Monetizing Social Exchange

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Abstract

Abstract. We address the role of monetizing trades in an environment when reciprocal trade acts as the alternative means of exchange and opportunism is possible. We illustrate that money has three roles: (i) money enable trade on contractible goods, (ii) money aids trade in non-contractible goods through the use of voluntary transfers, and (ii) money possibly induces inefficient pricing and production decisions. We show a number of cases where allowing trades to be monetized reduces welfare and also illustrate how an inefficient instantaneous means of exchange can sometimes increase trade more than pure money. Finally, analogous to the role of barter in facilitating efficient exchange, we illustrate that otherwise classically inefficient restrictions on trading may have a similar desirable effect.

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** This paper has evolved into something which is quite different from the original version that was first circulated in 1995. In addition, some portions of the original paper have been published elsewhere (see references) during the intervening time. Nonetheless, we have maintained the original title.

1 Introduction

It is a universal theme in economics that the existence of fiat money facilitates exchange. Since money is an asset that has less deadweight loss in its transfer than other assets, it best overcomes the famous absence of 'double coincidence of wants' between consumers and producers that plagues non-monetary exchange. Despite this apparent consensus among economists, many economic exchanges do not take the form of goods for cash. Perhaps the most common form of non-monetary exchange involves individuals trading favors, with the promise of a future reciprocated favor acting as implicit payment. The objective of this paper is to address the role of pure money in an environment where agents can reciprocate favors but can also act opportunistically. We consider a variety of forms of opportunism, ranging from the a failure to supply goods to inefficient pricing decisions. We show that in this setting, money has a series of beneficial and harmful roles different from those in the existing literature on exchange. We further illustrate a role for requiring that some trades remain non-monetary despite the availability of cash.

In the existing literature, money acts as an *efficient* means of facilitating *instantaneous* trade. Money is efficient in that it is desired by agents and there is (typically) no deadweight loss in its transfer. Such efficiency facilitates anonymous trade where accounts are instantaneously balanced by the exchange of money for goods. The alternatives to money typically involve deadweight loss in transfer through the absence of a double coincidence of wants. In this paper, we propose two other benchmark means of exchange. First, we consider a role for a delayed, efficient means of exchange, where agents repay services provided by others by reciprocating needed services. The services are surplus-increasing (so they are an efficient form of transfer) but they are delayed. Thus while there may be no static double coincidence of wants, reciprocation of favors can potentially offer a dynamic double coincidence. Second, we also consider the use of an inefficient, instantaneous means of exchange rather than allowing (technologically efficient) money in an environment where reciprocity is also available. This form of exchange is usually referred to as barter.

Perhaps the most important distinction between our work and the existing literature on exchange (such as Kiyotaki and Wright (1989), (1991), (1993), Trejos and Wright (1991), and Matsuyama, et al. (1993)) is that we allow for opportunistic behavior by buyers and sellers. This literature typically considers trade in goods whose quality can be observed by inspection. However, one of the central themes of economics over the last decade has been the inability of agents to contract over efficient behavior. We consider a simple trading situation where a producer provides some service for a consumer where the quality of some goods cannot be easily specified. Opportunism here can take the form of providing low quality goods or by failing to pay for goods received. For instance, suppose that an agent asks another for costly advice on some matter. It is difficult to contract over the quality of the advice, and can only be determined only after it is provided. The provider of the advice can therefore only be rewarded after it has already been consumed, so that the recipient may have no incentive to reward the other. But without payment, the provider may put in little effort in giving advice. We call such services *non-contractible*. The quality of other goods can easily be determined on inspection, and it these *contractible* goods that have been the focus of the existing literature on the optimal means of exchange. Our objective is to address the optimal means of exchange where some goods can be easily specified but others cannot.

We suppose that simultaneous trades between two individuals are enforceable, but there are no external mechanisms for enforcing multi-period trades (e.g., goods delivered today for a promise of something in the future); instead, all such trades must be supported by the demands and incentives of the two trading parties. Because of the absence of legally enforceable multi-period contracts, two possible forms of exchange transactions exist. First, because in our setting the quality of contractible goods can be observed before consumption, agents can *simultaneously* trade these goods for pure money (or any other currently available *quid pro quo*). No enforcement mechanism is necessary as there is a static double coincidence of wants. We call such instantaneous swaps of goods for money (or other goods) simply *simultaneous* trades. Second, agents may also transfer goods and/or money to each other with legally nonbinding promises today for the delivery of goods or money in the future with only the use of strategically credible threats by the players to enforce the promises. This latter transaction mechanism is the well-known implicit contract in which cooperation today is supported by promises of cooperation in the future. Here, even though there is no static double-coincidence of wants, there is a dynamic one which facilitates trade when agents are sufficiently patient. In our analysis of these two trading conduits (and the interactions between them), we highlight three roles for pure money in exchange:

1. The existence of money guarantees a static double coincidence of wants and therefore supports the efficient trade of contractible goods in all instances (formally, both on and off the equilibrium path). This improves efficiency on the contractible goods, but generally hinders trade on the non-contractible goods (which may otherwise be exchanged through dynamic reciprocity);

2. Dynamic reciprocity (i.e., implicit contracts enforced through reputational concerns) are aided by the presence of money through voluntary monetary payments which relax the intertemporal incentive compatibility requirements of the relationship;

3. Introducing money into an economic environment changes the bargaining power of sellers which can cause them to price inefficiently.

These three effects of money lead to a variety of costs and benefits. We begin in Section 2 by considering a model of dynamic reciprocity where agents trade both contractible and non-contractible goods and examine the effect of money on feasible trades. First, as with the existing literature, pure money efficiently enables trade on contractible goods. But this affects the willingness of agents to provide non-contractible goods because it reduces the sanctions from failing to fulfill obligations. Consider a world where two individuals interact over time and can reciprocate favors for one another. In this setting, if an agent demands a favor, the other must decide whether to provide it. As is standard, trade is constrained by the threat of punishments if an agent deviates from the appropriate course of action. A natural punishment is to terminate all future trade; traded quantities then depend on discount rates in the usual way. Now consider the effect of adding pure money to this relationship. Pure money enables trade on contractible goods. But this is likely to be true independent of the previous behavior of the agents; therefore trade continues even after an agent has cheated on his obligations. In other words, while money does have the standard effect of enabling simultaneous trades, it also reduces the ability of agents to impose sanctions on one another in the event of cheating.

This effect (which has also been pointed out in various settings by Bernheim and Whinston (1990), Baker, Gibbons and Murphy (1994,1996), Schmidt and Schnitzer (1995), di Tella (1998) and, most relevantly, Kranton (1996)), implies that money harms trade on non-contractibles. However, money can be voluntarily offered by the consumer if the producer fulfills his obligations which relaxes the incentive compatibility constraints.[1] These transfers mitigate the harmful effect of money described above and yields the following simple results: (i) If non-contractible trades are more important than contractible trades, money always increases welfare, (ii) If non-contractible trades are less important than contractible trades, the effect of money on trade is non-monotonic. For agents who interact very infrequently (or are very impatient) money improves welfare, while for intermediate rates of interaction, money always reduces welfare. For sufficiently patient players, money has no effect on trade. These effects are counterintuitive. If contractible goods are relatively more important (in the sense of comprising a larger fraction of buyer demands), one would think money is always *more* rather than *less* desirable as money can support trade on contractible goods without reliance upon dynamic concerns. This intuition ignores the fact for moderately patient agents it is possible that without money both forms of goods may be consumed at near-efficient levels; introducing money in such a case can dramatically reduce trade on non-contractible goods – since such a large portion to the market is now tradeable without reliance on reputation – with

[1] The idea that monetary payments can pool incentive compatibility constraints was first noted in MacLeod and Malcomson (1989).

the net result that the gains from more efficient trade on contractible goods is entirely offset by the losses on the non-contractible market.

The effect of money on sanctions is one of two costs to monetizing trades which are outlined here. The second reason why money can harm efficient trade is that the desirability of money makes sellers more likely to engage in inefficient activities that garner this money, namely, monopoly pricing. In Section 3 we consider a situation where only contractible goods are traded but there is uncertainty about the valuation of the consumer. The seller would like to extract rents from the consumer, as in any monopolized setting. However, in the absence of an instantaneous means of exchange, it is difficult for the seller to capitalize on his monopoly power. This is not true when buyers have an asset that they can instantaneously transfer to potential sellers, where the buyer has the opportunity to demand a price which exceeds that which guarantees that efficient transfers occur. We show that it may be efficient to prohibit any instantaneous means of exchange. In other cases, the optimal instantaneous means of exchange should not be pure money but instead should involve static inefficiencies (barter).

So far, we have only considered efficient reciprocity. Section 4 addresses how agents exchange when all they have at their disposal is favors which are not equally valued by both agents. For instance, politicians may trade favors through log-rolling when one politician values the favors more than the other. Our objective here is not to illustrate that such inefficient favors can dominate the use of money but rather to show how production and consumption decisions differ from those which would operate in a monetized economy. In this section, production has both a primary role (consumption) but it also can be used to provide liquidity. This role for production results in such outcomes as (i) higher production of goods which are less valuable than that of more valuable goods, and (ii) over-production of less valued goods relative to the first best. We see this section as initial observations that the rules which govern non-monetary trade differ from those which prevail for monetized trades.

Finally, we address the choice of network trading structures on exchange efficiency. Here, like in the analysis of barter versus money, we again find that classically inefficient trading restrictions between agents may improve welfare when we operate in the world of second best. Specifically, we consider restrictions on the choice of trading partners. We know from Ricardo's classical theory of comparative advantage that when there is a diversity of marginal rates of transformation across producers, larger trading networks are always welfare enhancing. When some trades are not contractible and markets are not complete, however, restricting trading networks to smaller, classically-inefficient but autonomous trading groups may generate sufficiently large gains from improved cooperation so as to offset the unexploited gains from comparative advantage. We explore this general notion in the context of a simple trading model which builds on our previous cooperative results.

We begin in Section 2 by setting up our basic model of social exchange and illustrating how money enables contractible trades though sometimes at the expense of their non-contractible counterparts. This ambiguous welfare effect of monetizing trades is extended in Section 3, where we show that even in a situation where all goods are contractible, the introduction of money can reduce welfare as it gives suppliers an incentive to price aggressively. Section 4 addresses the effect of trading inefficient favors. Section 5 examines the potential value of restrictive trading circles. We conclude with a brief summary of (many) unresolved issues.

2 Monetizing Trade

This section illustrates the effect of two of the three implications of pure money on repeated exchange, namely, (i) that money enables trades of contractible goods, and (ii) that money can be used as a voluntary gift upon receipt of a service. To do so, we set up a simple model of repeated exchange, where agents randomly demand a good from each other, where the good demanded is either contractible, so its quality can be verified at the time of transfer, or non-contractible, where quality is only known upon consumption of the good at a later date. We begin by considering the set of enforceable trades in the absence of money, where standard results on the role of patience apply.[2] We then consider the role of money in this environment, and illustrate its ambiguous effect on traded quantities.

2.1 A Simple Illustrative Model of Reciprocal Exchange

Consider two individuals who interact over time, potentially providing goods to one another other. Each party to the relationship has two potential goods which they may demand in any period of time. We will denote one good as "noncontractible" and use the n subscript, and we will denote the other good as "contractible" using the k subscript. By contractible, we mean simply that quality can be observed upon inspection. Non-contractible goods are characterized by the fact that the recipient can only determine its quality by consuming the good. It is impossible to guarantee trade of high quality non-contractibles for money (or any asset) because the potential buyer cannot be excluded from consumption once quality is determined. Therefore, exchanges of the noncontractible good must be self-enforceable because the buyer must be willing to offer cash after consumption and/or the seller must be willing to offer the good without guaranteed repayment.

[2] See, for example, Telser (1980) and Klein and Leffler (1981) for early economic applications and Fudenberg and Maskin (1986) and Fudenberg and Tirole (1991; ch. 5) for the more general game theoretic developments.

Define $s(q_i) \equiv q_i - c(q_i)$ as the social welfare or joint surplus created from the trade of good i, where for example q_n is the quantity of the non-contractible good traded. When good i is demanded by individual A and q_i units are supplied by individual B for A's use, a surplus of q_i is generated for agent A at a cost of $c(q_i)$ which is borne by individual B; the reverse is true when project i becomes available for individual B. Agents cannot satisfy their own needs. For simplicity, let $c(q_i) = \frac{1}{2}q_i^2$. Technically, we assume that for non-contractible goods, the producer can either produce good quality goods with valuation $v = 1$, or observationally identical low quality goods which inefficient to exchange (i.e., low-quality goods have value less than cost). Inference on quality can only be determined by consumption, which occurs instantaneously after receipt of the good. Lastly, we consider the arrival of projects to be a random process with project i arriving during a short period of time, dt, with probability $\lambda_i dt$; i.e., projects arrive according to a Poisson process. In particular, this implies that a double *static* coincidence of wants (the simultaneous arrival of two projects, one for each individual, during the same small interval of time) occurs with insignificant probability. We assume that each individual has a discount rate of r where δ is the associated discount factor, $\delta \equiv \frac{1}{1+r} \in (0, 1)$.[3]

2.2 Monetizing Exchange with Limited Contractibility

We consider two scenarios. The first is where money does not exist and trade can only be done by favors. We then compare this to a situation in which money does exist and can be used freely in any trade. We find that depending upon the discount factor and the importance of both types of trades, such monetization can either be a blessing or a curse.

