

General Features of Monetary Models and their Significance*

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June 11, 2002

Abstract

The recent literature on models of money with nice micro foundations is reviewed from the point of view of three general features: (i) the extent and kind of *idiosyncratic uncertainty* (ii) the extent to which the past actions of people are common knowledge, the degree of *monitoring*; (iii) the *size of the trading group* (one extreme is trade in pairs and another is centralized trade). The goal is to point out the connections between these features and the implications of the models, including their implications for policy issues.

1 Introduction

There is a relatively new and large body of work in monetary theory which stresses nice micro foundations for models of money. Among the important papers are Kiyotaki and Wright [14], Levine [20], and Kocherlakota [15]. However, most of this new work consists of loosely related papers: each paper has a distinct setting and often a distinct equilibrium concept. Therefore, it is difficult to discern what general features of the models are connected to what general implications. My goal is to point out some of these connections.

*Prepared for the "Swiss National Bank-Fed Cleveland Workshop on Monetary Economics," July 2-3, 2002.

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I will discuss three general features of models. One is the extent and kind of *idiosyncratic uncertainty*. A second is the extent to which the past actions of people are common knowledge, the degree of *monitoring*. The third is the *size of the trading group*: at one extreme is trade in pairs; at the other is centralized trade. In terms of these categories, Kiyotaki and Wright [14] has idiosyncratic uncertainty in the form of random pairwise meetings, no monitoring of past actions, and pairwise trade; Levine [20] has idiosyncratic uncertainty in the form of preference shocks, no monitoring of past actions, and a centralized market.

Before beginning, I should say a bit about what I mean by nice micro foundations for models of money. For me, there are two necessary conditions. First, it ought to be sensible to apply mechanism design—or, perhaps, I should say, implementation theory—to the model. Second, when that is done, the model should imply that monetary trade is essential in the sense that some good allocations are implementable using monetary trade that would otherwise not be implementable. Although too confining for some purposes—even for a discussion of Kiyotaki and Wright [14], which is primarily about commodity money—I define monetary trade to mean trade using intrinsically worthless objects, fiat money.

These necessary conditions are fairly stringent. Although I may be engaging in wishful thinking, most researchers would agree that it is not sensible to apply mechanism design to models with real balances as arguments of production or utility functions or to cash-in-advance models. Hence, those models fail the first necessary condition. As for the second, it requires that monetary trade not just be one of many equivalent ways to implement good allocations. Given that these conditions are stringent, what do we gain by restricting ourselves to models that pass them?

We avoid implicit inconsistencies and we gain new insights. Thus, if money is essential, then it must be that credit as a way to accomplish trades is difficult. In other words, it is inconsistent to believe that money is essential and to use a model of money with perfect credit markets. New insights come from deriving the consequences of what makes credit difficult or impossible. Also, a mechanism design approach takes a stand on what are feasible policies. For example, if there is no monitoring, then the entire economy is like an underground economy. In an underground economy, it does not seem sensible to assume that people can be easily taxed. More generally, the features that make monetary trade essential has implications for the kinds of policies that are feasible.

2 Two canonical (and incomplete) settings

Although it may seem inconsistent with my aim of discussing general features, it will facilitate my discussion to be able to refer to two familiar settings. One is the setting introduced by Green [8] to study optimal risk sharing in the presence of private information. The other is a perishable and divisible goods version of Kiyotaki and Wright [14]. I will label the first model A and the second model B . I will throughout assume discrete time and a fixed population of infinitely lived people who maximize expected discounted utility with discount factor $\beta \in (0, 1)$. (For my purposes, overlapping generations versions would not be significantly different.)

2.1 Model A

There is a $[0, 1]$ continuum of people and one perishable consumption good per date. The period utility function is increasing and concave in the amount of the good consumed. If a person's endowment at the previous date was w_i , then the person's endowment at the current date is w_j with probability $\pi_{ij} > 0$ for $i, j \in \{1, 2, \dots, I\}$, where $0 < w_i < w_{i+1}$. There is no aggregate risk in the sense that at each date a fraction $\sum_i \pi_{ij}$ of people receive the endowment w_j . Each person's endowment realization and consumption is private information. This is model A .

