

THE ECONOMIC INSTITUTION OF INTERNATIONAL BARTER

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ABSTRACT

The Economic Institution of International Barter*

Starting with the international debt crisis in the early 1980s, the volume of international barter trade increased substantially. This paper examines how barter can help highly indebted countries to finance imports if they cannot use standard credit arrangements. We argue that payment in goods is easier to enforce than payment in money. But there is also a risk that the debtor pays with inferior quality products. We rank goods with respect to these incentive properties and derive the economic institution of commodity money which explains the trade pattern in barter. The predictions of our model are consistent with data on actual barter contracts.

JEL Classification: F1, G3, L14, O12, P33

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NON-TECHNICAL SUMMARY

Starting with the international debt crisis in the early 1980s, the volume of international barter trade increased substantially. International barter is a form of trade in which an importer in Eastern Europe or a developing country (EE or LDC) pays with an offsetting export to an OECD country either simultaneously or at some later date. It is estimated that about 10–20% of world trade is governed by barter agreements. More recently, Russia and the former Soviet Republics experienced a turn to international as well as domestic barter when their creditworthiness deteriorated after 1992 and when they suffered a severe domestic liquidity and debt crisis.

Why is it that, in a fully monetized world economy, goods are paid with goods rather than money? Is it a regression to bilateralism and reciprocity as many experts have argued, or can we find efficiency reasons for this form of trade? A common explanation is that countries pay with goods if they are short of cash and insufficiently creditworthy to receive trade loans. In the majority of cases, however, the barter contract contains a credit arrangement in the sense that the subsequent export that serves as payment for the original import takes place at a later point in time. Based on institutional analysis this paper argues that agents might want to pay in goods rather than money because in so doing they solve incentive problems which would otherwise prevent trade from taking place at all.

Until recently contracts and institutions have been neglected in international trade theory; trade is determined by factor endowments, productivity, preferences, market structure and economies of scale. Our analysis suggests that some forms of trade, like international barter, cannot be understood without an institutional analysis, however. The pattern of specialization in barter trade differs significantly from that in conventional trade. Barter exports from EE and LDCs consist mainly of consumer goods (31.9%) and investment goods (35.5%), whereas in conventional trade these two categories account for only 15% and 10% respectively. We introduce incentives as an additional determinant of the pattern of barter trade, and thereby provide an institutional explanation for why exports such as consumer and investment goods, in which EE and LDCs do not have a comparative advantage, dominate among barter exports from these countries.

Our theory suggests that barter has important advantages over traditional credit arrangements. The main difference between a promise on future money (credit) and a promise on future goods (barter) is that goods have superior

credit enforcement properties when compared with money. Money is an anonymous medium of exchange. This anonymity can prove disadvantageous in trade with countries which lack creditworthiness, since the debtor in EE or LDC can use it for purposes other than repaying debt. Goods, on the other hand, can be earmarked as the property of the creditor in the OECD country and can thus serve as collateral. Consequently, the debtor in EE or LDC is less free to use them for other purposes than paying debt. Thus, goods act as 'special purpose money'. Since goods are less anonymous and property rights on goods are easier to define and enforce than property rights on the future cash flows of the export returns of a country, goods are better collateral than money. We show in the paper that by allowing property rights to be defined as belonging to the creditor in the OECD country, barter provides a superior credit enforcement mechanism compared to 'reputation' and the threat of trade sanctions. Reputation effects and the threat of financial autarky are enforcement mechanisms extensively discussed in the sovereign debt literature.

We confront our theory with data on actual barter contracts. We use survey data of 230 barter contracts signed by OECD firms between 1984–8 who use Austria as the basis for their barter activities. From our model we derive several hypotheses of the factors that determine the value of the collateral (relative to the trade credit) generated by the barter contract. The deal-specific collateral will need to be larger, the greater the incentive of the EE or LDC country to cheat on debt repayment. That is, the lower a country's creditworthiness, the better its export opportunities outside barter and the less important it is for the EE or LDC to keep essential imports or its reputation as a good debtor.

Although barter can solve the incentive problems of debt repayment of highly indebted countries, allowing them to overcome the credit constraint that arises in transactions with money, payment in goods introduces new incentive problems, due to informational asymmetries. The debtor is tempted to pay with low-quality goods, because creditors who do not produce or consume the good used as payment are less well informed about the physical and market characteristics of the good in question. Thus, goods tend to be less liquid than money. We discuss the implications of these quality problems for the choice of commodity money used in barter transactions. By focusing on these incentive problems we can derive the institution of commodity money and hence the trade pattern of international barter. Goods used as a medium of exchange in barter must have certain attributes to qualify as commodity money. The challenge is to find goods that are relatively liquid and exhibit a low degree of anonymity. High liquidity means that debtors have little room to cheat on the

quality of goods offered as payment. Low anonymity means that creditors are offered valuable collateral in that the goods in question can easily be labelled as the property of the creditor, and debtors can only use these goods for the special purpose of repaying debt. We rank goods by their liquidity (the severity of the quality problem) and by their anonymity (the degree to which goods can be labelled for debt repayment use only).

Using data on actual barter contracts we classify the barter exports from EE and LDCs into basic goods, consumer goods and investment goods. We show that basic goods are most similar to money because of the absence of asymmetric information problems (basic goods tend to be standardized goods which are traded on an organized market). Consumer goods, in contrast, involve potential quality problems, because they tend to be differentiated goods which are not traded on an exchange. The moral-hazard problem of quality is reduced when the debtor pays in consumer goods, however, because creditors tend to undertake an investment in marketing the good offered as payment. Such a relationship-specific investment, while costly, offers two advantages. First, it allows the creditor in the OECD country to become actively involved in the quality design of the good offered as payment and thus to become a better judge of its quality. This, in turn, reduces the debtor's incentive to cheat on quality. Second, the differentiation and design of the good used as payment, in line with the creditor's marketing, makes the good even less anonymous. In other words, consumer goods tend to be made more liquid and less anonymous when the creditor invests in the relationship, reducing the debtor's incentive to offer 'bad money' and reducing the value of the medium of exchange to all parties except the creditor. Finally, investment goods turn out to be 'bad money'. The debtor's incentive to pay with low quality goods is not controlled, since the creditor tends to dispose of the investment good offered as payment on the local market and does not invest in the relationship.

This ranking of commodity money implies that the severity of the incentive problem of debt repayment varies with the type of medium of exchange used as payment in barter. We do indeed find that the larger the debtor's incentive problem in the credit relationship the more likely it is that a collateral good is used as payment which ranks high on the liquidity scale and low on the anonymity scale, i.e. the more likely it is that basic goods and the less likely it is that investment goods are used to collateralize future payments. Given this prediction of the choice of collateral goods used as payment, our theory can explain the observed pattern of specialization of barter. Our theory predicts that countries that differ in their creditworthiness will show a different pattern of barter trade. More specifically, countries with lower creditworthiness will use

higher value collateral goods as means of payment in barter. Eastern Europe, with an average debt to GDP ratio of 33.8 in 1987, was substantially more creditworthy than the developing countries with an average debt to GDP ratio of 76.6. Eastern Europe has thus used investment goods as means of payment in barter because it could 'afford' to use 'bad money' with low collateral value. Investment goods provided collateral of sufficient value compared to the gains from defaulting. Consumer goods turn out to be 'good money' and here also qualify as collateral for countries with low creditworthiness. In contrast to Eastern Europe, developing countries with lower creditworthiness use predominantly the most liquid goods, basic goods, as means of payment in barter. The large share of investment good exports among barter can be explained by the dominance of barter contracts with East European countries in the sample, a region whose creditworthiness problem has not been too severe. The large share of consumer good exports among barter can be explained by the fact that consumer goods are 'good money' with equal collateral value as the most liquid goods, basic goods.

1. Introduction

Starting in the early eighties, the international debt crisis led to a dramatic decline in private lending to developing and Eastern European countries. Even though debtors hesitated to invoke total repudiation commercial banks have been reluctant to provide new loans, skeptical that they will ever be repaid in full.¹ As highly indebted countries found it increasingly difficult to finance their imports, unconventional forms of trade and trade financing experienced a resurgence. One of the most noteworthy developments has been the rise in barter trade.² Barter is a reciprocal form of trade in which an exporter is paid with an offsetting import, either simultaneously or at some later date. Estimates are that about 10 to 20 percent of total world trade are governed by barter agreements (Hammond, 1989).

The negative implications of a high indebtedness for the creditworthiness of a country are well known from the sovereign debt literature. Often the creditors' main concern is not so much that a debtor may become insolvent but rather that he may be unwilling to repay. The problem is that foreign debt cannot be collateralized in the same way as domestic debt (Eaton, 1991). Creditors who finance exports to foreign firms or trade organizations need the assistance of local governments to enforce repayment. However, the more indebted a country is the less foreign creditors can count on governmental support because the more attractive repudiation becomes from the point of view of the whole country (Cohen, 1991).

Why should developing countries turn to barter if they face a credit constraint due to the sovereign debt problem? A common explanation is that countries pay with goods

¹See e.g. Sachs (1989). Gooptu and Soledad (1992) emphasize that commercial banks are reluctant to provide new loans unless they are insured by the creditor's governments.

