Barter relationships

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Abstract

We offer a simple economic model of repeated barter to explore current economic exchange in Russia: individuals trade with each other in a dynamic environment where the threat of dissolving the relationship constrains the incentives to cheat. We show how the value of future interactions affects the willingness of individuals to trade with each other; only when rates of interaction are large can trust compensate for an absence of money. Moreover, when trading relationships are asymmetric – either in the trading partners' values for each other's goods or in their relative bargaining power – the resulting barter allocations are distorted, as goods must be used for liquidity reasons. When third-party middlemen exist who can facilitate barter, they command a premium for their services, and have preferences for improved liquidity which may or may not correspond with the other traders in the barter economy. Fourth, we demonstrate that the restriction of trading to tight trading networks may be a socially efficient response to insufficient barter interactions. Finally, we consider how liquidity constraints affect pricing, and illustrate how the existence of a barter market can mute incentives to change prices in response to credit crunches.

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1 Introduction

Economists interested in barter and non-monetary exchange often talk at cross-purposes to anthropologists and sociologists. Central to the anthropological literature is the notion of delayed reciprocity, where barter deals "require delays in payment and several exchanges before the transactors are satisfied" (Humphrey (1998)). This observation has been a central theme in the anthropology of exchange since Mauss (1990[1950]) and Malinowski (1961), and an important component of this research has focussed on the realization that such exchange requires institutions that persuade people to reciprocate favours. However, traditional monetary economics has largely dealt with cases in which such enforcement issues are absent, either by assuming simultaneous barter or enforceable long-term borrowing and lending contracts. Missing from this literature is the importance of implicit arrangements which are based on trust.[1] The purpose of this paper is to redress this somewhat, relying on a large, recent literature on self-enforcing contracts, which often examines trade where money is absent. We argue that useful insights on barter can be obtained by using an economic analysis of repeated exchange with little or no money or external enforcement mechanisms, but where trust plays a central role.

This chapter is not meant to provide a holistic view of non-monetary social exchange in general, which involves an array of moral, religious, cultural, and economic aspects. Instead, its objective is to address some aspects of repeated exchange which operate in the wild economic environment of Russia.[2] It considers the operation of agents (firms or individuals) in an "economy of favours" (Ledeneva, 1998a), each of whose objective in exchange is to maximize their own economic return subject to whatever social, institutional, or implicit constraints that they and their trading partners face. Given the breakdown of social commitments and moral obligations which characterize the descriptions of Russian exchange in this volume, we believe that the tools of economics can provide a useful framework for understanding some phenomena.[3]

Throughout the paper, we borrow liberally from recent advances in the economic literature on repeated game theory which studies environments in which there is little external enforcement of contracts, but where the individuals themselves must design informal institutions to manage

[1] For example, Lemon (1998) cites economists as "believing barter to be the extreme case in which no trust is present in the system."

[2] As described in this volume, the environment of exchange is characterized by "pride in acquiring" rather than giving (Humphrey, (1998)), replete with opportunities for "cheating, defaulting and illegalities" and where there are "no longer pregiven social commitments" (Anderson (1998)). These aspects will be features of the economic model we offer below.

[3] Having said that, neither author is an expert on Russia, and we may ignore an aspect of Russian culture or institutions which will render an observation of less relevance or importance than it might be. Despite this, we believe that the theoretical apparatus offered here should help at least to frame some of the discussion of demonetization, despite its absence of a "thick description" of barter in Russia.

trade.[4] With some notable exceptions such as Kranton (1996, 1998), there have been few attempts to understand barter arrangements from this perspective – a perspective which recognizes the delay and trust which is inherent in barter exchange. We have also tried to minimize as much as possible the technical difficulties of the paper. For those interested in a more technical treatment of some of these issues, see our companion papers (Prendergast and Stole, (1998a, 1998b, 1998c)). In cases where some technical details are required, they are largely relegated to an Appendix to render the paper more readable.

A number of themes run throughout this paper. The first theme which we emphasize is the costs of barter relative to a monetized economy. This is a central concern of classical monetary theory which emphasizes reductions in trade which arise because there is an absence of a *static* double coincidence of wants.[5] Money, because of its commonly accepted value, provides for this double coincidence. We leave such inefficiencies largely in the background and instead emphasize a series of more subtle and less studied issues. First, we begin with the most basic model of reciprocated exchange in Section 2, where two individuals would like to trade with each other over time, but do not have money to facilitate exchange. The individuals are symmetric in that they value each other's good equally and with similar frequency, though (importantly) their demands are not simultaneous. In this simple setting, we illustrate the ability of the individuals to reciprocate trade when the penalty for failing to do so is the dissolution of the relationship, a common enforcement mechanism in many societies (see Sahlins (1972) on this).[6] In our simple benchmark model with similar traders, the ability to trade depends on the importance of the relationship, namely, the frequency of interaction and the patience of the individuals, where traders compare the benefits of reneging on the relationship with the lost surplus that would ensue if they did.

The purpose of section 2 is simply to illustrate how the modern tools of economics can aid in our analysis of the decisions taken by agents and the resulting levels of trade.[7] The simple economic model we present, while useful in developing an understanding of the importance of future interactions, is limited in that there are many dimensions on which the model fails to capture important aspects of observed exchange. Recognizing these limitations, we proceed through the

[4]For those interested in learning more about this literature, we recommend a textbook by Fudenberg and Tirole (1991). For early work on self-enforcing contracts, see Telser (1980) and Klein and Leffler (1981).

[5]To take a trivial example, if you only have broccoli to trade for my coffee, and I don't like broccoli and can't easily trade it on to someone else, the trade is unlikely to be consummated.

[6]In this sense, we differ little from Firth's (1939) observation on the Maori that "the main emphasis of the fulfillment of obligation lies..[in] the desire to continue useful economic relations" (page 421).

[7]By "modern" we mean the economic tools which have been developed in the past 25 years to deal with incomplete information and strategic interaction. These tools are complementary and distinct to the well developed methodology of neoclassical economics which has largely assumed full information and ignored strategic interaction. We make this distinction precise because it is our experience that most non-economists narrowly define economics as the application of the neoclassical paradigm.

remaining sections of the paper by introducing variations into our framework to explore these additional issues.

In section 3 we adapt our model of repeated exchange to deal with the fact that one agent may need the good of this trading partner more than vice versa, or one agent may be more "powerful" than the other. In this section, we demonstrate a second theme: such asymmetries can cause additional barter inefficiencies through different outcomes than those which would occur in an exchange environment mediated with money. For example, when individuals find it difficult to enforce trade through reciprocal exchange, production of "unwanted" goods is typically higher than those which are in greater demand, in sharp contrast to the outcome of a monetized economy. The reason for this is that these unwanted goods serve, in part, the role of currency and one may find "liquidity" value in them as a means of exchange. We also relate the resulting outcomes to discussions of pricing in other chapters of this volume, where we show how the terms of trade offered to those with "unwanted" goods depends on the trading relationship. Specifically, the price paid for valued goods (in terms of "unwanted" goods) gets worse as relationships become less important.

Another recurring theme of the papers included in this volume is the importance of networks for facilitating trade. Section 4 analyzes a simple network to illustrate some issues which appear relevant to the Russian experience. Foremost among these issues is an understanding of the distributional implications of barter exchange in Russia, a third theme of the paper. It seems clear from the work presented by Alaina Lemon (1998), Alena Ledeneva (1998b), Caroline Humphrey (1998) and David Anderson (1998) that transacting through personal contracts does not lead to a level playing field. One can think of established network links as a scarce economic resource which takes time to develop, and whose presence tilts economic power towards the linked trading partners. In particular, established firms, often those from the Soviet era, appear to be in a particularly good position due to both the volume of trade that they are involved in and the central position that they hold in production networks. These are the "good old" contacts described by Ledeneva (1998b). By contrast, some firms and individuals appear to have been left behind in this world of contacts, not least the Roma described by Lemon (1998). An additional implication of this, modeled in Section 4, is the demand which this generates for middlemen, who appear to play a central role in many of the network discussions in this volume. However, these middlemen typically take advantage of their position in the networks and extract some of the surplus from the trade based on whatever they can contribute to the exchange. This section also points to an additional distributional implication of the barter economy, namely, that there are likely some individuals which have benefited from the demonetization of the country, largely as it increases the value of their advantaged position in networks, which in a monetized economy would be of lesser importance.

