THE TRANSMISSION MECHANISM TO BARTER

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Abstract

This paper sets up a model to inquire into whether the rise and fall in barter transactions in Russia and other CIS countries during the 1990's was an involuntary decision resulting from credit rationing or the consequence of firms' optimal choice. We find that the transmission mechanism of the government policy contains the necessary information to answer the question. An inquiry into the empirics of the model is then conducted using data from Russia.

Abstrakt

Zmeny v rozsahu využívání výmenného obchodu v Rusku a zemích Spolecenství nezávislých státu v období 1990-2000 mohly být dusledkem omezení dostupnosti úverových zdroju (credit rationing) anebo optimální volby v rozhodovacím procesu podniku. Zjistili jsme, že mechanizmus výkonu vládní politiky obsahuje informace na urcení prícin techto zmen. Pro empirické testování modelu byla použita data z Ruska.

JEL: E0, E4, E5, F41, P24, P26
Keywords: Barter, interest rate, credit rationing, optimal choice

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I. INTRODUCTION

Barter transactions have usually been seen as an expensive, peculiar process that must be dominated by money. The literature on search and money aims to explain the inefficiencies of bartering and why it must be dominated by money (Kiyotaki and Wright 1989). Another explanation is that in some CIS countries, firms choose to barter to evade the official economy, hindering the efforts to restructure the economy and develop efficient market relations (Hendley, Ickes and Ryterman 2000). However, barter has always been around. History is full of instances where people have substituted legal tender for other stronger currencies, primitive money or simple barter (Kindleberger 1993). Yet, barter transactions also represent a significant share of total transactions in modern economies. Recent examples are the "Tablitas" in Argentina and the rise of barter in many industrialized western economies. Barter is clearly an exchange technology available in modern societies (Ellingsen and Stole 1996; Time magazine, February 5, 2002; International Reciprocal Trade Association, www.irta.com).

Barter is defined as the trading of goods or services without exchanging money. This includes transactions where there is the double coincidence of wants, although this situation barely occurs. More often, we find barter networks where a chain of barter transactions occurs, for instance, trader A sells some goods to B, B to C, and so on, until Y to Z; the chain closes when Z sell some goods to A. In modern western economies, the necessary network to make these chains is set up by barter companies; in Russia and

other CIS, it is made through informal and friendly arrangements directly made among firms' directors. Frequently, chains cannot close and the last trader receives some assets that it uses as temporary medium of exchange. In modern western economies, these assets are often legal tender; in Russia and other CIS countries some goods are commonly accepted as media of exchange include cigarettes, vodka, electronic equipment and cars, but also promissory notes issued by firms called *veksels*, debt swaps, and debt and tax offsets involving firms and local governments called *zachety* (Ledeneva and Seabright 2000).

A common characteristic in both Western and CIS economies is the existence of *Barter Credit*, which are loans made in goods, to be repaid in goods. In Western economies, barter credit is often given by barter companies. In Russia and other CIS, it often takes the form of trade credit: inputs are given to firms in exchange for future production that is frequently traded in some barter arrangement later on. Barter is a quid pro quo of one good for another at a point in time and it is a substitute for monetary transactions; yet, barter credit is an inter-temporal exchange of goods and it is a substitute for cash credits given by banks or other financial institutions (Huang, Marin and Xu 2004; Marin 2005).

Barter has been an important phenomenon in many transition economies. Computations based on the World Business Environment Survey conducted by the World Bank/EBRD during the years 1996 and 2000 show that barter transactions represented more than 10% of total transactions in Belarus, Bosnia, Croatia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Slovakia, Slovenia, Ukraine and Uzbekistan; in five of them, Croatia, Moldova, Russia, Ukraine and Uzbekistan, it represents more than 20% (see Table 1).

Several possible explanations rest on real factors like soft budget constraints, tax avoidance, delay in restructuring, the virtual economy and the lock in. A traditional monetary explanation for barter is hyperinflation. Yet, a simple look at some statistics discards this explanation. Table 2 shows significant negative correlations between barter share transactions in total transactions and the money growth and inflation rates in Russia. Figure 1(a) shows that barter in industrial sales grew in Russia from 7% of total transactions in 1992 and reached a 54% peak in August 1998, exactly one month before the collapse of the ruble in September 1998; from that date on, it declined continuously to its initial level. For the same period, Figure 1(b) shows how real money balances decreased as government debt was steadily increasing until the end of 1998. Thus, the declining money growth and inflation rates, and the increasing real public debt suggest that a tight monetary policy affected the share of barter in total transactions (Commander, Dolinskaya and Mumssen 2000; Linz and Krueger 1998; Marin and Schnitzer 2002).

Explanations based on monetary factors include liquidity shortage and credit rationing. A tight credit market makes interest rates increase; thus, if interest rates increase beyond a threshold or a credit rationing situation occurs, traders might find barter credit as alternative to cash credit to finance their operations, if barter networks are available. Traders that own financial resources may find the opportunity cost of self-financing their operations too high and thus switch to barter. For those subject to credit rationing, barter is a Hobson's choice, and for all others it is their own choice.