²Throughout this paper we will use the term barter in its widest sense, including all forms of countertrade. Bussard (1987, p. 17) reports that the number of countries engaged in barter rose from 27 in 1979 to 88 in 1984. Likewise, the number of barter transactions that was reported by a group of survey respondents increased on average by 50 % between 1980 and 1981, by 64 % between 1981 and 1982, and by 117 % between 1982 and 1983. Hammond (1989) observes that precedents of this striking co-movement of debt problems and barter can be found in the late nineteenth century and in the depression of the 1930s. More recently, Russia and the former Soviet Republics experienced a turn to international as well as domestic barter when their creditworthiness deteriorated after 1992 and when these countries suffered a severe domestic liquidity and debt crisis. Estimates suggest that in the Ukraine 43 % of exports and 50 to 70 % of domestic trade took the form of barter in 1994. Similar estimates are given for Russia and Kazakhstan. For a theoretical discussion of financing transition economies in Eastern Europe see Holmström (1994).

if they are short of cash and not creditworthy enough to receive trade loans. However, in the majority of cases the barter contract contains a credit arrangement in the sense that the subsequent export that serves as payment for the original import takes place at a later point in time.³

Why then do we observe the frequent use of barter? In a companion paper (Marin and Schnitzer, 1995) we showed that barter can solve incentive problems related to the technology transfer to developing countries. In that paper we also suggested that barter can be used to collateralize trade credits. In particular, we assumed that goods earmarked as a collateral for a barter contract cannot be sold to a third party and that this makes it impossible for the debtor to cheat on his payment. The purpose of the present paper is to derive this assumption endogenously as a result of the model and to justify it on empirical grounds. Most importantly, however, we analyse the implications of this argument for the institution of commodity money that serves as a medium of exchange. The pattern of specialization in barter trade differs significantly from that in conventional trade. Barter exports (from the point of view of the debtor) consist mainly of consumer goods (31,9 %) and investment goods (35,5 %) whereas in conventional trade these two categories account for only 15 % and 10 %, respectively. We give an institutional explanation for this deviation of the export pattern of barter which complements our previous explanation of the import pattern in Marin and Schnitzer (1995).⁴

Our analysis suggests that barter has important advantages over traditional credit arrangements. The main difference between a promise on future money and a promise on future goods is that goods have superior credit enforcement properties as compared to money. Money is an anonymous medium of exchange. This anonymity can prove disadvantageous in trade with countries which lack creditworthiness since the debtor in the developing country can use it for other purposes than repaying his debt. Goods instead can be earmarked that they belong to the creditor in the developed country. Consequently the debtor in the developing country is less free to use them for other purposes than paying his debt. Thus, goods act as "special purpose money". Since goods are less anonymous and property rights on goods are easier to define and enforce than property rights on

³In our data sample of 230 barter contracts the time between the original import and the subsequent export ranges between 0 and 120 months (Marin, 1990).

⁴For the barter trade pattern, see Marin (1990).

future cash flows of the export returns of a country goods are better collaterals than cash.

In our model, there are two main advantages of barter. First, in case of default the creditor will be able to recover a larger fraction of the outstanding debt. Second, perhaps less obviously, if the creditor has priority rights on specific goods, he has a stronger incentive to track down these goods and to establish his claims as compared to a situation where he has no priority rights but has to share the benefits from his legal actions with many other creditors. Hence, with a barter contract the debtor is more likely to suffer in case of default from his goods being seized when he tries to sell them somewhere else. This effect makes repudiation less attractive.

Our analysis is closely related to the sovereign debt literature. We use a simple dynamic model in which creditors and debtors interact repeatedly. This allows us to compare the enforcement mechanisms discussed by the sovereign debt literature, such as “reputation” effects and the threat of trade sanctions, with those if trade credits are “collateralized” through barter agreements.

In a seminal paper, Eaton and Gersovitz (1981) have shown how “reputation effects” can sustain sovereign lending. But, as Bulow and Rogoff (1989a) pointed out, reputation effects alone cannot sustain any positive repayment if the debtor can switch to “cash-in-advance” contracts after repudiation. Kletzer and Wright (1990) show that the problem caused by cash in advance contracts can be mitigated if it is possible to give initial creditors a seniority right on any monetary transfers made by the country that defaulted on its debt. However, seniority rights on cash are notoriously difficult to enforce. Our paper shows that barter offers a more viable alternative to sustain sovereign lending of highly indebted countries by giving seniority rights on export goods.

The paper is also closely related to the recent developments in the theory of money. Our argument that payment in kind may have advantages over payment in cash contradicts the conventional wisdom in the theory of money. The common view is that barter is inefficient because it does not overcome the double coincidence of wants problem as money does. In recent search theoretic models of the exchange process money evolves as a medium of exchange which reduces the search and transaction costs associated with barter (Kiyotaki and Wright, 1993). While eliminating the need for a “double coincidence of wants” is certainly an important advantage of money, we argue that incurring some

additional transaction costs by reselling the goods received as payment may be a small price for overcoming a credit constraint that otherwise would prevent trade from taking place at all.

A second, more important objection to payment in kind is raised by Banerjee and Maskin (1996) in their adverse selection theory of money. They argue that if sellers are paid with goods which they do not use themselves they will find it difficult to judge the quality of the goods offered as payment. This asymmetry of information gives rise to moral hazard and adverse selection problems since the buyer has an incentive to pay with low quality goods given that the seller cannot distinguish different quality levels. The principal role of money is to overcome the asymmetric information problem that arises in barter. An important implication of this adverse selection problem is that not all goods are equally well qualified to serve as a medium of exchange in a barter contract. We deal with this issue in the second part of the paper where we show how the institution of commodity money explains the export pattern (the goods offered as payment) of barter. Using data on actual barter contracts we characterize different types of goods in terms of anonymity and liquidity and we discuss which of them would be the best candidate for collateralizing future payments.⁵

The empirical analysis is based on a survey among firms that are engaged in barter trade and that use Austria as a basis for their activities. The problem is that barter is not documented in official trade statistics and therefore data on the characteristics of actual barter contracts are very difficult to obtain.⁶ Our sample consists of 230 contracts, signed between 1984 and 1988. Almost all previous empirical studies on barter use macro data and test (on the basis of relatively few observations) how debt ratios of various countries affect the estimated volume of barter in these respective countries.⁷ An important advantage of our micro data set is that it contains detailed information on about 40 aspects

⁵Prendergast and Stole (1996) offer a different type of reasons for nonmonetary trade like improved ability to impose social sanctions, improved information revelation, and the prevention of inefficient rent-seeking activities which may complement our results. However, they do not offer any testable empirical implications.

⁶One of the reasons is that exports and imports frequently take place in different periods. Also, governments are reluctant to release information on their barter activities, concerned they might come into conflict with GATT regulations.

⁷For example, Casson and Chukujama (1990) report evidence (based on 35 observations) that countries with higher debt ratios are more strongly engaged in barter. Hennart and Anderson (1993) use different aggregate variables and find (on the basis of 40 observations) that a country's creditworthiness is positively correlated with its barter activities.

of each contract. This allows us to test a much richer set of predictions, in particular predictions on the optimal design of barter contracts, on the basis of a (comparatively) large number of observations. In the last part of the paper we use these data to test empirical predictions on the necessary size of the collateral as well as on the optimal choice of commodity money.

The paper is organized as follows. In Section 2 we first compare a credit relationship (payment in cash) to a barter transaction (payment in kind) to identify the advantages of barter. We then turn to the quality problems that may arise in payment with goods and analyse how this affects the optimal choice of commodity money and hence the export pattern of barter. In Section 3 we derive empirical implications of our theory of commodity money and use our data sample to test these predictions. Section 4 concludes.

2. The institution of commodity money

2.1 Anonymous money

Consider two parties, A (she), a firm in a developed country, and B (he), a firm or a trade organization in an Eastern European (EE) or a developing (LD) country. B wants to buy one unit of good 1 from A in period 1 but can pay for it only one period later because he is cash-constrained. Without loss of generality, we assume that if such a trade credit is granted this is done directly through A (rather than a bank) in form of a supplier credit. B 's willingness to pay for good 1 is v_1 and A 's production cost is c_1 , with $v_1 > c_1$. In period 2, B can produce one unit of good 2 at cost c_2 and sell it on the world market. This generates foreign exchange revenues of value v_2 . Both parties A and B have a common discount factor $\delta = \frac{1}{1+r}$, where $r > 0$ is the world interest rate per period. We assume that B 's revenues v_2 in period 2 are sufficient to pay for A 's production cost c_1 in period 1, i.e. $v_2 \geq \frac{1}{\delta}c_1$. Thus, a price p_1 can be found such that p_1 covers A 's production cost ($c_1 \leq p_1$) and such that B is able to pay $\frac{1}{\delta}p_1$ in period 2 ($\frac{1}{\delta}p_1 \leq v_2$).

A common problem with this kind of transaction between a developed country and an EE or LD country is to enforce B 's payment in period 2. Even though B is able to settle his debt, he cannot be forced to do so by the courts in A 's country, and the government

or the courts in B 's country cannot be relied on to enforce A 's claim.⁸ All A can do in case of default is to ask the courts in her own country to seize assets that B holds in A 's country. Let $a \geq 0$ denote the value of these assets. This punishment potential imposes an upper bound on the maximum credit that B voluntarily repays, $\frac{1}{\delta}p_1 \leq a$. Note that A is willing to deliver good 1 on a credit basis only if $c_1 \leq p_1$ and if B will indeed pay $\frac{1}{\delta}p_1$. Thus, we say that B is "creditworthy" if and only if

$$a \geq \frac{1}{\delta}c_1. \quad (1)$$

If instead $a < \frac{1}{\delta}c_1$ we say that B faces a credit constraint because there exists no p_1 such that $p_1 \geq c_1$ and $\frac{1}{\delta}p_1 \leq a$ are satisfied simultaneously. In the following we will focus on cases where B is not creditworthy in the sense defined above.

A question studied extensively in the sovereign debt literature is to what extent implicit ways of credit enforcement through "reputation equilibria" are possible if A and B are engaged in a long term relationship where B intends to buy good 1 on a credit basis not just once, but repeatedly. The idea is that A threatens that she will never again deliver good 1 if B repudiates once. Thus B would lose his discounted payoff from all future purchases of good 1. However, as Bulow and Rogoff (1989a) pointed out, reputational concerns alone cannot enforce repayment if B can switch to "cash-in-advance" contracts. In this case B can take the foreign exchange revenues that were destined for credit repayment and use them for importing goods instead. The problem is that even if everybody believes that B will not repay any debt in the future, A and A 's competitors cannot commit not to deal with B if he offers to pay cash in advance. But A may have other possibilities to punish B and to recover some of her money. In particular, A may try to track down B 's future exports and imports and take legal action in order to confiscate these goods or the payments associated with them.⁹ For instance, A may have goods seized that are shipped by B to A 's country but not paid yet, or goods that are destined for B and paid but not yet shipped.

