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Barter, Credit, and Welfare: A theoretical inquiry into the barter phenomenon in Russia

By: José Noguera and Susan J. Linz

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by

José Noguera
CERGE-EI

Susan J. Linz
Michigan State University

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Contact Information:

Jose Noguera, P.O. Box 882, Politických věžňů 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

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Abstract

This paper develops a model to investigate the welfare implications of barter in Russia and other transition economies during the 1990s. We argue that barter is a welfare-improving phenomenon that acts as a defense mechanism against monetary instability. When firms react to tighter credit markets by switching to barter, the risk they face diminishes, allowing for a higher level of production.

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

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I. INTRODUCTION

Russian and Western scholars alike have devoted considerable attention to the causes and consequences of the growth in the volume of commodity transactions among Russian firms during the 1990s. Unlike the transition economies in Central and Eastern Europe that exhibited an increase in the use of money in transactions between firms as the emergence of product and factor markets replaced central planning, barter transactions in Russia not only continued during the transition process, but also increased over time. Figure 1 documents the relatively high the share of barter in industrial sales in Russia: increasing from 10% of total transactions in 1992, to a high of 50-60% in 1998, and a significant decline after the financial crisis in August 1998, falling to 10-15% of total industrial sales by the end of 2001. Although not seen in Figure 1, the share of barter transactions in Russia grew even as inflation declined after 1995. This is reflected in the negative correlation between barter and inflation shown in Table 1.

Barter transactions were possible at an unprecedented scale in Russia's transition economy, in part, because a double coincidence of wants routinely occurred. Food producers and processors traded goods; suppliers to construction or construction materials companies were willing to take payment in services or product. Similar types of pairings were widespread in the early 1990s, motivated in large part by deteriorating economic and financial conditions, and facilitated by the Soviet legacy of firms, which routinely, albeit unofficially, traded goods to facilitate plan fulfillment (Berliner 1957, Freris 1984, Gregory and Stuart 1986). Yet frequently, multiple firms were involved in what would have been a single transaction in a cash economy. Barter chains emerged as Russian enterprise directors negotiated for the acquisition of inputs, sales and delivery of output, and means for payment of their workers in cash or in-kind.[1]

[1] Humphrey (2000) identifies three different kinds of barter arrangements involving more than two firms: (i) lineal barter chains with a series of discrete swaps; (ii) star-shaped barter chains, where "a trader at the center makes a series of deals between himself and a number of other firms in order to convert the product he starts with into the good he wants (usually money)"; and (iii) circular barter chains, where the initial transactor is also the end transactor in a series of trades. See also Clarke (2000), Ledeneva and Seabright (2000) and Linz (2001).

While competing explanations regarding the cause of barter transactions in Russia exist, all relate in some way to financial considerations, either at the macroeconomic or microeconomic level. Litwak (1997), Pissarides *et al* (2002), and others observe the serious constraints faced by Russian entrepreneurs on external financing.[2] In many analyses of barter transactions in Russia, however, the distinction between (and relative importance of) macroeconomic and microeconomic financial conditions is not clearly delineated. This has contributed to two strands in the literature – one strand views barter as a choice made by firms and one strand views barter as dictated by circumstance.

Three major explanations argue that barter is a choice made by firms. One explanation involves the "virtual economy" hypothesis where firms use barter to hide revenues and exaggerate costs in order to avoid restructuring (Gaddy and Ickes 1998, 2002; Goldman 1998a, 1998b). Another explanation states that barter allows firms to take advantage of their monopoly power to price discriminate (Guriev and Kvassov 2004; Ellingsen 1998; Prendergast and Stole 1996). In a third explanation, firms choose barter to avoid taxation. Russia's tax system prior to 1998 was confiscatory, based on revenues and not on profits. Thus, it was rational to avoid taxes because they could account for up to 120% of revenues. Moreover, during the early stages of Russia's transition, tax payment was due upon payment for the transaction. In Russia's near hyper-inflationary environment between 1992 and 1995, delaying payments significantly reduced the actual tax burden (Aukutsionek 1998, 2001).

Among the analyses that view barter transactions in transition economies as dictated by circumstance, one branch of the literature argues that barter results from "poor" financial circumstances driven by under-developed institutions. One such argument is based on the poor payment system in Russia during the 1990s when monetary payments going through the banking system took up to six months to clear. In this environment, barter represented a quicker and cheaper way to conduct transactions (Goldman 1998a, 1998b; Hendley *et al* 1998; Kuznetsov and Kuznetsova 2003; Yakovlev 2000).

Another set of explanations refer to Russia's fiscal and monetary policies. When the federal government issued short-term bonds (GKOs) to finance their expenditures, loans became too costly, and firms moved away from using banks (Dutta 2000; Pinto *et al* 2000, Posner 1998).

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[2] Litwak (1997) reports that credit to the non-financial sector in Russia fell from 20% of GDP in 1993 to less than 10% in 1996 as the GKO market developed. For a discussion of the lack of access to bank financing by firms, see

High interest rates generated by government policies contributed to create credit-rationing situations, obliging firms to engage in barter transactions to survive until economic and financial conditions improve (Bevan *et al* 2001; Brana and Maurel 2000; Commander and Mummsen 2000; Commander *et al* 2002; Linz and Krueger 1998; Makarov and Kleiner 1996, 2000; Marin 2002; Marin and Schnitzer 1999). At the same time, however, when interest rates are high, firms not facing cash constraints may also be better off if they lend their cash and switch to barter (Linz and Luca 2002). In any case, the interest rate is the key explanatory variable. Regardless of whether the cause of barter is choice or circumstance, both of these situations generate a multiplier effect that spreads barter from particular pairs of firms to the rest of the economy.

In addition to debate over whether barter is voluntary or involuntary, a second debate focuses on whether the unprecedented scale of barter transactions has been a positive or a negative phenomenon for Russia and other transition economies. There is a strong division on this issue. The virtual economy explanation considers barter as a negative phenomenon since it allows firms to avoid restructuring (Gaddy and Ickes 1998, 2002). Guriev *et al* (2002) assert that barter transactions among firms in distressed financial conditions have external negative effects on profitable firms and thus undermine efficiency. Carlin *et al* (2000) claim that barter has negative impact on productivity in Russia. Kim and Pirttila (2004) maintain that barter causes cash prices to fall, sending recession signals. On the other hand, Commander *et al* (2002) and others claim that, with an economy in recession, barter allows output to rise, or at least not to fall. Ellingsen (1998) claims that barter improves the welfare of the firm.

The present paper contributes to the barter literature in several ways. First, the previous work on barter transactions in transition economies sees the welfare issue associated with barter transactions from the point of view of firms and production. We consider the welfare issue not only from the point of view of producers, but also consumers. Second, most of the previous work on barter transactions in transition economies has been empirical in nature and, as far as we know, none of the previous work uses welfare theory to provide an answer to question of whether barter has been a positive or negative phenomenon in Russia or other transition economies. We set up a general equilibrium model and use the tools of welfare theory to provide a more definitive answer to this question. Third, most of the previous literature links the emergence and growth of barter to the deterioration of a number of important macroeconomic

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Schoors (2001) and Gara (2001).

indicators. We incorporate these observed linkages. However, we analyze the problem from a different perspective than is found in the existing literature. We compare an economy that has access to a barter technology to an identical economy without access to barter. In this way, we can properly assess whether the existence of barter has had positive or negative effects.

