A Theoretical Model of Barter in Russia

Jose Noguera
Susan Linz

CERGE-EI

Charles University
Center for Economic Research and Graduate Education
Academy of Sciences of the Czech Republic
Economics Institute

WORKING PAPER SERIES (ISSN 1211-3298)
Electronic Version

207

A THEORETICAL MODEL OF BARTER IN RUSSIA

José Noguera, CERGE-EI

Susan Linz, Michigan State University

March 2003

Contact Information:

Jose Noguera, P.O. Box 882, Politických vězňů 7, 111 21 Prague 1, Czech Republic, phone (420-2) 240.05.107, e-mail: Jose.Noguera@cerge.cuni.cz

Susan Linz, 101 Marshall Hall, Department of Economics, Michigan State University, East Lansing, MI 48824, USA, phone 1-517-353.72.80, e-mail: linz@msu.edu

A THEORETICAL MODEL OF BARTER IN RUSSIA

José Noguera, CERGE-EI

Susan Linz, Michigan State University

Abstract

This paper develops a general equilibrium model and proposes a theory to explain the main stylized facts about the growth of barter transactions in Russia during the 1990s. Because of the high opportunity cost of using fiat money, with a tight enough credit market it may be optimal for firms to barter if they have access to that transaction technology, yet the riskiest firm will keep using money. We also claim that, in the short run, Russian managers might avoid restructuring because it jeopardizes their access to alternative transaction technologies, and that this phenomenon might also take place in well-developed market economies.

Tato práce odvozuje model celkové rovnováhy a navrhuje teorii, která vysvětluje hlavní stylizovaná fakta o růstu směnného obchodu v Rusku v průběhu devadesátých let. Kvůli vysokým alternativním nákladům používání peněz při pevném kreditním trhu může být pro firmy směnný obchod optimální, pokud mají přístup k této transakční technologii. Nejrizikovější firma však bude stále používat peníze. Taktéž tvrdíme, že v krátkém období se ruští manažeři mohou chtít vyhnout restrukturalizaci, která by mohla ohrozit jejich přístup k alternativním transakčním technologiím. Tento jev se může vyskytnout i v rozvinutých tržních ekonomikách.

JEL: E0, E6, P20, P21, P23, P26

Keywords: Barter, money, payment system, interest rate

INTRODUCTION

Russian and Western scholars alike have devoted considerable attention to the causes and consequences of the growth in the number of transactions between commodities among Russian firms during the 1990s. Sometimes these transactions take the form of simple barter, if it happens to be a double coincidence of wants; other times, firms accept commodities as media of exchange; and on still other occasions, these media of exchange are widely accepted in some local areas of the country. Commander and Mumssen (1998) document that, although simple barter has been used frequently in Russia, promissory notes issued by firms (*veksels*), debt or tax offsets between firms, or between firms and local governments (*zachety*), and debt swaps are the instruments most widely used to conduct non-monetary transactions. Nevertheless, no credit market has yet emerged using these commodities as units of accounts, and although some of these items might have evolved into a sort of commodity money in some areas, for the sake of simplicity, in this essay we refer to all transactions between two commodities as barter.

According to the Russian Economic Barometer (Summer 2002), barter in industrial sales grew in Russia from 5-10% of total transactions in 1992 to a high of 50-60% in 1998 before falling to 10-15% in 2002. Numerous surveys of Russian firms between 1996 and 1999 suggest that the "normal" volume of commodity barter in Russia during that period hovered between 40% and 70% of total transactions, depending on the industry and on the location of the firm.[1] Even though the Russian case has captured much attention, the phenomenon is not unique. Kindleberger (1993) documents many

[1] See Aukutsionek (1998), Commander and Mumssen (1998), Hendley et al (2000), Linz and Krueger (1998), and Makarov and Kleiner (1996).

cases in history where people have substituted legal tender for other stronger currencies, primitive money or simple barter.

Although barter is usually viewed as a costly anomaly in the transition process, preserving features of the planned economy which impede the development of efficient market relations, any modern academic economist should accept that the transaction technology used in Russia must be the result of the optimal choice firms have available. One explanation for the phenomenon asserts that firms choose barter to evade the official economy, impeding enterprise restructuring efforts.[2] If this were the case, the recent drastic decline in barter must be the result of structural changes in Russia that have encouraged firms to return to the official economy. Marin (2002), however, finds some empirical evidence against this approach.

On the other hand, a number of empirical works documenting the barter phenomenon have related the growth in barter transactions with the behavior of some monetary aggregates.[3] This line of research suggests that credit rationing or shortage of money could explain the rise in barter. Although there is abundant empirical literature, this approach has not received much theoretical attention, and no formal model or theory has been proposed.

This paper contributes to the latter literature by developing a general equilibrium model and proposing a theory to explain the main stylized facts about the growth of barter transactions in Russia during the 1990s. Yet, unlike much of what that literature suggests, no credit rationing or money shortage is necessary. We show that, if the credit market if tight enough and firms have access to a barter technology, they may find

[2] Gaddy and Ickes (1999) and Hendley et al (2000).

optimal to barter instead of using money to conduct transactions. This may also encourage managers to avoid restructuring in order to access to this alternative transaction technology. The phenomenon may also occur in industrialized market economies.