A fourth theme which we address is how individuals choose to construct their networks. Many sociologists take a rather structuralist approach to networks (see Burt (1992), for example), where networks are simply assigned, even though it frequently appears to be the case that individuals explicitly and strategically create networks. In Section 5 we consider an additional aspect of networks in that when money is absent, it induces individuals to have concentrated networks, rather than relying on many producers who may be able to produce at lower cost. An implication is that individuals will sometimes forego the benefits of comparative advantage in order to keep a relationship going. The reason for such a policy of "putting all your eggs in one basket" is that it tends to increase incentives for trustworthy dealings compared to a situations where one's partner is of little importance. A related implication of this contribution is that in barter settings, it may be difficult to break into a trading network, even in cases where a producer has something of value to another.

Finally, in Section 6, we consider how barter markets can interact with cash markets. Specifically, we consider a world characterized by liquidity shocks, where individuals simply may not have enough money to buy their preferred goods. We are particularly interested in the effect of barter and liquidity shocks on prices. We assume that liquidity shocks are not common across all people in the economy: instead, they differentially affect people with low valuations more than those with high valuations. For example, people with low income are less likely to purchase certain goods at any given prices, even without a liquidity shock, and so it is these people who are most affected by such a shock. Using this assumption, we show three main effects of a liquidity shock on prices. First, if the liquidity shock is large enough, prices will fall below those which arise without a liquidity shock. This supports our usual notion that demands for money are tempered in a setting where there is little money. However, our second finding is that, again if the liquidity shocks are large enough, the reduction in prices caused by liquidity shocks is muted when sellers can also barter their goods. In other words, the opportunity to barter stops prices from falling as much as they would otherwise. As a result, the barter market constrains price reductions from a liquidity shock. Third, for less severe liquidity shocks, we show that prices will be above those without a liquidity shock, a result which arises either with or without the opportunity to barter. But the price movements induced by liquidity shocks are nonetheless more muted in the presence of barter. In other words, barter has the effect of reducing cash-price flexibility in response to shocks, as the barter markets provide an effective alternative to the cash market and become relatively more attractive when liquidity dries up.

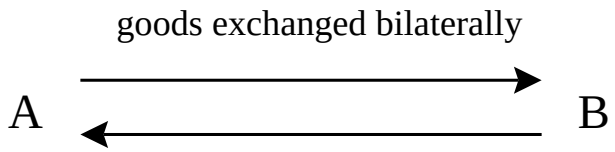
2 A Simple Model of Reciprocal Barter

We begin by considering the simplest possible setting of repeated exchange, where two symmetric individuals with equal bargaining power interact to supply goods to each other. To do so, we set up a stylized "repeated game," in which two individuals trade with each other, but where the only way to reward a trade partner is by offering a good in the future; there is no money to satisfy a static double coincidence of wants. Periodically, each party demands goods from the other, and the other must make a voluntary choice whether to provide those goods. The individuals interact repeatedly so that one partner can use the threat of terminating the relationship as a way of persuading the other partner to supply goods to them. As a result, agents weigh the personal gain from continuing the relationship and supplying goods to the other at some immediate cost against violating the implicit duty to supply which would end the relationship. In this setting, not surprisingly, the importance of the future relationship to the individuals plays a critical role, with trade being easier to enforce when the relationship has dense or highly valuable future trading opportunities than when trade is sporadic or of low value.

The formal model we offer requires some notation but is logically straightforward. In keeping with the specifics of much of Russian barter, we assume an absence of a double coincidence of wants; instead there is some delay between exchanges so that the individuals must reciprocate goods and favours to each other over time. Consider two individuals who interact over time, potentially providing goods to one another other whenever called upon to do so. Each party to the relationship has a good which their partner may demand in any period of time. To be specific, we assume that when a good is demanded by individual A and q units are supplied by individual B, a value of q accrues to agent A at a cost of $c(q) = \frac{1}{2}q_i^2$ which is borne by individual B; the reverse is true when the demand is made by individual B. We can then define $v(q) \equiv q - c(q)$ as the joint *surplus* created from the trade of the good. Importantly, agents cannot satisfy their own needs. We consider the arrival of demands (which we sometimes refer to as projects) to be a random process with a project for person i arriving during a short period of time, Δ, with probability $\lambda\Delta$; i.e., projects arrive according to a Poisson process. This seemingly complicated dynamic process is in fact extremely simple to deal with, as we will see below. With this description of the availability of productive projects, we can think of a higher λ as corresponding to more frequent trading opportunities. Indeed, simple statistical calculations verify that $\frac{1}{\lambda}$ represents the average time between opportunities. Another attraction of thinking about projects arriving randomly over time according to our λ distribution is that that a double *static* coincidence of wants occurs with insignificant probability; as a result, reciprocal exchange over time is the only possible avenue for trade.

Visually, the trading network can be illustrated as in 1.

FIGURE 1: BILATERAL EXCHANGE



Recall that $\frac{1}{\lambda}$ represents the average time between trading opportunities. The time between trades is relevant as people are impatient: Everything else equal, consumption today is better than consumption next year, and production today is more costly than production next year. We model this impatience by assuming that individuals have a subjective discount rate which can be thought of as an internal rate of interest; we denote this rate with the notation r. Mathematically, it will be the case that the ratio of the interaction rate to the value of that time, λ/r, will be the critical determinant for whether or not cooperative trade is sustainable. This ratio is a measure of the relative frequency of trade. A higher ratio implies that the expected present value gains from ongoing trade is higher, and hence we will see that cooperation through dynamic reciprocity is easier to sustain. Lower values of this ratio indicate that the relationship is more transient with only sporadic interaction.

To see the role of this ratio more precisely, consider trade in this environment where there is potentially reciprocated exchange. Here, the agents enforce reciprocal trades through the threat of dissolution of the partnership.[8] We initially consider symmetric solutions to this problem, where each agent receives the same quantity of q from the other.[9] Then if one agent requires q, the other agent is willing to provide it only if

$$V(q) \geq c(q), \tag{1}$$

where $V(q) \equiv \frac{\lambda}{r}[v(q)]$ represents the expected return of the indefinitely recurring relationship to a trader. Therefore, $V(q)$ is the value of the relationship. Note the importance of the $\frac{\lambda}{r}$ term: a higher ratio directly implies a higher value to the relationship.

The requirement for cooperation in the incentive equation above forms the foundation for this paper so it deserves some elaboration. The person who is called upon to produce has a choice; either produce the good, which costs $c(q)$ or renege, in which case no costs are incurred. All other

[8] "We know what happens when a trade partner is disinclined to reciprocate - the sanction everywhere is dissolution of the partnership" (Sahlins (1972), p. 312).

[9] This is the outcome that arises when maximizing the sum of the two individual's utilities.

things equal, the person would prefer not to incur this cost. However, if she fails to produce, she has reneged on the relationship and loses the future value of that relationship, which is $V(q)$, as the relationship is dissolved. Therefore only if $V(q) - c(q) \geq 0$ will she actually carry out her obligations.

The next step in solving this problem is in understanding how much trade individuals will be willing to fulfill. If each party could pay for the goods in a commonly accepted currency, the quantity traded would be $q^{eff} = 1$ – this is the "efficient" level of trade which maximizes the relationship's value, $V(q)$. However, our agents do not have money and must rely on the reciprocal exchange of favours. They choose the maximum level of q (up to the efficient level of 1) that the provider of the good is willing to offer. The trades can be characterized by two regions. For large enough $\frac{\lambda}{r}$, the incentive constraint (1) does not bind at the efficient level of trade, $q^{eff} = 1$, so they will produce efficiently. In other words, if agents interact frequently, or the surplus is large enough, trade is efficient and the absence of money is overcome by the existence of repeated exchange. In more colloquial terms, trust can substitute for cash. For lower rates of interaction, both quantities are below the efficient level, as the value of the relationship does not make producing higher output worthwhile. Note that the quantities of both goods continuously increase in $\frac{\lambda}{r}$ so that as the relationship becomes more important, quantities rise to the surplus maximizing levels.