This paper proposes a theoretical model to ascertain whether barter has been a voluntary or involuntary decision, and tests the model using monthly data from Russia during the period 1995-2003. Section II presents the theoretical model and analyzes its

operation. Section III shows the empirical model; examines the data, shows the unit root and Granger causality tests, and uses those results and the impulse response functions to analyze the empirical results of the VAR. Section IV concludes.

II. THE MODEL

Firms. There is assumed to be a continuum [0, 1] of risk-neutral firms. At every period t, each firm has an indivisible project, which yields a real return R_i^S with probability q_j, where j is the index of the project. If the project fails, it yields R^f, which is common to all projects and can be zero. To undertake its project, each firm needs to conduct transactions for a real value of L. Consider first a firm that at the beginning of every period does not have any initial financial endowment; thus, if they want to conduct monetary transactions they have to borrow money or ask for barter credit. Lenders cannot distinguish among the quality of borrowers.

Suppose that the firm borrows local cash at period t–1 to conduct cash transactions. Loans are of a standard debt form. The return is obtained and the loan repayment made at time t. If the project fails, the firm pays the available return R^f and so its return is zero, but if it succeeds, it repays the loan at a nominal interest rate i_t. Let P_t be the price index at period t. At that period, the firm must also pay a real valued lump-sum tax T_t. Thus, firm j's expected nominal return is $q_j\left[P_t R_j^S - (1+i_t)P_{t-1}L\right] - P_t T_t$. To obtain expected real profits, we divide this expression by P_t, so

(1) $$E(\Pi_t^j) = q_j\left[R_j^S - (1+r_t^e)L\right] - T_t,$$

where $1+r_t^e = (1+i_t)/(1+\pi_t^e)$ denotes the expected real interest rate and π_{t+1}^e is the expected inflation rate.

Suppose that firm j finances their operational cost through barter. Barter credit in the CIS countries takes the form of trade credit between firms which is repaid in goods instead of cash (Huang, Marin and Xu 2004; Marin 2005). As in conventional trade credit transactions, in barter credit firms lend goods to other firms. Explanations for trade credit include the monitoring advantages of suppliers over banks (Schwartz and Whitcomb 1979; Biais and Gollier 1997), suppliers' informational advantages since inputs are much less easily diverted than cash (Burkark and Ellingsen 2004), buyers' private information about their own willingness and ability to pay and the sellers resulting incentive to price discriminate (Brennan, Maksimovic and Zechner 1988), suppliers' private information about product quality (Smith 1987 and Lee; Stowe 1993), and suppliers' advantage in liquidating collateral (Frank and Maksimovic 1998). All these make trade credit, and therefore barter credit, less risky than cash credit. Yet barter credit is even less risky than traditional trade credit operations since it does not face the risk of converting illiquid assets into liquid ones. This leads to the conclusion that barter credit is much less risky than cash loans and that barter credit is much easier to enforce than cash loans. For the sake of simplicity, assume that barter credit can always be enforced.

Barter credit operations also involve the use of networks that need the employment of real resources that can be very costly. As others in the literature, assume that the real resources spent to conduct barter operations is a fixed proportion of the real value of total resources needed to undertake the project, cL. This assumption does not have any qualitative implication and can be easily relaxed by making c dependent on firm characteristics like quality and risk (Huang, Marin and Xu 2004).

Firms that engage in barter also have better opportunities to evade taxes (Commander and Mumssen 1999; Marin, Kaufmann and Gorochowskij 2000). Suppose that if firm j engages into barter, it evades a share ϕ of its tax duties, that is, it pays $(1-\phi)T_t$, and therefore, its expected return is

$$(2) \qquad E(\Pi_t^j) = q_j R_j^S + (1-q_j)R^f - cL - (1-\phi)T_t .$$

Firm j borrows cash if this allows it to obtain a higher expected return. From (1) and (2), this occurs if

$$(3) \qquad q_j < \frac{cL - \phi T_t - R^f}{(1+r_t^e)L - R^f},$$

A higher barter cost (c) makes the right-hand expression in (3) increase; if it is too high, it will always be greater than one, making barter credit unaffordable. This echoes the traditional literature, which considers barter so inefficient that it is always dominated by some medium of exchange. Assume that τ is small enough so that barter technology is feasible and define $\mu(r_t^e)$ as follows:

$$(4) \qquad \mu(r_t^e) = \min\left\{\frac{cL - \phi T_t - R^f}{(1+r_t^e)L - R^f}, 1\right\}.$$

Then, $\mu(r_t^e)$ is the cutoff probability of success that makes a firm use barter credit. Let r_t^b denote the interest rate that makes the right-hand side in (4) equal to unity, thus

$$(5) \qquad r_t^b = c - \phi T_t / L - 1 .$$

If the market interest rate is less than r_t^b, then μ = 1 and all firms without the initial financial endowment borrow cash and conduct cash transactions, yet if it is greater than r_t^b, firms with $q_j > \mu(r_t^e)$ ask for barter credit. This means that firms with the riskiest projects continue borrowing cash, making the cash credit market even riskier. The reason

is the traditional lemons argument. An increase in interest rates makes projects riskier, and therefore, to continue borrowing, firms require higher profits. This result is in accordance with other papers in the literature (Huang, Marin and Xu 2004).