The paper is organized into five sections. Section I rationalizes the key assumption that Russian firms have access to barter technology, and that this may occur as well in a well-developed market economy. Section II summarizes the main stylized facts about the barter phenomenon in Russia. Section III develops the model and analyzes its operation. Section IV contains the central analysis of the paper; it provides an explanation for the main stylized facts and analyzes the circumstances under which some firms choose to barter, and Section V extends the model to incorporate the cost of inflation. Finally, Section VI concludes, and discusses the significance and limitations of the analysis.

I. ACCESS TO A COMMODITY TRANSACTION TECHNOLOGY

Two major factors inherited from the Soviets have given the Russian economy access to barter technology: shortages in the official economic system, and the payment system.

Circumventing Shortages in the Official Economy. Barter is not new to enterprise managers in Russia's transition economy. In the simplest view, the Soviet economy was a barter economy, with Gosplan and Gossnab acting as mediators between ministries. Quinquennial plans designated the flow of materials and goods, with little regard to financial aspects. Above-plan production in the Soviet economy was frequently traded between firms in barter arrangements (Berliner 1976). Moreover, failures in vertical

[3] See Bevan et al (2001), Brana and Maurel (2000), Commander et al (2000), Ellingsen (1998), Linz and

linkages caused persistent and pervasive shortages in the Soviet economy that were overcome by unofficial horizontal linkages through the establishment of barter trade between firms to obtain the requisite materials that the planning authorities failed to deliver.[4] Makarov and Kleiner (1996) estimate that between 2% and 6% of transactions between firms prior to perestroika were established by the firms themselves in order to smooth out plan fulfillment, and in many instances, local party officials acted as a clearinghouse for barter transactions, thereby reducing the time and energy required to establish a "double coincidence of wants."

Woodruff (1999) documents the use of barter transactions by local, regional and provincial leaders as a means of extending their control over resources (trading food, fuel, paper, tires, construction materials, and consumer durables), and of diminishing control exerted by Moscow.[5] This activity intensified during perestroika, as more goods were siphoned off from the official economy. New forms of ownership like cooperatives, leased firms, and joint ventures were legalized. These firms were not part of the planned allocation of materials, thus had to compete for resources with state organizations.[6] Efforts to increase the independence of firms from planning authorities without changing the price formation system increased the demand for materials, but without establishing a corresponding mechanism to meet that demand. The resulting shortages caused firms to resort to trading in-kind: cars, building materials, and video equipment replaced rubles as the currency of exchange. Provincial leaders, seeking ways to prohibit scarce goods from

---

Krueger (1998), Makarov and Kleiner (2000), and Marin and Schnitzer (1999).

[4] *Tolkachi* are described in every analysis of enterprise operations in the Soviet economy. See for example Linz and Martin (1982). The competition between the official and unofficial economy – barter, black market, blat and bribe – is described by Grossman (1992).

[5] Yeltsin and Gorbachev met during an exchange of metal and timber from the Urals for food products from Stavropol. The role of official and unofficial commodity exchanges is documented in Grossman (1982).

leaving their region, used commodity transactions to circumvent planned allocations, and formed interregional alliances to facilitate commodity transactions. Indeed, Yeltsin signed special decrees in 1990 and 1991 which granted provincial leaders rights to 10% of enterprise production in their region for barter purposes, as well as partial rights to exports and hard currency earnings.[7] Nesterovich (1998) estimates that between 1985 and 1990, the acute scarcity of goods and materials generated during perestroika increased commodity transactions to at least 35% of all sales.

The payment system. Soviet state-owned firms typically settled accounts with one another through the "payment order" system. At the time the contracted goods were shipped, the supplying enterprise sent a payment order to the bank of its customer, which would then pay it automatically from the funds on the customer's account. When the customer had no available funds, unpaid bills accumulated in "card file number 2" and were paid in the order of arrival (Woodruff 1999). In short, customers were automatically extended short-term credit by producers.

This payment system was kept by the Russian state-owned firm counterparts during the first stages of the transition process. Thus, once the privatization process was undertaken, the newly privatized firms had at their disposal the production chains and supplier-customer relationships inherited from the Soviets, that is, the necessary network to conduct barter transactions.

Indeed, during the high inflation episode between 1992 and 1995, despite the significant increase in accounts in arrears, producers did not worry much about whether their customers paid. Enterprise directors formed a strong political lobby enabling them

[6] For a detailed discussion, see Jones and Moskoff (1989).
[7] Yeltsin tried to reverse this trend at the end of 1991(see Presidential order #143 and #269).

to secure the continuation of credits and subsidies, and thus continued producing. Cash received was frequently hoarded for speculative purposes, especially in the foreign currency market, rather than paying for materials or wages, and was rarely deposited in banks since often it was difficult to withdraw and bank accounts were raided by tax authorities. When large amounts of debt accumulated and debt obligations were clarified, Russian authorities sanctioned debt offsets (zachety), using a procedure available since the Soviets, and payments could be made in-kind rather than in cash (Ickes and Ryterman 1993).

Barter transactions in well-advanced economies. Barter has usually been seen as an inefficient form of exchange. However, there exists significant bartering between firms in well-advanced economies. First, a large amount of trade between firms takes place in organized barter markets. In the United States, approximately 300,000 firms participate in such exchanges, trading a great diversity of goods and services for an amount estimated in the USD 10 billions; second, data prior to 1990 shows that between 10% and 20% of world trade was conducted by some form of barter, although a large portion of this trade involved exchanges between the Soviet-bloc and free-market economies, and has diminished during the 1990s[8].