Example 1: For an illustrative case consider the setting in Figure 2. The curve in the top graph gives the (maximal) flow value from the relationship $rV(q)$ as a function of the frequency of interaction (normalized by the cost of time) $\frac{\lambda}{r}$. This is the total surplus generated for each party. The curve in the bottom graph measures the provided quantity as a function of $\frac{\lambda}{r}$.

FIGURE 2. THE EFFECT OF INTERACTION FREQUENCY ON DYNAMIC RECIPROCITY

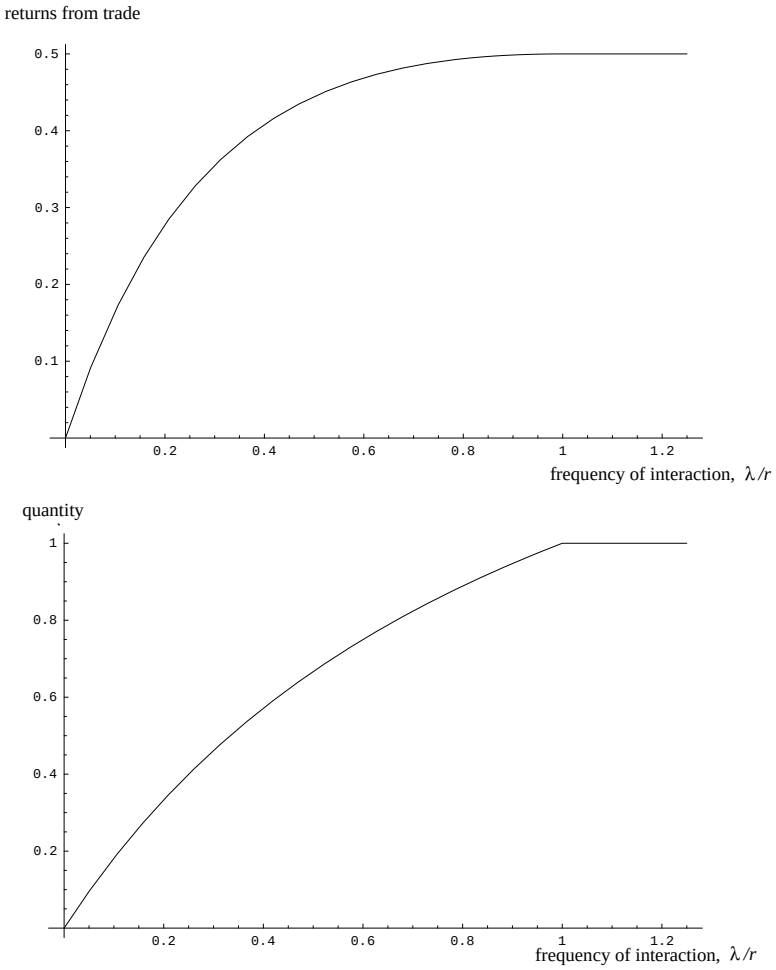


Figure 2 illustrates the importance of $\frac{\lambda}{r}$ for trade, with quantities traded increasing in the frequency of interaction, up to the point of efficient trade, beyond which there is no reason to increase trade further. This section demonstrates the importance of repeated interaction in effecting barter exchange. If money were freely available, there would be no reason for repeated exchange. With money absent, the threat of dissolution acts to constrain cheating, and so it is important that the agents value the relationship in order to act honestly.[10] This section therefore illustrates one cost to barter exchange in repeated settings, namely, that individuals are sometimes focused on short term gains so much that they renege on their reciprocal obligations. (Or to phrase it another

[10]In one sense, this section is little more than a formal illustration of the schema of reciprocity offered by Sahlins (1972). He characterizes different types of reciprocity based on the distance of a trade partner from the individual. At the top of this hierarchy is generalized reciprocity, where high levels of trade are possible with members of one's own kinship groups. At the other extreme is the negative reciprocity offered to strangers, where an individual will happily harm the person he is trading with. This model describes distances in terms of $\frac{\lambda}{r}$.

way, as individuals value relationships less and less, smaller quantities of trade can be supported.) There is much evidence to suggest that such inefficiencies arise. First, many of the contributors to this volume cite the wild nature of the Russian economy where incentives to default prevail, while Ledeneva (1998b) also emphasizes the critical importance of "good old" personal contacts for ensuring that trade actually happens.

3 Inefficient, Delayed Rewards and the Liquidity Value of Trade

This section deals with 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? So far, we have offered one reason why economic relationships without money can be inefficient: trade is not frequent enough (or, alternatively stated, individuals are not sufficiently patient). However, there are other problems which can arise when money is absent, many of which related to inherent asymmetries between the two parties. (Remember that in the previous section, we have assumed that the two parties value each other's goods equally.) A recurring theme on barter in this volume is that many of the goods traded are not so desirable to one of the parties, and may take time and involve other costs to offload. Equally there are cases where one party needs things frequently from the other, while the reciprocal demands from the other party are much more intermittent. There is furthermore considerable evidence from these papers that the terms of trade depend on what currency is bartered, which this section also addresses.

When individuals value each other's contributions differently, two additional insights arise. First, agents trade with one another not simply for the consumption value of trade but also to provide "liquidity," serving a role as a *quid pro quo* for the exchange.[11] The role of commodities as a form of money gives rise to qualitatively different outcomes than those which arise in a monetized economy. Second, pricing depends on both the goods traded and on the importance of the relationship, where low-value goods and goods in sporadic relationships may receive poorer terms of trade relative to high quality goods.

3.1 Asymmetric Values in Trading Relationships

In order for such liquidity provision to play a role, we first consider asymmetries between the agents, where one agent values a unit of consumption of the other's good more than vice versa. To this end, we extend our basic model of Section 2 by assuming that one individual, person A, values a unit of the other agent's good at αq, where $\alpha > 1$. We call this high-valuation *consumer* the α-agent.

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

The other individual, B, continues to have unit marginal utility for consumption. Note that higher optimal production, $\overline{q} = \alpha > 1$, is called for when serving the α-agent, relative to the other agent for whom optimal production remains at 1. These are the outcomes of a monetized economy. However, to induce the other person to offer higher quantities of the α-good in a barter setting, the agent 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 satisfy the other agent's demands at the higher level of production. 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.[12] The lower-quality good has a "liquidity" or *quid-pro-quo* value in a barter exchange which accounts for why it is over-traded relative to the allocation in a monetary economy.

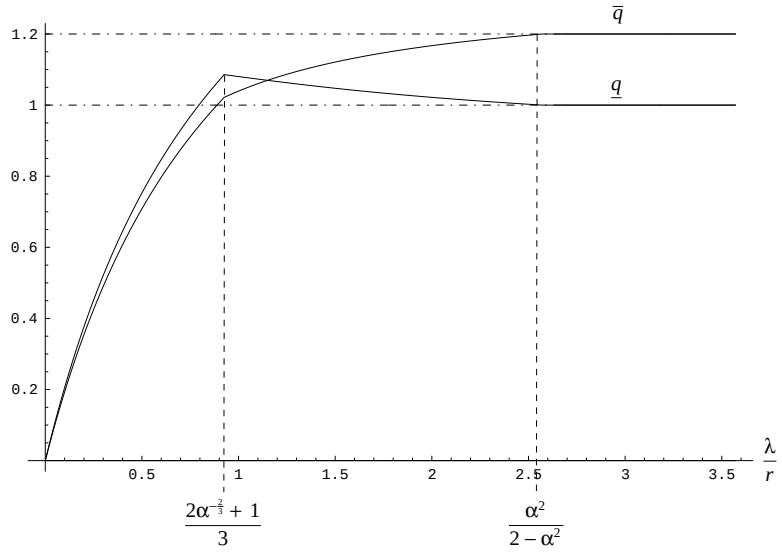
Our interest here is in identifying the quantities of goods which the individuals are willing to trade. In order to render the paper more readable, we relegate much of the technical detail to the Appendix of the paper, where a more formal proof of the propositions is offered. Verbally, the quantities traded have the following characteristics. First, if the agents do not interact frequently, trade is below its efficient level, and trade of the low-value good *exceeds* that of the superior good. Ironically, the worse is the low-value good relative to the superior, the greater is its relative production. For intermediate rates of interaction, trade in the low-value good is below that of the superior good, but *higher* than the efficient level which would arise if money were available. Finally, if the individuals interact frequently enough, there is no difference between the outcomes with barter and with money.[13]

A visual characterization of the solution is given in Figure 3, where $\overline{q}$ is the production of the superior α-good and $\underline{q}$ is the production of the lower-valued good. In this example, we set $\alpha = 1.2$.