To make this point more formally consider the following dynamic framework which is an infinitely repeated version of the credit relationship just described. In each period,

⁸This sovereign debt problem arises in particular if B 's country is highly indebted already, and if B is a state-owned trade organization or has close relations to the government. For a recent survey on the large literature on the sovereign debt problem see Eaton and Fernandez (1994). In the following we consider the extreme case where A cannot count on her claim being enforced in B 's country at all.

⁹An extensive discussion of the legal aspects of these actions can be found in Bulow and Rogoff (1989b).

starting with period 1, B wants to buy one unit of good 1 at some fixed price \bar{p}_1 from A . Suppose that \bar{p}_1 is the spot market price for good 1 and that there are other sellers in developed countries offering this good at the same price. Furthermore, starting with period 2, B can produce one unit of good 2 at cost c_2 each period and sell it on the world market at price v_2 . Again we assume $v_1 \geq \bar{p}_1 \geq c_1$, $v_2 > c_2$ and $\delta v_2 \geq \bar{p}_1$.

The question is whether there exists a self-enforcing “implicit agreement” between A and B (which cannot be enforced by the courts), saying that in each period A gives a trade credit to B in order to finance the purchase of good 1, and B repays $\frac{1}{\delta}\bar{p}_1$ out of his revenues v_2 one period later. An implicit contract is a subgame perfect equilibrium of the repeated game, i.e., it has to be optimal for each party to stick to the terms of the agreement on and off the equilibrium path. Abreu (1988) has shown that a path of behavior can be sustained as a subgame perfect equilibrium if and only if it can be sustained with the threat of the worst possible punishment equilibrium for each player. In our context, the crucial question is to determine the worst possible punishment equilibrium for firm B . The worst that can happen to B in case of default is that A seizes his assets a and refuses to trade with B in the future. B has the option to switch to other suppliers of good 1. While they may not be willing to offer a trade credit to B , they will not refuse to deliver good 1 if B pays cash in advance. However, given the possibility of legal action by A described above, the expected gains from trade of future exports and imports are reduced by a factor π , $0 \leq \pi \leq 1$. If the probability that A manages to seize good 2 is sufficiently high, it is optimal for B not to produce good 2 at all but to save his production cost. In this case, $\pi = 0$. If A 's legal action is less effective, however, it may become optimal for B (given that he wants to default) to produce good 2 and to try to sell it to a third party which generates an expected surplus $\pi(v_2 - c_2)$. Thus B 's payoff in case of default is given by¹⁰

$$v_1 - \delta a + \delta(v_2 - c_2 + \pi(v_1 - \bar{p}_1)) + \sum_{t=2}^{\infty} \delta^t(\pi(v_2 - c_2 + v_1 - \bar{p}_1)). \quad (2)$$

Note that B can default only after the export in the second period has been carried out, since the revenue v_2 from this export was supposed to be used to repay $\frac{1}{\delta}\bar{p}_1$. Hence, A 's punishment can affect the import in the second period at the earliest.

¹⁰Period 2 is the first period in which a payment is due. Since the problem is completely stationary, it suffices to show that it is not profitable to deviate in this period.

If B sticks to the terms of the implicit agreement, his payoff is

$$v_1 + \sum_{t=1}^{\infty} \delta^t [v_1 - \frac{1}{\delta} \bar{p}_1 + v_2 - c_2] . \quad (3)$$

Comparing (2) to (3) B will repay his debt in every period if and only if

$$\begin{aligned} v_1 + \frac{\delta[v_1 - \frac{1}{\delta} \bar{p}_1 + v_2 - c_2]}{1 - \delta} \\ \geq v_1 - \delta a + \delta(v_2 - c_2 + \pi(v_1 - \bar{p}_1)) + \sum_{t=2}^{\infty} \delta^t \pi(v_2 - c_2 + v_1 - \bar{p}_1) , \end{aligned} \quad (4)$$

which is equivalent to

$$\frac{1}{\delta} \bar{p}_1 \leq \frac{1}{1 - \pi \delta} [(1 - \pi)v_1 + (1 - \delta)a + \delta(1 - \pi)(v_2 - c_2)] \quad (5)$$

On the other hand, A is willing to participate in the transaction if and only if $\bar{p}_1 \geq c_1$. The following proposition summarizes this discussion.

Proposition 1 *B 's creditworthiness can be restored through a repeated credit relationship if and only if*

$$\frac{1}{1 - \pi \delta} [(1 - \pi)v_1 + \delta(1 - \pi)(v_2 - c_2) + (1 - \delta)a] \geq \frac{c_1}{\delta} . \quad (6)$$

Note that if $\pi = 1$, i.e. if A cannot affect B 's gains from future international trade, we are back to the case considered above where the repetition of the credit relationship did not improve B 's creditworthiness as compared to a one-shot relationship.

2.2 Nonanonymous goods

In the following section we want to ask whether B 's creditworthiness can be further improved if B turns to barter trade. Again, we assume that B cannot pay for good 1 in period 1, neither with money nor with goods. However, suppose that instead of selling good 2 on the world market and using its revenues to pay for good 1 B agrees to deliver good 2 in period 2 to A as a payment in kind.

But with a barter contract, a new incentive problem arises. Since B cannot be forced to produce and deliver good 2 to A , he must be induced to do so voluntarily. This corresponds to the problem to induce B to pay $\frac{1}{\delta} p_1$ in a simple credit arrangement. There

is an advantage of a barter contract, however. With a credit arrangement B is supposed to use his revenues from selling good 2 to repay his credit, but if he defaults his revenues cannot be seized by foreign creditors anymore. In case of barter instead, good 2 is used as a collateral for the payment of good 1, giving A a property right on it. This means that B is not free anymore to use good 2 as he wants to. If he refuses to deliver to A he may not be able to sell good 2 at all. A can use the courts in her own country (or in other industrialized countries) to enforce her claim and seize good 2 when it is shipped to some third party. However, A 's control over good 2 is typically not perfect, and she may succeed in tracking down her collateral only with some positive probability. We model this as follows: Given the possibility of legal action by A , the potential surplus from selling good 2 on the world market, $v_2 - c_2$, is reduced to $\hat{\pi}(v_2 - c_2)$, $0 \leq \hat{\pi} < \pi \leq 1$.

It is important to note that $\hat{\pi}$ will be smaller than π for the following reasons: Suppose that B repudiates his debt and tries to sell good 2 to some other party C . With barter, A has a property right on good 2. Thus, if she manages to track down good 2, she has a direct claim on it and can ask the courts in C 's country to seize it. With a credit arrangement A does not have a direct claim on good 2. If she manages to track it down, she will get the courts to seize it only if the good does not yet belong to C . Furthermore, even if the good is seized, the returns from good 2 have to be shared by all of B 's creditors. Thus, a property right on good 2 gives A a larger return than a claim on cash. This in turn increases A 's incentives to track down good 2.¹¹ The term $\hat{\pi}$ can be thought of as a measure of the anonymity of good 2. If $\hat{\pi} = \pi$, good 2 is as anonymous as cash. However, if A can successfully label good 2 as belonging to her, then $\hat{\pi} < \pi$. In this case good 2 is less anonymous than money and it is harder for B to use it for any other purpose than paying his debt to A . Good 2 functions like "special purpose money" which makes it a

¹¹This difference of seniority rights of an investor in case of a promise on goods and in case of a promise on cash is analogous to the difference of seniority rights in case of debt (where some investors can have priority rights) and in case of equity (where all investors are treated equally), the importance of which for economic incentives has been stressed by Hart and Moore (1995). Of course, the same effect could be achieved if A could be given seniority rights on B 's return streams from selling good 2. However, this is typically not feasible for two reasons. First, it is much more difficult to seize cash than to seize physical goods. Thus, it may be impossible for A to enforce her claim. Second, if B is highly indebted already, there are other creditors having claims on B 's return stream who will refuse their consent to giving A seniority rights. This is the classical debt overhang problem (see e.g. Krugman (1992)). An example for the ineffectiveness of seniority rules in case of financial assets is described in Bulow and Rogoff (1988). They report that in February 1988, Mexico, as part of a buyback scheme, issued new debt, promising to treat it as senior to existing bank debt. However, the market reaction to this announcement indicates that creditors were not convinced of the enforceability of these seniority rights.

better collateral than money.

To make this more precise suppose that A and B agree to repeat the following barter deal infinitely often. In every period A delivers one unit of good 1, starting in period 1, and B delivers one unit of good 2, starting with one period delay. If B sticks to the barter agreement his payoff is

$$v_1 + \sum_{t=1}^{\infty} \delta^t (-c_2 + v_1) \quad (7)$$

What is the worst possible punishment if B deviates in period 2, refuses to deliver good 2 to A , and switches to cash-in-advance contracts thereafter? Again, A can seize B 's assets a and try to confiscate some of B 's future trades. This is modelled by assuming that B 's future gains from exporting good 2 (if he defaulted on the barter deal) are reduced to $\hat{\pi}(v_2 - c_2)$, with $\hat{\pi} \leq \pi$, as argued above. Thus, B 's payoff in case of default is

$$v_1 - \delta a + \sum_{t=1}^{\infty} \delta^t [\pi(v_1 - \bar{p}_1) + \hat{\pi}(v_2 - c_2)] \quad (8)$$

Note that B 's incentive to deviate depends on the price \bar{p}_1 he has to pay if he switches to another supplier of good 1. Let us consider the case where B 's incentive to deviate is maximal, that is where $\bar{p}_1 = c_1$.¹²

Substituting $\bar{p}_1 = c_1$ in (8) and comparing this expression to (7), B will not deviate from the barter agreement if and only if

$$(1 - \delta)a \geq \hat{\pi}v_2 + (1 - \hat{\pi})c_2 - (1 - \pi)v_1 - \pi c_1. \quad (9)$$

On the other hand, A is willing to participate in the barter agreement if and only if

$$\sum_{t=0}^{\infty} \delta^t c_1 \leq \sum_{t=1}^{\infty} \delta^t v_2. \quad (10)$$

The following proposition shows under what conditions a barter contract can achieve efficiency.