Exchange without Money. Consider first exchange without money. Here, the agents enforce reciprocal trades through the threat of dissolution of the partnership. Assume that quantities q_k and q_n are traded in equilibrium. Then if one agent requires q_k, the relevant incentive compatibility constraint is that the other agent is willing to provide it, which implies that

$$-c(q_k) + \frac{1}{r}\left[\lambda_k s(q_k) + \lambda_n s(q_n)\right] \geq 0. \tag{1}$$

If the agent requires q_n, incentive compatibility requires that

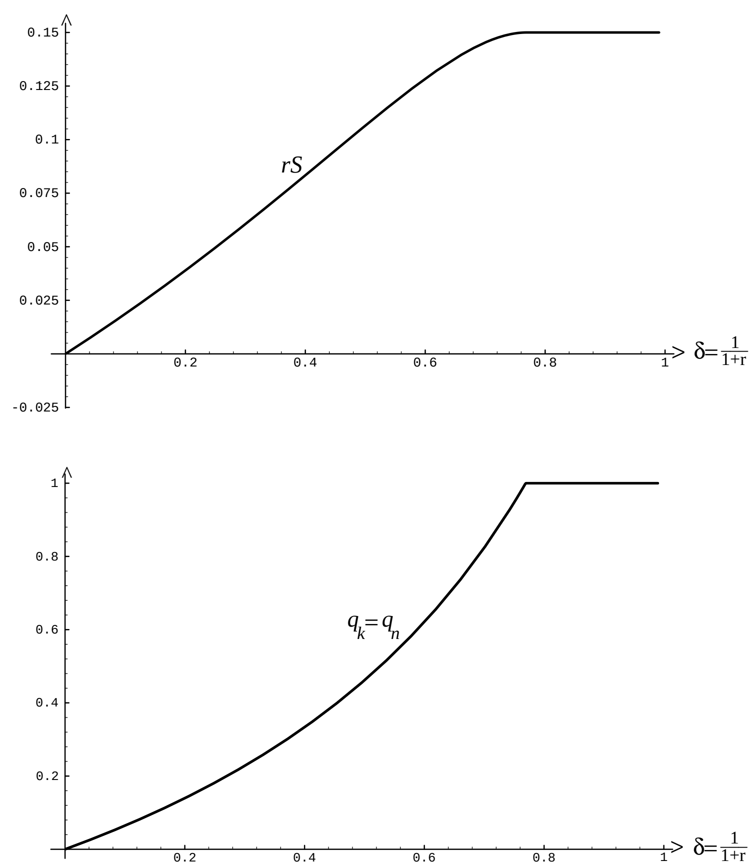
$$-c(q_n) + \frac{1}{r}\left[\lambda_k s(q_k) + \lambda_n s(q_n)\right] \geq 0. \tag{2}$$

[3]Although this is a model of continuous time where a discrete representation of patience such as $\delta = \frac{1}{1+r}$ would never appear in any incentive compatibility constraint, we use δ as a useful normalization of patience where an agent with $\delta = 0$ (i.e., $r = \infty$) is infinitely impatient and $\delta = 1$ (i.e., $r = 0$) is perfectly patient.

For notational simplicity, we will sometimes refer to the present value of utility to an agent as $S \equiv \frac{1}{r}[\lambda_k s(q_k) + \lambda_n s(q_n)]$ and the average flow value as rS. Throughout the paper, we consider symmetric solutions to this problem, where each agent receives the same quantity of q_i. With these constraints, the equilibrium trades can be characterized by two regions. For large enough δ, neither constraint binds at the first best level of trade, which is given by $q^{eff} = 1$. Then the first best level of trade is enforceable. For lower δ, both constraints bind and so both quantities are below the efficient level, with traded quantities of both goods continuously increasing in δ.

Example 1: For an illustrative case consider the setting in which $\lambda_k = .25$ and $\lambda_n = 0.05$ in Figure 1. The solid curve in the top graph gives the maximal equilibrium flow value $rS \equiv \lambda_k s(q_k)+\lambda_n s(q_n)$ as a function of the discount factor δ while the solid curve in the bottom graph measures the provided quantities as functions of δ.

FIGURE 1.



Exchange with Money. Suppose that we now add money to this trading relation. This paper is not meant to be a general equilibrium theory of money. Instead, our interest is in understanding the importance of allowing money to settle account for situations where a commonly accepted form of money already exists. For instance, should two divisions in a modern corporation be allowed to trade money for goods? The defining characteristic of money in this paper is that it is an instantaneous means of exchange. Accordingly, we assume that pure money is an asset which has unit value to all agents and which has no deadweight loss in its transfer. Therefore, if one agent transfers $1 to the other, the donor's utility falls by 1 and the recipient's utility rise by 1. (Later in the paper we will consider instantaneous means of exchange which involve deadweight transfer loss, i.e., barter.) For simplicity, we ignore stock-out problems by assuming that each agent has sufficient stocks of money that he never has liquidity problems.[4]

Given this definition, money has two features that affect the set of attainable trades. First, money is an asset that can be transferred with no deadweight loss. Second, money can be exchanged for the contractible good simultaneously, thus enabling trades on q_k. In terms of the relevant incentive compatibility constraints, this implies three effects of money. First, and most immediate, first-best trade always takes place on the contractible good, $q_k = q^{eff} = 1$. This statement is true in any subgame; while an agent may threaten another with complete exclusion from trade, we feel that such threats are incredible because subgame perfection requires that agents exchange contractible goods for money. Second, as a consequence of the efficient production of contractibles, punishments are less severe because a failure to cooperate can only be met with a dissolution of the partnership on the noncontractible good; trade always continues at its efficient levels on the contractible good.[5] The introduction of money thus has a deleterious effect by reducing credible punishments. Third, money directly affects trade on the non-contractible good, even though the non-contractible good cannot be verified by anyone outside the relationship and it is not known that service has been provided until after its consumption. This arises because money can be offered as a voluntary payment when quality has been observed to be satisfactory. Because such transfers are voluntary, they are likewise governed by the standard incentives to renege that occur with goods transfers. Despite their voluntary nature, money transfers play a central role in relaxing the relevant constraints as these transfers pool the incentive compatibility constraints within a

[4] Note that we have ignored liquidity constraints or more generally risk aversion as a means of generating non-monetary trades. Such observations are little more than saying that sometimes it is not efficient to trade money for standard efficiency reasons, as monetary trades may harm surplus more than some other means. This is not the theme of this paper and so is ignored.

[5] We take the position that trade on the contractible good is efficient on- and off-the-equilibrium-path because we see the repeated game we study as a metaphor for a world where information is collected on the "type" of a trading partner, where failure to reciprocate illustrates a lack of trustworthiness. In this world, it is only credible to exclude a deviator from non-contractible trades.

period of cooperation across the two individuals. More specifically, in the absence of money, the present discounted value of the surplus of the producer from the relationship must exceed his costs of production if he is to provide the good. With voluntary transfers, if the *sum* of the present discounted value of the surpluses of the producer and consumer exceeds the producer's cost, production can be induced.[6]

To determine the efficiency of money we focus on trade in good n since good k is always traded at efficient levels. Let t be the voluntary equilibrium transfer made by an individual immediately after receiving the equilibrium transfer of (high quality) q_n. This transfer must be set such (i) the seller is willing to provide q_n on the expectation of a transfer t, and (ii) the buyer is willing to voluntarily offer t. There are now two relevant incentive compatibility constraints analogous to (2):

$$\frac{\lambda_n}{r}s(q_n) \geq c(q_n) - t, \tag{3}$$

for the producer of good i, and

$$\frac{\lambda_n}{r}s(q_n) \geq t, \tag{4}$$

for the donor of the transfer. Comparing to (2), there are two changes. First, note the absence of the surplus on the contractible good, $s(q_k)$, because dishonesty on good n cannot be penalized from exclusion from trade on good k. Setting $t = 0$, the incentive compatibility constraint is more difficult to satisfy than (2), due to the absence of "multi-market contact" on which to penalize the deviator. This is the cost of using money in our model. But transfers can relax the producer's incentives.[7] It is clear that by setting $t = \frac{1}{2}c(q_n)$, the slackness on the recipient's constraint is perfectly pooled with the binding production constraint. With an optimally chosen monetary transfer, there is only one relevant incentive compatibility constraint:

$$2\frac{\lambda_n}{r}s(q_n) - c(q_n) \geq 0. \tag{5}$$

Thus, once the sum of the punishments exceed the cost of production, trade occurs. The question then remains as to whether the net effect of money on the relationship is beneficial or not. This is a simple comparison of (2) and (5). If $\lambda_n < \lambda_k$, the modified incentive compatibility constraint (5) is more difficult to satisfy than (2), due to the absence of multi-market contact on which to penalize the deviator. This is the cost of using money in this section. The question then remains

[6] A similar argument is presented in Macleod and Malcomson (1989).

[7] Another interpretation of this result is that when only non-contractibles are traded, there is never a cost to allowing money transfers, so that pure favors (i.e., no immediate rewards offered by the recipient of the good) are always dominated by allowing monetary transfers. A similar point is made in Holmstrom and Kreps (1995) in the context of promises.

as to whether the net effect of money on the economy is beneficial or not. Proposition 1 identifies the relevant conditions.

Proposition 1 *Suppose that $\lambda_k > \lambda_n$. Then there exist $\underline{\delta}$ and $\overline{\delta}$ where $\overline{\delta} > \underline{\delta}$ such that*

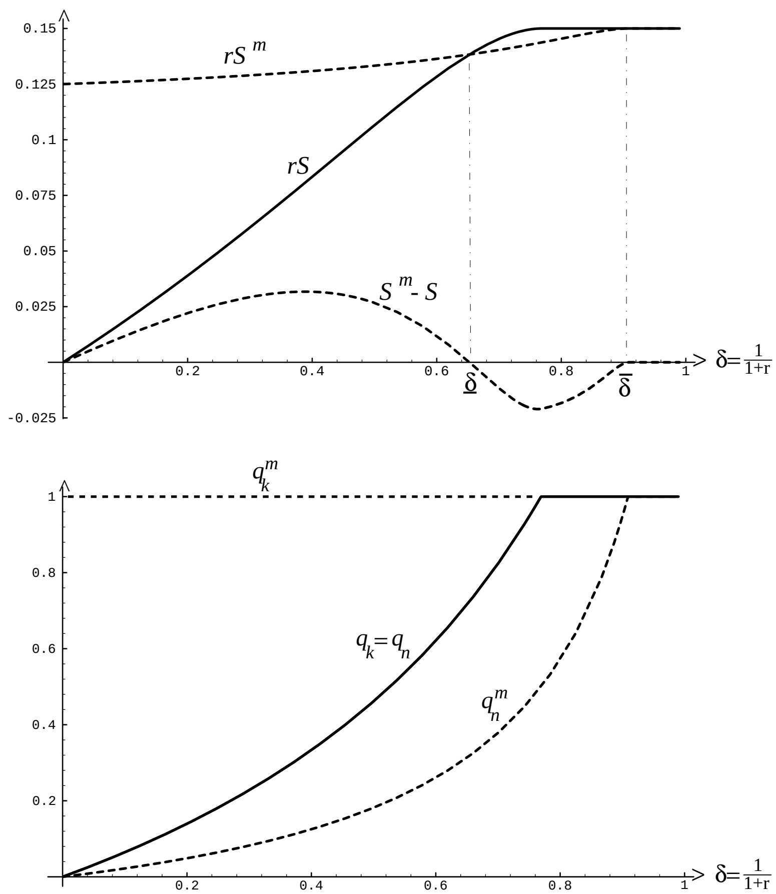
- *for all $\delta \in [0, \underline{\delta}]$, monetary trade over the contractible good is strictly beneficial,*
- *for all $\delta \in (\underline{\delta}, \overline{\delta})$, monetary trade over the contractible good is strictly detrimental, and*
- *for all $\delta \in [\overline{\delta}, 1]$, monetary trade over the contractible good is irrelevant.*

Whenever $\lambda_k \leq \lambda_n$, $\overline{\delta} = \underline{\delta}$, so monetary trade over the contractible good is (weakly) beneficial.

Proposition 1 illustrates that the benefits of money depend on the discount rate in a simple non-monotonic fashion. If the discount rate δ is below $\underline{\delta}$ or if $\lambda_n \geq \lambda_k$, the introduction of money is beneficial for the reason that little could be enforced through reciprocity. However, in the range of discount rates – between $\underline{\delta}$ and $\overline{\delta}$ – money harms welfare. Therefore for intermediate discount factors, the value of enforcing trades on good k is outweighed by the costs in terms of enforcing good n. This range of discount factors has strictly positive length if $\lambda_k > \lambda_n$. If $\lambda_k \leq \lambda_n$, the gift-giving role of money dominates the effect of multi-market contact enforcing the collusive arrangement.

Once again consider the parameter valued from Example 1 from above, but now in the presence of money.

FIGURE 2.



Here the quantities traded are given by q_i^m and shown with dashed lines. Good k is traded at its first best level of 1 while trade in good n is (weakly) lower than without money because in this example $\lambda_k > \lambda_n$. Welfare in the top part of the figure is given by $rS^m = \frac{1}{r}\left[\lambda_k s(1) + \lambda_n s(q_n^m)\right]$, and the difference between the two is given by the broken line, illustrating the non-monotonic effect of money in the discount rate, where greatest benefits of money accrue for low discount rates.

Note that money can be harmful only if *both contractible and non-contractible goods are important* as it is the interplay between the two types of goods that generates our results. Consider the role of money when all goods are non-contractible so that the only role of money is as a voluntary payment. By setting $t = \frac{1}{2}c(q_n)$, this is equivalent to cutting the effective interest rate in half which relaxes the incentive compatibility constraints and (weakly) causes more trade. As a result, this analysis has the paradoxical result that money can only be beneficial if all goods are non-contractible, but can be harmful when some can be contracted over. This ambiguous effects of money arise from the interplay of social sanctions and voluntary transfers.