Of special interest is the role of tax evasion. Given *T*/*L*, the higher ϕ, the greater the amount firms evade in taxes if they switch to barter, and thus the higher the incentive to engage in barter transactions and the lower r_t^b is. Suppose now that firm *j* owns enough financial resources to undertake the project. If firm *j* finances the project with its own resources, its profit function is

$$E\left(\Pi_t^j\right) = q_j R_j^S + \left(1 - q_j\right) R_j^f - \left(1 + r_t^e\right) L - T_t,$$

where the last term $\left(1 + r_t^e\right) L$ accounts for the investment and its opportunity cost. If the firm decides to conduct barter transactions and lend its financial endowment, since it cannot distinguish among the quality of borrowers, its profit function is

$$E\left(\Pi_t^j\right) = q_j R_j^S + \left(1 - q_j\right) R^f - cL + q\left(1 + r_t^e\right) L - \left(1 - \phi\right) T_t .$$

where *q* is the probability for the lenders to be paid back by firms, that is,

$$q = \int_{\mu}^{1} q_j g\left(q_j\right) dq_j , \tag{6}$$

and $g(q_j)$ is the density function that characterizes the distribution of q_j across firms. In this case, firm *j* obtains higher profits financing the project with its own resources if

$$q < \frac{1}{\left(1 + r_t^e\right)} \left(c - \phi \frac{T_t}{L} \right) - 1 .$$

If the interest rate increase is high enough, the inequality reverses, the firm faces a high opportunity cost and is better off if it switches to barter and lend its financial resources. If ϕ is high, the incentive for tax evasion is high, the inequality may break and the firm may

choose to barter even though the credit market is very lax. Since firms' behavior with respect to barter is the same, regardless of their use internal or external finance, for the sake of simplicity, from now on we assume that firms do not own financial resources and thus need to borrow to conduct their operations.

The Demand for Credit. Denote by L_t^f firms' total demand for credit. From (3) and (4), firm *j* borrows local currency if $q_j < \mu(r_t^e)$. Thus, firms' aggregate demand for credit is

$$(7) \qquad L_t^f = L\int_0^{\mu} g(q_j)dq_j .$$

If $r_t^e \leq r_t^b$, all firms conduct cash transactions, the integral in (7) becomes one and firms' demand for credit is constant and equal to *L*. However, as the interest rate surpasses r_t^b, firms start switching to barter credit $(d\mu/dr < 0)$, and the demand for cash credit decreases. Thus, from (4), (7) and the discussion above, we obtain

Lemma 1: The firms' total demand for credit function is constant and equal to L if $r_t^e \leq r_t^b$, and a decreasing function with respect to i_t if $r_t^e > r_t^b$.

From Lemma 1, the demand for credit curve has the shape of curve L^f in Figure 2. Suppose that, for reasons to be explained later, the overall economy becomes riskier and so it does for every individual firm, from (5) r_t^b remains the same, but for $r > r_t^b$ less firms have incentive to switch into barter. Thus, the credit demand shifts from a curve like L_1^f to curve like L_2^f in Figure 3.

The Supply of Funds. Consider the expected real payoff that lenders receive for making loans to firms,

$$E(\Pi_L) = (1 + r_t^e)L \int_0^{\mu(r_t^e)} q_j g(q_j) dq_j + R^f \int_0^{\mu(r_t^e)} (1 - q_j) g(q_j) dq_j .$$

This is so regardless whether this is a specialized lender or firms awarding loans. Differentiating $E(\pi_L)$ with respect to r_t^e we obtain

$$(8) \qquad \frac{dE(\Pi_L)}{dr_t^e} = L \int_0^{\mu} q_j g(q_j) dq_j + \frac{d\mu}{dr_t^e} [(1 + r_t^e) L \mu g(\mu) + R^f (1 - \mu) g(\mu)];$$

From (8) we obtain the impact of an increase in the expected real interest rate on the expected return of the cash lender. The first term on the right-hand side in (8) is positive and reflects the higher expected repayment because of the higher interest. For $r_t^e \leq r_t^b$, all firms borrow so $\mu = 1$, $d\mu / dr_t^e = 0$ and the lender's expected profit is an increasing function of the interest rate with a constant slope. Yet, for $r_t^e > r_t^b$, μ decreases $(d\mu / dr_t^e < 0)$, the integral in the right-hand size of (7) becomes smaller, the second term turns negative and increases in absolute value; this reflects the deterioration in the quality and quantity of borrowers; the latter affects negatively lenders' expected profits. Eventually, $dE(\Pi_L) / dr_t^e$ turns negative, which means that the expected profit reaches a maximum at some interest rate r^*.