Prendergast and Stole (2001) explain that, under some circumstances, barter facilitates exchanges for cash-constrained firms and is a means of market segmentation that allows firms to increase their profits and welfare. This can occur even in an advanced-industrialized economy.

II. THE STYLIZED FACTS

[8] Prendergast and Stole (2001) summarize some of the facts.

Over the last ten years, an interesting empirical literature documenting the barter phenomenon in Russia has emerged, and concludes the following:

Stylized Fact 1: Barter transactions increased continuously up to the late 1990s and have decreased since the end of the last decade (Krueger and Linz 2001).

Some studies find relationships between the use of barter and a number of macroeconomic indicators:

Stylized Fact 2: There is a negative correlation between real cash balances and the use of barter (Krueger and Linz 2001).

Stylized Fact 3: There is a negative correlation between the inflation rate and the use of barter (Brana and Maurel 2000).

Stylized Fact 4: There is a positive correlation between the real interest rate and the use of barter (Brana and Maurel 2000).

Stylized Fact 5: There is a negative correlation between the good performance of firms and the use of barter (Brana and Maurel 2000).

Other studies look at managers' desire to use either barter or money to conduct transactions:

Stylized Fact 6: Firms use barter even though they would like to avoid it (Krueger and Linz 2001);

Stylized Fact 7: Many firms use barter because their partner traders lack liquidity (Commander and Mumssen 1998, Linz and Krueger 1998).

Stylized Fact 8: Many firms use barter to maintain output, facilitate sales and continue operating (Blanchard and Kremer 1997, Carlin et al 2000, Marin and Schnitzer 1999).

Stylized Fact 9: Barter allows money to be used to better effect (Ickes and Ryterman 1993, Commander and Mumssen 1998).

The model below offers an explanation for these stylized facts.

III. THE MODEL

The working of the model is as follows. There are four kinds of agents: households, firms, lenders and a government. Households demand goods made by all firms. Firms produce goods and demand inputs from other firms; they are risk-neutral, have monopoly power and, to acquire the inputs they need, can either borrow money in the credit market or engage in barter; they do whatever is cheaper for them. Lenders are the sole holders of financial wealth. The government finances its expenditure by issuing bonds or printing money.

The model shows that if government borrowing is small, the cost of borrowing is accessible to all firms and dominates barter. However, if the government's participation in the credit market increases, the cost of borrowing also increases, and barter may become an alternative technology to conduct transactions.

Demand. The representative household has a constant elasticity of substitution utility function

$$U = \left[\int_0^1 d(j)^{\rho} dj \right]^{1/\rho}, \qquad \rho \in (0, 1),$$

where $d(j)$ is the household's consumption of good j. Since we are free to choose the units of measurement for output, we choose real wages; thus, the household's budget constraint can be written as $\int_0^1 \left(\frac{P_j}{P} \right) d(j) dj = 1$, where P_j is the money price of good j and

P is the economy's money price index. The household's problem is to maximize its utility function U subject to the budget constraint. If we assume that there is a continuum [0,1] of households, the solution to this problem gives total households' demand functions as $D_j^h = (P_j / P)^{-\sigma}$, where $\sigma \equiv 1/(1 - \rho)$ is the elasticity of substitution between two goods. Since prices are measured in monetary units, they only reflect those transactions conducted through a monetary exchange, and do not take into account those made through alternative transaction technologies like barter.

There is also a government whose total real expenditure is g; for the sake of simplicity, assume the government distributes its expenditure in the same way as households do, so its demand function for good j is $D_j^g = (P_j / P)^{-\sigma} g$. Thus, total demand for good j is

$$D_j = (P_j / P)^{-\sigma}(1 + g). \tag{1}$$

Since firms have market power in this model, to ensure an interior equilibrium with positive output, we require $\sigma > 1$.

There is assumed to be a continuum [0,1] of firms, and each of them has a project. Each firm has a cost function $C(x) = cx$, $c > 0$. Firm j produces good j, and to conduct transactions, it can either use cash or barter. Firms own no cash; thus, to make purchases using fiat money, they must borrow it.

Exchanging Using Money. Consider a firm that conducts transactions using cash. Firm j has a project to produce x_j units of output and sells it for a unit price P_j. To acquire inputs with money, the firm must obtain a loan, which will be repaid at a nominal gross interest rate I if the project succeeds. Thus, the project's real cost is $(R\ c\ x_j)$, where $R = I/\pi$ is the

local real interest rate and π is the inflation rate. Assume that each firm j is a monopoly and its project succeeds with probability q_j. Since the risk is assumed by the lender, the expected real profit function for firm j is

$$EB_j = q_j\left(\frac{P_j}{P}x_j - cRx_j\right).$$

The monopoly chooses the combination price-quantity that maximizes its expected real profits. Thus, using (1) to solve the monopoly problem, we find

$$(2) \qquad \frac{P_j}{P} = K^{-1/\sigma}cR,$$

where $K = (1-1/\sigma)^{\sigma}$ is constant. The price set by the firm is a markup of the unit cost. The higher the real interest rate, the higher the relative price firm j sets. From (1) and (2), we obtain the firm's output

$$(3) \qquad x_j = K(1+g)(cR)^{-\sigma}.$$

Note that the firm's output and relative price are independent of the firm's initial real money balances and the project risk. Thus, firm j's expected profit if it uses cash for transactions is

$$(4) \qquad EB_j = K' q_j (1+g)(cR)^{1-\sigma}.$$

where $K' = (1-1/\sigma)^{\sigma-1}/\sigma$ is constant. In a monetary economy, all transactions are conducted using cash, so

$$E\int_0^1 P_j x_j dj \le M \qquad \text{or} \qquad \int_0^1 q_j P_j x_j dj \le M,$$

where M denotes the aggregate money supply, and E is the expected value operator. Thus, using (2) and (3) in the last inequality we have