Green [8] studies optimal risk-sharing in this model with $I = 2$, with π_{ij} not dependent on i , and with two other important assumptions. First, people can commit. A person cannot, for example, at any time defect to autarky and consume his endowment process. (There is now a substantial literature that drops the commitment assumption.) Second, people are perfectly monitored in the sense that previous announcements (of endowment realizations) are common knowledge.

Levine [20] studies a preference shock version, which is not quite a special case of this model, but only, it seems, because he wants to construct special examples. It is a Markov switching model of an extreme sort. Let w_i now stand for a realization of a preference shock, the only exogenous feature that differentiates people. Levine assumes $I = 2$, and an initial position in which half the population is in one of the two states. There is an aggregate two-state

random variable, denoted z , that determines π_{ij} as follows: for $i \neq j$,

$$\pi_{ij} = \begin{cases} 1 & \text{if } z = \textit{switch} \\ 0 & \text{if } z = \textit{not switch} \end{cases} .$$

In contrast to Green [8], Levine [20] assumes that there is no monitoring of past actions.¹

Both in Green [8] and Levine [20], everyone is together at each date. As emphasized by Levine [20], the absence of monitoring implies that any trade must be spot trade. Moreover, with everyone together, in order for outcomes to be in the static core at each date, the spot trade must be competitive. The resulting model shares many features with Bewley [2], but Bewley does not try to justify the assumption that the only trade in his model is spot, competitive trade.

2.2 Model B

There are $S > 2$ perishable types of goods at each date and a $[0, 1]$ continuum of each of S types of people. A type s person consumes only good s and is able to produce only good $s + 1$ (modulo S). The period utility function is $u(x) - y$, where x is consumption of the relevant good and y is production of the relevant good. The function u is strictly concave and increasing, and satisfies $u(0) = 0$. In addition, there exists $y' > 0$ that satisfies $u(y') = y'$. This is model B .

Model B , a divisible and perishable goods version of Kiyotaki and Wright [14], was first formulated and studied by Trejos-Wright [34] and Shi [30]. It is designed to have the following feature: if people meet in pairs, then there is at best a single coincidence. This model has, for the most part, been studied with exogenous and random meetings in pairs, but I want to leave the specification of meetings open for now.

¹Levine [20] assumes that utility is piecewise linear as an aid to constructing examples. A smooth-preference generalization of this model is in Kehoe, Levine and Woodford [12]. As is noted in that paper, the special case in which $z \equiv \textit{switch}$ is the model in Townsend [32].

3 Idiosyncratic uncertainty and heterogeneous money holdings

Although the three features under discussion interact, I will discuss them one at a time. I start with idiosyncratic uncertainty and throughout this section assume that there is no monitoring—no memory of past actions. I also assume that people cannot commit to future actions, and, therefore, must see a current reward from current actions.

The no-monitoring and no-commitment assumptions preclude explicit risk-sharing arrangements. Instead, any risk-sharing must come about through saving and dissaving. For now I assume that all saving must take the form of accumulation of fiat money. Then, as is well-known, idiosyncratic shocks will tend to give rise to heterogeneous money holdings.

Models in which the distribution of money is endogenous are generally quite complicated, complicated enough to preclude closed-form solutions and complicated enough to make it difficult even to demonstrate existence of outcomes in which money has value. Not surprisingly, then, considerable effort has been devoted to constructing models in which that distribution is simple, in the extreme degenerate. One approach has been to exogenously limit the set of individual money holdings—for example, by assuming that money is indivisible and that people can hold at most one or a few units. Another approach has been to make special assumptions that make the idiosyncratic shocks ephemeral in the sense that their effects do not persist.

Shi [31], and Faig [7] assume that the decision-making unit is a very large family among whose members shocks average out. Lagos and Wright [19] achieve degeneracy in a different way. They assume that centralized trade occurs periodically and that when it does quasi-linear utility gives rise to a unit marginal propensity to save for all wealth levels below a critical level and a zero marginal propensity for all higher wealth levels. These approaches are consistent with degenerate distributions of money holdings even though money is divisible and individual holdings are unrestricted.