Let ρ_l denote the expected real return to an individual lender, $\rho_l = E(\pi_b) / L$, and suppose that the supply of funds is an increasing function of the expected real return to an individual lender, $L^S(\rho_l)$ and $dL^S / d\rho_l > 0$, then the supply of funds increases with respect to r_t^e if and only if ρ_l does it, and the credit supply curve shape is like the curve L^S shown in Figure 2. This is the typical credit supply curve that makes possible credit rationing situations (Stiglitz and Weiss 1981).

Suppose now that the overall economy becomes riskier. Then, for a given μ, the share of firms whose projects have a probability of success equal to or less than μ increases, and so it decreases the expected real payoff that lenders receive for making loans to firms. Since the supply of funds is increasing with respect to ρ_l, then L^S decreases. What about r^*? Let $\mu^* = \mu(r^*)$, then from (8):

$$L\int_0^{\mu^*} q_j g(q_j) dq_j = -\frac{d\mu(r^*)}{dr_t^e}[(1+r_t^e)L\mu^* g(\mu^*) + R^f(1-\mu^*)g(\mu^*)].$$

As the economy become riskier, the right hand side in this expression is not affected, but the integral in the left side increases; thus, the slope of the supply curve turns to positive at that point, and the new credit supply curve reaches a maximum at a higher interest rate. Hence, the credit supply shifts from a curve like L_1^S to one like L_2^S in Figure 3

Credit Market Equilibrium. In a low-risk economy, we may think that most firms have a high q_j. In this case, equilibrium is given by point *A* in Figure 2. In this case the demand for credit is fully satisfied and there is no barter. Yet, consider Figure 3 and suppose that the economy becomes riskier. The credit demand curve shifts from L_1^S to L_2^S, where the downward sloped part of the credit demand curve shifts to the right. The new equilibrium may lead to four different situations. The first is at another non-barter equilibrium on the flat part of the demand curve. Yet, if it becomes too risky, equilibrium may be reached at point *B* in the intersection L_2^f and L_2^s. At that point, the demand for credit is fully satisfied, but equilibrium has surpassed the turning point r_b and so a number of firms would be better off if they quit the credit market and conduct barter transactions; for those firms, barter is the best choice and so it is voluntary.

A third type of equilibrium is shown in Figure 4, where $r^{**} \leq r_t^b$. In this case, the tighter credit market leads to a credit rationing situation. Lenders will not increase the interest rate beyond r^{**}; the demand for credit is at point *C* but lenders are willing to supply credit only up to *C'*, so there is credit rationing by *C*-*C'*. In this case, firms engage into barter because there is no other choice for them to keep operating and thus barter is an involuntary phenomenon.

The fourth situation shows also a credit rationing equilibrium (see Figure 5). Since if $r^{**} > r_b$, those firms with probability of success $q_i > \mu(r^{**})$ will find barter as their best choice; for them, barter is voluntary. But, there will be some other firms that still want access to credit and will be subject to rationing. In this equilibrium, voluntary and involuntary barter coexist.

The Government. The government spends a real value $\overline{g}$ in goods and services every period. To finance that amount of real expenditure at period *t*, it obtains real tax revenue T_t^g, borrows a real amount of cash L_t^g, and obtain seigniorage for an amount $\theta_t = (M_t - M_{t-1})/P_t$. Government's loans are repaid at the expected real interest rate r_t^g. Therefore, the government budget constraint is

$$\overline{g} + L_{t-1}^g\left(1 + r_{t-1}^g\right) = T_t^g + L_t^g + \frac{M_t - M_{t-1}}{P_t}.$$

If a share μ of firms borrows in the credit market, the government's tax revenue is:

$$(9) \qquad T_t^g = T\left[1 - \phi\int_{\mu}^{1} q_j g\left(q_j\right) dq_j\right],$$

where T is exogenously given. Consider the government bond market. The expected real payoff for lending to the government is $E(\Pi_G) = (1 - q^g)(1 + r_t^g)L_t^g$, where q^g is the probability of default of government bonds. The expected payoff is an increasing function of r_t^g, thus the government is never rationed.

The debt overhang theory explains how the stock of government debt affects the economy: in a highly indebted country, investors may fear that the government's debt level can exceed its repayment ability and be tempted to increase taxes in order to meet its obligations; thus, investors may be less willing to invest today lowering the expected output tomorrow (Krugman 1988; Sachs 1989). Frequently, the government's debt service obligations are financed by distorsionary taxes like inflation tax (Agénor and Montiel 1996); in these circumstances, investors generally prefer to exercise their option of waiting (Serven 1997). Investors, thus, are most likely to undertake only projects with quick return or place their capital in safer harbor, that is, capital flights (Oks and van Wijnbergen 1995). This makes the overall economy riskier and creates balance of payment problems.