Proposition 2 *Suppose that B is not creditworthy. Then there exists a barter agreement which restores B 's creditworthiness and implements the efficient allocation if and only if*

$$\frac{1}{1 - \delta\pi} [(1 - \pi)v_1 + (1 - \hat{\pi})(v_2 - c_2) + (1 - \delta)a] \geq \frac{c_1}{\delta} \quad (11)$$

¹²If there is a supplier different from A with production cost smaller than c_1 , B should have dealt with him in the first place already.

Proof: See Appendix.

Condition (11) shows that the moral hazard problem of debt repayment can be solved only if the problem of creditworthiness is not too severe, i.e. a is not too small, and if the deal-specific collateral v_2 is sufficiently large.

Let us compare barter, the promise on goods, to a credit arrangement, the promise on cash. Comparing the left hand sides of (11) and (6), it is obvious that

$$(1 - \hat{\pi})(v_2 - c_2) > \delta(1 - \pi)(v_2 - c_2) \quad (12)$$

which proves the following corollary.

Corollary 1 For all $0 < \delta < 1$ and all $0 \leq \hat{\pi} < 1$, $\hat{\pi} \leq \pi \leq 1$ the set of parameters under which the efficient allocation can be implemented is strictly larger in the barter trade as compared to a credit arrangement.

There are two reasons why barter outperforms a credit arrangement. First, $\hat{\pi} < \pi$, i.e. a claim on good 2 is easier to enforce than a claim on cash. Second, since A has a property right on the export good produced by B in period 2, she can affect B 's export payoff in period 2 already.

We conclude this section with a summary of the four main advantages a promise on goods (barter) offers over a promise on cash (credit arrangements).

Advantage 1 Goods are less anonymous than cash and therefore it is easier to establish property rights on goods than on cash.

Advantage 2 Property rights on good 2 make it easier for A to seize this collateral good when B defaults and tries to sell it to a third party.

Advantage 3 Property rights on good 2 give A 's claim priority over other creditors who have purely financial claims and therefore increase A 's expected payoff in case of default.

Advantage 4 Since property rights on good 2 give A a higher payoff in case of default, A 's incentive to seek legal recourse and to track down B 's export of good 2 is larger. Therefore chances of success are higher.

2.3 Export pattern of barter trade

In the preceding section we have seen that barter offers an important advantage over transactions in money: it removes the anonymity of the medium of exchange and thus allows to establish property rights on the medium of future payment. This is why the use of commodity money helps to overcome the credit constraint. However, as Banerjee and Maskin (1996) have pointed out, the payment in goods introduces new incentive problems, due to informational asymmetries. The debtor has an incentive to pay with low quality goods because creditors who do not produce or consume the good used as payment are less informed about the physical characteristics (different quality levels) and about the market characteristics (value when resold) of the goods in question. Thus, goods tend to be less liquid than money. Banerjee and Maskin argue that these moral hazard and adverse selection problems lead to inefficiencies which can be overcome only when fiat money is introduced, that is a good whose physical and market characteristics can be discerned by everybody.

In this section we discuss the implications of these quality problems for the choice of commodity money in barter transactions. Since goods differ with respect to their liquidity and anonymity not all goods are equally suited to serve as a collateral. We argue that by focussing on these incentive problems we can explain the choice of commodity money and hence the export pattern of barter trade. Recall from Proposition 2 that in the absence of quality problems B 's creditworthiness problem can be solved if and only if condition (11) is satisfied. Rearranging this condition we get

$$v_2 - c_2 \geq \Delta + \hat{\pi}(v_2 - c_2) . \quad (13)$$

where $\Delta \equiv (1 - \delta\pi)\frac{a}{\delta} - (1 - \pi)v_1 - (1 - \delta)a$. The term $v_2 - c_2$ on the left hand side captures the surplus generated by delivering good 2 to A . The term $\hat{\pi}(v_2 - c_2)$ on the right hand side denotes the surplus that B can derive if he cheats on A and sells good 2 to a third party instead.

Consider now the case where good 2 is not standardized but can be produced in two quality levels, high or low quality. Let \bar{v}_2 and \bar{c}_2 denote the value and cost associated with a high quality product and \underline{v}_2 and \underline{c}_2 those for a low quality product, respectively. Assume further that producing high quality is efficient, i.e. $\bar{v}_2 - \bar{c}_2 > \underline{v}_2 - \underline{c}_2$.

The problem according to Banerjee and Maskin is now that A may not be able to judge the quality of the good delivered if she does not use it herself and if she has no experience with it. Therefore, B has an incentive to pay with low quality goods, if at all. We capture this by assuming that if B delivers good 2 to A the surplus will be $\underline{v}_2 - \underline{c}_2$. In contrast, a third party who is a frequent customer of B 's may be in a better position to judge the quality level of good 2 so that B cannot cheat when delivering directly to this final customer. Thus, the surplus in case of a delivery to an experienced third party is given by $\bar{v}_2 - \bar{c}_2$.

The following corollary summarizes how this affects the chances to solve B 's credit-worthiness problem.

Corollary 2 Suppose good 2 is not standardized and A cannot judge the quality of good 2. Then there exists a barter contract that restores B 's creditworthiness if and only if

$$\underline{v}_2 - \underline{c}_2 \geq \Delta + \hat{\pi}(\bar{v}_2 - \bar{c}_2) . \quad (14)$$

This follows immediately from (13) and our assumptions that the surplus if good 2 is sold to A is $\underline{v}_2 - \underline{c}_2$ whereas it is $\hat{\pi}(\bar{v}_2 - \bar{c}_2)$ if the good is sold to a third party.

Let the surplus to be generated when the good is standardized, with no information problems, be denoted by $\bar{v}_2 - \bar{c}_2$. Then a comparison of (13) and (14) shows that condition (14) is more restrictive than condition (13) since $(\bar{v}_2 - \bar{c}_2) > (\underline{v}_2 - \underline{c}_2)$. This suggests that standardized goods are the preferred medium of exchange in barter transactions, since they are more liquid than non standardized goods.

Why then should a creditor ever agree to accept non standardized goods as payment? She will be willing to do so only if she can take measures to reduce the quality problems spelled out above. Recall that the asymmetry of information is particularly acute in the absence of a double coincidence of wants, i.e. if A does not use good 2 herself and has no experience with it. One possible remedy to overcome this informational gap is to make some investment in getting better acquainted with good 2. To fix ideas, suppose A invests in the future marketing of good 2 by taking an active role in the design of good 2. Such an investment, while being costly, offers two advantages. First of all it allows A to learn about good 2 and to be a better judge of its quality. This in turn reduces B 's leeway

to cheat on quality. Secondly, by differentiating and designing good 2 for A 's marketing, good 2 becomes even less anonymous and thus worsens B 's outside option if he should try to cheat on A and sell good 2 to a third party.

To capture these ideas consider the following set-up. Let i denote the cost of such a marketing investment to be carried out by A . If the investment takes place, A can discern the quality of good 2 so that B cannot cheat but has to deliver high quality if at all. Thus, the surplus from delivering good 2 to A is again $\bar{v}_2 - \bar{c}_2$. Furthermore, since the good becomes more relationship specific, B will receive only $\hat{\pi}(i)(\bar{v}_2 - \bar{c}_2) < \hat{\pi}(\bar{v}_2 - \bar{c}_2)$ if he delivers it to a third party rather than to A .

Recall that if no investment takes place B 's incentive and A 's participation constraints with non standardized goods as commodity money are given by

$$(1 - \delta)a \geq \hat{\pi}(\bar{v}_2 - \bar{c}_2) + \underline{c}_2 - (1 - \pi)v_1 - \pi c_1 \quad (15)$$

and

$$\sum_{t=0}^{\infty} \delta^t c_1 \leq \sum_{t=1}^{\infty} \delta^t v_2 \quad (16)$$

respectively. An investment affects the constraints as follows.

$$(1 - \delta)a \geq \hat{\pi}(i)(\bar{v}_2 - \bar{c}_2) + \bar{c}_2 - (1 - \pi)v_1 - \pi c_1 \quad (17)$$

and

$$\sum_{t=0}^{\infty} \delta^t c_1 + i \leq \sum_{t=1}^{\infty} \delta^t \bar{v}_2 . \quad (18)$$

The following proposition summarizes under what conditions these two constraints can be fulfilled simultaneously.

Proposition 3 *Suppose B 's creditworthiness cannot be restored through barter if A and B choose a non standardized good as commodity money and if A cannot judge the quality of this good. Suppose further that A undertakes a marketing investment to make this good more liquid and less anonymous. Then B 's creditworthiness problem can be solved if and only if*

$$(\bar{v}_2 - \bar{c}_2) \geq \Delta + \frac{1 - \delta}{\delta} i + \hat{\pi}(i)(\bar{v}_2 - \bar{c}_2) \quad (19)$$

Proof: See Appendix.

The investment is efficient if the gains outweigh the investment cost i . This is the case if and only if

$$(\bar{v}_2 - \bar{c}_2) - (u_2 - \underline{c}_2) + (\hat{\pi} - \hat{\pi}(i))(\bar{v}_2 - \bar{c}_2) \geq \frac{1 - \delta}{\delta} i, \quad (20)$$

i.e. if and only if (19) is less binding than (14). Comparing condition (19) to the condition when standardized commodity money is used, (13), we find that (19) is less binding if and only if

$$(\hat{\pi} - \hat{\pi}(i))(\bar{v}_2 - \bar{c}_2) \geq \frac{1 - \delta}{\delta} i. \quad (21)$$

This is summarized in the following Corollary.