Section II presents the model and analyzes its operation. The model concentrates on fiscal and monetary factors, but does not consider the virtual economy and price discriminating explanations.[3] While the model captures the transition environment in several ways, it is not as well-suited to analyzing barter transactions in developed market economies. In developed market economies, like the USA or the UK, for example, barter is a growing industry because the costs associated with finding a partner are reduced with the use of modern computers and the internet. Indeed, barter has become more common, especially among small firms, in the last two decades as information acquisition opportunities expanded (Marvasti and Smyth 1999). In developed market economies, barter works alongside a well-established financial sector and does not cause any information asymmetric problem, yet barter is unlikely to become a significant part of total transactions. In contrast, in transition economies, especially in Russia's transition economy, barter has been a large share of total transactions, caused in part by under-developed and mal-functioning financial markets and the mismanagement of monetary policies, and in part by the incentive and opportunity to use barter has as a tool for tax evasion. The model we develop to analyze barter transactions in transition economies is thus not suited for a similar analysis of barter transactions in developed market economies[4].

Section III examines the welfare implications of bartering. We look at the effect of barter on firms' production as well as consumers' utility. Section IV focuses on the barter phenomenon in Russia, and offers concluding remarks.

II. THE MODEL

The model consists of four kinds of agents: households, firms, lenders and a government. Households demand consumption goods. Each firm has a monopoly on the goods it sells. This

[3] Ivanenko (2004), Marin (2002), and Marin and Schnitzer (1999) find strong empirical evidence against the virtual economy.
[4] Kutnetsov and Kuznetsova (2003), and Pyle (2001) provide deeper analyses comparing barter in Russia and barter in western economies.

reflects the highly imperfect market structure of the Russian economy.[5] In fact, Russia's price liberalization in the early 1990s was widely criticized as strengthening the monopolies created during the Soviet planned economy.

Firms may or may not own cash to finance their transactions. Assume that there is a continuum [0,1] of cashless firms, and another [0, 1] of cash-owing firms. Lenders are risk-neutral and the sole holders of financial wealth.

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

(1) $$U = \sum_{t=0}^{\infty} \beta^t u_t \qquad \beta \in (0, 1)$$

where $u_t = \left[\int_0^1 d_t(i)^{\rho} di + \int_0^1 d_t(j)^{\rho} dj \right]^{1/\rho}$, $\rho \in (0, 1)$, and $d_t(i)$ and $d_t(j)$ are the household's consumption of good *i* and *j*, respectively, and *i* and *j* denote the goods produced by cashless firms and cash-owing firms respectively. Since we are free to choose the units of measurement for output, we choose real wages. Then, the household's budget constraint can be written as $\int_0^1 P_{it} d(i) di + \int_0^1 P_{jt} d(j) dj = 1$, where P_{it} (P_{jt}) is the price of good *i* (*j*) at time *t*. The household's problem is to maximize its utility function *U* subject to the budget constraint. If we assume a continuum [0,1] of households, the solution to this problem also gives total households' demand functions as $D_{it}^h = P_{it}^{-\sigma}$ and $D_{jt}^h = P_{jt}^{-\sigma}$, where $\sigma \equiv 1/(1 - \rho)$ is the elasticity of substitution between two goods.

Government's total real expenditure, g_t , is financed in part by the tax revenue, S_t, and in part by the issue of new debt, $b_t - b_{t-1}$. Consequently, the government's budget constraint is

(2) $$g_t = S_t + \left(b_t - R_t b_{t-1}\right),$$

where R_t is the real gross interest rate. For simplicity's sake, assume the government distributes its expenditures in the same way as households, so its demand function for goods *i* and *j* are $D_{it}^g = P_{it}^{-\sigma} g_t$ and $D_{jt}^g = P_{jt}^{-\sigma} g_t$. Thus, total demand for each good is

(3) $$D_{it} = P_{it}^{-\sigma}\left(1 + g_t\right) \text{ and } \qquad D_{jt} = P_{jt}^{-\sigma}\left(1 + g_t\right).$$

[5] Rosefielde (1999) analyzes why all power-seeking behaviors, including monopolies and other market imperfections, are decriminalized in Russia.

Firms. To conduct transactions, firms can use either cash or barter. There are two states of nature: good and bad. The good state occurs with probability q, and to produce x units of good i (j), firm i (j) incurs the cost function $C(x) = cx$, where $c > 0$. However, in the bad state, firm i (j) sees its costs increased by a factor $1/h_i (1/h_j)$, where $0 < h_i, h_j < 1$; thus its cost function turns to $C_i(x) = \frac{c}{h_i} x$ or $C_j(x) = \frac{c}{h_j} x$; the lower h_i (h_j) the riskier firm i (j)'s project. Suppose that in the bad state, firm's receipts are not enough to cover costs[6].

Cashless Firms. Consider first a firm that owns no cash. Let x_{it}^{ml} and P_{it}^{ml} denote output and price respectively that the cashless firm i sets at time t if it uses cash transactions. The superscript "*m*" denotes that the firm uses cash to make transactions and the superscript "*l*" denotes that it is cashless. If the firm owns no money, the firm can obtain a loan, using production as collateral. In the good state, the firm pays back the loan at the real gross interest rate R_t. In the bad state, the lender obtains the firm's output and thus the firm has zero profit. Therefore, firm i's expected profit is

$$E\pi_{it}^{ml} = q\left(P_{it}^{ml} x_{it}^{ml} - cR_t x_{it}^{ml}\right).$$

The cashless monopolist chooses the price-quantity combination that maximizes its expected real profits. Using (3) we find

(4) $$P_{it}^{ml} = cKR_t,$$

where $K = 1/\rho$ is the markup of the unit cost. The higher the real interest rate, the higher the relative price firm j sets. From (3) and (4), we obtain

(5) $$x_{it}^{ml} = (1 + g_t)(cKR_t)^{-\sigma}.$$

Output is decreasing with respect to the interest rate, and both output and relative prices are independent of the firm's project risk. Output also increases as government debt increases. This is because monopolies react by increasing production as the demand for their products increases. Firm j's before-tax expected profit if it uses cash for transactions is

(6) $$E\pi_{it}^{ml} = \frac{K-1}{K^{\sigma}} q(1 + g_t)(cR_t)^{1-\sigma}.$$

[6] Below it will be clear why we have chosen to introduce h_j in the denominator.

Suppose now that firms have the network and/or social capital necessary for engaging in barter transactions; that is, firms have access to a barter technology. Consider a firm that chooses not to ask for cash loans, but instead asks for barter credit -- the firm chooses to "borrow" the inputs needed from other firms and arranges to repay the loan in goods produced from these inputs. Marin and Schnitzer (2003) offer an excellent analysis of how barter is used to collateralize trade credit.

Barter credit transactions impose upon the firm costs that would not be incurred if the firm conducted cash transactions only. To model the barter technology in a simple way, we assume that the barter credit cost takes an iceberg form: when a firm finances its inputs using barter credit, for every unit of good *j* sold, a fraction $\tau > 0$ evaporates.[7] Thus, its before-tax expected profit function becomes

$$E\pi_{it}^{bl} = (1-\tau)P_{it}^{bl}x_{it}^{bl} - \left(q + \frac{1-q}{h_i}\right)cx_{it}^{bl},$$

where P_{it}^{bl} and x_{it}^{bl} denote price and output of firm *i* at time *t* if the firm is cashless and conduct barter transactions. In this case, from the monopoly problem we obtain

$$(7) \qquad P_{it}^{bl} = \frac{cK}{1-\tau}\left(q + \frac{1-q}{h_i}\right).$$

The price is lower when the barter technology becomes less cumbersome (lower τ) or the project is less risky (higher h_i). From (3), the firm's output is

$$(8) \qquad x_{it}^{bl} = \left(\frac{cK}{1-\tau}\right)^{-\sigma}\left(q + \frac{1-q}{h_i}\right)^{-\sigma}(1+g_t).$$

Output increases if there is a lower barter cost or less risky projects. As in the previous case, it also increases as government debt increases. The expected profit for firm *j* if it barters is

$$(9) \qquad E\pi_{it}^{bl} = \frac{K-1}{K^{\sigma}}c^{1-\sigma}(1-\tau)^{\sigma}\left(q + \frac{1-q}{h_i}\right)^{1-\sigma}(1+g_t).$$

Unlike the cash credit case, the factor h_i is present here. This occurs because the firm, not the lender, faces the risk when barter is employed.

