

Demand Uncertainty and Decentralization:  
A Simple Pure Transaction Model of Money

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A simple model of backed money without a store of value function is presented, discussed, and defended. The function of money in the model is to replace complex contingent contracts traded on a centralized exchange with simple trades in decentralized markets.

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Demand Uncertainty and Decentralization:  
A Simple Pure Transaction Model of Money

by

John Bryant\*

Money makes the world go 'round -- Cabaret  
So violent an outrage upon credit, property, and liberty as  
this compulsory paper currency has seldom been  
exhibited by the alliance of bankruptcy and tyranny... --  
Edmund Burke, Reflections on the Revolution in France

Demand uncertainty and costly centralized exchange can explain a system of money backed by private assets. As the model is the key to our observation, let us start with the model. Our commentary follows the model.

The Model

There are goods, 1, --, J which can be produced at points 1, --, J respectively, where points 1, --, J are located sequentially on the circumference of a circle. On an axle implanted in the center of the circle are wheels of the same diameter numbering NJ,  $N > 0$ . Attached to the edge of each wheel is a single individual. Each individual is endowed with a unit of labor. An individual can costlessly place her labor on only one production site, and production sites are chosen costlessly by individuals. If  $X_j$  units of labor are placed on production site  $j \in \{1, 2, \dots, J\}$  at the beginning of the period,  $f(X_j) \geq 0$  units of good j are

produced at the end of the period, where  $f'(X_j) > 0$ . In the middle of the period all the wheels are spun, stopping with the attached individuals suspended above the sites 1, ..., J. If an individual ends up at site j, good j is what the individual desires to consume, and such consumption is all that enters that individual's utility function. Moreover, the individual at site j has the common-to-all utility function  $U(C_j)$  where  $C_j$  is the individual's consumption of good j.

This model is capturing the notion that at the time labor and production decisions are made, the individuals involved do not know what (when or where?) they individually are going to want to consume. The rest is commentary.<sup>1</sup>

#### Contracts, Private Notes and Money

We now consider three alternative mediums of transaction in this model, multi-lateral contracts, multiple private note issue, and "money."

First let us consider multi-lateral contracts. Our convention is that before the spinning of the wheels, individuals can sign multi-lateral contracts for future exchange of the goods, such contracts being negotiated on a centralized competitive commodities futures exchange. Clearly a complete set of such contracts is very complicated in the sense that all individuals must be involved and the contracts must be contingent upon the  $J^{NJ}$  possible outcomes of the wheel spins. This convention involves all individuals knowing the process determining all the individual demands.

Second, let us consider multiple private note issue. Our convention is that individuals are on a competitive basis awarded claims to the final product

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<sup>1</sup>This model occurred to the author in contemplation of the Cass-Yaari [3] circle. More elaborately, one can treat an unsegmented product market in which, for example, wheels stop between sites, both of which goods are desired by the individual.

of the site they choose. By competitive basis we mean that the claims are in proportion to the individual's labor input, and the total of all claims equals actual production. After the spin of the wheels individuals trade their claims to production in a centralized competitive commodities exchange. To isolate the attributes of this private note issue we consider two mechanisms for the spin of the wheels.

Our first mechanism is that the wheels are spun in a manner so that exactly  $N$  individuals end up at each site, but prior to the spinning each individual is equally likely to end up at each site. This is, of course, just the limiting result of independent wheel spins as  $N$  grows large. In this case, as compared to the multi-lateral contracts convention, all that the private note issue does is reduce the complexity of the set of contracts, and for two reasons. First, it need not be determined which state has occurred. Second, contracts contingent upon states which did not occur need not be written.

Our second mechanism is that the spins of the wheels are independent. As a result, for  $N < \infty$  there is aggregate demand uncertainty. This aggregate demand uncertainty imposes two risks, a diversifiable risk and a non-diversifiable risk. The risk of many individuals demanding the same good as oneself is not diversifiable, for as one only wants the good in question, one cannot be compensated. On the other hand, the risk of few individuals demanding the good one has produced is diversifiable, it can be shared between individuals demanding the same good. The multi-lateral contracts convention allows the diversifiable risk to be shared, while the private note issue convention does not. Therefore in this case, as compared to the multi-lateral contracts convention, private note issue simplifies the set of contracts at the cost of not sharing the diversifiable risk imposed by aggregate demand uncertainty. The private note issue convention involves all individuals knowing the process determining aggregate demands, but not necessarily the process determining all the individual demands as in the multi-lateral contracts convention.