Before concluding this section, it is worth noting that these observations are best suited to describing the effect of money on decentralized trade, where there are no third parties to enforce punishments. In settings where there are additional players in the game who can observe the history of trades (and their quality), it is easy to conceive of situations where a deviating agent could be excluded from all trades, where the "other" agents would threaten to ostracize any agent who trades in *contractible* goods with a deviator. If such sanctions can be enforced, then the introduction of money will be beneficial, as the cost of being excluded from contractible trades is at least as high as without money and voluntary transfers can still be offered. However, we believe that the ability to enforce such punishments are severely limited by an inability to observe all trades by potential punishers outside the immediate exchange; for this reason, we see this paper as best suited to describing decentralized private exchange.

2.3 Anthropological Observations

Though economists have typically ignored potentially harmful effects of money, the value of monetizing trades remains a subject of concern among anthropologists studying so-called primitive societies, where in the words of Sahlins (1972, p.298), "social relations, not prices, connect buyers and sellers". Unlike economic models of exchange, which typically consider anonymous instantaneous exchange with barter as the alternative, anthropologists consider the effect of money in societies where the reciprocal exchange of favors acts as the alternative.[8] In this literature, there is a view that the introduction of the cash economy was "a powerful dissolver of the traditional ties of dependence" (Dalton, 1965) in a way that he believes ultimately harmed some components of society. A common concern is that the introduction of monetary trade broke social bonds for much the same reasons as are outlined above; namely, that individuals were less obligated to provide favors for others. For instance, according to Mair (1965), "outside sources of income create inequalities among people who traditionally are sharers [where] the fortunate ones do not readily recognize the obligation to share outside a very narrow circle". Similarly, Healy (1984) argues that the "lack of political integration between communities increases the risk that agents will default", but "embedding such relations in a kinship matrix lowers the risk because of added sanction." Thus, multi-dimensional punishments are necessary to maintain the provision of favors. Similarly, Geertz (1973), emphasizes the importance of a "multi-stranded relationship" where transacting parties see one another in church, school and family gatherings in a way that will help enforce reci-

[8]Similar to our model, the threat of dissolution of the partnership is used to enforce reciprocal behavior. For instance, Sahlins notes that "the risk of .. future economic penalty tends to keep people on course" as "we know what happens when a trade partner fails to reciprocate - the sanction everywhere is dissolution of the partnership" (1972). Similarly, Firth realizes that "the main emphasis of the fulfillment of obligation lies [in] the desire to continue useful economic relations" (1957).

procity.[9] As a result, we feel that the model above may be of relevance to understanding the effect of modernization on the supply of various goods and the breakdown of various types of trades.[10]

It is useful to conclude this section with a more colloquial version of our results. The essence of our results is that sometimes it is valuable to make agents "rely upon" each other. Partial independence has some virtues but it may render individuals less willing to help each other as they are no longer so dependent. For instance, consider two divisions within a firm which require goods from each other. Sometimes their demands from each other are routine (and can be easily contracted over), such as the use of manual workers. Yet at other times, their demands are far more complex, where the providing division is required to exert effort in specializing its input for the other division. In this setting, it is easy to see why headquarters in the firm may wish to constrain monetary transfers between the divisions, in order to have them maximally dependent on each other, as this requires them to "get along".

3 Money Facilitates Rent-Seeking

The premise of this section is that introducing a means of exchange that is technologically efficient can cause sellers to carry out activities which reduce welfare. We consider two distinct scenarios. First, in section 3.1 we show that in an economy where reciprocal exchange facilitates trade and all goods are contractible, more efficient money can induce sellers to act monopolistically in a way not possible without such an "efficient" asset. This effect is in addition to (and can more than offset) the favorable effects of money on relaxing intertemporal incentive constraints. Our second example in section 3.2 illustrates a similar point in that money can induce overproduction of contractible goods at the expense of non-contractible goods. The central point of this section is that the optimal means of exchange may involve the use of an instantaneous, inefficient means of exchange (e.g., barter) rather than money.

[9] It should also be emphasized here that while this section could be interpreted that sometimes economies would do better to remain non-monetized, we are comfortable with a less stark interpretation of this result. In particular, while the model gives example of welfare falling forever as a result of monetization, we feel that in many cases these phenomena may be transitory while an economy moves towards the full benefits of monetization. For example, it seems reasonable that when an economy moves away from implicit relationships towards more arms-length contracts, the benefits which accrue (such as the returns to specialization) take time, as necessary investments must be made. A less stringent interpretation of our results is that during this interim period, there are likely to be reductions in trade for the simple reason that implicit contracts are becoming less important, thus reducing interim welfare.

[10] Related to this is the effect of markets on family structure. There has been considerable work in sociology on the fact that the introduction of markets reduces the extent of interactions among extended families, where families have become more nuclear units (Parsons and Bales, (1955), Goode (1964)). The reason for such changes could, of course, be efficient, as access to markets reduced the importance of extended links. However, the result above could point to a less rosy interpretation, namely, that the fact that less trade between these parties (with intermediate discount factors) can be held together means that there is less efficient trade. Thus this paper interprets the break-up of extended family relations as possibly a reflection of the inefficiencies of market trades, which must be made up for by improved trade on contractible goods with strangers.

3.1 Monopoly

We argue here that the existence of money facilitates monopoly power.[11] In the model we set out in the previous section, trades are set at a one-for-one exchange rate. Demands for greater returns from one seller are constrained because reciprocation can only occur at a later date, at which point that seller himself has the same monopoly power as that held by the original seller. Hence, we hold throughout that efforts to extract rents by demanding terms of trade different from one-for-one will not be successful. This is not necessarily the case where there is an instantaneous means of exchange available. In that instance, a seller can credibly demand the instantaneous means of exchange in return for supply of the good as in any static monopoly setting.

Assume that unlike the previous section, (i) all goods are contractible, and (ii) there is uncertainty about buyers' valuations of the goods that they purchase. We assume the absence of non-contractible goods simply to ignore the interplay between the two types of goods inducing the effects of money on punishments, which were central above. We drop the k subscript throughout as there is now only one type of good. Concerning valuation uncertainty, we assume that demands arrive according to a Poisson process with arrival rate λ, but conditional on such an event, the agent values a unit of q at v, where v takes on the value $\overline{v}$ with probability θ and $\underline{v}$ with probability $1-\theta$, where $\overline{v} > \underline{v}$ and v is independently distributed across time. To retain similarity with the previous section, let $E(v) = 1$ and $c(1) = \frac{1}{2}$. Valuation is private information to the buyer and is independently distributed across periods. Assume further for simplicity that the quantity supplied is discrete, equal to either 0 or 1, and that $\underline{v} > \frac{1}{2}$, so that it is efficient to supply the good in all states.

We consider two possible means of exchange which exist simultaneously. First, we allow agents to reciprocate trades at a relative price of unity as above. Second, the agents have access to an instantaneous means of exchange where a 1 unit transfer from one party has benefits $\gamma \leq 1$ to the other. In this setting $\gamma = 1$ is equivalent to pure money while $\gamma < 1$ is suggestive of inefficient exchange such as barter. The case where $\gamma = 0$ is equivalent to banning all money. Long term contracts cannot be enforced, so the instantaneous price that the seller charges cannot be contracted on ex ante (i.e., before it is known who will be buyer and seller). We assume that the seller now has the option of making a take-it-or-leave-it money demand to the buyer after he has produced the good. The timing of the game is (i) following the announcement of demand by a prospective buyer, the seller produces the good or not and (ii) if he produces the good, he makes a take-it-or-leave-it

[11] Ellingsen and Stole (1996) in a similar spirit have demonstrated in a model of international trade that the requirement of barter by the government of one country ("mandated countertrade") can serve to weaken the monopoly power of the firms involved in a bilateral trade negotiation, thereby enhancing the efficiency of trade.

offer to the buyer.[12]

The equilibria that we address follow naturally from the previous section; following a demand realization, the producing agent transfers the good to the consuming agent for an agreed-upon instantaneous price of $p \geq 0$. It must be the case that the buyer is willing to pay p for the good, and similarly that the seller prefers to offer the good at a price p than any other. If the seller demands a price other than p or refuses to produce, he is deemed to have violated the implicit contract and we impose the maximal credible punishment in the continuation game. Similarly, if the buyer refuses to purchase in the periods where he demands the good and is supposed to pay p, he has violated the implicit contract.

It is useful to begin by considering the optimal static profit-maximizing price for the seller. Given the binary nature of valuations, the chosen price will either be $\underline{v}$, $\overline{v}$ or ∞ (i.e., refuse to produce). To illustrate monopoly distortions, we assume that the static optimal price is either $\overline{v}$ or ∞. This requires that $\theta\overline{v} > \underline{v}$; note that if γ is sufficiently small such that $\gamma\theta\overline{v} < \frac{1}{2}$, then $p = \infty$ is optimal. After reneging on equilibrium obligations, agents can continue to sell for the static monopoly price in the continuation game.

3.1.1 When is Full Trade Implementable?

We begin by considering whether an equilibrium exists in which trade occurs for both types of consumers (i.e., the trading outcome is "full" rather than partial as in monopoly pricing).[13] If trade always occurs, it must be that low valuation consumers always get the good. First consider the seller's utility. The utility in the continuation game conditional on violating the implicit contract is (i) if $\theta\gamma\overline{v} - \frac{1}{2} > 0$, the optimal continuation is to offer a price of $\overline{v}$, yielding the expected present value of profits of $\frac{\lambda}{r}(\theta\gamma\overline{v} - \frac{1}{2})$ albeit with no consumer surplus, and (ii) otherwise not produce. In addition, the seller gets its immediate profit (net of cost) upon reneging, given by $\max\{0, \theta\gamma\overline{v} - \frac{1}{2}\}$,

[12]Note that there is a delay between producing and selling. In some monopoly settings, orders could be taken before production so that there is no possible deadweight loss from this lag. However, there is no direct enforcement mechanism in the model to require buyers to honestly reveal their intentions to purchase. Given this, if the buyer desires to do so, he can claim that he will purchase even in settings where he has no intention to buy. In this model, we impose maximal punishments on those who deviate, so buyers will indeed follow such a strategy. Thus the lag between production and sale occurs as a natural component of our equilibrium. Alternatively, one could construct a model in which the cost of production is only paid if a sale is made. In this case, it is possible to demonstrate that our "region 2" below cannot emerge, and therefore improving the means of exchange is always detrimental to the prospects of full trade.

[13]Note that we have not demonstrated that the optimal social outcome is necessarily to implement trade for both types of customers for a given γ. An alternative equilibrium arrangement is one in which only high valuation consumers demand the good and a transfer is paid which exceeds $\underline{v}$. Trade is lost on the low types but trade may be more efficient on the high types (e.g., trade may occur where before it could not when the low-type buyers also consumed). For our purposes, however, this is irrelevant, as we are ultimately interested in the properties of the optimal γ. Whenever it is optimal for only the high valuations consumers to consume the good, this can be immediately implemented by choosing $\gamma = 1$ and playing the static monopoly pricing equilibrium in each period.

yielding total utility of $\max\{0, (1+\frac{\lambda}{r})(\theta\gamma\overline{v}-\frac{1}{2})\}$. If the seller does not renege, he gets utility of $\frac{\lambda}{r}[\frac{1}{2}-(1-\gamma)p]+\gamma p-\frac{1}{2}$, where the first instance of $\frac{1}{2}$ represents total expected surplus of trade (i.e., $\mathrm{E}[v]-\frac{1}{2}=\frac{1}{2}$), and where $(1-\gamma)p$ is the deadweight loss from the equilibrium transfer. Consequently, the incentive compatibility constraint for the seller is

$$\frac{\lambda}{r}\left(\frac{1}{2}-(1-\gamma)p\right)\geq\frac{1}{2}-\gamma p+\max\left\{0,\left(1+\frac{\lambda}{r}\right)\left(\theta\gamma\overline{v}-\frac{1}{2}\right)\right\}. \tag{6}$$

By analogous reasoning, if a buyer of type $\underline{v}$ refuses to pay p for the good, he loses welfare of $\underline{v}-p+\frac{\lambda}{r}[\frac{1}{2}-(1-\gamma)p]$.[14] He can price monopolistically in future so the price offered must be such that

$$\frac{\lambda}{r}\left(\frac{1}{2}-(1-\gamma)p\right)\geq p-\underline{v}+\max\left\{0,\frac{\lambda}{r}\left(\theta\gamma\overline{v}-\frac{1}{2}\right)\right\}. \tag{7}$$

Now consider whether efficient trade is feasible; that is, whether a price exists that simultaneously satisfies equations (6) and (7). This consists of determining a critical value of $\frac{\lambda}{r}$ above which trade can be sustained.

We are interested in determining the critical value of λ/r as a function of γ which is necessary to sustain trade for both types. To this end, we isolate three distinct regions of γ and describe the properties of the equilibrium in each region: $\gamma\in[0,\frac{1}{2}]$ (region 1), $\gamma\in[\frac{1}{2},\frac{1}{2\theta\overline{v}}]$ (region 2), and $\gamma>\frac{1}{2\theta\overline{v}}$ (region 3). We are interested in these three regions as they correspond to the cases where (i) transfers are not sufficiently valuable to be used, (ii) they have value in relaxing the incentive constraints as agents do not act monopolistically in the static game and (iii) agents will price monopolistically in the static game.

In the first region, γ is sufficiently low that (i) transfers cannot improve upon the seller's incentive compatibility condition and (ii) the seller's outside option of monopoly pricing is valueless. Transfers can only improve upon the seller's incentive compatibility condition (6) if the derivative with respect to p is positive. This is equivalent to $\gamma\leq\frac{\lambda}{\lambda+r}$. If such a condition is satisfied, the socially optimal transfer is $p=0$ and the seller's incentive compatibility constraint is simply $\frac{\lambda}{r}\geq 1$.[15]

Next consider region 2, for $\gamma\in[\frac{1}{2},\frac{1}{2\theta\overline{v}}]$. Here, γ is sufficiently large such that an increase in

[14] If a buyer of type $\underline{v}$ buys, then a buyer of type $\overline{v}$ will do likewise.