Corollary 3 Suppose that A can make a marketing investment in order to better judge the quality of non-standardized good 2. Then, for all $0 < \delta < 1$ and all $0 \leq \hat{\pi}(i) < \hat{\pi} \leq 1$ the set of parameters under which the efficient allocation can be implemented with standardized goods as commodity money is strictly larger than with non-standardized goods if and only if

$$(\hat{\pi} - \hat{\pi}(i))(\bar{v}_2 - \bar{c}_2) \leq \frac{1 - \delta}{\delta} i. \quad (22)$$

Thus, a priori it is not clear whether or not standardized goods are preferable as collaterals. This depends on how costly it is to make a non standardized good more liquid and less anonymous by investing in marketing the good.

3. Theoretical predictions and empirical evidence

In this section we discuss testable predictions from our model, look for proxies for the incentive problems we would like to measure, and estimate whether or not the derived predictions are consistent with data on actual barter contracts.

3.1 The data

The companies included in our sample of 230 contracts are either firms producing in Austria, or subsidiaries of multinational enterprises with their own in-house barter division located in Austria, or other firms in OECD countries using an international trading firm in

Vienna to carry out the barter transaction. 30 percent of the Western firms of the sample are based in the European Community and 62.7 percent in other industrialized countries including Austria, Sweden, Japan, and the USA. Each firm was asked for information on about 40 aspects of each barter trade.

Due to Austria's geographic proximity to Eastern Europe, East-West barter accounts for more than four fifths of all deals in our sample. The deals in our sample are mostly very large in size, ranging from US \$ 8,400 to US \$ 635 million with a mean of US \$ 11.1 million. All statistics presented in this paper are based on the number of contracts, rather than trade volume, as the unit of analysis.

Table 1 describes the variables included in the following empirical analysis and reports on some sample statistics.

3.2 Ranking of commodity money

In section 2.2 we demonstrated that barter can be sustained only if equation (11) is satisfied. Rearranging this expression shows that this is possible only if the value of the collateral is sufficiently large.

$$v_2 \geq \frac{c_1}{\delta} - v_1 + \pi(v_1 - c_1) - (1 - \delta)a + c_2 + \hat{\pi}(v_2 - c_2) \quad (23)$$

On the left hand side we have the value of the collateral created by the barter contract. This collateral has to cover at least A 's and B 's production costs c_1/δ and c_2 , respectively, as well as B 's payoff from defaulting and selling good 2 to a third party, $\hat{\pi}(v_2 - c_2)$, and buying good 1 from a third party on a cash in advance basis in the future, $\pi(v_1 - c_1)$. The collateral can be smaller the more A can punish B when he defaults. This is captured by the terms v_1 and $(1 - \delta)a$. The larger the right hand side of condition (23), the larger the value of the collateral needs to be in order to overcome B 's credit constraint.

In Section 2.3 we have argued that goods which are used as medium of exchange in barter have to have certain attributes to qualify as commodity money. The challenge is to find goods which are relatively liquid and which exhibit a low degree of anonymity. High liquidity means that the debtor has only little leeway to cheat on the quality of the good offered as payment. Low anonymity means that the creditor is offered a valuable collateral because she can successfully label the collateral goods as belonging to her and the debtor can use the good only for the special purpose of repaying his debt. In this

Table 1 - Definition of Variables and Sample Statistics

Variable	Observations	Description	Mean	Min.	Max.	Std Dev.
DEBT*	226	Debt to GDP ratio in 1987 of EE/LDC country	38.9	4.5	326.6	37.5
COMP	230	Compensation ratio: export value in percent of import value	71.4	2.0	400.0	51.4
EXPORT*	226	Export to GDP ration in 1987 of EE/LDC country	27.9	4.2	63.9	11.8
TECHIMP**	222	Share of technology imports in total imports in 1987 of EE/LDC country	33.5	11.6	45.4	7.3
BASIC	230	Type of good exported from EE/LDC country: basic goods or chemical product	D=1, 63 observations			
CONSUM	230	Type of good exported from EE/LDC country: consumer goods	D=1, 77 observations			
INVEST	230	Type of good exported from EE/LDC country: investment and machinery	D=1, 75 observations			
MDIF	224	Characteristics of export good from EE/LDC country: horizontally and/or vertically differentiated good	D=1, 116 observations			
MINF	85	Characteristics of export good from EE/LDC country: good traded on organized market	D=1, 30 observations			
REPEAT	227	Status of developed country firm (DC-firm): frequent exporter to EE/LDC trade partner	D=1, 149 observations			
FAMILIAR	212	Status of DC-firm and EE/LDC trade partner: frequent trade partners	D=1, 97 observations			
MUSE	230	Usage of export good from EE/LDC country by DC-firm: in own production	D=1, 55 observations			
RELATION	230	Characteristics of export good from EE/LDC country: technologically related to import good from DC-firm	D=1, 41 observations			
HIGHCASH	230	Characteristics of export good from EE/LDC country: sold at higher price outside barter	D=1, 20 observations			
LOCAL	230	Usage of export good from EE/LDC country: sold at local market	D=1, 71 observations			
SPECINV	230	Export good from EE/LDC country purchased at lower price in barter by DC-firm and not sold locally	D=1, 14 observations			

* World Debt Tables, World Bank.

** UN, Financial Statistics.

section we want to rank goods by their liquidity (by the severity by which the quality problem arises) and by their anonymity.

Suppose we can distinguish only two levels of liquidity, high and low. With high liquidity, the surplus generated by delivering good 2 to A is given by $(\bar{v}_2 - \bar{c}_2)$, with low liquidity it is $(\underline{v}_2 - \underline{c}_2)$. Similarly, suppose there are two levels of anonymity, high and low, with $\hat{\pi}(\bar{v}_2 - \bar{c}_2)$ denoting the surplus generated when delivering a good with high anonymity to a third party. In the second case we normalize this surplus to be zero. Consider now a good which ranks high on the liquidity scale and low on the anonymity scale. In this case, condition (23) becomes

$$\bar{v}_2 - \bar{c}_2 \geq \frac{c_1}{\delta} - v_1 + \pi(v_1 - c_1) - (1 - \delta)a + 0. \quad (24)$$

If instead a good ranks low on the liquidity scale and high on the anonymity scale, the relevant condition is

$$\underline{v}_2 - \underline{c}_2 \geq \frac{c_1}{\delta} - v_1 + \pi(v_1 - c_1) - (1 - \delta)a + \hat{\pi}(\bar{v}_2 - \bar{c}_2). \quad (25)$$

Comparing conditions (24) and (25) shows how the value of the collateral created relative to the severity of the incentive problems depends on the commodity money chosen. For a given problem of creditworthiness the value of the collateral is the larger the higher the chosen commodity money ranks on the liquidity scale; i.e., for a given right hand side of both inequalities the left hand side becomes larger with higher ranking of liquidity since $\bar{v}_2 - \bar{c}_2 > \underline{v}_2 - \underline{c}_2$. For a given quality cheating problem and thus for a given value of the collateral, the severity of the incentive problems in the credit relationship is the smaller the lower the chosen commodity ranks on the anonymity scale; i.e., for a given left hand side of both inequalities, the right hand side becomes smaller with lower ranking of anonymity since $0 < \hat{\pi}(\bar{v}_2 - \bar{c}_2)$.

We start by ranking different categories of commodity money with respect to their liquidity and anonymity. For this purpose we classify the export goods into three categories: basic goods BASIC, consumer goods CONSUM1, and investment and machinery goods INVEST1.

As a measure for the liquidity of the goods offered as commodity money, we use the following proxies which are supposed to capture the presence or absence of asymmetric

information problems. MDIF indicates whether or not the good offered as medium of exchange in barter is differentiated. MINF indicates whether or not the particular export good is traded on an exchange. When the good is not differentiated and/or an organized market exists for the good, we assume that *A* is not faced with an informational asymmetry, since she can either judge the quality or she can readily obtain information about the physical and market characteristics of the good from the market. *A* may trust *B* to keep promises about quality out of reputational considerations if they have dealt with each other for some time. We capture this familiarity with each other and with the good used as medium of exchange by the variable FAMILIAR. A last set of variables indicating the presence or absence of information asymmetry are MUSE and RELATION. *A* will be able to distinguish more easily between different quality levels of good 2 in case of the presence of a "double coincidence of wants", i.e. if she consumes the good herself. This is captured by MUSE which - besides FAMILIAR - reflects *A*'s familiarity with the physical characteristics of good 2. Furthermore, *A* will be better informed about the physical characteristics of good 2 when there is a technical relationship between the good 1 she sells to *B* and good 2 used as payment by *B* (e.g. good 1 is a machine and good 2 is output produced with this machine). This is measured by the variable RELATION.

As a measure for the anonymity of the goods offered as commodity money we use the variable SPECINV to capture whether or not *A* makes a relationship specific investment. As we have seen above, the creditor can undertake such an investment to make the good used as payment more specific to her relationship with the debtor and to improve her knowledge about the characteristics of the collateral good. SPECINV combines HIGHCASH with LOCAL. HIGHCASH captures *A*'s valuation of the offered medium of exchange. It also reflects *B*'s outside option to barter. The variable compares the price paid by *A* for good 2 in the barter trade relative to the typical price obtained for good 2 in monetary transactions. When good 2 is relatively liquid it is a desirable medium of exchange for *A*. Therefore, *A* will be prepared to pay a higher price for it in the barter trade relative to what is typically paid for it in a cash transaction. When good 2 is relatively liquid it also means that *B* has an attractive outside option to barter. Therefore, *A* will have to offer a high price for good 2 relative to cash transactions to make it attractive for *B* not to default. LOCAL captures whether or not *A* sells good 2 on the local market. We assume that *A* undertakes an investment into the medium of exchange when she pays

a lower price in barter relative to cash transactions and when she does not sell good 2 on the local market. The reason is the following. When *A* pays a lower price for the good in barter than in monetary transactions this indicates either that *A* does not want the good as payment or that *A* has to be compensated for an investment she makes into the medium of exchange. In order to distinguish between these two cases we combine HIGHCASH with LOCAL. *A* has to undertake an investment in marketing good 2 when she does not sell it locally (and the good is differentiated). Thus, when *A* pays a lower price in barter compared to monetary transactions and when she sells good 2 abroad, then we conclude that *A* has invested in the relationship.