(5) $PQ^m \le M$ where $Q^m = K^{1-1/\sigma} q^1 (1+g)(cR)^{1-\sigma}$

Q^m denotes the aggregate real output and $q^\mu = \frac{1}{\mu}\int_0^\mu \sigma(j) q_j dj$ represents a measure of risk for those firms conducting monetary transactions, where $\sigma(j)$ denotes the Lebesgue measure of those firms that succeed with probability q_j. Note that q^μ decreases with respect to μ. Inequality (5) represents a quantitative equation where the price index is proportional to money supply.

Exchanging Using Barter. Based on the discussion in Section 2, assume that firms have the network necessary for gaining access to a barter technology. Barter transactions impose costs on the firm and on society that would not be incurred in an economy dominated by cash transactions. For example, it requires the firm to expend time and energy to establish a double coincidence of wants, and to dispose of goods acquired but not needed in the production process. It also carries other costs like transportation, storage, perishability, and search. To avoid the complications of modeling such a technology, assume that barter transaction costs take the Samuelson's (1952) iceberg form[9]: if one unit of good j is exchanged, a fraction $\tau > 0$ evaporates. Since the firm does not bear any interest rate cost, its profit function under bartering is

$$EB_j = q_j(1-\tau)\frac{P_j}{P} x_j - c x_j .$$

In this case, from the monopoly's problem we obtain

(6) $$\frac{P_j}{P} = K^{-1/\sigma} \frac{c}{q_j(1-\tau)} .$$

The variance of price distribution is lower when the barter technology becomes less cumbersome (lower c) or the project is riskier (higher q). From (1), the firm's output is

(7) $$x_j = Kc^{-\sigma} q_j^{\sigma} (1+g)(1-\tau)^{\sigma}.$$

The optimal output increases if there is a lower barter cost, higher inflation or riskier projects. The expected profit for firm j if it barters is

(8) $$EB_j = K' c^{1-\sigma} q_j^{\sigma} (1-\tau)^{\sigma} (1+g).$$

Unlike the credit case, the risk factor q_j is present here. This occurs because when bartering, the firm faces the whole risk, whereas when asking for credit, only lenders assume risk.

Barter and Money. Let's now study the firm's decision whether to borrow or barter. Firm j asks for a loan if this allows it to obtain higher profits. Using (4), (8), and a bit of algebra, this occurs if

(9) $$1 > (1-\tau)^{\sigma/(\sigma-1)} q_j R.$$

Since $\sigma > 1$, a higher barter cost (higher τ) makes the right-hand expression in (9) decrease. Eventually, as τ tends to one, bartering becomes unaffordable. This echoes the traditional literature, which considers barter so inefficient that it is always dominated by some medium of exchange. In this paper, we assume that τ is small enough so as to make the barter technology feasible.

Consider Figure 1 (Appendix A) to analyze the effect of a change in risk. The right-hand side in (9) is an increasing straight line that goes from the origin to the point $(1-\tau)^{\sigma/(\sigma-1)} R$ as the probability of succeess q_j increases from zero to one. Given the rate of

[9] Samuelson uses this term to refer specifically to transport costs; here we use it in a broader context to

inflation, if the real interest rate is small enough, say R_0, this line can be represented by L_0. In this case, credit is cheaper than bartering regardless of any project risk, and all firms will choose to borrow and use money to make their purchases. On the other hand, if the real interest rate increases too much, say to R_1, the curve L_0 rotates to L_1, and the cost of borrowing becomes so onerous that firms with low risk projects, those with $q_j > \mu$, will prefer to transact through barter. Only the firms with the riskiest projects will remain in the credit market. This explains the finding of Marin and Schnitzer (1999) that "payment in goods is easier to enforce than payment in money." (p. 293) In this situation, borrowers' project risk lies on the interval $[0, \mu]$, $0 < \mu < 1$, and monetary transactions are subject to

$$\int_0^{\mu} q_j P_j x_j dj = M \ .$$

From (6) and (7) we thus have

(10) $\quad PQ_m^b \le M \ , \qquad$ where $\ Q^b = K^{1-1/\sigma}\, q^{\mu}\, (1+g)\, (cR)^{1-\sigma}$,

and q^{μ} is defined as in (5). Q^b measures the expected output that is transacted using money. Notice that $Q^m \ge Q^b$, that is, the expected output transacted using money is greater in a fully monetized economy than in a mixed monetary-barter exchange economy. Therefore, from (5) and (10), the price index in a fully monetized economy must be higher than in a mixed monetary-barter economy.

Lenders. There is a continuum [0, 1] of lenders; each of them owns W units of financial wealth. Financial wealth is divisible and consists only in local and foreign currency. Lenders can buy foreign-denominated currency, say US dollars, and obtain a real return

---

refer not only to the transport cost, but all other costs involved in bartering.

R^*. They can also make loans to local firms and ask for real interest R. However, since firms' projects are risky, loans may not be repaid.