[15] At such a transfer, *if* the seller's outside monopoly option is valueless (i.e., $\gamma\leq\frac{1}{2\theta\overline{v}}$), then the seller's incentive compatibility condition becomes simply $\frac{\lambda}{r}\geq 1$. At this value of λ, it must be that $\gamma\leq\frac{1}{2}$, which implies that the monopoly option is indeed valueless. Hence, we have an equilibrium point. Alternatively, suppose that the monopoly option has value. Then $\gamma>\frac{1}{2\theta\overline{v}}$ and then the seller's incentive compatibility becomes $\frac{\lambda}{r}\geq\frac{\theta\gamma\overline{v}}{1-\theta\gamma\overline{v}}>1$ (where the latter inequality follows from the supposition that the monopoly option has value). At this level of λ, $\gamma\leq\frac{\lambda}{\lambda+r}\frac{1}{\theta\overline{v}}<\frac{1}{2}\frac{1}{\theta\overline{v}}$, which is inconsistent with the monopoly option having value. Thus, through a rather complex fixed-point argument, we have established that the critical value of $\frac{\lambda}{r}$ which sustains trade for both types of consumers is unity, which is valid for all $\gamma\in[0,\frac{1}{2}]$.

the transfer price (although socially costly) can implement trade for both types for a larger range of λ than in region 1. This is because for $\gamma < \frac{1}{2\theta\overline{v}}$, the outside option of monopoly pricing is not profitable and the incentive compatibility conditions become simply

$$\frac{\lambda}{r}\left(\frac{1}{2}-(1-\gamma)p\right) \geq \frac{1}{2}-\gamma p,$$

and

$$\frac{\lambda}{r}\left(\frac{1}{2}-(1-\gamma)p\right) \geq p-\underline{v}.$$

The first equation places an lower bound on p; the second places an upper bound on p. Combining the two expressions we have the implementability requirement that

$$\frac{2r\underline{v}+\lambda}{2(r+\lambda(1-\gamma))} \geq p \geq \frac{r-\lambda}{2\gamma(r+\lambda)-2\lambda}.$$

Solving this inequality for the critical value of $\frac{\lambda}{r}$ we obtain

$$\frac{\lambda}{r}^*(\gamma) = \frac{\frac{1}{2}-\gamma\underline{v}}{\gamma-\underline{v}(1-\gamma)}.$$

Note that $\frac{\lambda}{r}^*(\gamma)$ is declining in γ so that a more efficient means of exchange improves the likelihood of full trade.

Finally, consider region 3. Here, transfers both potentially have a value (by relaxing the seller's incentive compatibility condition) and a cost (by increasing the seller's outside monopoly option). Surprisingly, the latter effect always dominates the former and a reduction of γ always makes full-trade implementation more difficult. To see this, note that the incentive compatibility conditions for the seller and buyer now become

$$\frac{\lambda}{r}\left(1-(1-\gamma)p-\theta\gamma\overline{v}\right) \geq \theta\gamma\overline{v}-\gamma p,$$

and

$$\frac{\lambda}{r}\left(1-(1-\gamma)p-\theta\gamma\overline{v}\right) \geq p-\underline{v}.$$

Combining the relationships we have the following feasible set available for implementing full trade:

$$\frac{r\underline{v}+\lambda-\gamma\lambda\theta\overline{v}}{\lambda(1-\gamma)+r} \geq p \geq \frac{\gamma(\lambda+r)\theta\overline{v}-\lambda}{\gamma(r+\lambda)-\lambda}.$$

Solving for the critical value of $\frac{\lambda}{r}$ such that this interval is non-empty yields

$$\frac{\lambda}{r}^*(\gamma) = \frac{\gamma(\theta\overline{v} - \underline{v})}{1 + \gamma - \underline{v}(1-\gamma) - 2\gamma\theta\overline{v}}.$$

In this region $\frac{\lambda}{r}^*(\gamma)$ is always *increasing* in γ, so that increases in the efficiency of the instantaneous means of exchange reduces the likelihood of full trade.

Proposition 2 *The critical value required to sustain full-trade is*

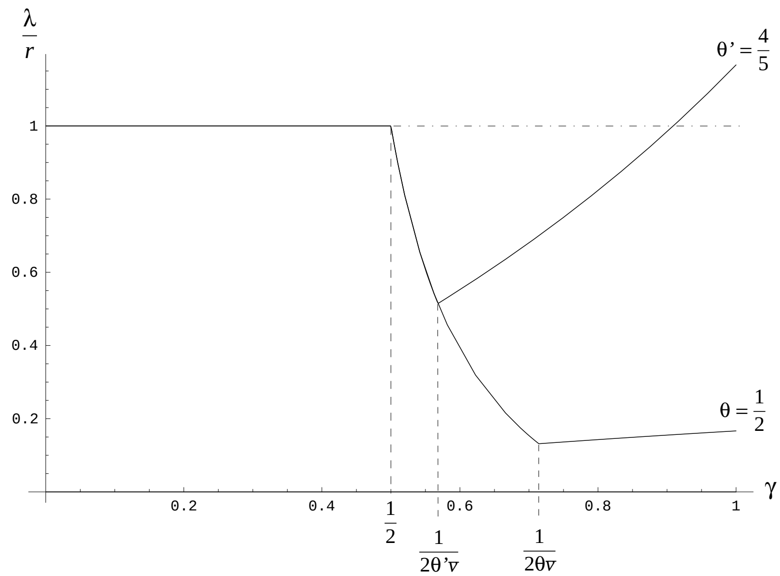
$$\frac{\lambda}{r}^*(\gamma) = \begin{cases} 1 & \text{if } \gamma \le \frac{1}{2}, \\ \frac{1-2\gamma\underline{v}}{2(\gamma-\underline{v}(1-\gamma))} & \text{if } \frac{1}{2} < \gamma \le \frac{1}{2\theta\overline{v}}, \\ \frac{\gamma(\theta\overline{v}-\underline{v})}{1+\gamma-\underline{v}(1-\gamma)-2\gamma\theta\overline{v}} & \text{if } \gamma > \frac{1}{2\theta\overline{v}}. \end{cases} \tag{8}$$

Moreover, $\frac{\lambda}{r}^*(\gamma)$ *is non-monotonic in* γ *as it is declining in* γ *for* $\gamma \in [\frac{1}{2}, \frac{1}{2\theta\overline{v}}]$ *and increasing for* $\gamma > \frac{1}{2\theta\overline{v}}$. *Note also that* $\frac{\lambda}{r}^*(1) > 1$ *iff* $\theta\overline{v} - \underline{v} > 2(1-\theta)\underline{v}$.

This proposition summarizes the observations above but also points out that pure money is worse than no money ($\frac{\lambda}{r}^*(1) > 1$) if $\theta\overline{v} - \underline{v} > 2(1-\theta)\underline{v}$. A graphical representation of the proposition is given in Figure 3 for the case in which $\underline{v} = \frac{3}{5}$ and $\theta = \frac{1}{2}$ or $\theta' = \frac{4}{5}$.[16] In the case where $\theta' = \frac{4}{5}$ the contemporaneous returns from monopoly are higher than with $\theta = \frac{1}{2}$ so that a more efficient means of exchange will be more costly in region 3 for that case.

[16]Note that $\overline{v}$ is determined by the requirement that $\theta\overline{v} + (1-\theta)\underline{v} = 1$, so that for these examples $\overline{v} = \frac{7}{5}$ or $\frac{4}{5}$ respectively.

FIGURE 3.



The parameter space is separated into the three regions described above. First, for $\gamma < \frac{1}{2}$, trade is independent of the means of exchange for the reason that positive transfers never occur and $\frac{\lambda^*(\gamma)}{r} = 1$. For γ between $\frac{1}{2}$ and $\frac{1}{2\theta\overline{v}}$, the use of that asset increases the likelihood of trade because the asset can be transferred in an environment where there is no incentive to price monopolistically. Finally for $\gamma > \frac{1}{2\theta\overline{v}}$, the incentive to monopoly price becomes relevant and a more efficient means of exchange harms the likelihood of efficient trade. The graphs outline the critical values of $\frac{\lambda}{r}$ for which efficient trade in goods can be attained for the two stated values of θ. As in the proposition, when $\theta = \frac{1}{2}$ we have $\theta\overline{v} - \underline{v} = \frac{1}{10} < 2(1-\theta)\underline{v} = \frac{6}{10}$, and so $\frac{\lambda}{r}^*(1) < 1$. Alternatively, when $\theta = \frac{4}{5}$ we have $\theta\overline{v} - \underline{v} = \frac{7}{25} > 2(1-\theta)\underline{v} = \frac{6}{25}$, and so $\frac{\lambda}{r}^*(1) > 1$. The purpose of the above analysis is to show that the effect of the efficiency of the instantaneous means of exchange on implementing full trade is non-monotonic; a more technologically efficient means of exchange initially increases the range of $\frac{\lambda}{r}$ where complete trade can occur but higher values of γ reduce the relevant parameter space.

3.1.2 The Efficient Means of Exchange

We have not, as of yet, considered the optimal means of exchange (i.e., the means of exchange which maximizes the sum of the agents' expected present value from trade); all that has been done is to identify circumstances where the good is exchanged in all instances where there is demand by the consumer. At one level, we are simply interested in the optimal means of exchange per se. However, the motivation for this section is partly based on the supposition that in many instances, the means of exchange is a choice variable. For instance, firms can choose what they will allow to be transferred between their agents. A relevant question here is what means of exchange will they choose, and most relevantly, should they prohibit the use of money? Suppose that the agents can choose an instantaneous means of exchange of any value γ *ex ante* to maximize expected welfare. This is the only instantaneous means of exchange which is then possible.[17] Our objective here is simply to show how in some circumstances the optimum involves (i) pure money (i.e, $\gamma = 1$), (ii) no instantaneous means of exchange (i.e, $\gamma = 0$), and (iii) an inefficient instantaneous means of exchange (i.e, $0 < \gamma < 1$).

In order to highlight a role for non-monetary trade, we only exclude pure money ($\gamma = 1$) as the optimal means of exchange when another means of exchange offers higher welfare. Thus non-monetary trade must offer higher welfare for the optimal means of exchange not to be pure money.[18]

Two cases are easily distinguished, depending on whether pure money is worse or better than no money at all. First, if $\theta\overline{v} - \underline{v} < 2(1-\theta)\underline{v}$, then according to Proposition 2, $\frac{\lambda}{r}^*(1) < 1$ and it is therefore more difficult to induce full trade with no money than with pure money. In such a case, when $\frac{\lambda}{r} \geq \frac{\lambda}{r}^*(1)$, the optimal exchange medium is pure money. But if $\frac{\lambda}{r} < \frac{\lambda}{r}^*(1)$, it is not possible to implement full trade with pure money. But since $\frac{\lambda}{r}^*(1) < 1$ full trade cannot occur with no money. As a result, the tradeoff facing a social planner is between using pure money with only the high types consuming or trading with inefficient means of exchange ($\gamma < 1$), but with both types of agents (possibly) consuming the good. In the latter case, the optimal γ is given by the value of γ which minimizes $(1-\gamma)p(\gamma)$ while insuring full trade for the given $\frac{\lambda}{r}$, providing one exists; if one does not exist, $\gamma = 1$ is clearly optimal. To show that $\gamma < 1$ always occurs for some $\frac{\lambda}{r}$, consider $\frac{\lambda}{r}$ close to $\frac{\lambda}{r}^*(1)$. A simple argument establishes that for $\frac{\lambda}{r} = \frac{\lambda}{r}^*(1) - \epsilon$, the socially optimal medium of exchange is the maximal value of γ that guarantees trade. To see this, note that the cost of introducing a comparably small distortion in γ in order to stay on the function $\frac{\lambda}{r}^*(\gamma)$ is $(1-\gamma)p$, which is of order ϵ. The gain, however, is discontinuous as the low-type buyers are served and their contribution to the social surplus is bounded away from zero. As one further lowers $\frac{\lambda}{r}$, the maximal γ which guarantees full trade (if one continues to exist) decreases, thereby further decreasing social welfare. Eventually, $\gamma = 1$ again becomes optimal either when the transactions costs of the imperfect medium become sufficiently great, or γ falls into region 2 implying the infeasibility of implementing full trade.

[17] An obvious question to address here is how the agents can commit over the available means of exchange. One interpretation of our results is that headquarters in a firm can outlaw available means of exchange but cannot micro-manage the individual divisions. At a more general level, however, our interest is simply in showing that in some instances the optimal means of exchange need not be pure money (i.e., $\gamma = 1$).

[18] For example, when $\frac{\lambda}{r}$ is extremely high the first best is attainable with many means of exchange. We denote the optimal means of exchange here to be pure money as there is no means of exchange that offers higher welfare.

In the second case to consider, it is harder to induce efficiency with pure money than with no instantaneous means of exchange. This occurs if $\theta\overline{v} - \underline{v} > 2(1-\theta)\underline{v}$ so $\frac{\lambda}{r}^*(1) > 1$. Then when $\frac{\lambda}{r} \geq \frac{\lambda}{r}^*(1)$, the optimal exchange medium is pure money. When $1 \leq \frac{\lambda}{r} < \frac{\lambda}{r}^*(1)$, the optimal exchange medium is no money (i.e., $\gamma = 0$). This is because both types will trade *and* there is no inefficiency in the exchange of a less than pure form of money which an interior choice (i.e., $\gamma \in (0,1)$) would generate. Lastly, if $\frac{\lambda}{r} < 1$, either the optimal value of γ is between $\frac{1}{2}$ and the value of $\overline{\gamma}$ which satisfies $\frac{\lambda}{r} = \frac{\lambda}{r}^*(\overline{\gamma})$, or $\gamma = 1$ will be optimal. In the former case, full trade occurs with some transactions costs from impure monetary exchanges (although γ is chosen to minimize such costs, $(1-\gamma)\underline{p}(\gamma)$, where $\underline{p}(\gamma)$ is the smallest value of p which is consistent with full trade); in the latter case, consumption takes place for the high valuation buyers with fully efficient monetary transactions. Proposition 3 records our preceding arguments.