The goal in these endeavors seems to be to make degenerate distributions consistent with trade in pairs and the essentiality of money. If that is the goal, then the following is a simpler and less contrived scheme that achieves the goal. Consider model *B* but with each agent being a single shopper-producer pair. At each date, let each type s shopper meet a randomly drawn type $s - 1$ producer. Then all meetings are single-coincidence meetings and

there are symmetric outcomes in which all households hold the same amount of money. Another version, of course, would have all the type s shoppers meet together, in a market, with all the type $s - 1$ producers. Call these models *directed-search* versions of model B .

If idiosyncratic preference shocks are added to this model, then non degenerate distributions of money holdings arise for either the trade-in-pairs version or the market version. Moreover, special specifications of preference shocks in the trade-in-pairs version would make the model identical to model B with random matching. Suppose each shopper-producer household at each date is subject to shocks that put it into one of three states: with probability $\frac{1}{5}$, it values consumption and is unable to produce; with the same probability, it does not value consumption and is able to produce; and with the remaining probability it neither values consumption nor is able to produce. Moreover, suppose each type s shopper in the first state always meets a random type $s - 1$ producer in the second state. Then, all meetings are single-coincidence meetings, but the allocations duplicate those of the random-matching model.

Although the preference shocks that duplicate random matching are very special, the existence of that kind of model should dispel the criticism sometimes voiced about the random-matching model: you mean that if I want ice cream, then I have to bump into people at random until I find someone who produces ice cream! Random matching is a source of idiosyncratic uncertainty about consumption and earning opportunities which produces heterogeneity; there are other ways to produce heterogeneity which have identical effects. However, a virtue of the directed-search version of model B is that it is much more general than the random-matching version. Also, the directed-search version more easily allows us to separate the presence and extent of idiosyncratic shocks that produce heterogeneity from the size of meetings in which trade occurs.

In any case, we can have nice models of money with or without heterogeneous money holdings. Does it matter and for what? As I now discuss, it matters at least for the consequences of lump-sum money creation and for the consequences of indivisibility of money.

3.1 Heterogeneity and lump-sum money creation

Scheinkman and Weiss [29] set out the idea that money creation at a rate accomplished through lump-sum (equal per capita transfers) could be a beneficial risk-sharing device in models with heterogeneous money holdings. In

other words, they suggest that inflation accomplished through lump-sum transfers could be good. That possibility has since been confirmed in a number of papers using nice models of money. As it happens, all use settings which are variants of models *A* and *B*.

All use a representative-agent welfare criterion and study steady states. The problem they study is to choose a rate of lump-sum money creation and an associated steady state that maximizes ex ante utility—ex ante in the sense that welfare is aggregated using the joint distribution of money holdings and any shocks. That is, the problem is to choose constant trades, a rate of money creation, and an initial distribution that replicates itself in order to maximize ex ante welfare. Levine [20] and Kehoe, Levine and Woodford [12] use the Levine version of model *A*. Imrohroglu [9] uses model *A*. Molico [23] uses model *B* with random meetings in pairs and with take-it-or-leave-it offers by consumers and with divisible and unbounded possible individual holdings of money. Deviatov and Wallace [6] study the same model but with indivisible money and individual holdings in the set $\{0, 1, 2\}$, the smallest set consistent with the possibility that money creation enlarges the set of distributions of money holdings. However, they do not impose a bargaining rule: they maximize over all individually rational trades.

All these papers contain examples in which lump-sum money creation is beneficial. Why are there only examples? Lump-sum money creation in these models has two effects: an intensive margin effect and an extensive margin effect. The intensive margin effect describes the effects on trades for a given distribution of holdings. This effect of money creation is generally harmful because money creation tends to make the acquisition of money less valuable, just as it does in models without heterogeneity. The extensive margin effect is the effect on the distribution of holdings. When that distribution is not degenerate, then a small amount of lump-sum money creation tends to shift the distribution toward the mean. That effect is generally beneficial: poor enough consumers can afford to consume very little and rich enough producers do not want to produce enough. Because the intensive and extensive margin effects generally work in opposite directions, we cannot hope for general qualitative conclusions. In particular, if there is heavy discounting of the future, then we should not expect to find beneficial effects of money creation.