The theoretical literature suggests the existence of a threshold; below this level, foreign borrowing has a positive impact on investment and growth, but beyond that, its impact is adverse and the expected repayment begins to fall (Cohen 1993). The initial empirical work of the overhang debt theory using linear approximations gives mixed results. Some of them provide strong support (Green and Villanueva 1991; Deshpande 1997; Fosu 1999; Chowdhury 2001), and others do not (Warner 1992; Hansen 2001). However, recent studies strongly suggest the existence of a non-linear relationship between the stock of external debt and growth. Using a large panel data of 93 developing

countries for the period 1969-1998, Pattillo, Poirson and Ricci (2002) find that the average impact of external debt on per capita GDP growth is negative if its net present value level is above 160-170 percent of exports or 35-40 percent of GDP. Pattillo, Poirson and Ricci (2004) find that this negative impact operates both through a strong negative effect on physical capital accumulation and on total factor productivity growth. Their results are robust across different estimation methodologies and specifications.

From the previous discussion, the default risks of government's debt and private loans are increasing functions of the stock of public debt, and we can relate the interest rate for private loans and the yield from government debt using the arbitrage condition:

(10) $$1+r_t^g = q\left(L_t^g\right)\left(1+r_t^e\right)+\sigma^g\left(L_t^g\right).$$

where $q\left(L_t^g\right)$, defined in (6) as the probability for the lenders to be paid back by firms, is a decreasing function of the stock of public debt, and the government bonds' risk premium $\sigma^g\left(L_t^g\right)$ is an increasing function of L_t^g. As the public debt is small, it has no effect on firms' default risk, so $q\left(L_t^g\right)=\overline{q}$, $\sigma^g\left(L_t^g\right)=0$, (10) becomes $1+r_t^g=\overline{q}\left(1+r_t^e\right)$ and the yield to government debt is always lower than the interest rate to firms, but as soon as the stock of public debt surpasses a certain threshold, $q\left(L_t^g\right)$ start to decrease and $\sigma^g\left(L_t^g\right)$ to increase. Notice that if investors perceive as imminent that the government will default, $\sigma^g\left(L_t^g\right)$ can be so high that the yield on government bonds can be higher than the interest paid by firms, $r_t^g > r_t^e$. This explains why the yield on government bonds was higher in Russia during the months previous to the ruble collapse in 1998, as shown in Figure 6.

Public Debt, Taxes, Interest Rates and Barter. The model developed so far allows us to identify several channels to barter. They are summarized in Figure 7. Suppose that the

government diminishes seigniorage, and offsets that loss by increasing the public debt, as suggested in Figure 1b. This leads to the three channels of bartering discussed above and shown in Figures 3, 4 and 5: barter is voluntary if the higher government borrowing affects the interest rate, and the latter affects barter, and it is involuntary if the causation goes directly from government borrowing to barter; coexistence implies that both channels occur simultaneously. Afterwards, barter causes lower tax revenues.

If the incentives for tax evasion (ϕ) or the tax base T increases, more firms switch to barter to evade taxes and total tax revenue decreases, and if the government issues more debt to offset the loss in taxes, the story of the previous paragraph repeats.

III. TESTING THE MODEL

The previous analysis suggests an empirical model to test whether barter has been a voluntary phenomenon. The model developed above involves four variables: the barter share in total transactions (B), tax revenue (T), the interest rate (r) and the stock of government debt (L). We use monthly data from Russia from January 1995 to March 2003. Causality from tax revenue to the barter share is taken as evidence of the tax evasion causation, and simultaneous causality from the stock of government debt on interest, and of interest on barter is taken as evidence that results from the high cost of credit; in either case, barter is voluntary. However, direct causality from government debt to barter is taken as evidence that it results from credit rationing and thus, it is involuntary. Several mechanisms may be simultaneously at work.

Data. We measure of the real government indebtedness by deflacting nominal public debt by the price index; commercial bank claims on the general government obtained from the Russian Economic Trends is used as a proxy for the nominal public debt. The real interest

rate is defined as in equation (1), the ratio between the nominal interest rate and the inflation rate. The money market rate and the increase in the CPI reported by the IFS/IMF are taken as proxies for the nominal interest and inflation rates.

The real tax revenue is measured as the ratio between the nominal tax revenue and the price index. The Federal Budget Tax Revenue, measured in rubles and reported by Russian Economic Trends, is used as a proxy for the government nominal tax revenue. The CPI reported by the IMS/IMF is used as a proxy for the price index.

As a proxy to barter activity, we use the share of barter in total industrial sales reported by the Russian Economic Barometer. They conduct monthly panel surveys among Russian enterprise managers asking the percentage of barter in sales. The sample comprises 500 industrial and 300 agricultural firms throughout Russia. Industrial firms are located rather evenly across Russia, and agricultural firms are from over 30 out of the 80 Russian regions. In the econometric exercise below, we use the logs of the real government indebtedness, real tax revenue and share of barter transactions.