Proposition 3 *Let the optimal means of exchange be γ^*. Then*

- *If $\theta\overline{v} - \underline{v} < 2(1-\theta)\underline{v}$, then (i) for $\frac{\lambda}{r} \geq \frac{\lambda^*(1)}{r}$, the agents choose $\gamma^* = 1$, (ii) there exists a λ_0 such that for $\frac{\lambda^*(1)}{r} > \frac{\lambda}{r} \geq \frac{\lambda_0}{r}$, the agents choose $0 < \gamma^* < 1$, and (iii) for $\frac{\lambda}{r} < \frac{\overline{\lambda}}{r}$, they choose $\gamma^* = 1$.*

- *If $\theta\overline{v} - \underline{v} > 2(1-\theta)\underline{v}$, then (i) for $\frac{\lambda}{r} \geq \frac{\lambda^*(1)}{r}$, the agents choose $\gamma^* = 1$, (ii) for $\frac{\lambda^*(1)}{r} > \frac{\lambda}{r} \geq 1$, the agents choose $\gamma = 0$, (iii) for $\frac{\lambda^*(\frac{1}{2\theta\overline{v}})}{r} < \frac{\lambda}{r} < 1$, depending upon parameter values, either $\gamma^* \in (\frac{1}{2}, \overline{\gamma})$ (where $\overline{\gamma}$ solves $\frac{\lambda}{r} = \frac{\lambda}{r}^*(\overline{\gamma})$) or $\gamma^* = 1$ and (iv) for $\frac{\lambda}{r} < \frac{\lambda^*(\frac{1}{2\theta\overline{v}})}{r}$, the optimal means of exchange is $\gamma^* = 1$.*

The main contribution of Proposition 3 is that no money (i.e, $\gamma = 0$) or impure money (i.e., $\gamma \in (0,1)$) will be superior institutions to pure monetary exchange (i.e., $\gamma = 1$) for some values of $\frac{\lambda}{r}$. The first situation occurs whenever the agents can attain the first best allocation with no instantaneous means of exchange but cannot with pure money. The second situation arises whenever an inefficient means of exchange reduces the incentive to monopoly price by enough to make full trade occur while the corresponding transactions costs are not too high. Finally, note that for low enough values of $\frac{\lambda}{r}$, the optimum is pure money because the agents can do no better than static monopoly.

We believe that this model is particularly relevant to trading relations between employees or divisions within firms. Such agents operate in an environment which is partially constrained by implicit obligations, such as the obligation to read each other's papers, transfer workers between divisions during busy periods, or work some overtime without pay. This behavior is usually not contractually enforced, but is partially subject to the goodwill of the agents involved. These agents usually get some reward for their services, but it seems plausible that more could be demanded. For instance, a division could allow its workers to be transferred to a very busy division at a price above marginal cost, thinking that its partner division needs these workers badly. But such behavior is likely to have some repercussions, as an implicit agreement will have been deemed to have been violated. The point of this section is to show that sometimes it is efficient to ban instantaneous transfers as a way or reducing this monopoly incentive, but in other cases to allow transfers which do not come in the form of money (for instance, the donating division could be guaranteed some other asset which is not as valuable as money but at least makes the decision more palatable).

3.2 Multi-Tasking

The general theme of this section is that more technologically efficient means of instantaneous exchange can induce inefficient activities. Pricing in a monopolistic fashion is not the only such distortion. An alternative inefficient activity that could be induced is a multi-tasking distortion where agents allocate too many resources to contractible goods at the expense of non-contractible goods when an efficient instantaneous means of exchange is available (Holmstrom and Milgrom, (1991)). Consider a setting where the agents periodically demand a composite good, which consists of a contractible and a non-contractible good, where for example surplus is the sum of the quantities provided. Assume further that these two goods are substitutes in the producer's cost function (so, for example, the contractible component could be the quantity of the good, while the non-contractible dimension is its quality). Without an instantaneous means of exchange, there is no meaningful distinction between the two components. However, with the introduction of pure money, the reward for the contractible component may exceed that of the non-contractible one. In this setting, the same multi-market contact issues arise as in Section 2. However, with multi-tasking, there is an additional distortion associated with money because the incentive to cheat on the implicit agreement now involves overproduction of the contractible good (relative to the first best) because the cost of production is lower if the agent produces no non-contractibles. (In the previous section, deviating had no effect on the contractible good; here it increases supply of the contractible component as they are substitutes.) Thus the multi-tasking incentive causes a further incentive to deviate, as rents can be earned by overproducing contractibles.[19] For this reason, a more efficient means of exchange may again induce less trade than one which is less technologically efficient, but for the reason that it induces these inefficient multi-tasking actions. This point can be illustrated with a straightforward extension of the model in Section 2 and since the conceptual point is similar

[19]To phrase this another way, in Section 2, the introduction of money had the effect of simply taking contractibles out of the incentive constraints as trade occurred in these goods even after cheating. Here, contractibles impose a further negative externality on trade in non-contractibles as they are substitutes and the temptation to deviate by increasing production on contractibles becomes more tempting.

to that above, we eschew it in favor of this verbal description.

4 Inefficient, Delayed Rewards and the Liquidity Value of Trade

In previous sections we have considered a role for efficient reciprocity and an instantaneous, possibly inefficient means of exchange. This section deals with outcomes that arise when agents reciprocate trades in cases where one agent's goods are of higher value that those provided by the other. Put simply, how does reciprocity operate in situations where one agent demands more from the other than vice versa, and how does the introduction of an instantaneous means of exchange affect such trades? Our interest here is not simply to illustrate that the observations that we have made about efficient reciprocity in the previous sections can continue to hold when transfers of goods are not of equal value to both agents. In truth, this is little more than a trivial extension of our results above, since our effects are continuous in the efficiency of the means of exchange. Instead the main reason for addressing situations where some goods are more valuable than others is to illustrate the implications of agents with asymmetric demands trading with one another not simply to consume but also to provide liquidity.[20] The role of commodities as a form of money gives rise to qualitatively different outcomes than those of a monetized economy.

In order for liquidity to play a role, we consider asymmetries between the agents, where one agent values a unit of consumption of the other's good more than vice versa. Consequently, we extend our basic model of Section 2 by assuming that one agent values a unit of the other agent's good at αq, where $\alpha \geq 1$. We call this person the α-agent. The other agent continues to have unit marginal utility. To isolate the results of this section from those in the previous sections, we ignore (i) the multi-market contact results by assuming that all goods are non-contractible and (ii) the monopoly distortions by assuming that all valuations are known. Since goods are non-contractible, if money is allowed it can only be used as a voluntary reward or gift. Note that the α-agent has higher optimal production, $\overline{q} = \alpha \geq 1$, than that of the other agent, whose optimal production is 1. However, to induce the other person to offer higher quantities of the α-good he must offer something in return. In the absence of money, this becomes the other good, so that production decisions will be partly determined by the desire to offer liquidity to the other agent. In this sense, production decisions will be partly determined by a wish to create a dynamic double coincidence of wants, as there is no static coincidence of wants.

[20]See Calvert (1989), who applies a similar game-theoretic approach to log-rolling by politicians.

4.1 Liquidity Value of Goods without Money

Consider a world where there is no instantaneous means of exchange, so that all rewards must be provided by the future return of goods. First, under what conditions will the agents be willing to supply the first-best efficient levels of output?[21] The relevant incentive constraint is that of the agent required to produce $\overline{q} = \alpha$ good while enjoying consumption of $\underline{q} = 1$. He will be willing to provide quantity α iff

$$\frac{\lambda}{r}\left(1 - \frac{\alpha^2}{2}\right) \geq \frac{\alpha^2}{2},$$

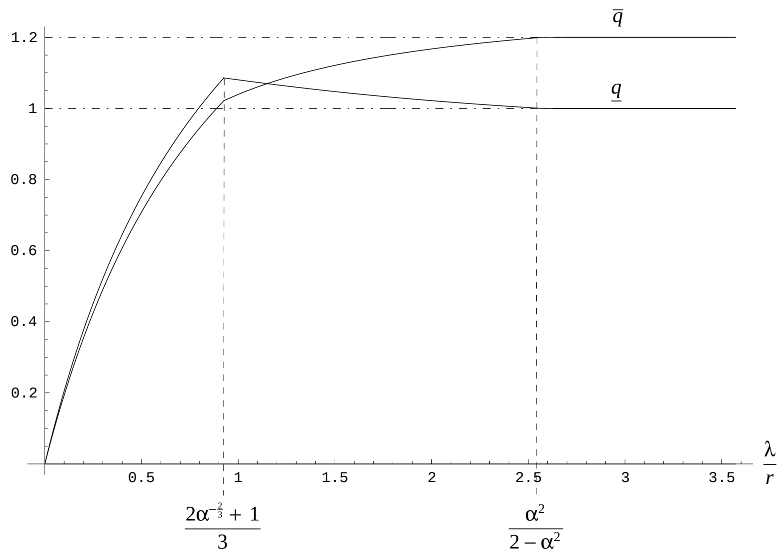
or $\frac{\lambda}{r}(2-\alpha^2) \geq \alpha^2$. Note that this condition can only be satisfied if $\alpha < \sqrt{2}$. Assume that this is the case for the moment; we will return to the situation where it is violated below. If $\frac{\lambda}{r} < \frac{\alpha^2}{2-\alpha^2}$, the agent who values his good least will be unwilling to provide the efficient quantity for the other agent. The optimal equilibrium solution to this problem is for the α-agent to "overproduce" the other good in order to provide the other agent with goods that he values. Thus production has both a consumption value and a liquidity value. Let $\underline{q}$ be the production level of the inferior good and let $\overline{q}$ refer to the production of the more valued good.

Proposition 4 *Assume that $\alpha < \sqrt{2}$. If $\frac{\lambda}{r}(2-\alpha^2) \geq \alpha^2$, the first-best level of trade arises. For all other values of $\frac{\lambda}{r}$ and α, (i) trade in $\overline{q}$ is increasing in $\frac{\lambda}{r}$, (ii) there exists a critical value of $\frac{\lambda}{r}$, such that trade in the low-value good, $\underline{q}$, is increasing up to that critical level, and is decreasing in $\frac{\lambda}{r}$ above that critical level. Finally, there exists a range of $\frac{\lambda}{r}$ such that the low-value good is oversupplied in equilibrium.*

A visual characterization of the solution is given in Figure 4 in which $\alpha = \frac{6}{5}$.

[21] Throughout this section, we simply maximize the sum of utilities. An interpretation of this is that each agent is ex ante identical, where nature determines which agent is the α-agent. Decisions on the equilibrium are taken before the draw from nature, so all agents agree on the objective function. An alternative interpretation would not assume such interpersonal utility comparison, but instead will use a bargaining solution to this problem.

Figure 4: Optimal Trades in the Absence of Money



First, if $\frac{\lambda}{r}$ is sufficiently high (at least $\frac{\alpha^2}{2-\alpha^2}$), agents attain the first best level of production as they are sufficiently patient. For somewhat less patient agents, the α-agent over-produces the less valuable good relative to the first best, but the agent required to produce the higher value good is not willing to produce the (higher) efficient level of that good. Thus, the output of the less efficient good is always higher than the more efficient good in this region. Mathematically, these results are driven by the fact that the low-value agent's incentive compatibility constraint is binding while the analogous constraint for the α-type agent is slack. Finally, for lower levels of the $\frac{\lambda}{r}$, the incentive compatibility constraints for both agents bind.

We have described these regions of the state space for the simple reason that they illustrate a variety of liquidity effects on trade. First consider the case where interaction is infrequent ($\frac{\lambda}{r}$ low). Then $\underline{q} > \overline{q}$ so that more of the low-value good is made. This occurs even though the marginal utility of the better good is higher. Therefore, liquidity concerns imply not only that the production of the less efficient good is higher than it would otherwise be, but that *its production is higher than for the more efficient good.* Thus liquidity concerns reverse our normal intuition on the supply of goods, where goods with higher marginal valuations have higher production. Second, note that liquidity effects result in the supply of some goods being above their optimal level. Once again, this reflects the liquidity value of trade where for some values of $\frac{\lambda}{r}$, the "liquidity good" must be oversupplied. Third, note that trade in the less desirable good declines in $\frac{\lambda}{r}$ after some point. The reason for this is that in this region, as $\frac{\lambda}{r}$ increases, the value of the relationship rises for all agents, this reducing the need to oversupply the less useful asset. Thus increased patience reduces trades.

Finally, for large enough $\frac{\lambda}{r}$, the first best occurs.[22]

These observations are perhaps unsurprising as they are a straightforward implication of the fact that the agents use commodity money. However, we have provided these observations as a simple indication of how non-monetary exchange operates in a different fashion to monetary exchange. For instance, it is one of the most basic premises of economics that goods which have higher marginal surplus will have higher production than those which are less valuable. But this outcome is violated here, where over large ranges of the parameter space, there is more production of the less useful good. We see this as an indication that the means of exchange has important implications for how supply and demand respond to shocks. For example, it would imply that the process of log-rolling, where politicians trade projects over time as in the repeated game setting of Calvert (1989), would likely involve the overproduction of bad projects and the underproduction of better projects simply because these projects are operating as commodity money.