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[7] The idea of iceberg cost was proposed by Samuelson (1952) as a shortcut to incorporate some costs in a model without the need of endogenize the working of that particular industry. That approach is widely used in the new economic geography and evolutionary economics literatures (see Fujita et al 2000).

Consider now the firm's decision about whether to barter or borrow. Cashless firm *j* asks for a loan if this generates higher after-tax profit; that is, if the after-tax expected profit using cash transactions is higher than that using barter. Let s_t denote the tax rate paid by firms that conducts cash transactions. Thus, firm *i*'s after-tax expected profit if it conduct cash transactions is $(1-s_t)E\pi_{it}^{ml}$. Since firms that engage in barter have better opportunities to evade taxes (Marin, Kaufmann and Gorochowskij 2000), assume that the firm conducting barter transactions evades taxes such that its net profit increase by a factor ϕ, where $1<\phi<1/(1-s_t)$. That is, if firm *i* conducts barter transactions, its after-tax expected profit is $\phi(1-s_t)E\pi_{it}^{bl}$. Thus, from (6) and (9) and a bit of algebra, cashless firm *i* conduct cash transactions if

$$h_i < \frac{1-q}{(\phi/q)^{1/(\sigma-1)}(1-\tau)^{\sigma/(\sigma-1)}R_t - q}. \tag{10}$$

Observe also that the higher the barter cost (τ), the bigger the right-hand side in (10). In this situation, the inequality tends to hold, and fewer firms will choose to barter. As τ increases, barter eventually becomes unaffordable. This echoes the traditional literature, which considers barter as so inefficient that it is always dominated by some medium of exchange. On the other hand, ϕ represents the tax evasion incentive to barter. The higher the tax evasion incentive (higher ϕ), the smaller that right-hand side in (10), and thus, the higher the incentive to engage in barter activities.

In this paper, we assume that τ is small enough so as to make the barter technology feasible. Define μ as follows:

$$\mu_t^l = Min\{1, Z^l(R_t, \tau, \phi)\}, \tag{11}$$

where $Z^l(R_t, \tau, \phi) = \frac{1-q}{(\phi/q)^{1/(\sigma-1)}(1-\tau)^{\sigma/(\sigma-1)}R_t - q}$. μ_t^l is the cutoff risk level that makes a firm indifferent between conducting either cash or barter transactions. If the real interest rate (R_t) is such that $Z^l(R_t, \tau, \phi) \geq 1$, inequality (10) always holds and all cashless firms conduct cash transactions. Yet, as R_t increases, μ_t^l eventually becomes less than one; firm *i* will choose to barter if $h_i > \mu_t^l$, and ask for a loan otherwise. In other words, firms whose projects have a high probability of success choose to barter, and those with probability of success less than μ prefer to use cash for transactions.[8] The fact that the safest firms tend to use barter credit and the riskiest firms use cash credit suggests that it must be easier to enforce payment to firms using barter credit than to firms using cash [Marin and Schnitzer (1999), p. 293].

Firms Owning Cash. A firm that owns cash can use the cash to finance its project or lend it and ask for barter credit. If it uses its cash to finance its project, then it bears the risk. Thus, firm *j*'s expected profit becomes

$$E\pi_{jt}^{mc} = P_{jt}^{mc} x_{jt}^{mc} - \left[q + \frac{1-q}{h_j} \right] c x_{jt}^{mc} - (R_t - 1) c x_{jt}^{mc},$$

where the superscript "*c*" denotes that the firm own cash. The last term reflects the opportunity cost of using cash instead of lend it. The firm sets the price-quantity combination that maximize its profit,

$$(12) \qquad P_{jt}^{mc} = cK\left(q + \frac{1-q}{h_j} + R_t - 1 \right) \quad \text{and} \quad x_{jt}^{mc} = (cK)^{-\sigma} \left(q + \frac{1-q}{h_j} + R_t - 1 \right)^{-\sigma} (1 + g_t).$$

The firm's profit is

$$(13) \qquad E\pi_{jt}^{mc} = \frac{K-1}{K^{\sigma}} c^{1-\sigma} \left(q + \frac{1-q}{h_j} + R_t - 1 \right)^{1-\sigma} (1 + g_t).$$

On the other hand, if the firm lends the cash and asks for barter credit, its expected profit function becomes

$$E\pi_{jt}^{bc} = (1-\tau) P_{jt}^{bc} x_{jt}^{bc} - \left[q + \frac{1-q}{h_j} \right] c x_{jt}^{bc}.$$

In this case, the price-quantity combination that maximize the firm's profit is

$$(14) \qquad P_{jt}^{bc} = \frac{cK}{1-\tau} \left(q + \frac{1-q}{h_j} \right) \text{and} \qquad x_{jt}^{bc} = \left(\frac{cK}{1-\tau} \left(q + \frac{1-q}{h_j} \right) \right)^{-\sigma} (1 + g_t),$$

and firm *j*'s profit becomes

$$(15) \qquad E\pi_{jt}^{bc} = \frac{K-1}{K^{\sigma}} c^{1-\sigma} (1-\tau)^{\sigma} \left(q + \frac{1-q}{h_j} \right)^{1-\sigma} (1 + g_t).$$

[8] The fact that the less risky firms quit the credit market as interest rates increase is a consequence of the lemons argument and is one of the main conclusions in the credit rationing literature, see Jaffee and Stiglitz (1990) for a survey in credit rationing. The lemons argument in the context of the barter literature in Russia is also recognized in Huang, Marin and Xu (2004).

Thus, from (13) and (15), firm *j* obtains higher profit financing the project with its own resources if

(16) $R_t - 1 < Z^c(h_j, \tau, \phi)$, where $Z^c(h_j, \tau, \phi) = \left(q + \frac{1-q}{h_j}\right)\left((1-\tau)^{\sigma/(1-\sigma)} \phi^{1/(1-\sigma)} - 1\right)$.

Define μ_t^c such that

(16a) $R_t - 1 = Z^c(\mu_t^c, \tau, \phi)$.

The right-hand term in (16) is positive if $(1-\tau)^\sigma \phi < 1$. This reflects the fact that, for firms to have the incentive to use cash, the barter cost cannot be too small. Assume thus that $(1-\tau)^\sigma \phi < 1$. When the interest rate is low, the left-hand term in the last inequality is small and firms holding cash use their financial resources to finance their investment. However, as the interest rate increases, the left-hand term in (16) also increases. Eventually, the inequality does not hold and firms with financial resources find it convenient to switch into barter activities and lend the cash. As in the case of cashless firms, the less risky firms have the highest incentive to engage in barter activities.

Notice that in the deduction of inequalities (10) and (16), we have assumed that firms are monopolists. Are these results robust to that assumption? Since the markup *K* decreases as markets become more competitive, and since *K* does not appear in (10) and (16), we conclude that results are robust as long as markets are imperfect. When markets are perfectly competitive, *K* = 1 and $E\pi_{it}^{bl} = E\pi_{it}^{bc}$. Thus, firms are indifferent between using cash or conducting barter transactions. It will be apparent that the results below hold for any *K* > 1 and so they are also robust to the market structure assumption.

Output and Output Value. Let us compare output and output value when the firm decides to switch into barter activities. Consider a cashless firm. From (5), (8) and (11), $x_{it}^{bl} > x_{it}^{ml}$ when the firm switches to barter if

(17) $\tau > 1 - q/\phi$.

For cash-owing firms, from (12) and (14), $x_{it}^{bc} > x_{it}^{mc}$ when the firm engages into barter if

(18) $\tau > 1 - 1/\phi$.

By assumption, $q<1$ and $\phi>1$. Thus, the last two inequalities state that the firm increases output when it engages in barter activities if the barter cost is high. The reason is that, if the barter cost is too high, by the time firms decide to engage in barter, the interest rate is very high and the output produced by firms conducting cash transactions is already too small.