Unit Roots. To avoid the size distortion and low power problems that may occur in the traditional Dickey-Fuller and Phillips-Perron unit root tests, we conduct the forward-reversed Dickey-Fuller regressions test (Leybourne 1995). First, the test computes the DF regression $y_t = \rho y_{t-1} + e_t$, and finds the DF t-statistic, DF_f:

$$DF_f = (\hat{\rho} - 1)[\mathrm{var}(\hat{\rho})]^{-1/2},$$

where $\hat{\rho}$ is the estimation of ρ. Then, it considers the reversed DF regression, that is, define $z_t = y_{T+1-t}$, where T is the sample size, and compute the DF t-statistic using the

same expression as DF_f with z_t replacing y_t. Let DF_r denote that statistic. The Leybourne *DF* statistic is defined as

$$DF_{max} = Max\left(DF_f, DF_r\right).$$

Critical values for the forward and reversed Dickey-Fuller regressions for this exercise are between –3.22 and –3.12 (Leybourne 1995, p. 565). Results for both tests are shown in Table 3. The null hypothesis of unit root is rejected for every variable and thus, we can use VAR to conduct Granger causality test and find the impulse response functions.

Both the Akaike information and the Schwartz Bayesian criteria suggest setting the number of lags to one. In addition to the lags, regressions include an intercept and a deterministic trend, so the VAR model is:

$$\mathbf{Y}_t = \mathbf{a} + \mathbf{b}t + \mathbf{A}\mathbf{Y}_{t-1} + \mathbf{e}_t \quad (11)$$

where $Y_t = \left(B_t, T_t, r_t, L_t\right)'$ is a column vector, **1** is a vector of ones, *t* is the time trend, e is a vector of stochastic disturbances, and **a**, **b** and **A** are coefficient matrices of the appropriate ranks.

Estimations and Impulse Response Functions. Using (11), Table 4 shows the computed F statistics for the null hypothesis that the variable in the top row Granger causes the variable in the first column. The critical value for rejection of the null hypothesis with 95% confidence is 3.97, and 99% confidence is 6.99. Consider Table 4, the tests fail to reject the null hypothesis that barter share Granger causes the government's tax revenue, and that the real stock of public debt Granger causes the barter share, the real amount of tax revenue and the interest rate. With 95% confidence, it also fails to reject the null

hypothesis that interest rates Granger causes the stock of public debt, but it rejects it with 99% confidence. In all other cases, the null of Granger causality is rejected.

Figure 8 shows impulse response functions. A closer inquiry combining Granger causality and the impulse response highlights several important results:

1) An increase in either interest rates or tax revenues has no effect on the barter share in total transactions;
2) An increase in the real stock of public debt makes the interest rate increase;
3) An increase in the government debt has a direct effect that raises the barter share;
4) An increase in public indebtedness has an initial positive impact on tax revenue;
5) An increase in the barter share of transactions makes the tax revenue decrease; and
6) An increase in interest rates makes the stock of public debt decrease.

Result (1) does not support tax evasion as an explanation to the rise and fall of barter transactions in Russia during the period considered, and together with (2) leads to the conclusion that barter was not firms' voluntary decision. Result (3) suggests that barter in Russia has been an involuntary decision forced by a tight credit market causing credit rationing situations. Results (4), (5) and (6) complete and enhance that story. From (4), the increase in public debt caused improves tax collection; this reflects the traditional multiplier effect found in introductory macroeconomic textbooks. From (5), the rise in barter made tax collection decrease because of the incentive that barter transactions provide for tax evasion. From (6), an increase in the interest rate discourages the issuing of public debt; this result, however, is not robust.

These results obtained completely match with and thus suggest the credit rationing story: increasing public indebtedness causes situations of credit rationing, forcing firms to engage into barter transactions, thus facilitating firms' tax evasion.

IV. CONCLUSION

This paper provides a theoretical framework to inquire into whether the rise and fall of barter transactions in several transition economies during the 1990s and early 2000s has been the result of voluntary or involuntary decisions, and tests the model with a VAR analysis that uses Russian monthly data from 1995 to 2003. For the purpose of controlling high inflation during the early stage of transition, the Russian authorities changed their source of government revenues from seigniorage to public debt. The increasing public indebtedness was enhanced with the fall in oil price in the aftermath of the Asian crises. As expected, inflation decreased, explaining the negative correlation between barter and both money growth and inflation rates shown in Table 2.

The increasing public indebtedness created an upward pressure on interest rates that, once surpassed a certain threshold, led to the debt overhang problem. Investors, perceiving the economy as increasingly risky, required increasing risk premiums to offset the default risk of government bonds, fostering capital flights and creating balance of payment problems. The private sector also became more fragile, and the tighter policy resulted into credit rationing situations that forced firms to involuntary quit the credit market and engage in barter activities to continue operating; for them, barter was a Hobson's choice. This explains the rise and fall of barter activity during that period.

Investors' expectations were met during the ruble crisis in 1998. In the aftermath of the crisis, the Russian government defaulted and rescheduled their payment

agreements restoring investors' confidence, an increasing amount of financial resources were injected into the Russian economy, the real interest rate decreased, the credit market eased and many firms returned to cash transactions.