4.2 Liquidity Value and Money

These results above could arise for one of two reasons: first, it could be that the goods are non-contractible, so that money can never enforce trades, or, second, these results could arise from the fact that we have assumed that there is no instantaneous means of exchange available. In other words, do the perverse results above arise from the ability of money to enforce trades, or simply that it acts as an immediate means of exchange? To address this issue, we now allow our agents access to pure money. Remember that we have assumed that goods are non-contractible, so that the introduction of money cannot enable trade. Despite this, it turns out that the use of voluntary transfers fundamentally changes two of the results generated above so that the role of money is not simply as a means of contract enforcement. First, production of the less efficient good now never exceeds that of the efficient good; instead, for large ranges of the parameter space, production is identical (despite the fact that surplus is higher on one good). Remember this still contrasts with a world of contractible goods, where production is always higher for the more desirable good. Second, there is never over-production of the less able good.

Consider the same model as above, where the agents have access to pure money. They can now

[22] Remember that we are only considering the case where $\sqrt{2} > \alpha$. If $\sqrt{2} < \alpha$, the agent who produces the α-good will be unwilling to do so at that price even if $r = 0$. In other words, his costs of production exceed the (instantaneous) value of the other good. If this is the case, then as r tends to zero, the level of the inferior good produced will be higher than 1, as it is the only means of rewarding the agent. In this sense, oversupply of goods can occur for liquidity reasons, in the absence of anything to do with the repeated interaction that underlies the paper. However, even in the case where $\sqrt{2} < \alpha$, it remains the case that over some region, quantities increase in $\frac{\lambda}{r}$, but beyond that region trade in the less efficient good always declines until it reaches its terminal point (where $r = 0$). Thus limited commitment always implies that the less efficient good is oversupplied, even when the benchmark is the level that would occur in the absence of commitment problems but where it exceeds 1. Therefore, we believe that liquidity concerns in this model are strongly linked to the repeated interaction story underlying the paper.

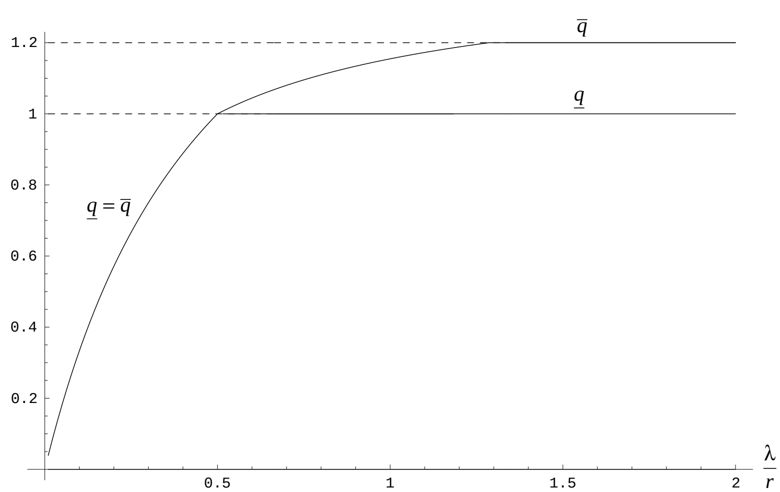
offer each other rewards after they receive high quality non-contractibles. Let $\bar{t}$ be the transfer made by the consumer of the α-good for a quantity $\overline{q}$, and let the equivalent transfer by the other agent be $\underline{t}$, for a quantity $\underline{q}$ of the other good. It must be incentive compatible for an agent to be willing to produce in exchange for an immediate reward as well as to pay a required award after having consumed the good. Formally, the incentive compatibility constraints for the two agents are as follows.

$$\frac{\lambda}{r}\left(\underline{q} - c(\overline{q})\right) \geq \max\{c(\overline{q}) - \bar{t}, \underline{t}\},$$

$$\frac{\lambda}{r}\left(\overline{q} - c(\underline{q})\right) \geq \max\{c(\underline{q}) - \underline{t}, \bar{t}\}.$$

Despite the fact that money cannot be used as a means of enabling trades, it turns out to have an important effect on the production of goods as reflected in Figure 5 for the case of $\alpha = \frac{6}{5}$.

Figure 5: Optimal Trades with Money



First note that it is never the case that $\overline{q} < \underline{q}$, unlike the previous section. For low values of $\frac{\lambda}{r}$, the two quantities are identical, whereas with low $\frac{\lambda}{r}$ and no money, the quantity of the inefficient good was higher. Further, the quantity of the inferior good never exceeds its efficient level; once the incentive compatibility constraints allow production of one unit, all future payment of the less efficient agent occurs through gifts of money. These results are summarized in Proposition 5.

Proposition 5 *Assume that money can be used. Then for sufficiently large* $\frac{\lambda}{r}$*, first-best trade arises. However, for lower levels of* $\frac{\lambda}{r}$*, trade in the high-value good,* $\overline{q}$*, is monotonically increasing in* $\frac{\lambda}{r}$ *until it reaches its efficient level,* $\overline{q} = \alpha$*. Trade in the low-value good,* $\underline{q}$*, is identical to that of the more efficient good until it reaches its efficient level,* $\underline{q} = 1$*, after which it remains constant in* $\frac{\lambda}{r}$*.*

Normal intuition suggests that the more efficient good should have higher production, but here there is no difference. This arises from the fact that the money transfers allow the agents to pool their incentive compatibility constraints. In particular, the rewards or gifts after consuming the good play the role of allowing the recipient of the good to partially subsidize the producer of the good. In this region where there is a common quantity $q = \underline{q} = \overline{q}$, it turns out that the recipient of the α-good pays $\overline{t} = \frac{1}{2}\left[c(q) + q(\alpha - 1)\frac{\lambda}{r}\right]$, while the other agent efficient agent pays only $\underline{t} = \frac{1}{2}\left[c(q) - q(\alpha - 1)\frac{\lambda}{r}\right]$. (Remember that in the previous section, each agent paid half the cost.) Therefore, the agent who earns higher utility pays more. But the consuming agent will only subsidize trade to the extent of his own surplus, which results in both quantities being equal, although the α-good agent obtains higher utility.[23] Only if the effective discount rate rises above a certain level does the usual efficiency consideration dominate, where $\overline{q} > \underline{q}$.

Our view of this subsection of the paper is that money plays an important role in determining production even in cases where its role is not to enable simultaneous trade. Instead, the role of money here is solely as a common means of value, which makes its gift-giving role important. As a result, money plays a role of partly alleviating distortions, where previously more of the inferior good was made for some discount factors, but now at least this result changes to equal quantities of the two goods. Only if money can be used to enforce trade (or interest rates are sufficiently small) can we be guaranteed that more of the more efficient good will be produced.

5 Choosing Friends

So far, we have discussed two implications of network structure, (i) that peripheral groups can be excluded and (ii) that there is a demand for middlemen who can extract rents for their services. In this section, we consider an additional issue of network choice, namely, how to choose a network, and how barter affects the diversity of agent with which one can trade.

Economics offers one simple rule for choosing trade partners: comparative advantage. In particular, one obvious advantage of markets is that it allows consumers and producers to profit from comparative advantage. This simple observation is the linchpin of many theories arguing in favor of free trade. One can phrase this in more familiar terms: that individuals should seek very diverse networks because they may find that the best provider of a given service varies across goods. The purpose of this section is to illustrate that with social exchange there exists a countervailing effect

[23]Formally, the reason why money improves trades here is that it allows the agents to pool incentive constraints within a single good. This implies that the Kuhn-Tucker Lagrange multipliers on the constraints for the donor and producer in any given trade are equalized. However, there is no way to subsidize trades across goods, as these are governed by independent incentive compatibility constraints. Thus there is no mechanism to guarantee that the multipliers on all constraints are identical, which would result in higher trade on the more efficient good.

which argues for restricting the ability of agents to trade with each other.

Individuals often spend considerable time investing in relationships, and must explicitly choose which relationships to cultivate. As illustrated above, trust is central to economic efficiency in a barter environment and may imply a different rule, namely, to "put all your eggs in one basket" rather than hold a diverse set of networks. The reason for this is that although it may be inefficient (in the usual economic sense) to rely too much on a small number of personal contacts, trust is more likely to operate when trade is dense than when trade is spread across many trading partners. As a result, it can make sense to select a small number of partners and trade intensively with them, even though they may not be the least cost providers of some goods that one may want. Thus the need for trust can make trading relations so tight that standard economic efficiency considerations are overturned.

In particular, we address the role of restricted trading networks in social relations, and argue that such restrictions are an integral component of social exchange.[24] We show that the decision on whether to restrict trades boils down to a simple trade-off between comparative advantage and contract enforcement considerations. If the comparative advantage is sufficiently small (i.e., no person is any better at producing a good than another), there is a role for restricted networks. Furthermore, as interactions become less frequent, the critical extent of comparative advantage, above which wide networks is optimal is harder to satisfy. In other words, when agents interact less frequently, denser networks becomes more important.

We extend the basic model of the previous section to allow for (i) comparative advantage and (ii) more agents, so that there is the possibility of choosing tighter or looser networks. We assume that there are 4 agents who can produce any of 4 goods. All trade must be enforced through reciprocity. We model comparative advantage by assuming that although each agent may produce any good at a cost of $c(q) = \frac{1}{2}q^2$, for three of the four goods the resulting consumption value to the other traders is q but for one good the resulting value to the other traders is αq, where $\alpha > 1$. Moreover, each agent has a comparative advantage in producing a unique one of these four goods. Thus the model extends that in the previous section by allowing agents to be talented at producing different goods. For notational convenience, let agent i produce good i with greater value, where $i = 1, \ldots, 4$. For simplicity, we assume that the agent does not demand the good in which he has a

[24] Restrictions on the ability to trade take many forms. First, social sanctions can serve to restrict the willingness of agents to trade with one another. For instance, it is rarely socially approved for individuals to engage in extra-marital affairs, an obvious restriction on trade in sex. In many countries, such trade is illegal. Second, there are a plethora of historical and anthropological examples where clans were only willing to trade with one another, and would have little to do with "outsiders". In some primitive societies, individuals are assigned a trade partner who has an obligation to help him and to whom he will reciprocate. Such obligations do not operate for other individuals and attempts to steal a trade partner were often dealt with harshly. For instance, among the Sio of North East New Guinea it was considered an offense worthy of homicide to attempt to lure away one's trade partner (Harding (1957)).

comparative advantage, but demands each other goods with a common rate λ. As before, we also assume that each agent must obtain these other goods from other producers; the agents cannot produce to satisfy their own demands.

The standard economic model of comparative advantage in a monetary economy would say that each individual produces one good – the one that he is most efficient at producing. Thus, there would be specialization, a characteristic of a monetized economy. In such an economy, if an agent demands good j, he will trade with agent j for α units of the goods (as this is the efficient level, where marginal benefits equal costs), with surplus created of $\frac{1}{2}\alpha^2$.

Suppose instead that agents trade in a barter environment. In this case, networks will matter. We take a simple approach to understanding network structure by assuming that in order to trade with someone, an initial investment must be made at the start of any relationship. In other words, at the beginning of the game, a decision must be made by the agents whether to form a link with the other agents. If the link is not formed then, it cannot later be generated. To keep matters simple, all agents can see the network structure and the initial cost of forming a link is small enough to be ignored. Our main point in this section is to show that even when forming a link is (essentially) free, the agents may decide not to do so. Instead, they commit to put "all their eggs in one basket" to facilitate trust.

What this set-up is meant to reflect is that once alliances are formed, it is hard to find other trading partners. (An extreme example of this is marriage, where bigamy is illegal and extra-marital affairs frowned upon socially.) Our model simply assumes that once a network is formed, it is impossible to break into another; realistically, this is too extreme as individuals can spend time building up such links. Our objective is simply to show that restrictions on letting people easily move between networks may make economic sense in a world of barter.

What matters then for working out how much trade occurs is the punishments meted out to those who deviate: the greater the punishments, the more likely is an individual to produce as required. This in turn depends on who observes the behavior of the individuals. If all agents observe any deviation from cooperative trade and are willing to punish the deviator by refusing to trade with the him in the future, then there is no value to restricting the trading network to obtain the socially optimal allocation of goods. (This would require everyone to cut off an agent from trade, even if that agent has only reneged on one of his obligations.) This statement is no longer true when there is limited observability of trades, or where agents are unwilling to punish transgressions which occur between other trading partners. We consider the case where only the agents involved in the trades can observe the behavior of the parties (and the level of trade between them), so that the maximum punishment that can be imposed on the agents is that the bilateral relationship breaks down. More formally, we consider a class of equilibria where trade between any two agents is independent of relations between any other links.

In this setting, we consider two natural networks. First, we address the case where all agents trade according to comparative advantage. In other words, if any agent requires good i, the good is produced by person i. Thus, all links are formed. We then compare this to an institution where each agent is assigned a unique trading partner where they trade all their desired goods with that agent. This has the disadvantage that it reduces the value of comparative advantage in the economy, but will be shown to increase the threat attached to cheating.

First consider the case where agent i produces good i for all agents when it is demanded. Since there is limited observability of trades, the cost of cheating the demander is that no trade will occur in future with that agent. Let $\overline{q}$ be the quantity traded in this equilibrium. Then the incentive compatibility constraint is that

$$\frac{\lambda}{r}(\alpha\overline{q} - c(\overline{q})) \geq c(\overline{q}).$$

The efficient level of $\overline{q}$ is α, so if $\frac{\lambda}{r} \geq 1$, this level of output can be attained. If this is the case, there is never any need to restrict trade to assigned trading partners. However, if $\frac{\lambda}{r} < 1$, the threat of dissolution of the bilateral relationship will not be sufficient to yield efficiency. As a result, straightforward manipulations yield a level of $\overline{q}$ for each good given by

$$\overline{q} = 2\alpha\frac{\lambda}{\lambda + r},$$

with total utility for each agent (across all three trades) given by

$$U^{ca} = 6\alpha^2(\frac{\lambda}{\lambda + r})^2.$$

In other words, there is not sufficient “trust” to induce efficient production.