Suppose that lenders face an adverse-selection problem, and cannot distinguish among borrowers. However, they know the distribution of risk among borrowers, and will give loans to projects whose risk is in the interval [0, μ]. Then, lenders expect to be repaid every unit of their wealth with probability q^{μ}. Denote by λ the share of a lender's portfolio assigned to local loans, and let $u(W) = \log(W)$ be the Bernoulli utility function, where W denotes wealth. Therefore, the lender's expected utility is

$$EU = q^{\mu} \ln\left[(1-\lambda)R^* + \lambda R\right]W + (1-q^{\mu}) \ln(1-\lambda)R^*W .$$

The lender's problem is to choose λ to maximize her expected utility function. From the first order condition, we obtain

$$\lambda = \frac{q^{\mu}R - R^*}{R - R^*}.$$

This equation determines the share of wealth that lenders invest locally. They will have a long position in local loans as long as $q^{\mu} R \geq R^*$. The greater q^{μ} is, the greater the probability that the loan will be repaid, and hence the lower the necessary local real interest rate for making lenders willing to give loans to local firms will be.

Given λ_t, the nominal cash balances supplied for loans is $M_t^{\,l} = \lambda_t P_t W$, or in real terms, $m_t^{\,l} = \lambda_t W$. That is,

$$M^l = \left(\frac{q^{\mu}R - R^*}{R - R^*}\right)PW , \tag{11}$$

where M^l is the amount of nominal cash balances held by lenders.

Equilibrium. To finance its real expenditure, g, the government acquires in every period new real value debt b, and prints $(\theta-1)M$ units of money. Thus, given government policy, θ, b and g, we determine equilibrium values for output, inflation, real interest rates, real money balance, and the set of firms that use money to fulfill transactions. In equilibrium, real money balances (m) are constant; thus, from either (5) or (10), nominal money supply and inflation increase at the same rate, that is, $\pi = \theta$.

In the credit market, the amount that lenders assign to the local economy in their portfolio determines the total real supply for loans (m^l), which is an increasing function with respect to total wealth. Although wealth usually increases over time, it is an exogenous variable in this model; thus, to get rid of unnecessary complications, we will assume that it is constant. Then, from (11), equilibrium real supply for loans is

$$(12) \qquad m^l = \left(\frac{q^{\mu} R - R^*}{R - R^*} \right) W ,$$

which is a concave increasing function with respect to the local real interest rate, R. On the demand side, the total real demand for loans (d^l) is the sum of government bonds (b) plus the production cost of those firms who plan to borrow cash:

$$d^l = b + \int_0^{\mu} cRx_j dj .$$

Plugging equations (2) and (3) into the last expression, we find the steady state real demand for loans,

$$(13) \qquad d^l = b + \mu K(1+g)(cR)^{1-\sigma} .$$

The loans' demand function decreases with respect to the real interest rate. Credit market equilibrium requires $m^l = d^l$. Suppose that the economy is fully monetized, so that $\mu = 1$.

Then from (12) and (13) we obtain the equilibrium interest rate (see Figure 2 in Appendix B). Suppose the equilibrium interest rate is initially R_0, the intersection between the credit supply and demand curves m_0 and d_0 respectively. If the government increases its demand for loans (b), curve d_0 shifts to the right, say up to d_1, and the interest rate increases up to R_1. Thus, as in the case of Russia during the 1990s, if the government switches its budget funding from seigniorage to borrowing simultaneously, given g, there will be a fall in θ and an increase in b; thus, the rate of inflation falls and the real interest rate goes up; this increase makes L rotate to the left until it eventually reaches L_2 (see Figure 1 in Appendix A). After that point, if the government keeps substituting seigniorage for debt as a source of income, firms with low risk projects will stop asking for loans. Firms holding a project with risk equal to or greater than μ will choose to barter, where μ is determined when (9) holds in equality, that is, $q_j = (1 - \tau)^{\sigma/(1-\sigma)}/R$.

IV. EXPLAINING THE FACTS

After the initial high inflation period at the beginning of the post-communist period, the Russian government made a major change in its monetary policy from the mid-1990s on. An important share of the government's finance source switched from seigniorage to government debt with the private sector. This change lowered inflation and the money growth rate (θ), but it increased the debt holdings (b) and pressured upward both the nominal and real interest rates. With a strong enough increase in the real interest rate, firms with access to a barter technology will give up money to conduct transactions and a barter economy emerges. This result, illustrated in the previous section, explains stylized facts 3 and 4, that is, the negative correlation between inflation and the use of barter, and the positive correlation between the real interest rate and the use of barter. The Russian

government kept a tight monetary policy during most of the 90s after the high inflation episode at the beginning of the decade, but abandoned it after the Russian crisis in 1998. This has made barter decrease too and explains fact 1: barter increased during the 90s and has decreased from the end of the decade on.

Suppose an increase in the interest rate is high enough so that a barter economy emerges; that is, the interest rate increases to a level equal to or higher than I_2 in Figure 1. The more constrained the credit market, the lower μ is, meaning that firms with low risk projects will choose to barter. This shrinks the share of the economy conducting monetary transactions, and increases its risk. This means that Q^b in equation (8) decreases and, given M, the price level measured in monetary units increases. Thus, real money balances also decrease. The negative correlation between real cash balances and the use of barter is hence explained (stylized fact 2).

As the interest rate increases, firms borrowing in the credit market face higher production costs, which hinder their economic performance. This explains the negative correlation between firms' good performance and the use of barter (stylized fact 5). It is important to note, however, that firms diminish in their performance until they decide to switch to barter transactions instead of borrowing in the credit market.