The empirical results are given in Table 2. To characterize the properties of the three categories of export goods, we use BASIC, CONSUM1, and INVEST1 as the dependent variables in the regressions. All the variables described above serving as proxies for the degree of anonymity and liquidity are used as independent variables in the estimation. Since BASIC, CONSUM1 and INVEST1 are dummy variables which are bounded between 0 and 1, we report OLS as well as LOGIT estimates.

Consider first the properties of basic goods given in specifications (1) and (2) of the table. BASIC is a dummy variable which takes the value of 1 if the export good is a basic good or chemical product and 0 otherwise. The negative coefficients on MDIF and the positive on MINF suggest that basic goods tend to be standardized goods which are traded on an organized market. These variables suggest that the moral hazard and adverse selection problem of low quality is of little concern when basic goods are used as medium of payment. Furthermore, SPECINV indicates that basic goods are relatively anonymous goods, since *A* does not invest in the relationship when she is paid in basic goods (the coefficient on SPECINV is negative and highly significant). The negative coefficient on SPECINV also indicates that basic goods are a desirable means of payment and collateral for *A*. The negative and significant coefficient on FAMILIAR, in turn, suggests that barter trade with basic goods as means of payment tend to take place in an anonymous setting, since the parties typically do not know each other from previous transactions. Finally, the positive and insignificant coefficients on MUSE and RELATION suggest that *A*'s experience as a consumer of good 2 and as a producer of good 1 typically does not play a facilitating role in judging quality. In sum, the data support that basic goods are relatively liquid goods.

Table 2 - Ranking Commodity Money

	BASIC		CONSUM1		INVEST1	
	OLS (1)	LOGIT (2)	OLS (3)	LOGIT (4)	OLS (5)	LOGIT (6)
MINF	0.44 (0.000)	2.16 (0.000)	-0.34 (0.000)	-1.92 (0.001)	-0.48 (0.000)	-2.78 (0.001)
MDIF	-0.12 (0.037)	-0.75 (0.030)	0.19 (0.015)	1.20 (0.008)	0.15 (0.065)	0.72 (0.083)
MUSE	0.06 (0.383)	0.35 (0.373)	-0.49 (0.000)	-3.07 (0.000)	0.08 (0.350)	0.38 (0.385)
FAMILIAR	-0.13 (0.027)	-0.76 (0.031)	0.18 (0.028)	1.05 (0.021)	0.14 (0.084)	0.73 (0.087)
RELATION	0.04 (0.628)	0.18 (0.671)	0.09 (0.310)	0.59 (0.255)	-0.24 (0.038)	-1.23 (0.039)
SPECINV	-0.26 (0.031)	-1.77 (0.047)	0.37 (0.005)	2.45 (0.009)	-0.01 (0.983)	0.15 (0.927)
Intercept	0.34 (0.000)	-0.63 (0.040)	0.46 (0.000)	-0.41 (0.293)	0.49 (0.000)	-0.10 (0.787)
F	7.4 (0.000)		9.0 (0.000)		7.0 (0.000)	
Adjusted R ²	0.15		0.27		0.22	
-2 LL		215.9		135.9		143.0
Perc. correct		75.8		73.9		72.5
N	211	211	134	134	131	131

Notes: Ordinary Least Square and Logit regressions. Numbers in brackets are p-values.

- BASIC Dummy variable equal to 1 when export good is a basic good or chemical product and equal to 0 otherwise;
- CONSUM1 Dummy variable equal to 1 when export good is a consumer good and equal to 0 if it is a basic good or chemicals;
- INVEST1 Dummy variable equal to 1 when export good is investment good and equal to 0 if it is a basic good or chemicals;
- MINF Dummy variable equal to 1 when export good is traded on an organized market and 0 otherwise;
- MDIF Dummy variable equal to 1 when export good is differentiated and equal to 0 otherwise;
- MUSE Dummy variable equal to 1 when export good is used by A herself and equal to 0 otherwise;
- FAMILIAR Dummy variable equal to 1 if DC-firm and EE or LDC partner have frequently traded with each other and equal to 0 otherwise;
- RELATION Dummy variable equal to 1 if export good is technologically related to import good and equal to 0 otherwise;
- SPECINV Dummy variable equal to 1 when HIGHCASH equal to 1 and LOCAL equal to 0;
- HIGHCASH Dummy variable equal to 1 if export good is sold at higher price outside barter trade and equal to 0 otherwise;
- LOCAL Dummy variable equal to 1 if A sells the export good locally and equal to 0 otherwise.

Next, consider the characteristics of consumer goods which are given in specifications (3) and (4) of Table 2. CONSUM1 is a dummy variable equal to 1 if the good is a consumer good and equal to 0 if the good is a basic good or chemical product. Thus, specifications (3) and (4) compare the liquidity and anonymity properties of consumer goods relative to basic goods and chemicals. In contrast to basic goods, consumer goods tend to be differentiated goods in which the problem of information asymmetry arises (MDIF has a positive significant sign). However, *B*'s incentive to pay with low quality consumer goods is controlled by the fact that *A* and *B* are familiar with each other from previous transactions (FAMILIAR has a positive and significant sign). That *A* can trust *B* to provide quality when *B* pays in consumer goods is important since *A* typically does not consume the good herself (MUSE has a negative and significant sign), consumer goods are not traded on an exchange (MINF has a negative and significant sign), and typically there is no technical relationship between the good *A* sells to *B* and the good *B* pays with (RELATION is positive but insignificant). These three variables indicate that *A* has difficulties in judging the quality of consumer goods. However, as the positive and significant coefficient on SPECINV suggests, *A* reduces her quality uncertainty by investing in the relationship, becoming more active in the quality design of the good and establishing a market for it. This investment makes the consumer good a medium of exchange specifically designed as payment for *A*. In sum, consumer goods are less liquid and less anonymous goods than basic goods. The moral hazard problem of quality gets alleviated, however, because *A* invests in the relationship and because part of *B*'s behavior is governed by trust due to *A*'s and *B*'s repeated interaction.

Finally, consider the properties of investment goods given in column (5) and (6) of Table 2. They differ in one important dimension from consumer goods. *A* typically does not invest in making the medium of exchange more liquid and less anonymous when she is paid in investment goods. The coefficient on SPECINV is insignificant. Investment goods tend to be disposed by *A* on the local market. *A* typically accepts investment goods as payment when she knows *B* from previous transactions. In sum, investment goods are less liquid and more anonymous goods than consumer goods. Moreover, investment goods seem to be less anonymous than basic goods (the coefficient on SPECINV is positive, although insignificant, while negative in the BASIC equation).¹³

¹³That basic goods seem to be more anonymous than investment goods is reasonable because the former

Table 3 - The liquidity of commodity money

	Investment goods	Consumer goods	Basic goods	Row Total
Excellent to good quality	(23.2) [31.0]	(38.9) [49.3]	(37.9) [58.1]	95 [45.7]
Others	(43.4) [69.0]	(33.6) [50.7]	(23.0) [41.9]	113 [54.3]
Column Total	71 (34.1)	75 (36.1)	62 (29.8)	208 (100.0)

Total number of cases; numbers in () brackets are row percentages, numbers in [] brackets are column percentages

The properties of commodity money described in Table 2 suggest a hierarchy with respect to quality problems and therefore with respect to their usefulness as collateral goods. According to the table, basic goods are expected to be the most liquid medium of exchange, followed by consumer goods. The most illiquid medium of exchange with severe quality problems are expected to be investment goods. We confront this prediction with data on the trader's judgement of the quality of export goods compared to an average quality of the same goods on the market. Table 3 indeed supports the prediction that commodity money can be ranked by quality problems. 58 percent of all basic goods and chemical exports, 49 percent of all consumer good exports, but only 31 percent of all investment good exports in barter trade of our sample were ranked to be of excellent to good quality relative to a market standard.

3.3 Value of collateral

Our model predicts that the larger the incentive problems in the credit relationship the larger the collateral created by the barter trade has to be in order to restore B 's are often fluid goods (like e.g. oil) for which property rights are harder to define than for bulky products (like a machine).

creditworthiness. Consider again condition (23).

$$v_2 \geq \frac{c_1}{\delta} - v_1 + \pi(v_1 - c_1) - (1 - \delta)a + c_2 + \hat{\pi}(v_2 - c_2) \quad (26)$$

From this condition we can derive a number of hypotheses on how the value of the collateral needs to be chosen for a given credit cheating problem.

We measure the value of the collateral by the value of B 's exports to A . The required value of the collateral will be influenced by the size of the original trade credit which A gives to B . To control for size effects we normalize the value of the collateral (export value) by dividing it through the value of the trade credit (import value). Hence, we use what the traders call the "compensation ratio" (the ratio of the export value to the import value, from the point of view of B) of each barter trade as the measure of the value of the collateral provided by the barter contract.

The following hypotheses report how the value of the collateral relative to the trade credit has to be chosen in response to different exogenous parameters.