[12]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.

[13]In this paper, we implicitly assume that α is not too large so that the asymmetries are not to great for sufficiently patient traders to overcome; to be precise, we require that $\alpha < \sqrt{2}$. If $\sqrt{2} < \alpha$, the agent who produces the α-good will be unwilling to produce at efficient levels, even when $r = 0$. 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 low-value 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. These are akin to the classical inefficiencies that are discussed in the static literature on barter. These issues are discussed in detail in Prendergast and Stole (1998b).

FIGURE 3: LIQUIDITY AND TRADE



Remember that if money was freely available, the outcomes would be $\overline{q} = \alpha$ and $\underline{q} = 1$ regardless of the rate of interaction, $\frac{\lambda}{r}$. Such efficient levels only emerge under dynamic reciprocity if the rate of interaction is high enough; again, if the relationship is sufficiently important, trust can substitute for cash. More generally, though, from Figure 3 one can see that there are three separate regions. The one that seems of most relevance to the examples cited for Russia concern those where interaction is infrequent ($\frac{\lambda}{r}$ low). This is the part where both lines are upward sloping. For example, Humphrey (1998) cites the "short horizons" of many barter participants. Note that when interaction is infrequent, production of the worse good $\underline{q}$ is higher than production of the better good and liquidity concerns reverse our normal intuition on the supply of goods, where goods with higher marginal valuations have higher production.[14]

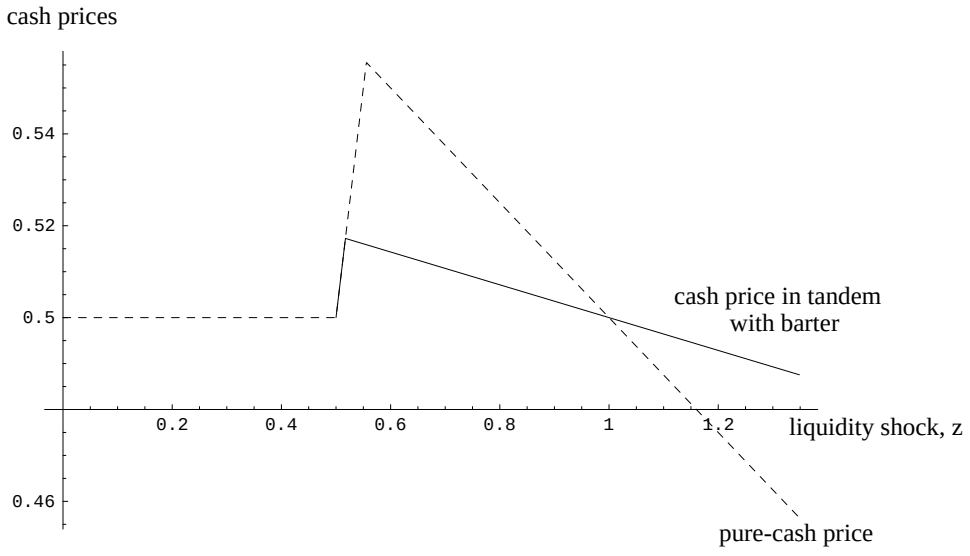
We can easily rephrase these results in terms of pricing behavior: in relationships where interaction in infrequent, those with poor barter goods get bad prices. In order to consume something that they like, those with poor barter goods generally pay a dear price, sometimes having to produce large quantities to get anything in return. This appears to correspond to a recurring theme in many of the papers offered in this volume. For example, Anderson (1998) describes the "exploitative side" of these trades, with barter prices being "more expensive than purchasing goods at

[14]It is worth briefly noting the two other regions of trade here, though it is not our primary focus. First, 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, thus reducing the need to oversupply the less useful asset. Thus increased patience reduces some trades. Finally, for large enough $\frac{\lambda}{r}$, the efficient allocation (i.e., the outcome of a monetized economy) occurs.

wholesale prices". It is easy to translate our results into relevant prices: the price is the quantity of one good which must be offered to get a unit of the other. Not surprisingly, as the difference between the two goods' qualities increases, more of the low-valued good must be offered to get a unit of the better good; in effect, the price of the better good rises. From this perspective, it is hardly surprising that the prices denominated in petrol would be better than those denominated in electric energy which "is not an easy currency" and "produces big discounts" (Ledeneva (1998b)). In essence, prices reflect the quality of the bartered goods.

Another implication of this simple model is that it shows how pricing varies by the importance of the relationship. Figure 4 plots the price of the α-good denominated in terms of the other good as $\frac{\lambda}{r}$ changes. This represents the amount of the less desirable good which must be offered to get a unit of the better good. It is immediately seen that the relationship is (weakly) downward sloping, so that the cost of getting the better good falls as the relationship becomes more important. Also note that in relationships which are more important, the terms of trade get closer to the efficient level, with traded quantities similar to those which would emerge in a world with money.[15] When the relationship is unimportant, the price of getting the preferred good is highest and most out of line with the efficient price level. Thus pricing depends on relationships.

FIGURE 4: PRICING IN RELATIONSHIPS



These observations illustrate 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

[15] With money the ratio of production of the unwanted good to the other is $\frac{1}{1.2}$.

which have higher marginal surplus will have higher production than those which are less valuable. But this basic premise is violated here where there is more production of the less useful good. In addition, we have pointed out the poor terms of trade which arise when agents have goods which have poor liquidity; those who pay in petrol generally do better than those paying in bricks.

3.2 Asymmetric Bargaining Power

So far, we have only considered those cases where bargaining power worked such that the sum of individual utilities was maximized. Yet many of the papers in this volume focus on the advantaged position of some agents relative to others, manifesting itself in terms of asymmetric bargaining power. A central theme of recent contributions to economics concerns inefficiencies that can be generated by bargaining distortions. Two cases are generally considered; those in which everyone knows the other's valuations and those where valuations are unknown. In this section, we consider the simplest case, where two agents trade with known valuations but where there is asymmetric bargaining power. In a set of related papers, we develop the effects of barter upon bargaining distortions in environments of incomplete information.[16]

When money is freely available, such asymmetric bargaining power worries economists little, as higher bargaining power results in a weak agent simply paying more money, with no change in the efficiency of the allocation. There is only a pure distributional effect about which we have little to say. However, this is not so in the case of barter; here asymmetric bargaining power directly affects the efficiency of the allocation – judged relative to a monetary economy – as greater bargaining power is now manifested in terms of inefficient distortion of goods. For example, a farmer in Russia with little bargaining power may be required to hand over excessively large quantities of food to a powerful buyer, who offers little in return. In a monetary economy in which both parties had ample monetary assets, such bargaining power may result in large cash transfers, but not in inefficient allocations of goods. Such distortions in production are the standard efficiency losses of economics.[17]

In order to isolate the effect of bargaining power *per se*, consider a case where agents interact so often that the incentive constraints are irrelevant (in the context of the formal model, assume that interaction is very high) and their demands are assumed to be symmetric, as in Section 2. Suppose instead of simply assuming that the agents split the surplus, they bargain over the allocation. Following work by Rubinstein (1982), a simple way of parameterizing bargaining power relates to

[16] Prendergast and Stole (1998a, 1998c).