Firms switch to barter because access to credit, and therefore their ability to pay in cash, becomes too expensive. Nevertheless, they would still prefer to receive payments in cash rather than in barter, since they would save in transaction costs. This explains stylized fact 6: firms use barter even though they would prefer to avoid it. In contrast, firms whose projects have a high probability of success, and who receive payments in cash, prefer to keep bartering and lend the cash. This way they can offset the barter cost

and obtain some additional earning; that is, the high opportunity cost of using cash for transactions makes firms with low risk projects avoid using that cash to finance its cost and instead use it for a better purpose. This explains fact 9.

Consider a firm with a high risk project that borrows cash in the credit market, and wishes to make a transaction with another firm with a low risk project. Suppose that the low risk project firm prefers barter transactions. If the high risk project firm is buying, it pays in cash, and there will be a monetary transaction; if the high risk project firm is selling, the low risk project firm will prefer to barter whether or not it has cash at its disposal. The high risk project firm will thus likely have the impression that its partner trader does not have cash. This explains fact 7: many firms claim that they barter because their partner traders lack cash.

Given certain macroeconomic conditions, firms choose barter because it is optimal for them to do it. As the credit market becomes more constrained, continued borrowing will cause lower output and profits (equations 3 and 4), which may lead them to eventual bankruptcy. The decline in output will stop once the firm makes the decision to switch to barter. This explains fact 8: the choice for bartering is a way to maintain output.

Finally, an interesting consequence of the model is that the access to a barter technology sets an upper bound to the economy's risk imposing a ceiling on the interest rate. To illustrate the argument, consider Figure 1 again, and suppose that the riskiest project firm succeeds with probability μ. Then, a real interest rate higher than R_1 would leave lenders without customers other than the government, since all firms would choose to barter.

V. INFLATION AND BARTER

Frequently, barter episodes have been related to situations of high inflation like the German and Hungarian hyperinflation episodes of the mid-20th century. Yet we use our model to explain a negative relationship between the share of barter transactions and inflation. These two situations, however, can be reconciled. Economies with high inflation show higher instability in most economic variables, generating considerable uncertainty for lifetime financial and business planning (see DeLong 1997; Shiller 1997). Lucas (2000) analyzes how inflation can negatively affect welfare and output. This allows us to extend the model and include an additional unit cost, $k\pi$, to those firms using money to conduct transactions in an inflationary environment. Assume that $k\pi$ is negligible for small inflation rates. The expected real profit function for firm *j* is

$$EB_j = q_j\left(\frac{P_j}{P}x_j - (cR + k\pi)x_j\right).$$

Solving the problem of the firm which conducts transactions using money, and repeating the exercise, we find that firm *j* will ask for a loan if

$$1 > (1-\tau)^{\sigma/(\sigma-1)} q_j (R + k'\pi),$$

where $k' = k/c$. This expression resembles inequality (9) but that R is substituted by the term $(R + k'\pi)$. This means that an increase not only in the real interest rate but also in inflation compels firms to switch from cash transactions to barter. In the case of Russia during the 1990s, if k' were small enough as should be expected, the disinflation effect encouraging cash transactions would be dominated by the interest rate effect fostering barter.

VI. CONCLUSION

Much of the literature on the growth of barter in Russia focuses on the consequence, and not on the causes, of using barter transactions and stresses the importance of reducing barter transactions among Russian firms to lower the costs imposed by that transaction technology on firms and the society. However, we have shown that barter can be the optimal transaction system under some given circumstances: a high risk economy with access to barter technology and a very constrained credit market. In this scenario, firms choose barter to reduce risk, and to avoid lowering production or closing down, yet the riskiest project firms will keep using money.

Once the credit market conditions are set, the expansion of barter transactions is possible as long as firms have access to this transaction technology. Yet this means that very tight credit market conditions might be what trigger firms to switch to barter and lock into specific arrangements which reproduce the socialist inefficient production and employment patterns, thereby reducing the entry of new firms and restricting competition as a force to lower prices and improve quality. These patterns force workers to trade in-kind wages, they facilitate tax evasion, and foster the moral hazard problem, rendering the credit market riskier, and making more fragile the banking system and reducing financial innovation. Thus, Russia's virtual economy, value-subtracting firms relying on relational capital to continue to produce goods for exchange, may be a consequence rather than a cause of barter transactions. In the short run, Russian managers might have avoided restructuring because it jeopardized their access to alternative transaction technologies.

REFERENCES

Aukutsionek, S. 1998. "Industrial Barter in Russia." *Communist Economies & Economic Transformation*, 10, no. 2 (June): 179-188.

Bevan, A., S. Estrin, B. Kuznetov, M. Schaffer, M. Angelucci, J. Fennema and G. Mangiarotti. 2001. "The Determinants of Privatized Enterprise Performance in Russia," William Davison Institute Working Paper No. 452, June.

Berliner, J. 1976. *The Innovation Decision in Soviet Industry*, Cambridge, Massachusetts: The MIT Press.

Blanchard, O., and M. Kremer. 1997. "Disorganization." *Quarterly Journal of Economics*, 112, no. 4, (November): 1091-1126.

Brana, S. and M. Maurel. 2000. "Barter in Russia : Liquidity Shortage Versus Lack of Restructuring." William Davison Institute Working Paper No. 271, May.

Carlin, W., S. Fries, M. Schaffer and P. Seabright. 2000. "Barter and non-monetary transactions in transition countries: evidence from a cross-country survey." In P. Seabright (ed.), *The Vanishing Rouble*, 236-256. Cambridge University Press.