Hypothesis 1 *The lower B 's creditworthiness, the larger will be the value of the collateral relative to the trade credit.*

In the model, B 's creditworthiness increases with a , the assets hold by B abroad which can be seized in case of default. Note that a reduction of a has a positive impact on the right hand side of (23). Intuitively, the smaller the collateral B can provide via a , the larger the collateral generated through barter has to be in order to restore B 's creditworthiness.

Hypothesis 2 *The value of the collateral relative to the trade credit can be smaller when barter trade is repeated.*

To see this, consider a situation where the two parties plan to carry out barter only once. In this case, B delivers good 2 if and only if

$$-c_2 \geq \hat{\pi}(v_2 - c_2) - a. \quad (27)$$

A on the other hand is willing to deliver good 1 only if she believes that B will deliver good 2 and if

$$-c_1 + \delta v_2 \geq 0. \quad (28)$$

It is straightforward to show that both constraints can be satisfied simultaneously if and only if

$$v_2 \geq \frac{c_1}{\delta} - a + c_2 + \hat{\pi}(v_2 - c_2). \quad (29)$$

A comparison of constraints (29) and (23) shows that the minimum value for the collateral needed is strictly larger if barter is a one-shot transaction since $(1 - \pi)v_1 + \pi c_1 \geq c_1 > \delta a$. Repeating the barter transaction generates an additional collateral which reduces the value of the collateral required in each barter deal.

Hypothesis 3 The better B's export opportunities in case of default the larger will be the value of the collateral relative to the trade credit.

In our model B's export opportunities in case of default are captured by the term $\hat{\pi}(v_2 - c_2)$. The larger $\hat{\pi}$, the larger the left hand side has to be to satisfy condition (23). We argue that the more B is integrated into the world market the less dependent he is on A as a customer and the easier it is for him to find alternative venues to sell good 2.

Hypothesis 4 The less B depends on his imports the larger will be the value of the collateral relative to the trade credit.

B's benefit from importing good 1 is given by v_1 in the model. A reduction of v_1 increases the right hand side of (23) which calls for a higher value of the collateral. The point is that the smaller v_1 , the less B has to lose if he is (partially) cut off from future imports.

Next, we want to consider what the ranking of commodity money of the previous subsection implies for how valuable different types of commodity money are as collaterals. Consider again (24) and (25). Our model predicts that the value of the collateral good is larger the higher the commodity money ranks on the liquidity scale and the lower it ranks on the anonymity scale. The ranking of commodity money in Table 2 gives us no clear distinction between basic goods and consumer goods for the combined property of liquidity and anonymity. Therefore we have the following hypothesis.

Hypothesis 5 The value of the collateral relative to the trade credit is smallest for commodity money with the pair of lowest liquidity and highest anonymity, that is for investment goods.

In order to test Hypotheses 1 to 5 we use the following variables. As a proxy for creditworthiness we use the debt to GDP ratio DEBT as reported by the World Debt Tables of the World Bank. The idea is that the more *B* is indebted already, the fewer assets remain to be seized by *A* in case of default, and thus the lower *B*'s creditworthiness. As a proxy for whether or not barter is repeated we consider REPEAT which measures the frequency of *A*'s exporting activity to *B*. The underlying presumption is that if *A* has exported to *B* regularly in the past, she is more likely to continue to do so in the future than if she trades with *B* for the first time. As a proxy for *B*'s export opportunities in case of default we use the export ratio of *B*'s country EXPORT. A high export ratio suggests that the country is well integrated into the world market indicating that *B*'s outside option to barter is good. As a proxy of *B*'s benefit from importing good 1 we use TECHIMP which is the ratio of technology imports over total imports in *B*'s country. A large share of technology imports indicates that *B* depends essentially on *A*'s imports and that it will be particularly difficult to find substitutes.

Specification (1) and (2) of Table 4 present the results of testing hypotheses 1 to 5. DEBT has a positive and significant coefficient for all specifications, confirming Hypothesis 1. The barter contract is indeed furnished with a larger deal specific collateral when the country lacks creditworthiness. The predicted negative and significant sign on REPEAT suggests that the barter contract requires a smaller deal specific collateral when *B* does not want to lose his reputation as a good debtor as has been suggested by Hypothesis 2 and the sovereign debt literature. EXPORT shows the expected positive, TECHIMP the expected negative coefficient and both variables are highly significant, confirming Hypotheses 3 and 4. When *A*'s punishment potential in case of *B*'s default is weak because *B* can easily trade with someone else, then the barter contract needs to create a larger collateral in order to restore *B*'s creditworthiness.

Finally, specifications (3) and (4) test Hypothesis 5. The positive and almost equal coefficients on BASIC and CONSUM suggest that these commodities have high and similar collateral values for different reasons. While basic goods rank highest on the liquidity scale they rank low on the anonymity scale. Consumer goods have the advantage (in spite of potential quality problems) that they can be made to rank low on the anonymity scale which makes them a valuable collateral. The negative and significant coefficient on INVEST confirms that investment goods are "bad" money with low collateral value. All

Table 4 - Value of the Collateral
Dependent variable lnCOMP

	(1)	(2)	(3)	(4)
lnDEBT	0.39 ^a (5.34)	0.24 ^a (2.73)	0.15 (1.89)	0.17 ^b (2.09)
REPEAT	- 0.50 ^a (3.69)	- 0.53 ^a (3.97)	- 0.30 ^b (2.34)	- 0.36 ^a (2.82)
lnEXPORT		0.51 ^a (3.67)	0.52 ^a (4.07)	0.47 ^a (3.61)
lnTECHIMP		- 0.83 ^a (3.54)	-0.71 ^a (3.35)	-0.72 ^a (3.28)
BASIC			0.82 ^a (5.44)	
CONSUM			0.87 ^a (6.40)	0.23 (1.57)
INVEST				- 0.63 ^a (4.22)
Intercept	2.93 ^a (11.16)	4.67 ^a (5.25)	3.88 ^a (4.74)	4.67 ^a (5.67)
F	20.8 ^a	16.4 ^a	21.5 ^a	18.7 ^a
Adjusted R ²	0.15	0.22	0.36	0.33

Ordinary least square regressions of 230 observations. Numbers in brackets are t-values. Levels of significance a = 1 percent, b = 5 percent.

lnCOMP	Log of the compensation ratio, export value as percentage of import value;
lnDEBT	Log of debt to GDP ratio of LDC or EE country in 1987,
REPEAT	Dummy variable equal to 1 when developed country firm exported to LDC or EE trade partner on a regular basis and equal to 0 otherwise;
lnEXPORT	Log of export to GDP ratio of LDC or EE country in 1987;
lnTECHIMP	Log of share of technology imports in total imports of EE or LDC country in 1987;
BASIC	Dummy variable equal to 1 when export good is a basic good or chemical product and equal to 0 otherwise;
CONSUM	Dummy variable equal to 1 when export good is consumer good and equal to 0 otherwise;
INVEST	Dummy variable equal to 1 when export good is investment good and equal to 0 otherwise.

specifications explain up to 36 percent of the variation of the data on the compensation ratio.

3.4 Economic incentives and trade pattern

In the preceding subsection we have argued that the larger the incentive problems in the credit relationship the larger the value of the collateral has to be chosen. We have also seen that the value of the collateral depends on the type of commodity money used. This ranking of commodity money implies that for a given value of the collateral the severity of the incentive problems in the credit relationship should vary with the type of medium of exchange used as payment. Thus, an alternative way to test our theory is to check how various incentive problems affect the choice of collateral goods. In order to do so we reformulate our previous hypotheses in the following way.

Hypothesis 6 The lower B's creditworthiness, the more likely it is that a collateral good is chosen which ranks high on the liquidity scale and low on the anonymity scale.

Hypothesis 7 If the barter trade is repeated it is less likely that a collateral good is chosen which ranks high on the liquidity scale and low on the anonymity scale.

Hypothesis 8 The better B's export opportunities in case of default the more likely it is that a collateral good is chosen which ranks high on the liquidity scale and low on the anonymity scale.

Hypothesis 9 The less B depends on his imports the more likely it is that a collateral good is chosen which ranks high on the liquidity scale and low on the anonymity scale.

We use the same variables as before to proxy the incentive problems, DEBT for creditworthiness, REPEAT for reputation considerations, EXPORT for B's export opportunities and TECHIMP for B's dependence on imports. Hypotheses 6 to 9 state that the larger B's incentive problems in the credit relationship (because the assets that can be seized are small (high outstanding debt) and because losing his reputation or essential imports is not important for B and because his export outside option is good) the more

Table 5 - Choosing collateral goods

	BASIC		CONSUMI		INVESTI	
	OLS (1a)	LOGIT (2)	OLS (3a)	LOGIT (4)	OLS (5a)	LOGIT (6)
lnDDEBT	0.05 (0.149)	0.31 (0.128)	-0.03 (0.597)	-0.09 (0.077)	-0.14 (0.009)	-0.18 (0.012)
REPEAT	-0.17 (0.005)	-0.90 (0.007)	0.08 (0.361)	0.08 (0.353)	0.32 (0.000)	1.50 (0.001)
lnTECHIMP	-0.23 (0.023)	-1.08 (0.032)	0.24 (0.090)		0.21 (0.114)	1.04 (0.129)
lnEXPORT				0.19 (0.031)		0.11 (0.182)
intercept	1.01 (0.015)	2.20 (0.287)	-0.20 (0.718)	0.22 (0.422)	0.06 (0.909)	-2.29 (0.414)
F	6.3 (0.000)	7.7 (0.000)	1.6 (0.198)	2.6 (0.055)	10.0 (0.000)	10.7 (0.000)
Adjusted R ²	0.07	0.08	0.01	0.04	0.17	0.18
-2 LL			230.7		170.7	151.0
Perc. correct			77.9		59.4	70.8
N	217	217	128	128	130	130

Notes: Ordinary Least Square and Logit regressions. Numbers in brackets are p-values.