[17] It is worth emphasizing that when we claim that asymmetric bargaining power in barter settings can generate inefficient allocations, that we are measuring the inefficiency relative to the monetary outcome. A barter allocation is still efficient in a money-less world, but the introduction of money could raise everyone's level of consumption without anyone being harmed by allowing an efficient reallocation of consumption across individuals.

the patience of the individuals involved. In this case, those with weak bargaining power cannot wait to consume the good, while those with stronger bargaining power are content to sit out some time before consuming. Although trades in these models occur immediately, the terms of trade benefit the more patient bargainer. Suppose initially that each party is equally patient. Then the bargaining outcome offers $q = 1$, the same outcome as with money. (Remember that we are restricting attention to the case where the agents have symmetric demands and interact frequently, so that we do not have to worry about the problems of the previous subsection.) This merely replicates our earlier results. However, the presence of asymmetric bargaining power will generate differences between the two allocations. As an example, consider the case where agent A has all the bargaining power, allowing her to make a take-it-or-leave-it offer to the her trading partner. Then the barter allocation has B's consumption given by $q_B < 1$ and agent A's consumption given by $q_A > 1$.[18] In other words, asymmetric bargaining power *per se* causes problems, with the party with more bargaining power getting quantities which are too high while his less patient partnership consuming too little relative to a monetized economy.

4 Networks and Distributional Effects of Barter

Perhaps the dominant theme of the papers in this volume has been the importance of contacts and networks in current economic exchange in Russia, and some of the more fascinating contributions illustrate the quite incredible sophistication of the networks which sometimes develop to satisfy a double coincidence of wants. Ledeneva's (1998b) contribution here is particularly apposite. The importance of this institution of exchange should not be underestimated in understanding how barter affects modern Russia. First, as Anderson (1998) nicely puts it: "the logic behind market economies is that commodities, such as money, are intended to bind together many diverse communities of exchange. The recent financial crisis .. (has) disqualified the (new) ruble from the role of an instrument of social integration". Or to put it another way, one person's money is as good as another's,[19] so money facilitates exchange between individuals with little in common. By contrast, one person's social contacts clearly are not the equal of anothers.

This transition from an economy based on money to one based on contacts surely has important effects on distribution and social integration. In terms of the simple model above, individuals differ in terms of their trading intensities (i.e., λ/r), where those with less frequent interactions become excluded from trades which would otherwise occur with money. There can be little doubt from Lemon's (1998) contribution that this has adversely affected the Roma, who are often seen

[18] More precisely, $q_B = 2^{-\frac{1}{3}}$ and $q_A = 2^{\frac{1}{3}}$.

[19] Though Lemon (1998) would surely disagree with this statement in the context of the Roma.

as untrustworthy by Russians. Equally, Humphrey (1998) notes that farmers are restricted to simultaneous barter arrangements, as they lack the relationships to ensure delayed reciprocity. Yet such exclusion is not restricted solely to particular ethnic or occupational groups. Instead, it is clear that individuals seek out trade partners with good pedigrees, or at least pedigrees where there is evidence of dense trade. As Anderson (1998) notes, there is a difficulty in building "networks of alliance in a space where there are no longer pregiven social commitments." For instance, Ledeneva (1998b) emphasizes the importance of "good, old" contacts, while Humphrey notes the importance of networks that are often "quite simply based on Soviet-era links," where firms "prefer to work with solid government-supported firms." Clarke (1998) notes that two classes of contacts become important:, those who "had their roots in old administrative structures" and "those outside the law."

These observations seem to point to the importance of established trade partners, those with links to many other firms, which may be necessary to provide the ultimate "cash" of the barter arrangement. Those with few links to other networks become poor trading partners, at least in the absence of middlemen. It is our sense that this is of critical importance for the Russian economy and perhaps political future. One implication of such barter networks is that they exclude individuals on the periphery (the Roma being the extreme social example of this) and also give a huge advantage to those who are already in established networks. It is not hard to see potential implications for restructuring and government in Russia. Particularly, because of demonetization, older established firms, often those which are the "dinosaurs" of Humphrey's (1998) analysis, are increasingly becoming central to economic exchange, despite the extinct nature of the outputs that they produce. Since these firms often have strong contacts to local government, it is also not hard to imagine a link to political entrenchment.

The importance of networks for facilitating trade has numerous implications. First, as described above, it can exclude peripheral individuals from exchange. A second implication, which we briefly model here, concerns the importance of middlemen to economic exchange. As Clarke (1998) notes, "to find new customers and suppliers, enterprises had to turn to intermediaries, ... individuals who had their own contacts and sources of finance". To illustrate this, we consider a simple network which requires a middleman to facilitate exchange. However, an additional purpose of this is to note that the middleman does not come for free; positions in networks generate rents which reduce the value of trade to the parties who are involved in production. Indeed, we will show below that middlemen may actually benefit from the demonetization process: they are only needed when times are sufficiently bad, and so (in some cases) may disappear when times get better.

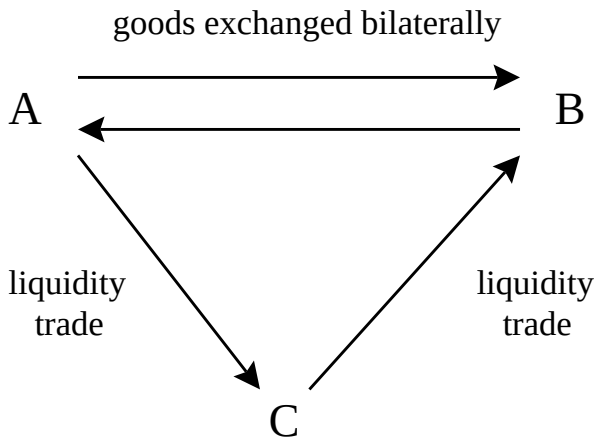
This section also deals with the fact that not all trade consists of reciprocal barter. There is

some liquidity in the system, though the trading individuals cannot be assured of having enough. To model this and the need for middlemen, we begin by extending the model of liquidity trade above in Section 3 by assuming that another individual can provide liquidity. As noted above, parties A and B may not interact enough to get to the same outcome as the monetized economy. This is where middlemen play a role. They can in effect partially monetize the barter transaction by providing transfers between the parties with some regularity. We model this simply here by assuming that there is another party, C. This party fills a need between A and B in the following way. We assume that A has a project with C where he can transfer a good to C. For simplicity we ignore the productive value of the trades with C by assuming that transfers from A to C are welfare neutral, where a transfer of goods costing x to A has value x to C. In turn, C can transfer something to B, where a transfer of goods costing x to C has value x to B. Thus C plays no role other than to shuffle resources from A, the consumer of the superior good, to B the consumer of the low-value good.[20] Thus, when A wants something, B will provide it and gets (possibly) two things in return: goods from A and and a transfer from C. These occur sometime in the future. (Without the middleman, B can only obtain goods from A.) The role of party C, who acts like a bank, is that it can transfer resources to B when available and required. To retain symmetry in the model, we also assume that C receives each of his projects (the project from A being one, the project to B being the other) with frequency $\mu\lambda$, where a higher value of μ is akin to increasing the liquidity available to party C. As with the liquidity model of Section 3, agent A prefers the good provided by B (with marginal utility $\alpha > 1$) relatively more than B likes A's good (which has marginal utility of 1).

Visually, our network is given in Figure 5.

[20] In effect, the welfare neutrality of C's transfer are as if the parties transact cash. But this is for simplicity. A perhaps more natural assumption would be to make the trades between C and the other parties inefficient rather than just neutral. In that case, the choice over using the middleman would depends on whether the liquidity creation by the middleman outweighs the costs of the inefficient trades.