The beneficial effect of money creation in the cited models comes from redistribution. To claim that money creation is beneficial, it must be argued that the redistribution cannot be better accomplished in other ways. Al-

though the models are different, Levine [20] and Deviatov-Wallace [6] argue that money creation is the only possible beneficial policy in their settings. In each case, the features that make money essential severely limit the kinds of policies that can be undertaken.

So, although heterogeneity is not necessary for money to be essential, it is important for the effects of lump-sum money creation. However, the source of heterogeneity seems not to be important. After all, the source of heterogeneity is endowment or preference shocks in the studies that are variants of model A , while it is random matching in those that are variants of model B . And, using the directed-search version of B , it could also be preference shocks in model B .

3.2 Heterogeneity and indivisible money

As documented by Sargent and Velde [26] and others, the provision of small change was a problem until at least the second half of the 19th century. It seems evident that if valuable monetary objects like gold and silver were (naturally) divisible, then there would be no problem of small change. Therefore, it is relevant to study the consequences of indivisibility of the monetary object. Zhu [37] has done that in model B with random matching, with an unbounded set of individual holdings, and with take-it-or-leave-it deterministic offers by consumers.² He shows that there is a steady state with an increasing and strictly concave value function defined on money holdings and with a distribution over money holdings that has full support.

As Zhu shows, that existence result implies non neutrality of the following sort. The relevant exogenous monetary feature of Zhu's economy is the per capita stock of money relative to the size of the indivisible unit. Call this m and let $S(m)$ denote the set of *all* steady states for m , not just the full support ones. He shows that if $m \neq m'$, then $S(m) \neq S(m')$.³ Moreover, if $m' = km$ for some integer k that exceeds unity, then $S(m) \subset S(m')$, where the inclusion is strict. The strictness is demonstrated by showing that Zhu's full-support steady state for m' is not in $S(m)$. Heterogeneity seems to play a crucial role in getting this result.

To see that, let's reinterpret the model as the directed-search shopper-producer preference shock version of model B with pairwise meetings. As

²The results would, if anything, be easier to obtain if he allowed for randomized offers.

³Steady states are distinguished from one another if and only if they are accompanied by different real allocations.

noted above, this model without preference shocks has a representative-agent version, one without heterogeneity. But without heterogeneity all the money trades hands at each date. If so, then the magnitude of m does not seem to matter. That is, if all trades consist of trades of m , then there would seem to be neutrality with respect to m .

4 The extent of monitoring and credit

In the models discussed in the last section, people are assumed to be anonymous. This effectively eliminates credit as a way to overcome absence-of-double-coincidence problems. Anonymity or no monitoring of past actions is one extreme assumption. An alternative extreme is complete monitoring. Given my definition of money, the application of implementation theory leads immediately to a very general result concerning complete monitoring: less than complete monitoring (of past actions) is necessary for money to be essential. This necessity claim goes back at least to Ostroy [24] (see also Townsend [33], Kranton [18], and Kocherlakota [15]).

One way to prove the necessity claim is to proceed by contradiction. Take any model with perfect monitoring and with money and show that any implementable outcome that makes use of money can also be achieved without using money (see Wallace [35]). In the context of a mechanism-design analysis, the role of money, a tangible and durable fiat object, is to weaken truth-telling constraints about past actions. (If money holdings are assumed to be observable, then no lying about such holdings is possible; even if not observable, lying by over-representing holdings is not possible.) If, however, past actions are perfectly monitored, then there are no truth-telling constraints about past actions to be weakened by making current actions dependent on money holdings. That is the logic behind the necessity result.

So we seem to understand two extreme situations regarding monitoring. No monitoring implies no credit, while perfect monitoring implies no essential role for money. In actual economies, we see both credit and money. The obvious way to get both to be important is to consider less extreme monitoring situations.

Against the background of model B with random matching, Kocherlakota and Wallace [17] assume that actions during some most recent interval are not monitored. The expected length of that interval, an updating lag, is

a parameter. They study how optima vary with that lag. Credit in the model takes the form of mutual insurance with people giving gifts in appropriate circumstances. If the lag is long, then only very small gifts are possible, because large gifts induce defection. Their main finding is that the set of implementable allocations is weakly larger the shorter the lag. Their formulation is one way to fill the gap between complete and no monitoring.