BASIC Dummy variable equal to 1 when export good is a basic good or chemical product and equal to 0 otherwise;

CONSUMI Dummy variable equal to 1 when export good is consumer good and equal to 0 if it is a basic good or chemicals;

INVESTI Dummy variable equal to 1 when export good is investment good and equal to 0 if it is a basic good or chemicals;

lnDDEBT Log of debt to GDP ratio of LDC or EE country in 1987;

REPEAT Dummy variable equal to 1 when LDC or EE country imported from developed country firm on a regular basis and equal to 0 otherwise;

lnTECHIMP Log of share of technology imports in total imports of EE or LDC country in 1987, UN, Financial Statistics;

lnEXPORT Log of exports to GDP ratio of LDC or EE country in 1987.

likely it is that basic goods and the less likely it is that investment goods are used to collateralize future payments.

Table 5 tests these hypotheses. We report OLS and LOGIT estimates because the dependent variables measuring the choice of collateral goods BASIC, CONSUM1, and INVEST1 are bounded between 0 and 1. We find that in specifications (1) and (2) for the choice of basic goods and in specifications (5) and (6) for the choice of investment goods all variables enter with the expected sign except EXPORT and most of them are highly significant. One possible reason why the coefficient on EXPORT comes out with the wrong sign is that countries which are successful in exporting consumer goods tend to have high export ratios. Note that in specifications (5) and (6) estimating the choice of investment goods all coefficients enter with an opposite sign as compared to basic goods (columns 1 and 2). The most interesting finding we get for the choice of consumer goods. In specifications (3a) and (4) all of the included variables are not significant, except TECHIMP. This suggests that consumer goods are equally good commodity money as basic goods confirming our previous observation in Table 4 that consumer goods rank equally with basic goods as collaterals. In contrast, investment goods have low collateral value and are used as payment in barter contracts only when the incentive problems in the credit relationship are not too severe.

Let us turn again to the actual pattern of specialization of barter trade described in the introduction. Among barter exports from developing countries and Eastern Europe consumer goods (32 percent) and investment goods (35 percent) dominate. How can we explain this pattern given the results of Table 5? The table predicts that investment goods will be used to collateralize future payments only when the country's creditworthiness is not too bad. Consumer goods instead are equally good collaterals as basic goods and therefore can be used as substitutes for them. Thus, the large share of investment good exports in our sample let us expect that the problem of creditworthiness, though present, is not too severe among the countries represented in the sample. This is indeed what we find in the data. The debt to GDP ratios of the countries in the sample vary widely, ranging from 5 to 327 percent (see Table 1). However, because of the dominance of Eastern Europe in the sample, in particular the former Soviet Union and former Czechoslovakia, we have a relatively large number of barter deals with countries that are not too severely indebted. Table 6 shows that 86.2 percent of the barter deals of the sample are with Eastern Europe

and 13.8 percent with developing countries. The table shows also that Eastern Europe with an average debt to GDP ratio of 33.8 is substantially more creditworthy than the developing countries with an average debt to GDP ratio of 76.6. Given this distribution of debt to GDP ratios in our sample, it is not surprising that in a large number of cases investment goods as "bad money" were used as payment. Investment goods provided a collateral which was sufficiently valuable as compared to the gains from defaulting. Consumer goods turn out to be "good money" and thus qualify as collaterals also for countries with low creditworthiness.

Another way to test the importance of incentives for the pattern of specialization in barter is to look at the trade pattern of each of these two regions separately. Our theory predicts that the developing countries with lower creditworthiness compared to Eastern Europe will use higher value collateral goods as means of payment in barter. We confront this prediction with data in Table 6 where we examine (with an analysis of variance ANOVA) whether the two regions show a different pattern of specialization. This is indeed supported by the data. In contrast to Eastern Europe, developing countries do not use investment goods as commodity money. The dominant means of payment in barter with developing countries are the most liquid goods, basic goods and chemicals (in more than 70 percent of the deals). Furthermore, among those developing countries which paid with basic goods the average debt to GDP ratio is 97 percent indicating a far greater problem of creditworthiness than for the entire population of developing countries in the sample where the average debt to GDP ratio is 76.6. The dominant commodity money used in barter with Eastern Europe are investment and consumer goods (in more than 70 percent of the deals). In accordance with the theory investment goods are used as a medium of exchange only by those Eastern European countries with a comparable lower problem of creditworthiness (with an average debt to GDP ratio of 28.8 as compared to 33.8 for the entire population of Eastern European countries).¹⁴

¹⁴We do not claim that this difference in the barter trade pattern between developing countries and Eastern Europe is exclusively driven by incentives. The conventional factors like differences in factor endowment, technology, and economies of scale as determinants of trade are of course at work here as well.

Table 6 - Creditworthiness and trade pattern

	Barter exports in percent	Debt/GDP		
		mean	std. dev.	no of cases
<u>Eastern Europe</u> ¹	86.2	33.8	26.4	194
<u>Export pattern</u> ³				
Investment goods	38.7	28.8	24.1	75
Consumer goods	35.6	38.3	28.6	69
Basic goods	13.4	34.4	26.3	26
Chemicals	7.2	33.4	22.9	14
Services	5.2	42.8	30.4	10
<u>Developing countries</u> ²	13.8	76.6	72.1	27
<u>Export pattern</u> ⁴				
Consumer goods	22.2	51.4	33.4	6
Basic goods	51.9	97.1	81.2	14
Chemicals	25.9	57.4	72.6	7
Total		39.1	37.7	221
ANOVA	F=35.2,	marginal significance 0.000		

¹ Former Soviet Union, former GDR, former Czechoslovakia, Hungary, Poland, former Yugoslavia, Rumania, Bulgaria, Albania.

² Brazil, Ecuador, Argentina, Nicaragua, Philippines, Indonesia, Malaysia, India, China, Israel, Iran, Egypt, Algeria, Syria, Cyprus, Togo, Zambia, Zimbabwe.

³ The percentages in the first column refer to total barter exports from Eastern Europe.

⁴ The percentages in the first column refer to total barter exports from developing countries.

5. Conclusions

In this paper we have shown that barter can be an efficient institution that mitigates the incentive problems of highly indebted countries. Goods rather than money may be used as a medium of exchange in international trade with highly indebted countries because of

their superior credit enforcement properties. The reason why goods are better collateral than money is that they are less anonymous and therefore property rights on goods are easier to define and enforce than property rights on the future export returns of a country. Since the creditor in the developed country can label the goods as belonging to her the debtor in the developing country cannot use these goods for other purposes than paying back his debt. Thus, goods function like "special purpose money". However, payment in goods introduces new incentive problems due to informational asymmetries. The debtor has an incentive to pay with low quality goods which makes goods less liquid than money. We rank goods with respect to their anonymity and liquidity - with respect to the severity of the incentive problems - and show how the institution of commodity money can explain the export pattern of barter. For a given problem of creditworthiness commodity money with the pair of anonymity and liquidity is chosen as payment which solves it best.

Our analysis suggests that some forms of international trade cannot be understood without the analysis of contracts and institutions. The pattern of specialization in barter trade differs significantly from that in conventional trade. We introduce incentives as an additional determinant of the pattern of trade in barter. Thus, we can give an institutional explanation for why export goods like consumer goods and investment goods in which the developing countries or Eastern Europe typically do not have a comparative advantage dominate among barter exports from these countries. Our theory predicts that these goods are the appropriate medium of exchange for countries whose problem of creditworthiness is not too severe.

Appendix

Proof of Proposition 2: To see that (11) is necessary for restoring B 's creditworthiness note first that (10) is equivalent to

$$0 \leq v_2 - \frac{1}{\delta}c_1 . \quad (30)$$

and (9) is equivalent to

$$(1 - \hat{\pi})(v_2 - c_2) + (1 - \pi)v_1 + \pi c_1 - (1 - \delta)a \geq v_2 . \quad (31)$$

Thus, both conditions can be fulfilled simultaneously only if

$$(1 - \hat{\pi})(v_2 - c_2) + (1 - \pi)v_1 + \pi c_1 - (1 - \delta)a \geq \frac{1}{\delta}c_1 \quad (32)$$

which is equivalent to (11).

To see that (11) is also sufficient recall first that condition (30) (which is equivalent to (10)) is satisfied by assumption. Thus, as long as (11) is fulfilled the only possible problem that can arise is that condition (9) is violated, i.e.

$$(1 - \hat{\pi})(v_2 - c_2) + (1 - \pi)v_1 + \pi c_1 - (1 - \delta)a \leq v_2 . \quad (33)$$

If this were the case then A could induce B to deliver good 2 by making a monetary side payment s conditional on B 's delivery such that

$$(1 - \hat{\pi})(v_2 - c_2) + (1 - \pi)v_1 + \pi c_1 - (1 - \delta)a + s \geq v_2 . \quad (34)$$

As long as (11) holds it is possible to find a side payment s such that (34) and (30) are both satisfied, i.e.

$$(1 - \hat{\pi})(v_2 - c_2) + (1 - \pi)v_1 + \pi c_1 - (1 - \delta)a \geq v_2 - s \geq \frac{1}{\delta}c_1 . \quad (35)$$

Q.E.D.

Proof of Proposition 3: The proof is along the same lines as in Proposition 2. Note that (17) is equivalent to (9) with $\bar{v}_2 - \bar{c}_2$ replacing $v_2 - c_2$ and $\hat{\pi}(i)$ replacing $\hat{\pi}$. Similarly (18) corresponds to (10) with \bar{v}_2 replacing v_2 and with an additional investment cost of i .

Thus, as in Proposition 2 we can argue that B 's creditworthiness can be restored if and only if

$$\frac{1}{1 - \delta\pi} [(1 - \pi)v_1 + (1 - \hat{\pi})[v_2 - c_2] + (1 - \delta)a] \geq \frac{c_1}{\delta} + \frac{1 - \delta}{\delta}z \quad (36)$$

Rearranging this expression we get (19).

Q.E.D.

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