Suppose now that the societal norm is that an agent is required to get all his required goods from a single agent, where each agent is assigned to a single trading partner. Then as each agent demands three goods, this implies that each person will only be provided with only one “high quality” good, as distinct from three in the previous case. This provides the obvious cost of requiring concentration of trades.

Consider the set of enforceable trades with this trading norm. Notice that the efficient level of trade here is where agent i produces a quantity α of good i and a quantity 1 of the other two goods demanded by his partner. More generally, let $\overline{q}$ refer to the traded quantity of the “high quality” good and let $\underline{q}$ be the traded quantity for the other goods. Then the incentive compatibility constraints for the agent are

$$\frac{\lambda}{r}\left[\alpha\overline{q}+2\underline{q}-c(\overline{q})-2c(\underline{q})\right]\geq c(\overline{q}),$$

if the agent is required to produce the good he has a comparative advantage in, and

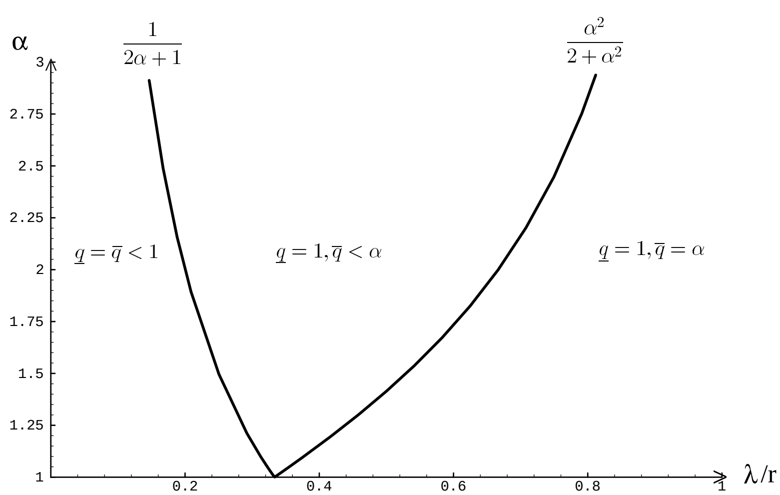
$$\frac{\lambda}{r}\left[\alpha\overline{q}+2\underline{q}-c(\overline{q})-2c(\underline{q})\right]\geq c(\underline{q}),$$

to produce the other goods.

First, for high enough $\frac{\lambda}{r}$, the agents will supply the required level of each goods. Straightforward calculations show that this is the case if $\frac{\lambda}{r}\geq\frac{\alpha^2}{2+\alpha^2}$. This yields utility of $\frac{\lambda}{r}\left(\frac{\alpha^2}{2}+1\right)$. Next, there is a region of the parameter space where the agent is willing to supply quantity of $\underline{q}=1$ but not quantity of $\overline{q}=\alpha$. This implies that the agent will provide the efficient level of the goods in which he does not hold a comparative advantage but will provide some quantity strictly between 1 and α on the goods he produces best. The quantity level chosen on this good is determined by the $\overline{q}$ at which the incentive compatibility constraint binds, which is given by $\overline{q}=\frac{lv+\sqrt{(lv)^2+2l(1+l)}}{1+l}$, where $l=\frac{\lambda}{r}$. This region occurs for values of $\frac{\lambda}{r}$ between $\frac{\alpha^2}{2+\alpha^2}$ and $\frac{1}{2\alpha+1}$. Finally, for $\frac{\lambda}{r}<\frac{1}{2\alpha+1}$, the agent is unwilling to supply output of 1 so all constraints bind, yielding quantities traded of $\overline{q}=\underline{q}=\frac{2\lambda(\alpha+2)}{r(1+3l)}$.

A simple way of understanding these components of the problem can be seen in the following figure.

Figure: Constrained Regions for Restricted Trade



Here we have plotted the quantity levels as a function of the parameter values. Note that for $\frac{\lambda}{r} \geq 1$, efficient trade levels occur with comparative advantage. For lower parameter values, trade governed by comparative advantage falls but for some region remains constant with trading partners, due to the extra sanctions associated with cheating. Next as $\frac{\lambda}{r}$ falls further, the agents refuse to produce α but are willing to produce unit output, the optimal level for the goods in which the agent does not hold a comparative advantage. Finally, for $\frac{\lambda}{r} < \frac{1}{2\alpha+1}$, the agent is not even willing to trade unit output on any good.

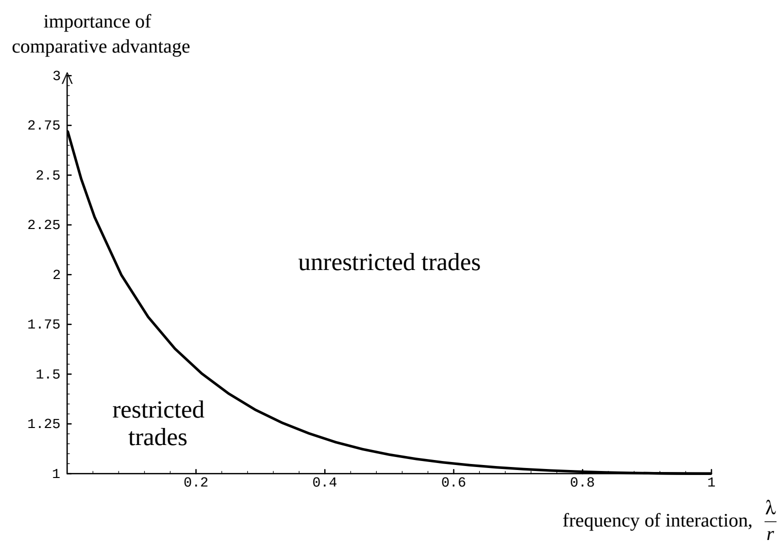
Determining the optimal trading relation then simply becomes a comparison of the utilities on the two regions. Allowing trade with all agents has the advantage that the agents are producing the goods at which they have the greatest ability. However, this has the problem that the costs of deviating are possibly smaller than with a trading partner, as the maximum punishment is exclusion from trade in a single (albeit more desirable) good. This effect can be seen from the fact that without the trading partners, the agent is willing to supply the good at the efficient level if $\frac{\lambda}{r} \geq 1$, while with the greater costs of deviating from a trading partner the agent is willing to supply if $\frac{\lambda}{r} \leq \frac{\alpha^2}{2+\alpha^2} < 1$. This simply illustrates the advantage of requiring trades to be concentrated. Proposition 6 identifies the main results regarding trading partners.

Proposition 6 *There exists a critical value of α given by a function $\alpha^*(\frac{\lambda}{r})$ such that for all $\alpha < \alpha^*(\frac{\lambda}{r})$ restricting trades to a single partner increases welfare, and for all $\alpha > \alpha^*(\frac{\lambda}{r})$ allocating trades according to comparative advantage maximizes welfare. Furthermore, for all $\frac{\lambda}{r} < 1$, $\alpha^*(\frac{\lambda}{r})$ is strictly greater than 1 and is declining in $\frac{\lambda}{r}$.*

It is intuitive that the tension in choosing networks is between the advantages of wide networks (taking advantage of comparative advantage) and their costs (that when a trading partner is not very reliant on one, the temptation to renege is greater). The above result is easily explained. First, for low enough levels of comparative advantage (i.e., if α is below some critical value α^*), the socially optimal network will consist of two distinct bilateral trading networks, even though these trading relationships fail to capitalize on some of the comparative production advantages which are present. This critical value of α always exceeds one if efficient levels of trade cannot be obtained without trading partners. Thus restricting networks increases welfare, thus overturning standard economic logic regarding the advantages of free trade. Furthermore, the desirability of such restricted trade increases as interactions become less common (or as the agent discounts the future more). In other words, there is little need to restrict trades among agents who interact extremely frequently, but as interactions become more frequent some constraints are needed.

The implications of this section are illustrated in the following figure.

Figure: Optimal Regions for Restricted Networks



Here we illustrate situations in which it is efficient to restrict networks in terms of frequency of interaction ($\frac{\lambda}{r}$) and the importance of comparative advantage (α). Below the curve drawn, it is efficient for individuals to only trade with one trading partner. They will forego the benefits of comparative advantage (i.e., trading with all three individuals), but can support more trade with their single trade partner when they are more reliant on one another. Above the line, agents should form more diverse links. Note that the line is downward sloped, which implies that as interactions become more frequent, it is less likely that the individuals need to restrict their networks.

The formal model above is simply meant to emphasize the importance of dense trade for reciprocity to operate. As a result, individuals may dedicate a large fraction of their trades to a single agent, even though that agent may not be the most effective provider of that good. At a more informal level, it also points to a difficulty which smaller firms may have in the network process. Although these new smaller firms may be more efficient providers of goods in the usual cost sense, trade partners may be hard to find as they see the importance of their existing networks, which though sometimes inefficient, are at least trustworthy.

6 Conclusion

Many trades are characterized by possibilities for opportunism. In such settings, money does not enable trade in the absence of some repeated interaction. The purpose of this paper has been to better understand how individuals trade such goods which cannot be easily specified in an environment where they also trade other contractible goods. As such, it is meant to provide some initial insights into how social exchange operates in conjunction with standard economic exchange mechanisms, which emphasize instantaneous means of exchange. We highlighted three roles for money; supporting simultaneous trades, allowing voluntary transfers which aid the supply of nebulous goods, and inducing activities which generate rents. We showed that allowing money is sometimes dominated either by prohibiting all instantaneous means of exchange or allowing only an inefficient form of instantaneous exchange. This arose for two conceptual reasons; (i) that an instantaneous means of exchange can offer better fallback positions to those who have deviated on their obligations, and (ii) that efficient instantaneous means of exchange make monopoly pricing too attractive. By addressing these areas, we feel that we are closer to understanding why many trades remain non-monetized even in economies where pure money is accepted.

While this paper is the first to address this variety of roles for a medium of exchange, there are a number of papers which have addressed some of the individual aspects of our model. First, one theme of the paper is that money restricts sanctions in a way that may harm welfare. The harmful effect of money on trade arises from the fact that it has effects both on and off the equilibrium path. This component of our work arises from work on multi-market contact by Bernheim and Whinston (1990) who note that the addition of another market on which to punish those who fail to collude will typically increase the amount of feasible collusion. In a different setting, Baker, Gibbons, and Murphy (1994), (1996) and Schmidt and Schnitzer (1995) note that the use of explicit contracts (piece rates) can harm the set of feasible trades for the reasons described above. Closest in spirit to this aspect of the model is Kranton (1996) who studies the role of money in a primitive societies. She considers two populations in a society, one which uses money while the other exchanges through reciprocity. Her primary interest is in identifying whether the each mode of transaction can become self-sustaining in a search setting. As with our model, she notes that those who have deviated on their obligations in their reciprocal relationships may find the monetized economy available. In this way, reciprocity is constrained by a monetized economy. Yet there is no efficiency reason why money should not be used by everyone; instead, what restricts the use of money is the search externality that if few others use money, there is no reason for any individual agent to do so. For this reason, the economy may remain non-monetized as agents cannot coordinate on money; however, once money is commonly accepted, there is no economic reason for trades to remain non-monetized. By contrast, our interests are in understanding the welfare effects of monetizing trades in an otherwise monetized economy and, as a result, why some trades should remain non-monetized in societies which use money for most trades, and so we focus on the issues above.

While we have highlighted a number of roles for money on trade, we believe that there are many others which have yet to be addressed. In the context of our basic model of repeated interaction, we see three possible additional roles of money. First, we have assumed that in the event of a deviation by one player or the other, the continuation of the game is where no further trade occurs in the non-contractible good. The implicit assumption which underlies this is one of asymmetric information, where there is uncertainty about the trustworthiness of a given agent, and a willingness to deviate illustrates a propensity to cheat in future. With this interpretation, it is not difficult to see how this punishment would be credible. However, an important question that has not been addressed here is in identifying the set of subgame perfect renegotiation proof equilibria of the game, and in particular the role of money in affecting such equilibria. One obvious possibility is that in the event of a deviation, the agents could forego the allocative inefficiencies of this model after the deviation by making a money payment to the other agent in lieu of being excluded from trade in non-contractibles. It is our (unproven) conjecture that the use of such payments increases the set of renegotiation proof equilibria, making trade more feasible.[25]

A second and related role for money arises from the observation that sometimes mistakes are made, and that it may be believed that some agent deviated when in truth they did not. As in Green and Porter (1984) and Abreu, Pearce and Stacchetti (1989), this implies the need for equilibrium punishment to occur. In the absence of money, these must take the form of distorting quantities traded. However, once money exists, these welfare costs can be eliminated by allowing agents to pay fines, as in Becker (1968). This becomes another reason why money can be valuable in repeated interaction settings. Third, we have assumed throughout the paper that when an agent demands a good, this event is common knowledge. But in reality, this may not be the case; instead, agents will often have private information about the utility that they derive from certain services. As a result, a danger arises that agents will demand goods from others even in cases where they truly do not need them. In the model we have developed above, demanders do not incur the full cost of production and so would demand too frequently. There are, of course, some ways of alleviating this, such as contracts with memory, but these measures are unlikely to be costless. In this environment, money plays an important role in identifying willingness to pay for contractible goods through prices. We have ignored this role for money.