Commander, S. and C. Mumssen. 1998. "Understanding Barter in Russia." European Bank for Reconstruction Working Paper No. 37.

Commander, S., I. Dolinskaya and C. Mumssen. 2000. "Determinants of Barter in Russia - An Empirical Analysis," International Monetary Fund Working Paper No. 00/155, October.

DeLong, J. B. 1997. "America's Peacetime Inflation: The 1970s," in C. Romer and D. Romer (eds.), *Reducing Inflation: Motivation and Strategy*, 247-80. Chicago: NBER.

Ellingsen, T. 1998. "Payments in Kind." Stockholm School of Economics Working Paper No. 244.

Gaddy, C., and B. Ickes. 1999. "An Accounting Model of the Virtual Economy in Russia." *Post-Soviet Geography and Economics*, 40, no. 2, (March): 79-97.

Grossman, Gregory (1982) "The 'Shadow Economy' in the Socialist Sector of the USSR." in NATO: *The CMEA Five-Year Plans (1981-1985) in a New Perspective*. 99-116.

Grossman, G. 1992. "Comparative Study of Economic Systems after the Great Collapse." *Economic Review (Keizai-Kenkyu)*, 43, no. 4 (October): 298-304.

Hendley, K., B. Ickes and R. Ryterman. 2000. "Remonetizing the Russian Economy." World Bank Discussion Paper no. 400.

Ickes, B. and R. Ryterman. 1993. "Roadblock to Economic Reform: Inter-enterprise Debt and the Transition to Markets." *Post-Soviet Affairs*, 9, no. 3, (July-September): 231-52.

Jones, A. and W. Moskoff. 1989. *Perestroika and the economy: New thinking in Soviet economics*, , London: Sharpe.

Kindleberger, C. P. 1993 *A Financial History of Western Europe*, 2nd ed. Oxford: Oxford University Press.

Krueger, G. and Linz, S. 2001. "Virtual Reality: Barter and Restructuring in Russian Industry." Manuscript, Michigan State University, November.

Linz, S., and R. Martin. 1982. "Soviet Enterprise Behavior under Uncertainty." *Journal of Comparative Economics*, 6, no. 1, (March): 26-36.

Linz, S., and G. Krueger. 1998. "Enterprise Restructuring in Russia's Transition Economy: Formal and Informal Mechanisms." *Comparative Economic Studies*, 40, no. 2, (Summer): 5-52.

Lucas, R. E. Jr. 2000. "Inflation and Welfare." *Econometrica*, 68, no. 2, (March): 549-569.

Makarov, V., and G. Kleiner. 1996. “Barter in the Economy of the Transition Period.” *Matekon*, 33, no. 3, (Spring): 31-54.

Makarov, V., and G. Kleiner. 2000. “Barter in Russia: An Institutional Stage.” *Problems of Economic Transition*, 42 no. 11, (March): 51-79.

Marin, D. 2002. “Trust versus Illusion: What Is Driving Demonetization in the Former Soviet Union.” *Economics of Transition*, 10, no. 1, (January): 173-200.

Marin, D. and M. Schnitzer. 1999. “The Economic Institution of International Barter.” *Economic Journal*, 112: 293-316.

Nesterovich, N. 1998. “Reforms on the Sectoral and Enterprise Levels: Reform of the Supply System.” in M. E. Sharpe (ed.), *The destruction of the Soviet economic system: An insiders' history*, 259-65. N.Y.: Armonk.

Prendergast, C. and L. Stole. 2001. “Barter, Liquidity and Market Segmentation.” unpublished manuscript, Department of Economics, University of Chicago, March.

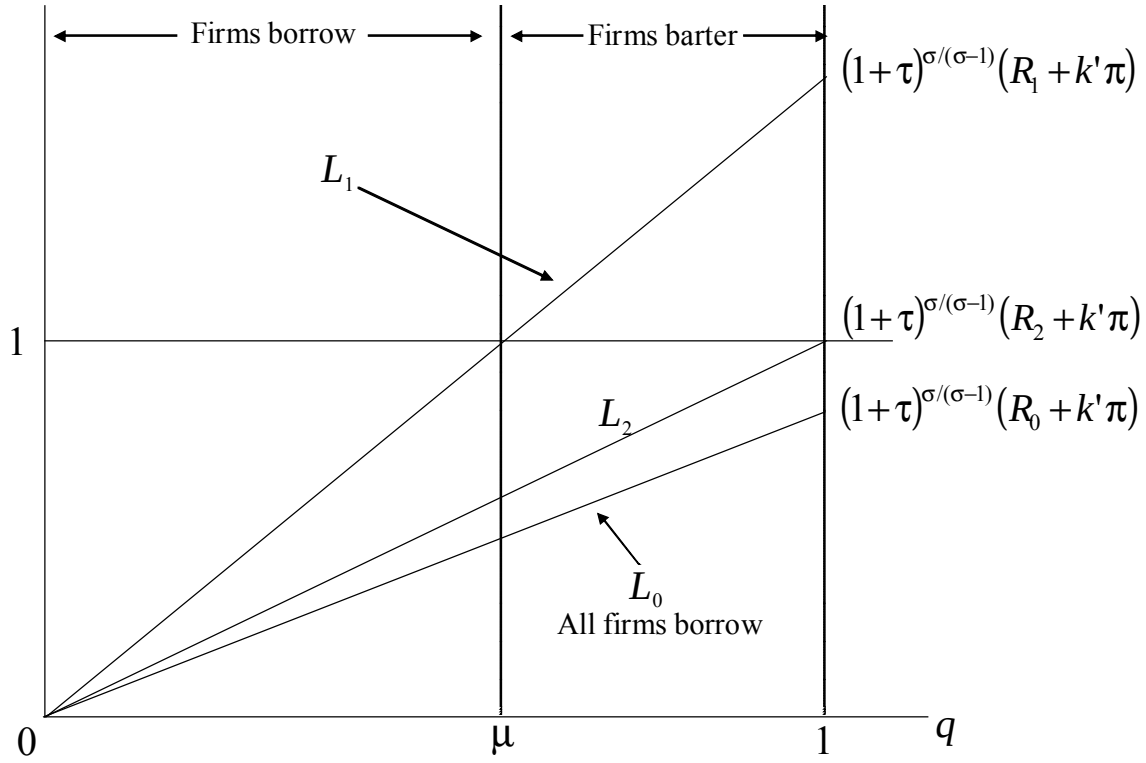
Samuelson, P. A. 1952. “The Transfer Problem and the transport Cost: The Terms of Trade when Impediments are Absent.” *Economic Journal*, 62: 278-304.