FIGURE 5: THE NETWORK WITH A MIDDLEMAN



Of course, the agent providing liquidity will not do so for free; A must pay him. Since it facilitates trade, C will demand a share of the increase in trade by threatening to abscond whenever he is required to give something to B. A must provide C with a credible promise of future returns to prevent this behaviour. Thus, when A has an opportunity to transfer value to C via some project, she will do so to the extent required. As with the previous sections, we assume that the parties maximize the sum of their utilities, subject to the relevant incentive constraints of the type described in Section 2.[21] The main difference in the formal model is now that party C must be induced to hand over a transfer to B when he is called upon to do so.[22]

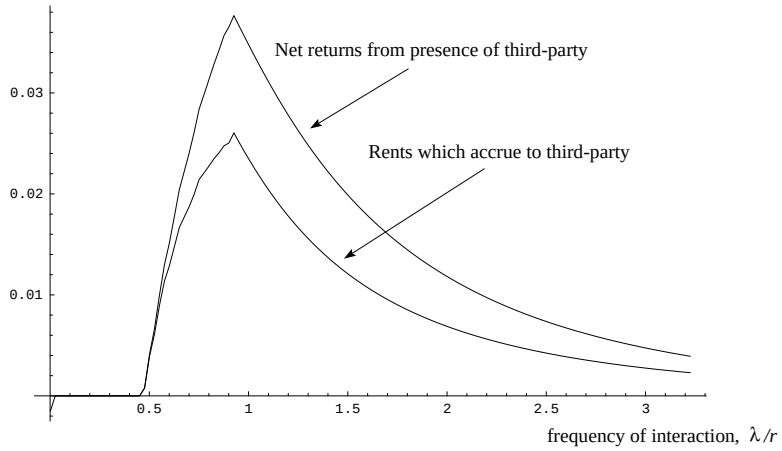
As in the previous sections, we do not provide exhaustive details of our theoretical results. Instead, we simply provide an example to illustrate the main implications of allowing middlemen. The outcome of the provision of liquidity by the middleman is provided in Figure 6, where we assume that $\alpha = 1.5$ and party C has money with frequency 15λ, so $\mu = 15$. In Figure 5 we provide two effects of the middleman. The top curve describes the increase in surplus to all three parties from the existence of the middleman. Since this is positive for levels of interaction above $\lambda = 0.5$, middlemen can improve overall surplus which explains why the agents use them. However, the

[21] Some readers may be uncomfortable with this and would prefer a more explicit bargaining structure. An obvious alternative to work with would be to use Nash bargaining. Nash bargaining is equivalent to maximizing the product of the agent's utilities, subject to the relevant incentive constraints. However, as we show in other work, Prendergast and Stole (1998c), this involves additional complications when monetary and non-monetary allocations are compared, as it changes the nature of the bargaining game. This adds additional complications which we do not discuss here: see our earlier work for details.

[22] Suppose that as part of an equilibrium allocation, agent C is required to give a transfer of t units of his good to B. Let V_C be the present value of the utility of agent C from the trading relationship with A and B. Then it must be the case that $V_C - t \geq 0$ for the agent to be willing to make the transfers when required to do so. The figure below takes account of these additional incentives.

bottom curve in Figure 6 plots the middleman's profits. In other words, how much of the net gain accrues to the middleman?

FIGURE 6: THE EFFECT OF THE MIDDLEMAN ON SURPLUS AND RENTS



As can be seen clearly, C gets some of the surplus that he creates, illustrating important distributional consequences of their role: middlemen do not come for free and sometimes can be very expensive. There are three regions worth remarking upon. In the first region, for sufficiently low interactions, there is no value to an intermediary such as C. The cost of transferring value through C is too high relative to the benefit of improved exchange between A and B, since A and B are unable to trade at even moderate levels. In the middle region of interaction, the use of C is a complement to A and B's interaction: the more they interact, the more value there is to transferring returns from A to B via C, as such transfers allow for more efficient (and asymmetric) exchanges. For sufficiently high levels of interaction, however, A and B can replicate the role of C in an autarkic trading network, so additional increases in interaction levels are a substitute for C's services. The reason for this fall is that parties A and B interact enough to execute their own trades and they need the middleman less as the interaction becomes more frequent. But then the interests of the middlemen towards demonetization differ from those of the other parties, unlike the middle region. Particularly, the two parties trading goods would prefer a sufficiently high level of interaction (or other monetary substitute) so that they can fulfill their trades themselves. By contrast, the middleman would be harmed in this case, as his role would be come redundant.[23] In the context of Russia, this relates to the possibility that the "dinosaurs" which Humphrey (1998) places in the center of her networks may be harmed by the remonetization of Russia, as their

[23]Of course, such middlemen may also have productive roles in monetized economies just as banks frequently add value.

services are no longer necessary and the outputs they produce are of little value in a monetized economy.

The purpose of this example is not simply to show that there is a demand for middlemen when barter arrangements predominate. Instead, its main purpose is to show that there are important distributional consequences from that derived demand. In the examples given above, it also points to the fact that there could be a group of agents who benefit from the demonetization process, as it implies that these individuals occupy a more central role in the required networks to facilitate trade. Since many of these central individuals in networks are also closely linked to local government, it raises the interesting question of the incentives of local government to aid any remonetization process.

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 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. To put this in more familiar terms, the trend towards short termism in Russia that Humphrey (1998) emphasizes makes efficient restricting of networks more likely.

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 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

[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)).

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.

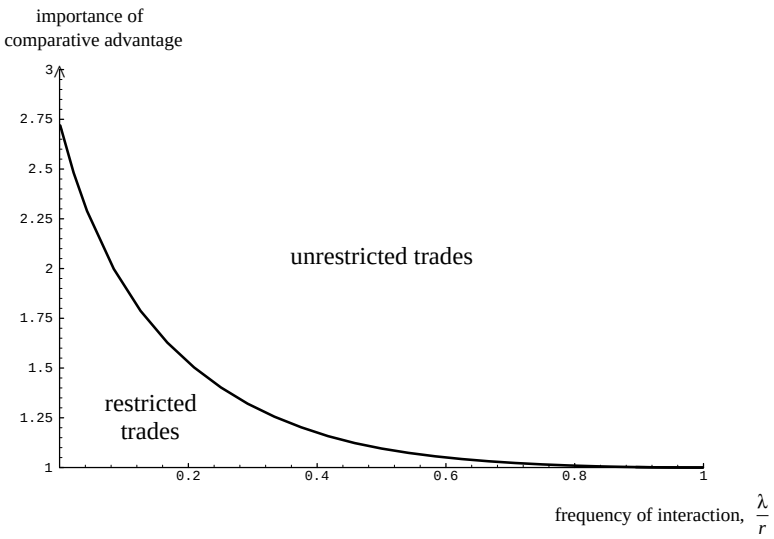
In this setting, we consider two natural networks. First, we address the case where all agents trade according to comparative advantage. In other words, if any agent requires good i, the good is produced by person i. Thus, all links are formed. We then compare this to an institution where each agent 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.

As with the previous sections, we relegate the technical details to the Appendix, where the formal model is analyzed. Nonetheless, 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 main result from the Appendix 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 Figure 7.

FIGURE 7: 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 Liquidity Shocks and Prices

So far, we have largely looked at barter arrangements as if there was not a money market also operating in tandem. This section, based on Prendergast and Stole (1999), begins to address what we feel is an important but unexplored topic in the context of barter societies, namely, the interaction between many currencies which simultaneously circulate, as occurs in Russia. It remains very unclear how these currencies interact with one another; their effects are hardly neutral on each other but exactly how the existence of rubles affects the use of pasta or social contacts remains unclear. Central to current trading in Russia is the absence of liquidity that drives much of barter trade. Our interest in this section specifically is in understanding the response of prices to a liquidity shock. To describe the issue, consider the following trivial example. Suppose that before the August 1998 shock everyone in Russia had £2 but that after the shock, liquidity dried up so that everyone has £1. An immediate question that arises is why don't prices adjust such that the real quantity of money is unchanged. In other words, why aren't prices simply cut in two?

Our answer to this relies on two building blocks.[25] First, we assume that prices may not be set competitively.[26] To model non-competitive setting of prices, we consider the standard monopoly

[25] As in the other sections of the paper, we do not provide much technical detail but instead offer an example which illustrates some of the relevant effects. This example is based on Prendergast and Stole (1999). The reader is referred there for more details.