Notice also that inequalities (17) and (18) do not hold if the tax incentive to barter (ϕ) is too big. The reason is that when the tax incentive to barter, tax evasion allow firms to obtain much higher after-tax profits, so firms respond by reducing output in order to diminish risk. By construction, ϕ is upper-bounded by $1/(1-s_t)$. Thus, a sufficient condition for (17) and (18) to hold is that $\tau > s_t$, that is, barter cost is greater than the tax rate. On the other hand, if the tax incentive to barter is small (low ϕ), inequality (18) always holds and cash-owing firms always increase output when they engage in barter activities.

<u>Lemma 1</u>: When firms switch to barter activities, we have that

(a) If the barter cost is high, so (17) and (18) hold, firms increase output. A sufficient condition for this to happen is that $\tau > s_t$;

(b) If the tax evasion incentive to barter is too high, firms decrease output;

(c) If the tax incentive to barter is small, cash-owing firms always increase output;

If conditions (17) and (18) hold, as interest rates increase, firms that keep using cash decrease output and those switching into barter increase output. Thus, the net effect on total output will depend on the distribution function. However, Figure 2 suggests that aggregate output decreases as barter was increasing. Table 1 confirms this suggestion showing that the correlation between both variables (-0.78) is negative and significant.[9] These findings suggest that either conditions (17) and (18) may not hold or the decrease in output of all firms that keep using cash is higher than the increase of those that switch into barter. In any case, firms that were previously conducting barter transactions maintain their output level.

Russia has access to barter technology but would have Russia done better if it did not have access to barter? Let us find aggregate output assuming that firms have access to barter, and compare it to the aggregate output, assuming that firms do not have access to barter. Since (17)

[9] Commander and Mummsen (2000) and Commander *et al* (2002) provide more exhaustive empirical support to this finding.

and (18) may not hold if the tax evasion incentive to barter ϕ is too high, for the purpose of this exercise and for the sake of simplicity, assume that $\phi = 1$.

Consider first the case of cashless firms. Let Q_t^{ml} denote the aggregate output of cashless firms conducting cash transactions. From (4) and (5), we have

$$Q_t^{ml} = (cKR_t)^{1-\sigma}(1+g_t)H(\mu_t),$$

where $H(\mu_t) = \int_0^{\mu_t^l} f^l(h_i)dh_i$ is the distribution function that characterize the distribution of h_i across cashless firms and $f^l(h_i)$ its associated density functions. Assume that $f^l(h_i)$ is continuous and bounded. From (7) and (8), we obtain aggregate output of cashless firms conducting barter transactions

$$Q_t^{bl} = \left(\frac{cK}{1-\tau}\right)^{1-\sigma}(1+g_t)\int_{\mu_t^l}^{1}\left(q+\frac{1-q}{h_i}\right)^{1-\sigma} f(h_i)dh_i .$$

The cashless firms' aggregate output is $Q_t^l = Q_t^{ml} + Q_t^{bl}$. On the other hand, from (4) and (5), aggregate output of cashless firms if they did not have access to barter is $Y_t^l = (cKR_t)^{1-\sigma}(1+g_t)$. Considering (11), we have

$$(19)\qquad Q_t^l - Y_t^l = (cK)^{1-\sigma}(1+g_t)J_1(\mu_t^l)$$

where
$$J_1(\mu_t^l) = H(\mu_t^l) - 1 + \frac{q}{1-\tau}\left(q+\frac{1-q}{\mu_t^l}\right)^{\sigma-1}\int_{\mu_t^l}^{1}\left(q+\frac{1-q}{h_i}\right)^{1-\sigma} f(h_i)dh_i .$$

When the interest rate is small, so $\mu_t^l = 1$, $J_1(1) = 0$, and $Q_t^l = Y_t^l$. Suppose now that the interest rate is high enough so $\mu_t^l < 1$. Taking derivatives with respect to μ_t^l,

$$\frac{dJ_1(\mu_t^l)}{d\mu_t^l} = \left(1-\frac{q}{1-\tau}\right)f(\mu_t^l) - \frac{q(\sigma-1)(1-q)}{(1-\tau)(\mu_t^l)^2}\left(q+\frac{1-q}{\mu_t^l}\right)^{\sigma-2}\int_{\mu_t^l}^{1}\left(q+\frac{1-q}{h_i}\right)^{1-\sigma} f(h_i)dh_i .$$

If the interest rate increases to more than R^l, where $Z^l(R^l, \tau, \phi) = 1$, some cashless firms switch to barter. The second term is always negative. If $\tau > 1-q$, the first term in $dJ_1 / d\mu_t^l$ is negative and thus $dJ_1 / d\mu_t^l < 0$.Yet, if $\tau > 1-q$ the first term in $dJ_1 / d\mu_t^l$ is positive and the sign is undetermined. Thus, we may conclude that there exist $\tau^* \in [0,1-q]$ such that for $\tau > \tau^*$,

$dJ_1 / d\mu_t^l < 0$ and as the interest rate increases, μ_t^l decreases, the difference $Q_t^l - Y_t^l$ increases, and cashless firms' aggregate output is higher if they have access to a barter technology than if they do not have access.

Given τ, since $H(\mu_t^l)$ is bounded and $Q_t^l > Y_t^l$ as μ_t^l tends to zero in (19), there exist μ^* such that $Q_t^l > Y_t^l$ for any $\mu > \mu^*$. Thus, if the interest rate is high enough, cashless firms' aggregate output is higher if they have access to a barter technology than if they do not. The reason is that, as the interest rate keeps increasing, firms using cash reduce output, but the firm's output has a lower bound if it has access to barter.

Now, let Q_t^c and Y_t^c denote cash-owing firms' aggregate output in the case when they have access to barter and when they do not, respectively. From (12), (14) and (16a),

$$Q_t^c - Y_t^c = (cK)^{1-\sigma}(1+g_t)(1-\tau)^{\sigma-1} J_2(\mu_t^c),$$

where $J_2(\mu_t^c) = (1-\tau)^{(2\sigma-1)/(\sigma-1)} \int_{\mu_t^c}^{1} \left(q + \frac{1-q}{h_j} \right)^{-\sigma} f^c(h_j) dh_j + \int_{\mu_t^c}^{1} \left(q + \frac{1-q}{h_i} \right)^{1-\sigma} f^c(h_j) dh_j$ and $f^l(h_i)$ is the density function cash-owing firms. It is apparent that $J_2(1) = 0$ and that $dJ_2 / d\mu_t^c < 0$. Thus, when the interest rate increases, cash-owing firms' aggregate output is higher if firms have access to barter than when they do not. The following lemma summarizes the previous discussion:

<u>Lemma 2</u>: Assume that the tax incentive to barter (ϕ) is small enough, so firms are better off conducting cash transactions when the interest rate is very low, then,

(a) Cash-owing firms' aggregate output is higher if firms have access to barter transactions than if they do not $(Q_t^c > Y_t^c)$;

(b) There exist a barter cost τ^*, $0 < \tau^* < 1 - q$, such that for any $\tau > \tau^*$, cashless firms' aggregate output is higher if firms have access to barter transactions than if they do not $(Q_t^l > Y_t^l)$.

(c) There exists a risk level μ^*, such that for any $\mu > \mu^*$, cashless firms' aggregate output is higher if firms have access to barter transactions than if they do not $(Q_t^l > Y_t^l)$.

Figure 3 illustrates these results. R^l is the interest rate if $Z^l(R^l, \tau, \phi) = 1$. For $R \le R^l$, we have $Q^l = Y^l$. For $R > R^l$, there are two cases. When $(\tau > \tau^*)$ (see Figure 3.a), $Q^l > Y^l$ always. But, when $(\tau < \tau^*)$ (see Figure 3.b), $Q^l < Y^l$ for $R^l < R < R^*$, but $Q^l > Y^l$ as the interest rate becomes large, $R > R^*$. The case of aggregate output for cash-owing firms is depicted in Figure 3.a. To compare aggregate output, we must consider $Q = Q^l + Q^c$ and $Y = Y^l + Y^c$. For $R > R^*$, $Q > Y$ and for $R > R^*$, the inequality can go either way. Yet, in any case, access to barter technology imposes a lower bound to the aggregate output. This conditions does not hold if the economy does not have access to the alternative transaction technology.