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TABLE 1
BARTER IN TRANSITION ECONOMIES

	1996	2000	Change (%)
Albania	0.0	0.0	0.0
Armenia	2.5	2.6	0.1
Azerbaijan	4.2	3.3	-0.8
Belarus	12.2	12.9	0.7
Bosnia	13.0	14.7	1.7
Bulgaria	3.7	3.8	0.1
Croatia	20.3	31.6	11.3
Czech Republic	3.7	2.9	-0.8
Estonia	4.7	3.8	-0.8
Georgia	6.3	4.6	-1.7
Hungary	1.7	0.7	-1.0
Kazakhstan	19.6	17.1	-2.5
Kyrgyzstan	15.5	16.6	1.1
Latvia	2.6	3.4	0.8
Lithuania	2.9	2.6	-0.3
Macedonia	8.4	9.1	0.7
Moldova	28.9	25.6	-3.4
Poland	3.6	4.3	0.7
Romania	8.2	6.8	-1.4
Russia	22.8	23.3	0.5
Slovakia	17.2	17.6	0.4
Slovenia	16.0	15.0	-1.1
Turkey	7.0	7.0	0.0
Ukraine	19.5	23.4	3.8
Uzbekistan	22.3	9.7	-12.6

Source: World Business Environment Survey, World Bank-EBRD and own computations.

TABLE 2

Correlation barter share – money growth rate	-0.52
Correlation barter share – inflation	-0.63

Source: IFS/IMF (money growth rate and inflation)
Russian Economic Barometer (Barter share)
Sample size: 125
Monthly data from February 1992 to June 2002

TABLE 3:
LEYBOURNE BACKWARD-FORWARD
DF UNIT ROOT TESTS
(Variables in levels)

	Leyborne Statistics
B	–12.8
T	–6.9
R	–9.5
L	–12.7

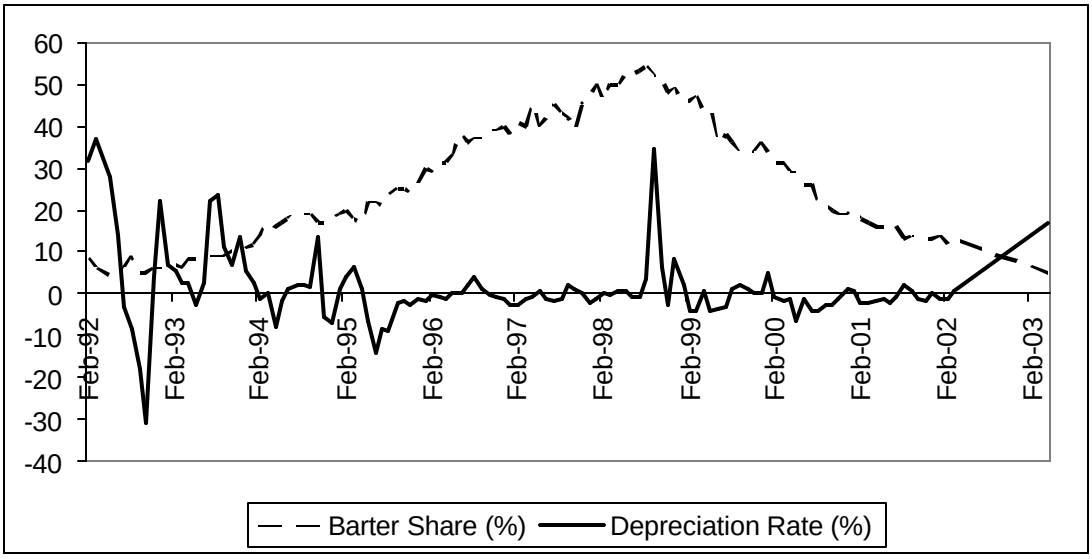
TABLE 4
PAIRWISE GRANGER CAUSALITY TESTS

	B	***T***	***R***	***L***
B	--	**28.9 (**)**	2.1	0.1
T	0.5	--	0.1	0.1
R	0.5	0.0	--	**5.3 (*)**
L	**7.9 (**)**	**7.0 (**)**	**22.3 (**)**	--

Note: (*) means that the Granger causality test is significant with 95% significance.
(**) means that the Granger causality test is significant with 99% significance.
Each cell shows the computed F-statistics for the null hypothesis that the variable in the first column Granger causes the variable in the first row; for example, the F-statistic for the null hypothesis that barter share (***B***) does not Granger causes tax revenues (***T***) is 28.9.