Third let us consider money, uniform note issue. Our convention is that at each production site are  $M$  units of indistinguishable paper notes. These notes are on a competitive basis awarded to the individuals at the site. After the spin of the wheels, individuals trade the notes for goods in the proportion of their holdings of the total note holdings of individuals ending up at the site.

We only consider the more complicated case of independent wheel spins. As compared to the multi-lateral contracts convention, money issue replaces the complex set of contingent contracts negotiated on a centralized exchange with  $J$  separate, decentralized, markets with uniform simple trades in each. As between the private note issue convention and money issue, there are two differences. First, money replaces the centralized exchange of claims with  $J$  separate, decentralized, markets. Second, money, unlike the private note issue convention, shares the diversifiable risk imposed by aggregate demand uncertainty. One's money holdings are independent of the demand for the good one has produced. The money convention does not involve individuals knowing the process determining individual demands or the process determining aggregate demands as in the multi-lateral contracts and the private note issue conventions respectively.

As long as decentralized markets are cheaper to run than centralized exchanges, money has a clear advantage over both multi-lateral contracts and multiple private note issue conventions.<sup>2</sup>

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<sup>2</sup>It may be worth noting that our model isolates an aspect of decentralized markets not present in the Cass-Yaari [3] circle. In the latter, individuals do engage in exchange only through a sequence of bilateral trades. However, in the latter individuals in order to trade must know the relative prices of all the goods, so the decentralization is largely illusion. Note that the money convention avoids the assignment of proprietary rights to one's product, and therefore any costs associated with allocating rents on the exchange of those products.

## A Hybrid Money--Multi-lateral Contracts Convention

One of the major anomalies in economics is that there seems to be both substantial individual and aggregate uncertainty, yet there is a paucity of contingent contracts. An obvious approach to this anomaly is to assume that such contingent contracts are prohibitively costly to write, perhaps because of moral hazard problems. Our model suggests another alternative. The money convention by itself shares the diversifiable risks and all that remains are non-diversifiable risks.

However, the ability of the money convention to share the diversifiable aggregate demand risk in our model is suspicious. Suppose there are many periods and a new generation each period. At the end of each period the amount of money at a given site depends upon the aggregate demand at that site. Unless that money is redistributed, production in the subsequent period is determined by the aggregate demand in the period just ended as money "wages" are equated over sites. The diversifiable aggregate demand risk is "born" by individuals in the following period in the form of a sub-optimal distribution of production.<sup>3</sup> This observation on sequences of money economies may explain the "shortages" of money that are reported in descriptions of the 19th century U.S. monetary system (see, for example, Timberlake [5]). This observation on sequences of money economies may also explain the serial correlations of aggregate economic variables observed in money economies.

A second way to view the ability of money to share the diversifiable aggregate demand risk is that the imposed initial allocation of money supplants one of the functions of the market. In our model, money has been

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<sup>3</sup>This distortion is limited by the private sector's ability to substitute multi-lateral contracts or multiple private note issue for money. It is also reduced if, for example, aggregate demands are martingales. More elaborately, one can treat multi-period lived individuals.

given an unnatural advantage relative to the other mediums of exchange. This, in turn, suggests a hybrid system of money and multi-lateral contracts combining some of the benefits of both. Our hybrid money--multi-lateral contracts convention is as follows. At each site  $j$ , each period a single individual gets site ownership in a competitive bidding. This owner borrows money from a central authority which she is required to repay at the end of the period. The individual owners share the diversifiable aggregate demand risk through multi-lateral contracts for future exchange of money, such contracts being negotiated on a centralized competitive futures exchange.