III. WELFARE IMPLICATIONS OF BARTER

To evaluate the welfare implications of barter, we define credit market equilibrium conditions and consider alternative scenarios to analyze the fiscal policy impact on interest rates and individuals' welfare.

Credit Market Equilibrium

Lenders and borrowers meet in the credit market to arrange loans. Borrowers' total real demand for loans (d_t^l) is the sum of government bonds (b_t) plus the production cost of cashless firms:

$$d_t^l = b_t + \int_0^{\mu_t^l} c x_{it}^{ml} f(h_i) dh_i \ .$$

Using (5) to solve the integral, we find

$$d_t^l = b_t + c^{1-\sigma} (K R_t)^{-\sigma} F(\mu_t^l)(1 + g_t)$$

where $F(\mu_t^l) = \int_0^{\mu_t^l} f(h_i) dh_i$. The demand for loans d_t^l is a decreasing function with respect to the real interest rate.

On the supply side, we assume that lenders cannot distinguish among borrowers and so there is a Stiglitz-Weiss loans supply curve, according to which the credit supply is an increasing function of the interest rate up to a point $\overline{R}$. If the interest rate increases beyond that point, the loans supply curve becomes negatively sloped, and tighter credit markets result in credit rationing (see Stiglitz and Weiss 1981). Denote the loans supply curve by $W(R_t)$, where $W'(R_t) > 0$ for $R_t < \overline{R}$, and $W'(R_t) < 0$ for $R_t > \overline{R}$.

When interest rates are high, a situation of credit rationing occurs. Cashless firms with access to barter have no other choice but to barter to avoid shutting down. In these circumstances, barter is a welfare-enhancing alternative. A more interesting analysis involves the welfare implications of barter when it is the result of a voluntary decision.[10] Below we discuss both cases.

Credit market equilibrium condition is given by the following equation:

(20) $W(R_t) = b_t + c^{1-\sigma}(KR_t)^{-\sigma} F(\mu_t^l)(1+g_t)$.

Given parameters ρ and *c*, the distribution of firms according to risk, $f^l(h_t)$ and $f^c(h_t)$, the barter cost τ and government debt b_t, equations (4), (5), (7), (8), (11), (12), (14), (16) and (20) is a system of equations that characterizes prices and output set by every firm, x_{jt}^{mi}, P_{jt}^{mi}, P_{jt}^{bi} and x_{jt}^{bi} (for $i = c, l$), the interest rate, R_t and the cutoff points, μ_t^l and μ_t^c.

Lemma 4: Assuming that $R_t < \bar{R}$, the interest rate is an increasing function of government debt, the barter cost, the tax incentive to barter and the credit market risk.

Proof: Define $V = W(R) - b - c^{1-\sigma}(KR)^{-\sigma} F(\mu^l)(1+g)$; since $\partial\mu_t^l / \partial R_t < 0$, then

$$\frac{\partial V}{\partial R} = W'(R_t) + c^{1-\sigma}(KR_t)^{-\sigma}(1+g_t)\left[\sigma F(\mu_t^l)/R_t - f(\mu_t^l)(\partial\mu_t^l/\partial R_t)\right] > 0$$

Notice that $\frac{\partial R_t}{\partial b_t} = -\frac{\partial V/\partial b_t}{\partial V/\partial R_t}$ and from (2) an increase in government debt, b_t, must be accompanied by either a decrease in tax revenue, $db_t = -dS_t$ or an increase in government spending, $db_t = dg_t$. Thus, assume first that $db_t = -dS_t$, so $dg_t = 0$ then $\frac{\partial R_t}{\partial b_t} = \frac{1}{\partial V/\partial R_t} > 0$. If $db_t = dg_t$, we have $\frac{\partial R_t}{\partial b_t} = \frac{1 + c^{1-\sigma}(KR_t)^{-\sigma} F(\mu_t^l)}{\partial V/\partial R_t} > 0$. Thus, the interest rate in increasing with respect to government indebtedness b_t.

$$\frac{\partial R_t}{\partial \tau} = \frac{f(\mu_t^l)(\partial\mu_t^l/\partial\tau)}{\partial V/\partial R_t} \quad \text{and} \quad \frac{\partial R_t}{\partial \phi} = \frac{f(\mu_t^l)(\partial\mu_t^l/\partial\phi)}{\partial V/\partial R_t}.$$

From (11), it is apparent that $\partial\mu_t^l/\partial\tau > 0$ and $\partial\mu_t^l/\partial\phi > 0$, so the interest rate is increasing with respect to the barter cost τ and the tax incentive to barter ϕ. Finally, notice from (11) that the credit market risk increases as μ_t^l decreases. Therefore, since $\frac{\partial R_t}{\partial \mu_t^l} = \frac{-f(\mu_t^l)}{\partial V/\partial R_t} < 0$, we conclude that interest rate is increasing with respect to the credit market risk.

[10] Noguera (2004) provides an analysis of voluntary and involuntary barter in Russia.

Q.E.D.

Let us now turn to welfare considerations. For that purpose, we consider only variables in steady state. This also allows us to drop the time subscript *t*. Since monotonic transformations of utility functions still represent the same preferences, using (1) we define the welfare function as

$$\Omega = \int_0^1 d(i)^\rho di + \int_0^1 d(j)^\rho dj .$$

In equilibrium, supply equals demand for every good *i* (*j*) so $x_i = d_i (x_j = d_j)$. Firms with $h_i < \mu^l (h_j < \mu^c)$ conduct monetary transactions, and all others barter. Thus, we can write individuals' welfare as

$$\Omega = \int_0^{\mu^l} (x_i^m)^\rho di + \int_{\mu^l}^1 (x_i^b)^\rho di + \int_0^{\mu^c} (x_j^m)^\rho dj + \int_{\mu^c}^1 (x_j^b)^\rho dj .$$

From (5), (8), (12) and (14) we have

(21) $$\Omega = (cK)^{1-\sigma}(1+g)^\rho (\Omega^l + \Omega^c), \qquad \text{where}$$

$$\Omega^l = \int_0^{\mu^l} R^{1-\sigma} f(h_i) dh_i + \int_{\mu^l}^1 \left(\frac{1}{1-\tau}\right)^{1-\sigma} \left(q + \frac{1-q}{h_i}\right)^{1-\sigma} f(h_i) dh_i \text{ and}$$

$$\Omega^c = \int_0^{\mu^c} \left(q + \frac{1-q}{h_j} + R - 1\right)^{1-\sigma} f(h_j) dh_j + \int_{\mu^c}^1 \left(\frac{1}{1-\tau}\right)^{1-\sigma} \left(q + \frac{1-q}{h_j}\right)^{1-\sigma} f(h_j) dh_j .$$

To find the impact of an expansion of government indebtedness and the barter cost on the individual's utility, assuming there is no credit rationing, we find[11]

$$\frac{d\Omega}{db} = (cK)^{1-\sigma}(1+g_t)^\rho \left(\frac{d\Omega^l}{dR} + \frac{d\Omega^c}{dR}\right)\frac{dR}{db} \qquad \text{and}$$

(22a) $$\frac{d\Omega^l}{dR} = (1-\sigma)\int_0^{\mu^l} R^{-\sigma} f(h_i) dh_i + \frac{\partial \mu^l}{\partial R} f(\mu^l)\left[R^{1-\sigma} - (1-\tau)^{\sigma-1}\left(q + \frac{1-q}{\mu^l}\right)^{1-\sigma}\right] \qquad \text{and}$$