Shiller, R. J. 1997. “Public Resistance to Indexation: A Puzzle.” *Brookings Papers of Economic Activity*, 162: 159-212.

Woodruff, D. M. 1999. “Erratum: It's Value That's Virtual: Bartles, Rubles, and the Place of Gazprom in the Russian Economy.” *Post-Soviet Affairs*, 15, no. 3, (July-September): 291

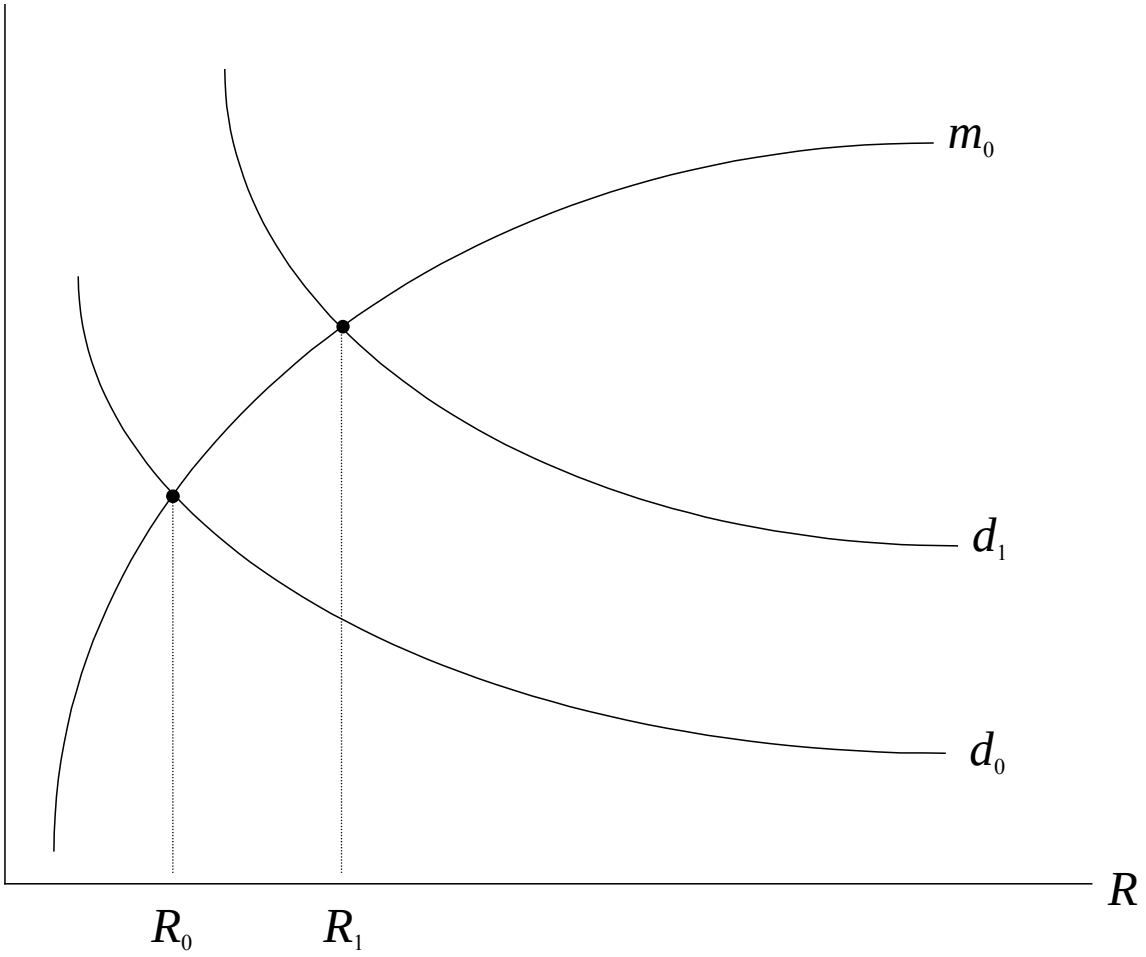
APPENDIX A

FIGURE 1



APPENDIX B

FIGURE 2



CERGE-EI
P.O.BOX 882
Politických vezòù 7
111 21 Prague 1
Czech Republic
http://www.cerge-ei.cz