This hybrid convention has only  $J$  individuals making (large) contracts involved in a centralized exchange compared to  $NJ$  individuals for both multi-lateral contracts and multiple private note issue conventions. This hybrid convention economizes on state contingent contracts relative to the multi-lateral contracts convention by the equivalence of all states implying the same aggregate demands. And, of course, this hybrid convention shares the diversifiable aggregate demand risk which the multiple private note issue convention does not, and which the money convention does only because of an unnatural, artificial advantage. This hybrid convention involves  $J$  individuals knowing the process determining aggregate demands.

#### Money: A Natural Monopoly?

On the face of it, multiple private note issue would seem to be the natural competitive private sector analog to money. However, as we have seen, multiple private note issue does not have all the advantages of money. This, in turn, suggests that money is a "natural monopoly", and that therefore the government should take the role of supplier of money.

The government, as unique supplier of money, can extract monopoly rent by continually printing and spending money, by imposing an inflation tax.

This inflation tax is limited by the private sector's ability to substitute multi-lateral contracts or multiple private note issue for money. Moreover, different groups of individuals may have different "elasticities of demand" for money, which has some interesting implications. In our model, suppose, for example, some individuals are endowed with more labor than others, and centralized exchanges handle large contracts relatively efficiently. Alternatively, suppose that a subset of the individuals know that they will end up at a subset of the  $J$  sites, reducing the necessary number of contracts and their cost of using centralized exchange. The resulting differing "elasticities of demand" for money raise the possibility of a discriminatory inflation tax through bond issue as discussed in Bryant and Wallace [2]. These differing "elasticities of demand" for money also raise the possibility of an illusory observation of dominance of money. Empirically between-period price level increases occurring when a class of individuals opts out of money in the face of promised higher inflation are confounded with that higher inflation. The observed high "inflation rate" may then imply a lower rate of return on money than that at which everyone substitutes multi-lateral contracts or private note issue for money.

However, counter to intuition, that money is a "natural monopoly" need not imply that the supplying of money is a natural function of government. The private sector may be able, in essence, to put the right to issue the single money up for competitive bid. Here the competition is not in terms of the price paid for the "license" to produce money, but in restrictions on behavior when the "license" is sold at zero price. Money is not a natural monopoly in the way that a declining cost industry is. Given this observation the governmental issuance of money must be explained either by regulation,

or by the impossibility or costliness of binding the behavior of the money supplier. Why the government might choose to impose its own monopoly through regulation is clear from the previous paragraph.

### Fiat or Commodity Money?

Notice, finally, that our money convention describes commodity money, not fiat money. Within period, money is backed by the production of the goods, while between periods money has no value, it is not an asset. Both of these attributes of our money convention, that it is backed by commodities and that it does not serve as a store of value, are at variance with fiat money models. We now argue that this interpretation of money as commodity backed and satisfying a pure transaction demand is not obviously wrong.

Admittedly, the existing system of government-issued currency is often taken to be a fiat money system. As the United States and other nations have moved off the gold standard, it has been assumed that the note issue became unbacked paper. Currency issued by the various governments only has value, then, because one believes that the next individual one wants to trade with will exchange goods for currency, because she believes that... . The currency itself is a claim to nothing, but is just a positive entry in this implicit accounting system. A government gains seigniorage from money issue as it gathers rent on its monopoly in the provision of this accounting system. Because it captures these attributes of fiat money so parsimoniously while remaining tractible, Samuelson's [5] pure consumption

loans model has become an increasingly used model of money (see Kareken and Wallace [4]).

It is, nonetheless, unclear that the existing system of government-issued currency is really a fiat money system. It is true, of course, that a Federal Reserve Note promises the holder only another Federal Reserve Note in exchange. But the Federal Reserve Note does not exist in a vacuum. Traditionally demand deposits are treated as a part of money stock, and demand deposits clearly are backed, at least in part, by the assets of banks. Moreover, a Federal Reserve Note is constrained to trade one-for-one with demand deposits. Additionally, a Federal Reserve Note is a license for a bank to engage in a certain amount of intermediation. Therefore, it is possible that the existing monetary system is better viewed as a uniform government issue backed by private assets.

#### Concluding Comments

The above model of money imposes a restrictive and strange structure upon the economy. It is, however, unclear that this is an undesirable feature. Empirically money is a robust institution, yet it is a strange one as viewed from the vantage point of traditional economics. The omnipresence of money ought to tell us something strong about the structure of economies.

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