(22b) $$\frac{d\Omega^c}{dR} = (1-\sigma)\int_0^{\mu^c} \left(q + \frac{1-q}{h_j} + R - 1\right)^{-\sigma} f(h_j) dh_j$$

[11] We assume that *db* = –*dS* so $dg_t = 0$, since this seems to be the case of Russia in the 1990s.

$$+\frac{\partial \mu^c}{\partial R} f\left(\mu^c\right)\left[\left(q+\frac{1-q}{\mu^c}+R-1\right)^{1-\sigma}-(1-\tau)^{\sigma-1}\left(q+\frac{1-q}{\mu^c}\right)^{1-\sigma}\right].$$

From lemma 4, $dR/db > 0$, thus the sign of $d\Omega/db$ is given by $\frac{d\Omega^l}{dR}+\frac{d\Omega^c}{dR}$. The first terms on the right-hand side in (22a) and (22b) are negative, and reflect the lower output produced by firms remaining in the credit market as the interest rate rises. If government borrowing is small enough so the interest rate is small and $\mu^l = \mu^c = 1$, all firms use money to conduct transactions and $d\mu/dR = 0$. Therefore, any increase in government lending makes individuals worse off. In other words, if the government keeps the debt within reasonable levels, the equilibrium interest rate remains moderate or low. As government borrowing drives up the interest rate, costs of production rise, and firms respond to higher costs by cutting production and thus consumption goods available for households. Therefore, we conclude the following:

Lemma 5: If fiscal and monetary policy are loose enough so that the equilibrium interest rate is such that $\mu^l = \mu^c = 1$, individuals' welfare is a decreasing function of government borrowing.

Suppose now that fiscal and monetary policy are tight, so the equilibrium interest rate is high and causes some firms to conduct barter transactions $\left(\mu^l, \mu^c < 1\right)$. In this case, the second terms in (22a, b) are no longer zero since $d\mu/dR < 0$, and so $(d\mu/dR)f(\mu) < 0$. This term reflects the reduction in quality and quantity of firms conducting cash transactions.

Using some algebra and using (11) and (16a), it is straightforward to show that the term inside the brackets is always negative in (22b), but only negative in (22a) if $\tau > 1 - q/\phi$. A sufficient condition for this to occur is that $\tau > s_t$. For a given μ, these terms measure the difference in the firm's output if it borrows instead of barters. Thus, the second terms in (22a, b) represent the net increase in overall production resulting from firms switching from cash to barter transactions for cashless and cash-owing firms. We may therefore conclude that there exists barter cost level, τ^{**}, $0 \le \tau^{**} < 1 - q$, such that $d\Omega^c/dR > 0$, and $d\Omega^l/dR > 0$ if $\tau > \tau^{**}$.

Notice, however, that the net effect of an increase in government borrowing on welfare is ambiguous because it depends on the density function *f*. If few firms switch to barter as the interest rate increases, the second terms in (22a, b) are small, the first terms dominate and the effect on welfare is negative. Yet, if many firms switch to barter, the increase in production of those firms switching to barter is greater than the decline in production of those firms that continue to borrow, and individuals will be better off. The following lemma summarizes the above discussion:

Lemma 6: If fiscal and monetary policy is so tight that both $\mu^l, \mu^c < 1$, as government indebtedness increases

i) The net effect on individuals' welfare in undetermined, and depends on the density function at each particular point;
ii) If the density function is such that few firms switch to barter, the net increase in welfare is negative;
iii) If $\tau > 1 - q/\phi$ and the density function is such that many cashless firms switch to barter, the net effect on welfare is positive; a sufficient condition for this to occur is that $\tau > s_t$, and
iv) If the density function is such that many cash-owing firms switch to barter, the net effect on welfare is positive.

Suppose now that firms did not have access to barter, then the welfare function would be $\Omega^M = (cK)^{1-\sigma}(1+g)^\rho \Omega^m$, where $\Omega^m = \int_0^1 R^{1-\sigma} f(h_i) dh_i + \int_0^1 \left(q + \frac{1-q}{h_j} + R - 1 \right)^{1-\sigma} f(h_j) dh_j$

Consider $\Delta\Omega = \Omega^l + \Omega^c - \Omega^m$. If this difference is positive, access to barter is welfare improving. From (11) and (16a), this can be written

$$(23) \qquad \Delta\Omega = (1-\tau)^{\sigma-1} \int_{\mu^l}^1 \left[\left(q + \frac{1-q}{h_i} \right)^{1-\sigma} - \left(q + \frac{1-q}{\mu^l} \right)^{1-\sigma} (1-\tau)/q \right] f^l(h_i) dh_i$$

$$+ \int_{\mu^c}^1 \left[\left(\frac{1}{1-\tau} \right)^{1-\sigma} \left(q + \frac{1-q}{h_j} \right)^{1-\sigma} - \left(q + \frac{1-q}{h_j} + T\left(q + \frac{1-q}{\mu^c} \right) \right)^{1-\sigma} \right] f^c(h_j) dh_j ,$$

where $T = (1-\tau)^{\sigma/(1-\sigma)} - 1$ and for the sake of simplicity we have made that $\phi = 1$. For $\mu^l = \mu^c = 1$, it is apparent that $\Delta\Omega = 0$. Suppose that $\mu^l, \mu^c < 1$ and let the interest rate increase a bit. Then,

$$\frac{d\Delta\Omega}{dR} = -(1-\tau)^{\sigma-1} \left(1 - \frac{1-\tau}{q} \right) \left(q + \frac{1-q}{\mu^l} \right)^{1-\sigma} f(\mu^l) \frac{d\mu^l}{dR}$$

$$-(1-\tau)^\sigma \frac{(\sigma-1)(1-q)}{q(\mu^l)^2} \left(q + \frac{1-q}{\mu^l} \right)^{-\sigma} \frac{d\mu^l}{dR} \int_{\mu^l}^1 f(h_i) dh_i - \tau(1-\tau)^{\sigma-1} \left(q + \frac{1-q}{\mu^c} \right) f(\mu^c) \frac{d\mu^c}{dR}$$

$$-\frac{(\sigma-1)(1-q)}{(\mu^c)^2}T\frac{d\mu^c}{dR}\int_{\mu^c}^{1}\left(q+\frac{1-q}{h_j}+T\left(q+\frac{1-q}{\mu^c}\right)\right)^{-\sigma}f(h_j)dh_j\,.$$

Since both $d\mu^l/dR$ and $d\mu^c/dR$ are negative, the last three terms are all positive, and the first term is positive if $\tau>1-q$. The analysis is analogous to that made for output in the discussion of lemma 2. The last two terms reflect the welfare advantage of barter due to the higher output of the cash-owing firms switching to barter. The second term reflects the fall in output due to higher interest rates of those cashless firms that would be bartering if that technology would be available. It appears positive since it makes Ω^M smaller. The first term reflects the net increase in output of cashless firms that would switch into barter, and is positive if $\tau>1-q$. In case of $\tau<1-q$, firms switching to barter decrease output and the net effect depends on the density function. However, from (23), as μ^l and μ^l tends to zero, it is apparent that $\Delta\Omega>0$. This means that as the economy becomes risky, even in this case, barter is a welfare improving choice.