Using the same background model, Cavalcanti and Wallace [5] fill that gap in a different way. They assume that some fraction of the population are perfectly monitored and the rest not all. Each monitored person has a printing press which turns out uniform, indivisible, and perfectly durable objects called notes. The notes of any person can be distinguished from those of any other person.⁴ They use that setting to compare the role of such inside money to outside money, money which no one in the model can create. They show that outside money is not essential and, moreover, that inside money is. Put differently, strictly more outcomes can be implemented using inside money than can be implemented without it; that is, using only outside money.

It seems evident that those results depend on the presence of idiosyncratic uncertainty. Without such uncertainty, inside and outside money would seem to be equivalent. It is far from evident that they depend on the source of the uncertainty. They obviously hold in the directed-search pairwise-meeting version of model *B* with observable preference shocks of the right sort. Whether they carry over and in what form if the preference shocks are more general or are private remains to be determined.

If the shocks are private information, then, in contrast, to what was done in Kocherlakota and Wallace [17], less extreme monitoring situations could be fruitfully modeled by assuming that current actions can depend only on some amount of most recent history—one of the ways of formulating bounded rationality. So far as I know, the connection between the degree of bounded rationality in this sense and the role of outside money has not been explored. The only attempt to do something like that is in Aiyagari and Williamson [1]. They study the endowment shock version of model *A* with a specification that is intermediate between complete and no monitoring. They specify the intermediate situation by assuming that individuals are subject at each date to a second idiosyncratic shock that determines the person's message space

⁴The results are consistent with also giving such printing presses to non monitored people.

at that date: with some probability, that space is empty. They use the model to study optimal inflation.

4.1 Differential monitoring, legal restrictions, and central banking

The model in Cavalcanti and Wallace [5], with some people monitored and some not and with the monitored people issuing claims, can be reinterpreted to provide a setting within which to study central banking. The reinterpretation is motivated by two features of economies with central banks. First, central banks generally have exclusive rights to the issuance of currency-like liabilities (payable-to-the-bearer claims).⁵ Second, central banks make loans in the form of currency-like instruments to monitored people who want those instruments in order to be able to offer them to non-monitored people. (Of course, the loans are often made indirectly through private banks and other financial intermediaries, but I will, in effect, net out such intermediaries in the following discussion.)

Cavalcanti and Wallace label the monitored people in their model bankers. In retrospect, that seems a misnomer. In the model, the monitored people issue currency-like liabilities in meetings with non-monitored people and generally in exchange for goods (or services) produced by the non-monitored people. In that sense, the monitored people are issuers of trade credit instruments which resemble currency. The instruments resemble currency because they are passed around among non-monitored people.

The mechanisms studied by Cavalcanti and Wallace have the following features: all monitored people behave the same way; no distinctions are made among the instruments, the notes, issued by different monitored people; and all monitored people stand willing to produce in exchange for all such notes—actions which result in the retirement or redemption of notes. It is significant that the mechanisms are not competitive: in particular, redemption occurs only because non-redemption triggers punishment, which, in turn, is possible because these people are monitored. In other words, redemption is like

⁵Indeed, in England and the U.S. and very likely in other countries, central banks emerged from private banking systems in which the right to issue payable-to-the-bearer claims was not centralized within a single institution. In England, the Bank of England was given the exclusive right to issue notes in the 1840's; in the U.S., note issue by state chartered banks was replaced by highly regulated note issue by nationally chartered banks in 1863, and that, in turn, was replaced by the Federal Reserve System in 1914.

taxation of monitored people.

It seems straightforward to interpret any such mechanism in terms of central banking: relabel the private money in the model central-bank money and say that each monitored person is given a credit line (and, if you like, a printing press) by the central bank subject to some rules.⁶ Indeed, because the mechanisms in Cavalcanti and Wallace are not competitive, they are almost easier to interpret in terms of central banking than in terms of private money.

Interpreting allocations as arising either from private intermediation or from central bank lending is not new. It was done by Sargent and Wallace [28] in a model of two-period lived overlapping generations in which the borrowers are people heavily endowed when old and the lenders are those heavily endowed when young. Why is it better to use backgrounds related to that in Cavalcanti and Wallace? In order to work well, the monetary instruments in Cavalcanti and Wallace have to trade among non monitored people. That is to say, they have to be widely accepted. That feature makes a central bank monopoly easy to enforce. In particular, the central bank monopoly cannot be subverted by defection (trade) between a pair of people or among a small group.⁷ That seems not to be the case in the Sargent and Wallace model.

