exercise the redemption option on their demand deposits. This cash is taken to the 'foreign' location where it is used to purchase output in the future period. Of course, there is an equal amount of cash arriving in the 'domestic' location from the young on the 'foreign' location who exercised the redemption option on their demand deposits. Thus, the total supply of government cash remains constant in each location.

As time unfolds, the young become old. Those that have cash, purchase claims to output (issued by the new bank that arises in that period). Those that still have their bank money use it to purchase output. Some of this output consists of the return to capital investment and some of this output consists of the endowment brought into the period by the new generation of young agents. This latter output is purchased by selling B dollars of government bonds (the amount remaining after satisfying the tax obligation) to the bank representing the new generation of young agents. The pattern of trades is depicted in Figure 1.

FIGURE 1
Pattern of Trades



5 Discussion

In the model developed above, interest-bearing government debt coexists with non-interest-bearing government money, despite the fact that private intermediaries are not legally restricted from issuing small denomination banknotes. The model does not explain why the government would want to issue large denomination interest-bearing debt. But given that it does, the model here explains the interest premium as follows:

1. Government bonds are issued in large denominations, so that ATMs

cannot discharge low-denomination government notes that pay interest;

2. While banks can and do intermediate large denomination government notes by issuing private liabilities that are backed by government bonds, these private liabilities are not an acceptable form of payment in some transactions (e.g., when I try to pay for groceries in New York with a check drawn on my bank in San Francisco).

Given that history appears to provide no examples of governments that have issued interest-bearing notes in the range of denominations available in their non-interest bearing counterparts, the theory developed above suggests that the coexistence of money and bonds should not be surprising. Likewise, the theory predicts that should the U.S. Treasury begin to issue interest-bearing notes in denominations as low as $1, they would drive current U.S. Federal Reserve notes out of circulation. This prediction does not appear to be all that crazy (to me, at least).

There remains, however, a subtler dimension to the coexistence puzzle, as alluded to earlier; namely, the coexistence of money and bonds of *identical* denominations (e.g., a 100 Franc Bank of France note and a 100 Franc *bon*). To explain this phenomenon, one needs to dispense with the assumption that the primary difference between money and bonds is in their denomination.

Aiyagari, Wallace and Wright (1996) examine the issue of coexistence in the context of a search-theoretic model of money that abstracts from denomination issues. According to these authors, bonds may trade at a discount if (for some unexplained reason) the government refuses to accept bonds as payment for government produced goods and services. In this random-matching environment then, holding bonds entails some exchange risk (despite the fact that they are free of default risk).

While these authors do not elaborate on whether the behavioral assumption they assume corresponds in any way to actual government practice, it in fact may appear to be the case. In particular, an almost universal property of all government money is that it constitutes *lawful (or legal) tender*; see Breckenridge (1903).[5] The phenomenon is too pervasive to be interpreted as mere coincidence or irrelevant custom; i.e., see Smith (1936). It seems more likely to suppose that this legal provision has at least some bite; i.e., at least

[5] Evidently, there is a distinction to be made between lawful and legal tender. The former has the power to discharge a debt obligation to the government; whereas the latter has the legal power to discharge debts in general (both public and private).

some payments at some level need (by legal decree) to be settled in terms of the economy's lawful tender. Thus, the probability of meeting a 'government agent' in Aiyagari, Wallace and Wright (1996) might reasonably be interpreted as an event that requires payment in the form of government-issued money (rather than bonds). In reality, this event may correspond to the stage in which tax obligations are ultimately settled in an economy.[6]

In fact, the Aiyagari, Wallace and Wright (1996) hypothesis is not inconsistent with the model developed above where π is reinterpreted to be the probability of being thrust in a situation that requires payment in lawful tender. As far as I can tell, there have been no historical cases in which risk-free interest-bearing government securities have been bestowed with lawful tender status.[7] In particular, unlike the notes issued by the Bank of France, *bons* were not made lawful tender. The key to understanding the coexistence puzzle then appears to be in recognizing that risk-free bonds are discriminated against along some dimension relative to money (i.e., either in denomination size, as I have emphasized; or in legal status, as in one interpretation of the Aiyagari, Wallace and Wright setup).[8]

6 Conclusion

In this paper, I have argued that the coexistence puzzle can be understood in terms of a modified version of the legal restrictions hypothesis initially put forth by Bryant and Wallace (1980). The modification is in terms of dropping a questionable assumption made by the original hypothesis; i.e., that large denomination government bonds cannot be intermediated by private

[6] To the extent that the legal tender status of government money has bite, one might question whether 'unbacked' government money should in fact be interpreted as fiat, since a legal tender note has the power to discharge a real tax obligation; see Goldberg (2004). On the issue of whether a purely fiat money has ever existed at all, see Goldberg (2003).

[7] The 'risk-free' qualifier is important here. In 2001, a regional government in Argentina issued an interest-bearing note (called the *patacon*) that the federal government evidently claimed would be acceptable in the discharge of tax obligations. However, being a provincially-issued note, it is unlikely that such bills were viewed as free of nominal risk.

[8] Another possibility, not emphasized above, is that money and bonds do not share precisely the same risk characteristics. In particular, money is issued by a central bank and represents a (nominally) risk-free claim against itself, whereas bonds are issued by a separate agency (e.g., the Treasury), representing low-risk claims against money. In the event of a fiscal crisis (however remote), the Treasury may be compelled to pay pennies on the dollar for its outstanding debt. Certainly, there are enough historical precedents to suggest that this may be a real possibility.

banks. This restriction is replaced by one that is arguably more palatable; i.e., that the intermediated monetary instruments created by private banks are not universally acceptable as payment for all exchanges (unlike government money). The friction that gives rise to this latter restriction is one that is commonly employed in monetary models where fiat money is essential for exchange.

There have been, of course, other attempts at explaining coexistence. For example, Shi (2003) considers an environment similar to Aiyagari, Wallace and Wright (1996) where matured bonds (indistinguishable from fiat money) are driven from circulation and newly-issued bonds trade at a discount owing to a temporary separation between product and asset markets. Zhu and Wallace (2003) view coexistence as one of many possible equilibrium outcomes that may occur in bilateral exchanges involving goods and two 'outside' assets (money and bonds). An equilibrium with coexistence appears to rely on the idea that there may be a 'convention' (an equilibrium selection) such that a buyer's bargaining power is increased with the amount of cash (as opposed to bonds) brought into an exchange. In this equilibrium, individuals are willing to hold cash (which is dominated in rate of return) since it allows them to extract a greater fraction of the surplus associated in any exchange opportunity. Camera, Noussair and Tucker (undated) find in experimental economies that a dominated financial instrument may coexist if it has a history of use as a payment instrument prior to the introduction of a higher return security.

As of today, there is still no consensus on what features of the economic environment (or government policies) are responsible for the coexistence puzzle. Future research directed at developing a clearer understanding of coexistence is important for two reasons. First, monetary policy is typically implemented by way of swaps of non-interest and interest-bearing government securities. Understanding what drives the wedge between such government securities may be important for understanding the underlying transmission mechanism of monetary policy. Second, features of the environment that give rise to coexistence may ultimately play a role in the design of an optimal monetary policy.

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