Suppose now that interest rates have reached the credit rationing level, $R=\overline{R}$, in which they do not react to an increasing government debt $dR/db=0$, and μ^l and μ^c have reached a lower bound $\overline{\mu^l}$ and $\overline{\mu^c}$ respectively. Cash-owing firms that remain conducting cash transactions are not forced to switch to barter. However, there is a subset of firms $\Gamma\subset[0,\mu^l]$ subject to credit rationing and forced to switch into barter. Assume again that $db_t=-dS_t$, so dg_t = 0, from (21) we find that $\Delta\Omega=(cK)^{1-\sigma}(1+g)^{\rho}\Delta\Omega^l$, where

$$\Delta\Omega^l=\int_0^{\overline{\mu^l}}R^{1-\sigma}f(h_i)dh_i-\int_{\Gamma}\left(\frac{1}{1-\tau}\right)^{1-\sigma}\left(q+\frac{1-q}{h_i}\right)^{1-\sigma}f(h_i)dh_i\,.$$

Thus, $\dfrac{\partial\Delta\Omega^l}{\partial b}=-\left(\dfrac{1}{1-\tau}\right)^{1-\sigma}\displaystyle\int_{\Delta\Gamma}\left(q+\frac{1-q}{h_i}\right)^{1-\sigma}f(h_i)dh_i<0$, where $\Delta\Gamma$ denote the set of rationed cashless firms. Since firms have no choice but to barter, output and thus welfare is higher if they have access to barter.

Lemma 7: Assuming that the tax incentive to barter (ϕ) is small enough, and thus firms are better off conducting cash transactions when the interest rate is very low; then,

(a) Individuals are always better off if cash-owing firms have access to a barter technology;

(b) There is a barter cost level τ^{**}, $0 < \tau^{**} < 1 - q$, such that for any $\tau > \tau^{**}$, individuals are better off if cashless firms have access to a barter technology;

(c) If the interest rate is high enough, so the economy is risky, individuals are better off if cashless firms have access to a barter technology; and

(d) In situations of credit rationing, individuals are better off if firms have access to barter.

IV. COMMENTS AND CONCLUSIONS

The model above can be used to explain facts associated with the barter phenomenon in Russia. Responding to the near hyper-inflationary period during the first years of transition when the Central Bank simply monetized the debt, the Russian government sharply cut the money growth rate and adopted legislation in 1995 that resulted in the financing of an important share of government expenditures by short-term bonds sold to the private sector. In fact, the money growth rate decreased from about 200% in 1994 to 21% in 2002. Figure 4 illustrates the corresponding change in government debt: it increased steadily until the end of 1998 and remained unchanged thereafter. The tightening of monetary policy reduced inflation, at the same time causing expected real interest rates to rise (see Figure 5). Under the new economic and financial conditions, rational managers would be motivated to conduct barter transactions in order to conserve cash for investment in short-term government debt instruments. Such behavior contributes to the observed negative correlation between the inflation rate and the use of barter, shown in Table 1. The empirical evidence suggests that conditions (17) and (18) may not hold and thus, as the economy becomes tighter and interest rates increase, firms switch into barter and overall output falls, explaining the negative correlation between the industrial index and the use of barter shown in Figure 2. Consequently, the real money demand for transactions decreases and thus there must be a negative correlation between barter transactions and real money balances. Table 1 shows the significant correlations that support these three facts. Commander and Mummsen (2000) and Commander *et al* (2002) provide a more exhaustive statistical analysis to support these results.

According to the model, individuals switch to barter to avoid the high cost of acquiring debt; however, money is still a precious asset because of their use to facilitate transactions and the opportunity cost of lend it. Therefore, even firms that switch into barter would still prefer to receive payments in cash, if possible (Commander and Mummsen 2000; Commander *et al* 2002; Krueger and Linz 2001).

Now consider a firm with a high-risk project that borrows cash and wishes to make transactions with a firm with a low risk project. If the low-risk project firm prefers barter transactions and the high-risk project firm is buying, the latter pays in cash, and there will be a monetary transaction. If the high-risk project firm is selling and the low-risk project firm prefers to barter, the high-risk project firm is likely to have the impression that its partner trader does not have cash. This situation and its multiplier effect can make traders feel that they barter because their partner traders lack cash. Commander and Mummsen (2000), Commander *et al* (2002) and Linz and Krueger (1998) report surveys supporting this conclusion.

The dramatic rise and fall of barter activity in Russia during the 1990s suggests that any explanations which ignore monetary and financial factors are inadequate. The model developed above explains the main contours of the relationship between barter activity among Russian firms and a number of monetary indicators. The model allows for different strategic or behavioral patterns among firms, and shows how barter is a welfare-improving activity. We demonstrate that barter should not necessarily be seen as an undesirable cost imposed on firms and the society, but as an alternative technology that firms can use to hedge against increasing instability.

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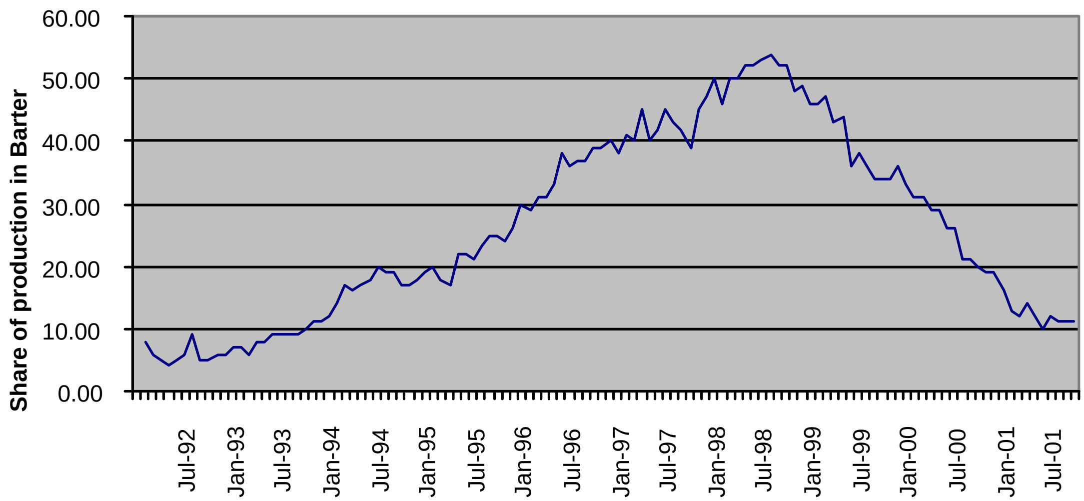
TABLE 1: Correlation coefficients: Barter and macroeconomic indicators

Correlation barter share - real money balances	-0.57
Correlation barter share – inflation	-0.63
Correlation barter share – industrial index	-0.78

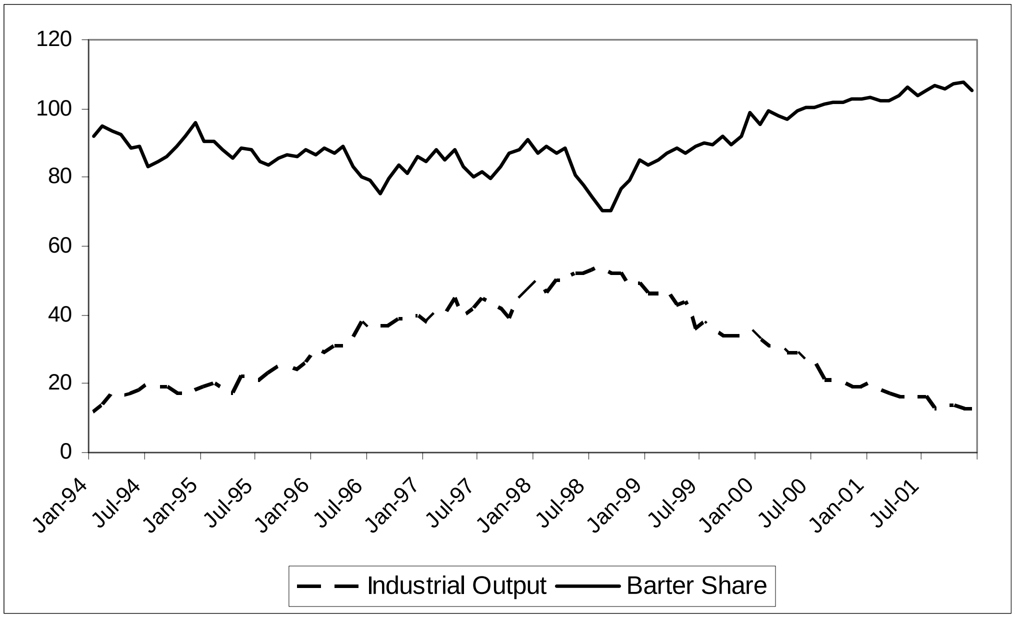
Source: IFS/IMF (real money and inflation)
Russian Economic Barometer (Barter share)
Russian Economic Trends (Industrial Index)
Own estimations

Figure 1: Monthly Barter from 1992 to 2001



Source: Russian Economic Barometer and Institute for Economy in Transition (IET).