Also, the Cavalcanti and Wallace model lends itself well to discussing the effects of central bank policy under that interpretation. In Sargent and Wallace, even if one accepts the assumed central bank monopoly, then whether central bank policy—for example, in terms of the rate at which it lends—is neutral or not depends on what is assumed about other ways of achieving allocations. If lump-sum redistributions are allowed, then central-bank lending policy in that model is neutral (see Sargent and Smith [27]). In Cavalcanti and Wallace, there is a large set of implementable allocations, even within the limited class of symmetric and stationary allocations they study. For example, notes could have one value when issued by monitored people, another value when traded among non monitored people, and still another value when

⁶This central bank interpretation can also be applied to Cavalcanti, Erosa, and Temzelides [3]. In a closely related environment, they can be regarded as studying equilibrium under a particular central bank lending rule: the central bank keeps track of a “balance” defined in a particular way, and the balance must be non-negative

⁷Indeed, as John Moore pointed out to me, the model implies that non use of “prohibited” printing presses in this model is implementable. That fact was used by Cavalcanti and Wallace in showing that outside money mechanisms are implementable.

redeemed. It is inconceivable that there is neutrality among such policies. So far, by the way, little is known about what allocations are good in that model. In particular, nothing is known about the set of Pareto efficient mechanisms defined by treating monitored and non-monitored people as different types.

Finally, as noted above, although Cavalcanti and Wallace work with random meetings as the source of idiosyncratic uncertainty, the main ideas are not tied to that source of uncertainty. If the source of idiosyncratic uncertainty were preference shocks which are private, then implementable lending arrangements under a central bank interpretation would presumably more closely resemble those we see.⁸

5 The Size of the trading group

There has been little discussion of the benefits from using a model in which trade occurs in small groups. That is surprising because we are all aware that there is a cost to using such models: there is no equilibrium concept applicable to small group trade which has the standing that the competitive model has in trade among a large number of people.

Although almost nothing hinges on the small group being two, I will follow the literature and concentrate on that case. To begin, I offer an interpretation of the assumption that trade occurs in pairs. In some settings—for example, models of marriage—the modeler can reasonably assume that the natural productive unit is a pair. This rationale for pairs or small groups does not seem to be available in the context of the kinds of monetary models under consideration. For example, when the motivation for trade is multi-good static trade as in model *B*, then the set of feasible trades grows with the number of people who interact with each other. Therefore, I interpret trade in pairs as an extreme version of a model with costs of people getting together: meeting one person is free but getting into contact with additional or other people is infinitely costly. On my interpretation, which I think is standard, trade in pairs should be viewed as part of the environment—not as part of the mechanism for conducting trade.

One possible role of trade in pairs is as a way of rationalizing the assumption that there is no monitoring. If there is a continuum of people, if pairwise

⁸In [4], Cavalcanti and Wallace add a version of such uncertainty to their model. However, they derive results only in the special case in which the set of monitored people is arbitrarily small.

meetings occur at discrete points in time, and if meetings are at least partly random, then permitting an agent to remember everything he has seen or been told is consistent with knowing nothing about a trading partner's past actions. However, there is a long tradition of treating people as anonymous in models with centralized trade. That being so, we may be willing, as I have been in the discussion above, to simply accept assumptions on monitoring as primitives. If so, then we have to seek other reasons to want to have trade occur between a pair of people.

One reason may be consistency with long-standing notions about absence-of-double-coincidence difficulties. If these difficulties are to be present in a model where the underlying motivation for trade is static trade involving many goods, then it would seem that everyone cannot be together. But, if the goal is only having money be essential, then model *A* and its variants imply that intertemporal absence-of-double-coincidence difficulties are sufficient. And, as is well-known, such difficulties are consistent with centralized trade. I propose that we look elsewhere for the benefits of models in which trade occurs in pairs.