[26] There is a considerable amount of discussion of current pricing arrangements in Russia. For example, Humphrey (1998) notes the prevalence of "exploiting opportunities by mispricing", where fixed prices are "replaced by agonized bargaining", while Ledeneva (1998b) devotes considerable time to understanding the negotiations that operate in barter networks. One view of such pricing arrangements has been emphasized above, namely, that the prices that are charged are merely a manifestation of the fact that barter goods are not a general claim on goods in the way that, say, pounds would be, and so sellers demand more in cases where these goods are hard to sell on. For instance, this surely is the primary reason why prices denominated in bricks would exceed those in petrol. It may also explain why Commander and Mumssen (1998) find lower prices denominated in veksels than for straight barter deals. Yet there remains the suspicion that some of the pricing decisions that are being described also reflect the absence of competition that often characterizes networks where there are a small number of traders. This would seem closer to the descriptions of many of the authors in this volume than simply the observation that efficient barter prices are being offered at all points in time, and raises the issue of how liquidity shocks, of the type that occurred in August 1998, affected the evolution of prices. In this section, we consider how liquidity shocks affect the exercise of monopoly power in a situation where barter exchange is also possible.

setting where there is uncertainty about the valuation of a buyer for the seller's good. We assume that when a seller is offering his good to a buyer, the buyer values a single unit of the good at v, where v is uniformly distributed between 0 and 1. Only the buyer knows how much he values the good. Assume further for simplicity that the quantity supplied is discrete, equal to either 0 or 1, and that the cost of the good is zero. As a result, of these assumptions, it is always efficient (but not necessarily most profitable) to supply the good. If there are no other constraints or opportunities, it is simple to show that the monopoly seller would choose his price to be $\frac{1}{2}$. In such a case, only half the population (those with valuations above $\frac{1}{2}$) would buy, but profits would be greater than at any other price.

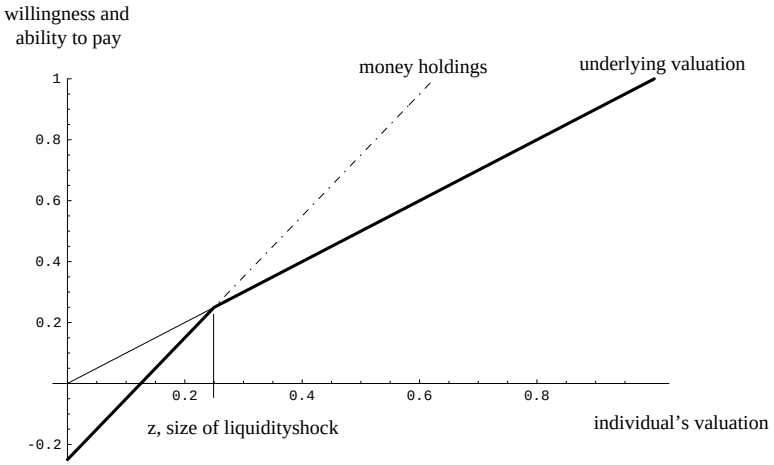
The additional assumption we make, however, is that there are liquidity shocks, where the buyer may be liquidity constrained with not enough money to pay for the good. To fix this idea, we assume that he has m units of currency with which he can buy the good. Then his "effective willingness to pay" will be the minimum of his valuation v and his money stock m. This represents a simple way to analyze the effects of liquidity.[27] However, importantly, not everyone is affected equally by the liquidity shock. Specifically, we assume that those who have low valuations are also likely to have little money. Put in loose terms, poor people are less likely to buy and are also those who are most affected by shocks to liquidity. Those in wealthier initial positions are more likely buyers because (i) they are more willing to buy the good if they have money and (ii) are more likely to have money even after the liquidity shock, perhaps because of their better positions in trading networks, as described in Section 4.

One natural way to model this is through a correlation between valuations and money holdings. We use a particularly simple form of correlation, where we assume that $m = a + bv$, $a < 0$ and $b > 1$.[28] In other words, a 1 unit increase in valuations increases money stocks by b. What this means can be most easily seen from Figure 8, where we have taken a simple example in which $b = 1.25$ and $a = -0.25$.

[27] Some readers may be uncomfortable with defining inherent valuations independently of money holdings. The simplest way to think of this is that m refers to a distinct composite good, where the marginal value of the seller's good (relative to the composite) is v.

[28] Of course, such a formulation has the unattractive aspect that money holdings can be negative for low valuations. This is only to simplify notation. Instead, one should think of money holdings are given by $\max\{0, a+bv\}$ and nothing in our results would be altered.

FIGURE 8: THE EFFECT OF LIQUIDITY SHOCKS ON WILLINGNESS TO PAY

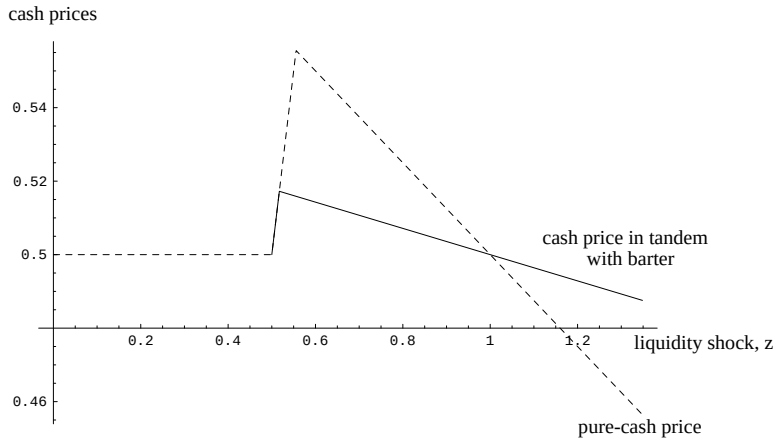


The dark shaded line represents the effective willingness to pay. For those who have high valuations (above z in Figure 8), the underlying valuation of the buyer is less than his money holdings. In other words, liquidity constraints are not important for that person, as he has enough money to pay for the good. However, this is not true for all individuals who value the good at less than z. In that case, the agents do not have enough money to pay their valuation: instead all that they can pay is their money holdings, m.[29]

Start by imagining that there are no opportunities for barter: this is not meant to reflect current reality in Russia, but is simply a counterfactual against which we will consider a world with barter. What we are most interested in is how prices are affected by the liquidity shock. Now remember from Figure 8 that those who have valuations below z are liquidity constrained. Therefore, as z gets bigger, the environment becomes more liquidity constrained. (This is equivalent to decreasing a with the technology above.) The hatched line in Figure 9 gives optimal prices which arise as a function of the liquidity shock.

[29]In the absence of a correlation between m and v, there is no opportunity for strategic segmentation of markets of the type studied here.

FIGURE 9: PRICES



It is simplest to begin at the two extremes: (a) where z is low (less than $\frac{1}{2}$), so few are liquidity constrained, and (b) where z exceeds 1, so everyone is liquidity constrained. First, when few are liquidity constrained, the price charged is $\frac{1}{2}$, unchanged from the case where there is no liquidity shock. This arises simply because the only people affected by the shock are those who would not have bought anyway: hence the optimal price is unchanged. When the liquidity shock is large, specifically when $z > 1$, everyone is affected by the shock. In this case, prices fall below the their level when there is no liquidity shock. This reflects the imagined direct effect of an absence of liquidity on prices: if people don't have any money, you should not demand as much as when they do.

However, the intermediate regions are also of interest, as they illustrate how liquidity shocks cause sellers to increase prices over some range and then to reduce them. This arises for the following reason. Consider a liquidity shock which causes some marginal buyers (those around $\frac{1}{2}$) to be liquidity constrained. One possibility is to reduce the price to pick these up: but this reduces the revenues on those with higher valuations who would have bought anyway. An alternative is to ignore these customers and choose a price at which only those who have high valuations (and money holdings) will buy. For intermediate ranges of liquidity shocks, the latter effect always dominates, so the optimal pricing strategy is to increase the price as customers initially become liquidity constrained in the relevant demand region. In short, the liquidity shock decimates the demand of the moderate purchasers, so it now is more profitable for the seller to focus attention on the cash market's high end purchasers.

But firms have another option which we have so far ignored: they can barter their goods through the kind of networks that are described at length in this volume. Rather than fully model the

repeated barter environment as we have done in the previous sections, we instead simply consider a "reduced form" structure of barter where we note that there is some cost to trading through barter rather than directly selling for cash. This could be the cost which must be paid to a middleman, as in Section 4, or the inefficient production which arises when goods are not equally valued by both parties, as in Section 3.1. Specifically, we assume that there is a "tax" on barter which reflects this: where a unit of the buyer's "commodity cash" (i.e., the goods which the buyer transfers to the seller in exchange for satisfying the buyer's demands) has value x to the seller (in terms of the composite), but which costs tx to the buyer to generate. We assume that $t > 1$, reflecting the standard inefficiencies of barter.