Somewhat outside the scope of this model is that we have ignored the possibility that the means of exchange itself could reveal information. Other social sciences have often contrasted the "cold and impersonal" nature of monetary exchange with the more personal connotations of delayed reciprocity (Blau (1964)). To give a stark example, offering money for sex clearly has connotations about the nature of the relationship involved. At a more common level, there is a

[25] The reason for this is that with money payments, the Pareto frontier becomes a negatively-sloped 45-degree line, and renegotiation proofness is much easier to attain when no Pareto-dominated outcomes are required to be played (Farrell and Maskin, 1990).

reluctance of friends to pay each other in money, preferring instead other means of rewards (flowers, for instance). For instance, Bloch (1946) argues that "morally binding relations, especially kinship relations, should be kept as far as possible from money transactions". We have ignored such inferences from the choice of means of exchange but take them up in other papers dealing with social exchange and formal barter markets (Prendergast and Stole, (1996), (1997)).

Finally, we have ignored a potentially important aspect of the means of exchange, namely, how it affects the allocation of rents from trades. What we have in mind here is the role that some agents have in facilitating the trades of others. Consider a model where there are three agents, but where two of the agents do not interact sufficiently with each other to yield efficient trades. One way of increasing their traded quantities is to funnel trades to third parties who themselves can provide utility to each of these parties. Here, trade with the third parties is not in itself efficient but is necessary as a conduit for providing utility to the two main trading parties. In effect, the third party is the only way to give more utility to the two main parties in the same way that inefficient projects were necessary in the section on liquidity. But in order to get the third party to act honorably, he must be offered rents for the usual incentive compatibility reasons. Thus third parties get rents as they happen to facilitate the trades of other parties. We see this as analogous to the notion of structural holes in sociology (Burt, (1992)). However, when money is introduced here, the third party is no longer necessary if the goods are contractible. Therefore, his rents disappear, illustrating the importance of the means of exchange for the allocation of rents from trades.

Appendix: Proofs of Results

Proof of Proposition 1: We examine each scenario separately. First, consider the scenario in which the contractible good is monetized, but the non-contractible good is not. Following a deviation by either player on the non-contractible good market, the worst subgame perfect continuation equilibrium is no trade on the noncontractible good, but continued monetary trade on the contractible one with $\hat{q}_k^m = 1$. Thus, the incentive compatibility constraint is

$$\frac{\lambda_n}{r}\left(q_n - \frac{1}{2}q_n^2\right) \geq \frac{1}{4}q_n^2,$$

where the left-hand side of the constraint is $\frac{1}{2}c(q_n)$ which is the net cost experienced when monetary rewards are optimally utilized. Thus, the constrained-optimal q_n exchange maximizes $q_n - \frac{1}{2}q_n^2$, subject to the above incentive compatibility constraint. There are two cases to consider depending upon whether or not the constraint is binding: when the constraint is slack, $\hat{q}_n^m = 1$, the efficient level; when the constraint is binding, $\hat{q}_n^m < 1$. Specifically, algebraic manipulation yields

$$\hat{q}_n^m(r) = \begin{cases} 1 & \text{if } r \leq 2\lambda_n, \text{ and} \\ 4\frac{\lambda_n}{2\lambda_n + r} & \text{if } r > 2\lambda_n. \end{cases}$$

Now, consider the scenario in which money does not exist. The best subgame perfect continuation equilibrium following a deviation is now no trade on either good. Thus, the relevant incentive compatibility constraints for trade in the two markets are

$$\frac{\lambda_n}{r}\left(q_n - \frac{1}{2}q_n^2\right) + \frac{\lambda_k}{r}\left(q_k - \frac{1}{2}q_k^2\right) \geq \max\left\{\frac{1}{2}q_n^2, \frac{1}{2}q_k^2\right\}.$$

Hence, either both constraints are slack, in which case $\hat{q}_n = \hat{q}_k = 1$, or both constraints bind in which case $\hat{q}_n = \hat{q}_k < 1$. Solving the related maximization program yields

$$\hat{q}_n^o(r) = \hat{q}_k^o(r) = \begin{cases} 1 & \text{if } r \leq \lambda_n + \lambda_k, \text{ and} \\ 2\frac{\lambda_n + \lambda_k}{\lambda_n + \lambda_k + r} & \text{if } r > \lambda_n + \lambda_k. \end{cases}$$

Define $S(q_n, q_k, r) \equiv \frac{\lambda_n}{r}(q_n - \frac{1}{2}q_n^2) + \frac{\lambda_k}{r}(q_k - \frac{1}{2}q_k^2)$ and $\Delta S(r) \equiv rS(\hat{q}_n^o(r), \hat{q}_k^o(r), r) - rS(\hat{q}_n^m(r), 1, r)$. Suppose that $\lambda_k > \lambda_n$. We know from above that $\Delta S(\lambda_n + \lambda_k) > 0$ since the first-best is attainable without money and is not in the presence of money. We also know that $\lim_{r\to\infty} \Delta S(r) < 0$. To prove that there is a unique $r^* \geq \lambda_n + \lambda_k$ such that $\Delta S(r^*) = 0$, it is sufficient to show that $\Delta S'(r) < 0$ for all $r \geq \lambda_n + \lambda_k$ such that $\Delta S(r) = 0$. Tedious algebra reveals:

$$\Delta S'(r) = \frac{2(\lambda_k + \lambda_n)^2(\lambda_n + \lambda_k - r)}{(\lambda_k + \lambda_n + r)^3} - \frac{4\lambda_n^2(2\lambda_n - r)}{(2\lambda_n + r)^3}.$$

We will show this is negative by demonstrating that the maximized value (over λ_k and λ_n) of this expression is negative. To this end, differentiating the expression with respect to λ_k one obtains

$$\frac{4(\lambda_k + \lambda_n)(2(\lambda_k + \lambda_n) - r)r}{(\lambda_k + \lambda_n + r)^4}.$$

Thus, $\Delta S'(r)$ is quasi-concave in λ_k and obtains its maximum at $\lambda_k = \frac{r}{2} - \lambda_n$. Substituting this value into the expression and simplifying, yields,

$$-\frac{2}{27}+\frac{4\lambda_n^2(r-2\lambda_n)}{(2\lambda_n+r)^3}.$$

Consider the range of $\lambda_n \in [0, \frac{r}{2}]$; the largest value of λ_n which satisfies $r \geq \lambda_n + \lambda_k$ and $\lambda_k \geq \lambda_n$ is $\frac{r}{2}$. On the endpoints of this range, the objective function is negative. Evaluating the first-order condition, there are two extrema over the range: $\lambda_n = 0$ and $\lambda_n = \frac{r}{4}$. The first is a minimum, the second is a maximum. At $\lambda_n = \frac{r}{4}$, the value of $\Delta S'(r)$ is $-\frac{1}{27} < 0$, thus we have proven existence and uniqueness of a root, $r^* \geq \lambda_k + \lambda_n > 2\lambda_n$. Therefore, we know that for all $r < 2\lambda_n$, the effect of money is irrelevant, for all $r \in (2\lambda_n, r^*)$ money is detrimental to exchange, and for all $r \in (r^*, \infty)$ money is preferred. By letting $\underline{\delta} = \frac{1}{1+r^*}$ and $\overline{\delta} = \frac{1}{1+2\lambda_n}$, we have the appropriate discount factors in the proposition.

Now consider $\lambda_k \leq \lambda_n$. For all $r \leq \lambda_n + \lambda_k$, money is irrelevant. For all $r \in (\lambda_k + \lambda_n, 2\lambda_n)$, money is superior as it achieves the first-best exchange which is not implementable without money. For $r \geq 2\lambda_n$, we use the argument above that established that $\Delta S'(r) < 0$ for all $r \geq \max\{2\lambda_n, \lambda_n + \lambda_k\}$. Because $\Delta S(2\lambda_n) < 0$, $\Delta S(r)$ must remain negative for all $r \geq 2\lambda_n$. □

Proof of Proposition 2:
The first part of the proposition is proven in the text. The nonmonotonicity of $\frac{\lambda}{r}^*(\gamma)$ is determined by differentiation. In region 1, it is flat; in region 2, it is downward sloping; in region 3, it is upward sloping. Whether or not $\frac{\lambda}{r}^*(1)$ is above or below unity can be determined algebraically. At $\gamma = 1$, we have

$$\frac{r(\theta\overline{v}-\underline{v})}{2-2\theta\overline{v}}.$$

The condition of the proposition immediately follows. □

Proof of Proposition 4:
Consider the Kuhn-Tucker Lagrangian of the social planner who optimizes the sum of the agent's expected present values of utility subject to the two incentive compatibility constraints:

$$\mathcal{L} = \underline{q} + \frac{1}{2}\underline{q}^2 + \alpha\overline{q} - \frac{1}{2}\overline{q}^2 + \underline{\mu}(\lambda\underline{q} - (\lambda+r)\frac{1}{2}\overline{q}^2) + \overline{\mu}(\alpha\lambda\overline{q} - (\lambda+r)\frac{1}{2}\underline{q}^2).$$

Due to the concavity of this program, the Kuhn-Tucker conditions are necessary and sufficient for a solution. For sufficiently low $\frac{\lambda}{r}$, both constraints must bind. In this case, we have $\overline{q} = 2\alpha^{\frac{1}{3}}\frac{\lambda}{\lambda+r}$ and $\underline{q} = 2\alpha^{\frac{2}{3}}\frac{\lambda}{\lambda+r} > \overline{q}$. The corresponding multipliers are $\overline{\mu} = \frac{2r\alpha^{\frac{-2}{3}}+r-3\lambda}{3\lambda(\lambda+r)}$ and $\underline{\mu} = \frac{2r\alpha^{\frac{2}{3}}+r-3\lambda}{3\lambda(\lambda+r)} > \overline{\mu}$; both expressions are homogeneous of degree 0 in λ and r. Because $\underline{\mu} > \overline{\mu}$, as we increase $\frac{\lambda}{r}$ we will reach a point at which $\underline{\mu} > \overline{\mu} = 0$; this occurs at precisely $\frac{\lambda}{r} = \frac{2\alpha^{\frac{-2}{3}}+1}{3} < 1$. Beyond this point, $\underline{q}$ and $\overline{q}$ are determined with a slack α-agent's constraint. Solving the first-order conditions and the low-type agent's incentive compatibility constraint for $\overline{q}$ and $\underline{q}$, we obtain $\underline{q} = \frac{1}{(1+r)^3}\left(\lambda^3(2+\alpha)+\lambda^2(3+2\alpha)+\lambda(3+\alpha)r^2+r^3-\lambda\sqrt{\lambda(\lambda^3+2(\lambda+r)^2(\lambda+\lambda\alpha+r))}\right) > 1$ and $\overline{q} = \frac{1}{(1+r)^2}\left(\sqrt{\lambda(\lambda^3+2(\lambda+r)^2(\lambda+\lambda\alpha+r))}-\lambda^2\right) < \alpha$. Finally, when $\frac{\lambda}{r}$ is increased further to $\frac{\alpha^2}{2-\alpha^2}$, both constraints become slack and $\underline{q} = 1$ and $\overline{q} = \alpha$. □

Proof of Proposition 5:

Consider the Kuhn-Tucker Lagrangian of the social planner who optimizes the sum of the agent's expected present values of utility subject to the two incentive compatibility constraints:

$$\mathcal{L} = \underline{q} + \frac{1}{2}\underline{q}^2 + \alpha\overline{q} - \frac{1}{2}\overline{q}^2 + \underline{\mu}_0(\lambda\underline{q} - (\lambda+r)\frac{1}{2}\overline{q}^2 + r\overline{t}) + \underline{\mu}_1(\lambda\underline{q} - \lambda\frac{1}{2}\overline{q}^2 - r\underline{t})$$
$$+ \overline{\mu}_0(\alpha\lambda\overline{q} - (\lambda+r)\frac{1}{2}\underline{q}^2 + r\underline{t}) + \overline{\mu}_1(\alpha\lambda\overline{q} - \lambda\frac{1}{2}\underline{q}^2 - r\overline{t}).$$

Due to the concavity of this program, the Kuhn-Tucker conditions are necessary and sufficient for a solution. Differentiating with respect to $\underline{t}$ and $\overline{t}$ and evaluating at zero implies that we can set $\underline{\mu}_0 = \overline{\mu}_1 = \eta$ and $\underline{\mu}_1 = \overline{\mu}_0 = \nu$. For $\frac{\lambda}{r}$ sufficiently low, both constraints bind and we have (using algebra) $\frac{1}{2}\underline{q}^2 = \underline{t} + \overline{t}$ and $\frac{1}{2}\overline{q}^2 = \underline{t} + \overline{t}$, so $\overline{q} = \underline{q} = q$. Substituting we have that this value of q is given by $\lambda q = \left(\lambda + \frac{r}{2}\right)\frac{1}{2}q^2$. Differentiating the Lagrangian with respect to $\underline{q}$ and $\overline{q}$ yields the following first-order conditions:

$$(1 - \underline{q})(1 + \lambda(\nu + \eta)) = \nu r \underline{q} \geq 0 \ \ (> 0 \ \text{ if } \nu > 0),$$

$$(\alpha - \overline{q})(1 + \lambda(\nu + \eta)) = \eta r \overline{q} \geq 0 \ \ (> 0 \ \text{ if } \eta > 0).$$

As $\frac{\lambda}{r}$ is increased, at some point $\nu = 0$ while $\eta > 0$, so one constraint becomes slack and $\underline{q} = 1$. To be precise, this point occurs at $\frac{\lambda}{r} = \frac{1}{2}$. In this region of intermediate $\frac{\lambda}{r}$'s, $\overline{q}$ is characterized by $\lambda = \left(\lambda + \frac{r}{2}\right)\frac{1}{2}\overline{q}^2$. As $\frac{\lambda}{r}$ increases further, eventually $\overline{q} = \alpha$ and $\eta = 0$. This latter critical level of $\frac{\lambda}{r}$ occurs at $\frac{\alpha^2}{2(2-\alpha^2)}$. □

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