5.1 Trade in pairs and asymmetric information

Williamson and Wright [36] use trade in pairs to study a classic question: is money beneficial because it is relatively recognizable? They work with the original Kiyotaki-Wright [14] formulation with indivisible and durable goods and money, but with only two goods and, therefore, no absence-of-double-coincidence problem. In their model, there are two versions of each good: a high-cost high-quality version and a low-cost low-quality version, and in a meeting the potential buyer gets a signal about the quality of the seller's good. They show that there are regions in the parameter space in which the best equilibrium makes use of money.

Jones and Manuelli [10] and Katzman, Kennan, and Wallace [11] use pairwise meetings to study the consequences of asymmetric information about the value of money: some people know more about the future value of money than others. Although the details are quite different, in each case the goal is to analyze the consequences of monetary uncertainty for output and price level fluctuations.

In all these cases, trade in pairs makes it sufficient for the modeler to describe the information situation between the two people in a meeting. In addition to simplifying the analysis relative to specifying information for a

larger group, the possibility that competitive prices reveal information does not arise.

5.2 Trade in pairs and endogenous transactions costs

If the notion of implementability requires only that there be no individual defection or even if it requires no group defection by meeting-specific pairs, then trade in pairs and discounting gives rise to many implementable outcomes. Among these outcomes are ones which resemble those that would arise from the presence of exogenous transaction costs.

Consider, first, the Cavalcanti and Wallace model of inside money described above (see [5]). They use no individual defection as the notion of implementability, but the results would not change substantially if they permitted defection by the pair in a meeting. With meetings in pairs, as noted above, inside money can trade for different amount of goods in the different kinds of meetings. In particular, there are implementable allocations in which it trades at a discount among non monitored people relative to what it trades for when redeemed in a meeting with a monitored person. This resembles safe banknotes trading at a discount, as seemed to have happened in the free banking era in the U.S. The model allows this to occur without any appeal to exogenous transaction costs. The model can also be used to ask whether such discounts are desirable. And the model can also be used to consider whether it is desirable to have inside money be universally accepted by all monitored people, the only kinds of allocations studied by Cavalcanti and Wallace, or whether it is better to have monitored people subdivided into groups with only within-group acceptability. Such possibilities seem not to arise if trade is centralized.

In a similar way, trade in pairs may also be able to explain different roles for different assets in trade. Ravikumar and Wallace [25] use it that way to explain possible discrimination against a foreign currency. They study a version of Matsuyama, Kiyotaki and Matsui [22] with divisible goods. While continuing to assume that each person holds at most one unit of some money, they allow small trades through randomization. Their notion of implementability is no group defection by meeting-specific pairs. They show that discrimination against foreign currency is implementable: if a producer is offered what is foreign money to the producer, then the gains from trade can be divided in a way that is more favorable to the producer than if he is offered home money. For two identical countries and in the class of allocations that are

symmetric over countries, they show that such discrimination is never beneficial. But what if the countries are not identical? In that case I suspect that some such discrimination may be desirable.⁹

The same kind of device could be used to explain instances in which there is rate-of-return dominance and in which the higher return assets are not used in trade. One glaring instance of this occurred in France during and after World War I (see Makinen and Woodward [21].) Of course, to be convincing the models have to be generalized to allow richer individual portfolios.

Is the combination of discounting and trade in pairs better than positing exogenous transaction costs? I think so. It makes sense to pursue mechanism design in the context of the trade-in-pairs models. It is less sensible to do so in models that posit exogenous transaction costs—especially, asset-specific transaction costs.

6 Conclusion

Existing work on nice models of money seems to consist of a wide variety of special models. In other areas of economics, there are broad categories that are useful for relating models. I have proposed three such categories for nice models of money. One is whether there is idiosyncratic uncertainty that produces heterogeneous money holdings; the second is the extent to which previous actions are monitored; and the third is whether trade takes place in pairs (small groups) or is centralized. The first is important because it determines whether a policy like lump-sum creation of money has both extensive and intensive margins effects. Monitoring is important because it is necessary for credit. Therefore, the extent of monitoring is important for thinking about the margin between credit and outside money. Finally, trade in small groups and discounting give rise to a multiplicity of implementable outcomes. That multiplicity may help us explain why we sometimes see seemingly good assets which do not play a monetary role.

⁹See Kocherlakota and Krueger [16] and Kiyotaki and Moore [13] for other ways of getting a benefit from distinct currencies.

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