How does the opportunity for barter affect the cash market? Clearly, it now gives sellers the opportunity to sell their goods not only for cash but also they can offer their goods for barter also. This provides them with an additional outlet for their goods which increases their profitability, but importantly also gives buyers an alternative option, where they can barter instead of buying for cash. The solid line in Figure 9 plots optimal money prices when barter is also an option. In this figure, we assume that $t = 1.5$.[30] Our primary focus is on the difference between the hatched line and the full line: in other words, how does the existence of barter exchange affect money pricing? Again, consider the extremes. When the liquidity constraints are not important, there is no difference in the price charged, for the reason that the barter market is never used.[31] At the other extreme, where $z > 1$, when liquidity constraints are extreme, prices when barter is an option are still lower than when there is no liquidity problem. However, they are higher than when only the cash market operated. In other words, the existence of the barter market mutes the incentive to reduce prices with liquidity shocks. In this region, both currencies circulate simultaneously, where those with high enough valuations (and money) use the cash market while those who do not will use the barter market. Why is it that prices are higher when barter is an option? The reason is that the benefits to a price reduction in a world without barter are that customers who would not otherwise buy the product now will purchase it at the lower price. When barter is present, a price reduction (holding the barter terms fixed) will only serve to convert bartering buyers into cash buyers. While this is profitable to the seller, conversion is not as profitable as new sales. Hence, the presence of bater mutes the incentive to reduce prices when liquidity shocks hit the system. Thus multiple currencies interact in non-trivial ways.[32]

[30] The more general importance of this assumption is that for the example we have computed it is the case that $t \geq b$. We have not yet analyzed the case where this condition does not hold.

[31] One might imagine that those buyers without money would be offered the opportunity to barter in this region. However, this is not the case because there is the temptation that those who would otherwise pay with cash will now switch to barter. The cost of this transition is enough to cause the firm to offer no barter swaps.

[32] It should be noted here that we have ignore one possibility here, which is where there is no cash market and

For intermediate liquidity shocks (for z between 0.5 and 1), prices are lower when barter is an option. In this region, firms realize that if prices are too high, customers can substitute into barter. The firm then faces a tradeoff when it increases money prices that is must simultaneously also make barter deals less attractive to the consumer. In this intermediate region, the costs of doing so are enough to constrain price increases, and so the firm does not target only the higher valuation consumers in the way that it would if barter were not available.

7 Conclusion

Why write this paper, which offers an economic model of the type of delayed reciprocity more commonly studied by anthropologists? If theoretical economics has anything to add to understanding non-monetary exchange, it must be through the insights that arise from the models (formal and otherwise) that it offers. Obviously, it is hardly valuable to convert anthropological ethnographies and descriptions into mathematical models simply for its own sake. Despite the fact we provide little in the way of the "thick description" that is often advocated by anthropologists such as Geertz (1973), it is our belief that much can be learned from simple models of the type offered here. We believe that the role of such models is twofold.

First, economics typically deduces the behavior of individuals from a small number of principles, such as profit and utility maximization subject to the relevant social and institutional constraints. The behavioral assumptions under which our agents operate are one-dimensional (personal gain) and cast individuals as calculating the angles when choosing whether to cooperate with another or not. These principles do not explain the entire motivation of individuals when they make decisions; they are not meant to. Instead, they offer a parsimonious structure to understand how well simple specifications of preferences can explain observed phenomena. In this paper, our premise is that individuals engage in trade to maximize economic gain, with the threat of dissolution acting to constrain cheating. Using this simple structure, we have offered what we feel are plausible outcomes which are consistent with the evidence cited in this volume so that it may be that a theory based on simple, broadly defined notions of rational choice can generate predictions which mirror the evidence provided by sociologists and anthropologists studying Russia. At a minimum, the models offered here should serve to clarify the way in which many economists think of barter in a repeated setting.

Second, economists use models for predictive purposes, an activity to which anthropologists are

instead the only form of exchange which occurs is where all goods are bartered. This will occur if the liquidity shock is so great that the firms decides that it is simply not worth selling on the cash market. We have ignore this here by only extending the plot to $z = 1.4$ and at this point, the firms still uses both forms of exchange.

less inclined. By positing responses by individuals to various stimuli, we have provided predictions about the response of trade in Russia to its various stages of demonetization. These predictions could be right or wrong, but at least they can conceivably be tested by looking at the response of trade, prices, and networks to the economics environment. First, in section 2 we characterized the decline in trade which has occurred through demonetization, with the greatest responses occurring in relations where trade was previously sporadic. A natural implication of this is that any subsequent remonetization is likely to most directly affect those with weakest links to others. Second, we have pointed to the use of commodities as currencies, where we predict "excess" trading in goods are not highly valued compared to trade in a monetized economy. This arises as such goods must be used as commodities, and we would predict that the production of such goods may actually fall after a remonetization process, unlike trade in more desirable goods. A related point is our prediction that the prices obtained for such less desirable goods is likely to be especially bad in sporadic relationships. Third, we have argued that there are distributional consequences from the demonetization of Russia, and that not everyone may have lost out. In particular, the "dinosaurs" of Humphrey's (1998) analysis occupy a central position in many networks, which they can use to their benefit. At they very least, we would argue that these firms have probably suffered less from the demonetization than firms on the periphery. Fourth, we have pointed to changed in optimal network structures, where we believe that there is now increased pressure to find trading partners through which much trade travels rather than use looser, more diverse networks. Furthermore, such problems are most severe for those who do not have strong existing networks. Finally, we have illustrated how liquidity shocks affect prices in non-monotonic ways and also how the existence of barter exchange mutes price changes with liquidity shocks. While these predictions obviously await more specific empirical testing, many of the contributions in this volume at least appear to support them.

Appendix: Proofs of Results

The Liquidity Value of Trade: Section 3

First, under what conditions will the agents be willing to supply the (first-best) efficient levels of output? 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 $\frac{\lambda}{r}(2 - \alpha^2) \geq \alpha^2$. This equation is nothing more than the analog of the incentive constraint in Section 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. Then 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 equilibrium to this problem is that the α-agent (i.e., the agent which has high value of consuming) will "overproduce" in order to provide the other agent with a *quid pro quo* for him with production of the high-valued α good. Thus production has both a consumption value and a liquidity value. Let $\underline{q}$ be the production level of the low-value good and let $\overline{q}$ refer to the production of the better good.

Proposition 1 *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.*

Trading Partners: Section 5

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

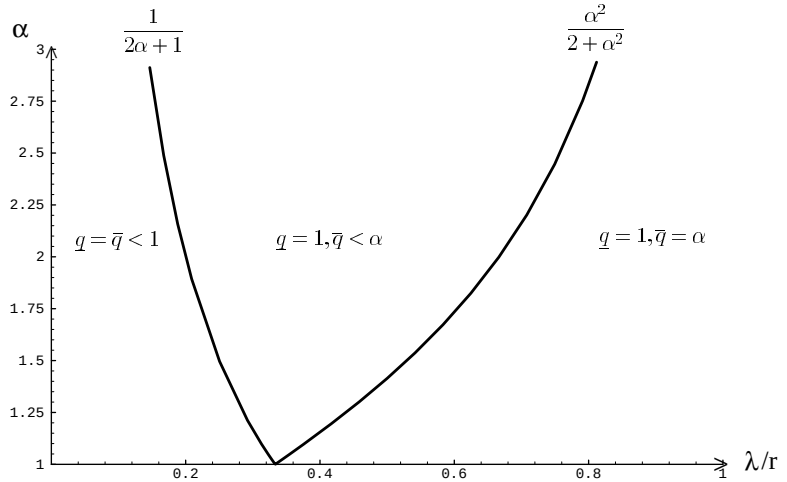
$$\frac{\lambda}{r}\left[\alpha\overline{q} + 2\underline{q} - c(\overline{q}) - 2c(\underline{q})\right] \geq c(\underline{q}),$$

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 from Figure A.1.

FIGURE A.1: 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 2 identifies the main results regarding trading partners.

Proposition 2 *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 $\frac{\lambda}{r}$.*

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