FIGURE 2: Barter Share of Total Transactions in Russia 1994-2001



Source: Russian Economic Barometer (summer 2002)

FIGURE 3

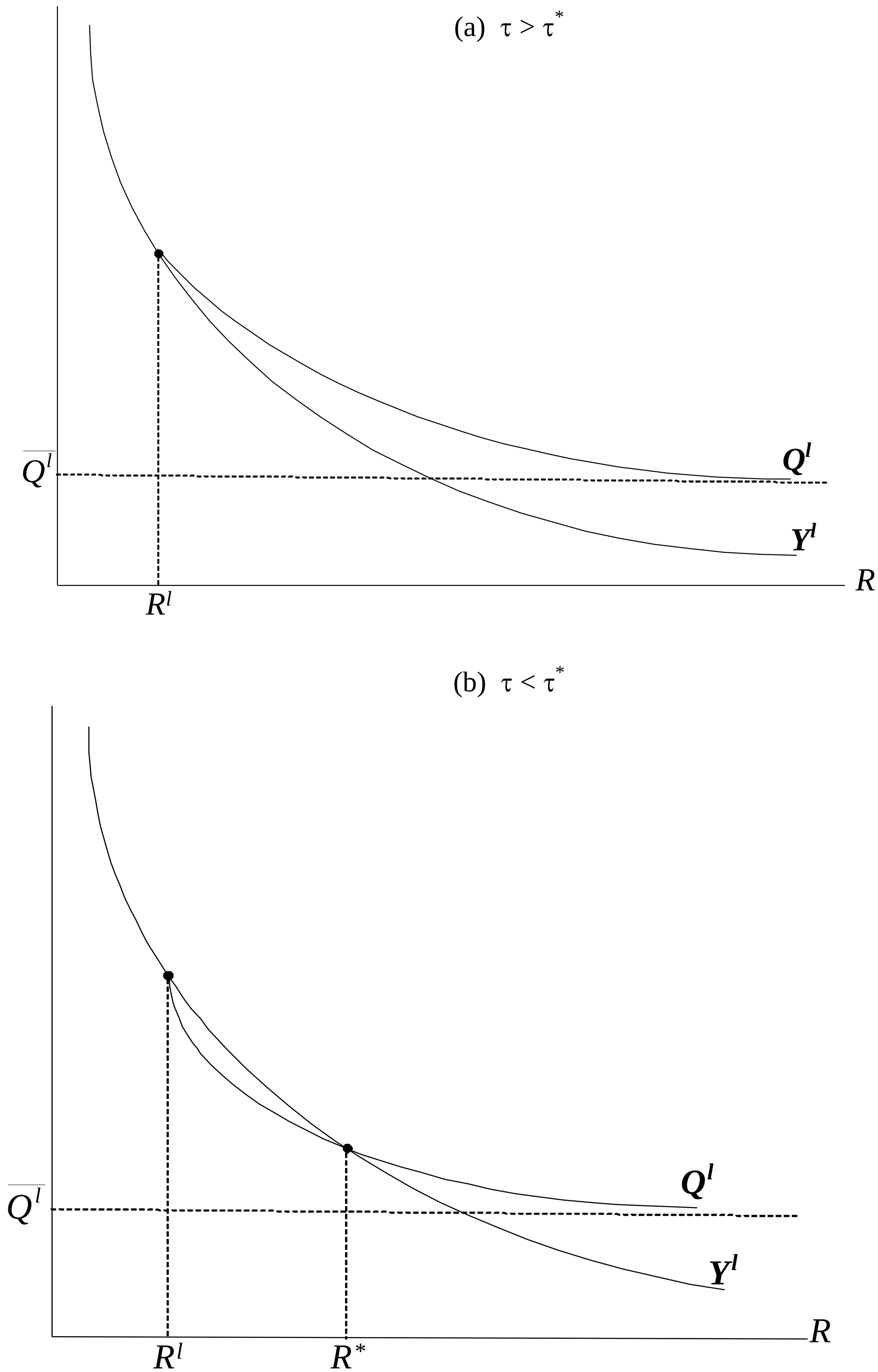
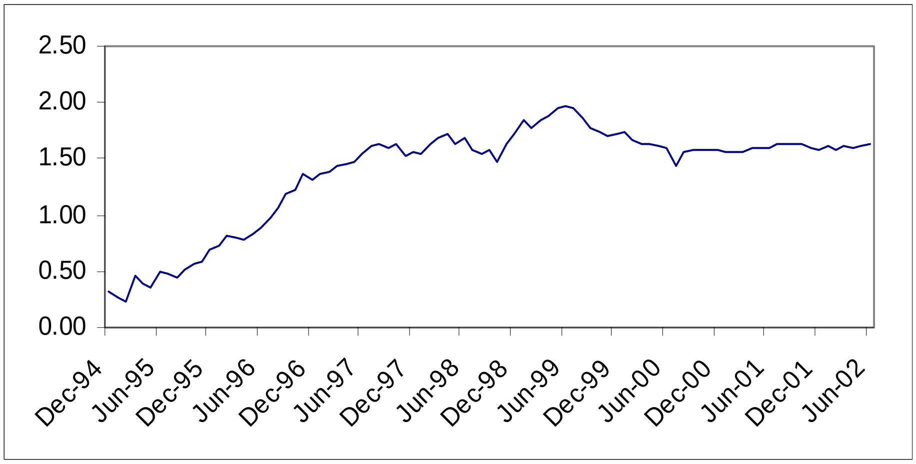
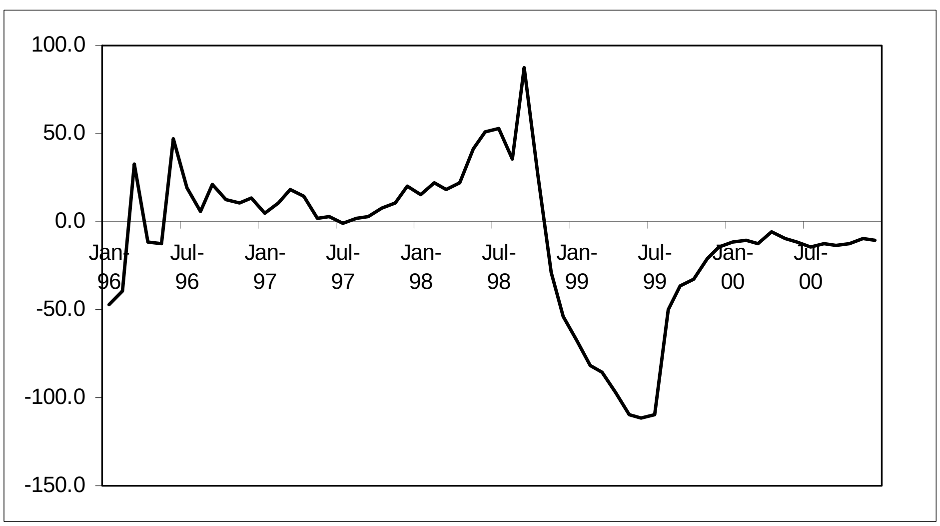


FIGURE 4: Real Government Debt to Commercial Banks in Russia



Source: Russian Economic Trends

FIGURE 5: Real Interest Rates in Russia (1996-2000)



Source: Russian Economic Trends and authors' own computations

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