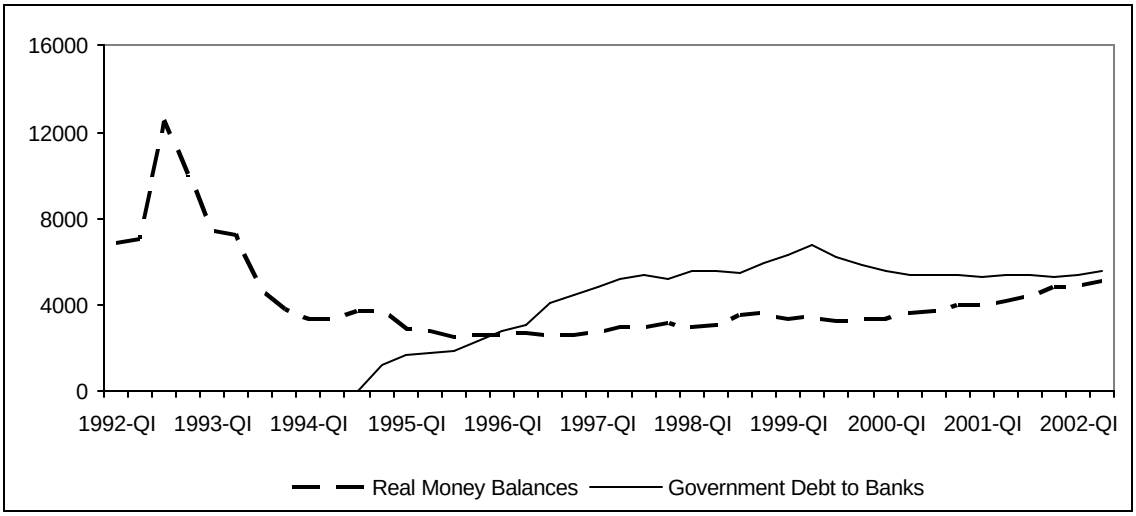
FIGURE 1

(a)
Barter and Depreciation Rate in Russia (1992-2003)



Source: IFS/IMF (real exchange rate depreciation rate)
Russian Economic Barometer (Barter share)

(b)
Money Balances and Real Government Debt in Russia



Source: IFS/IMF (real money balances)
Russian Economic Trends (Government Debt to Banks)

FIGURE 2

Supply and Demand for Credit: No Barter Case

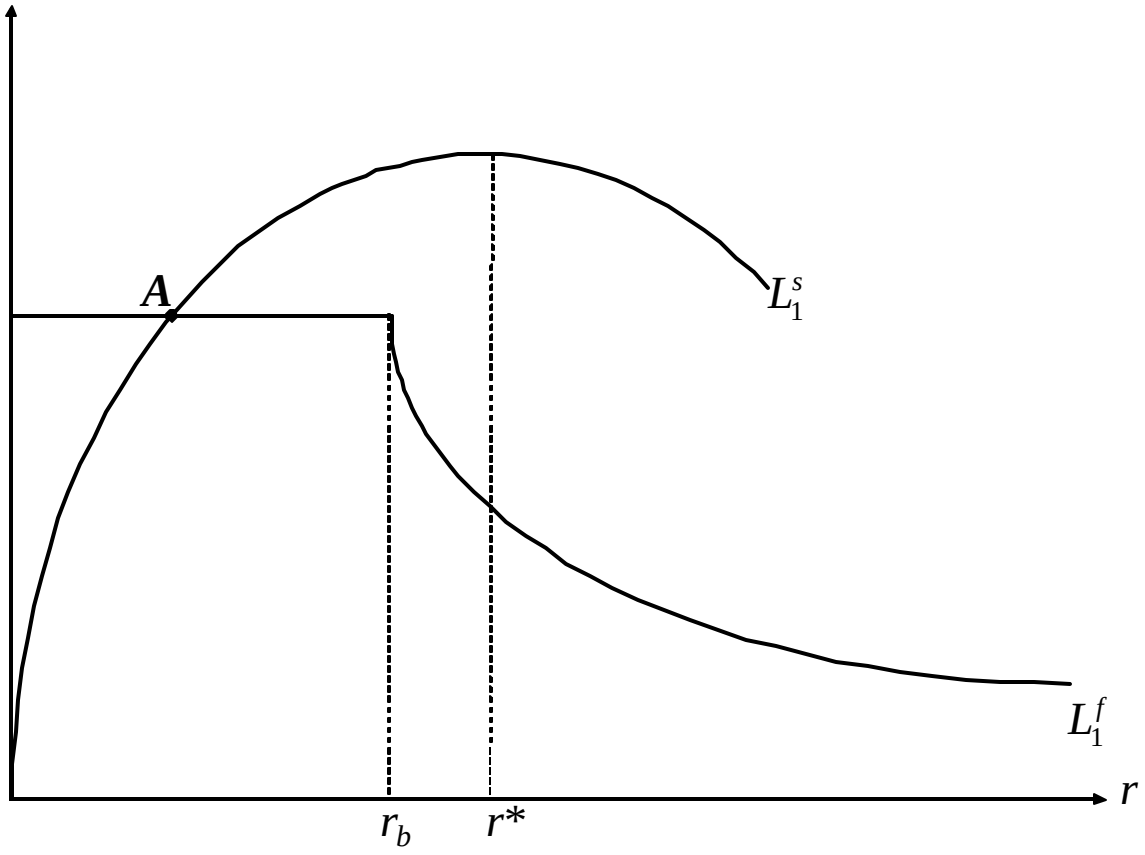


FIGURE 3

The Credit Market and Barter: Credit Demand Fully Satisfied

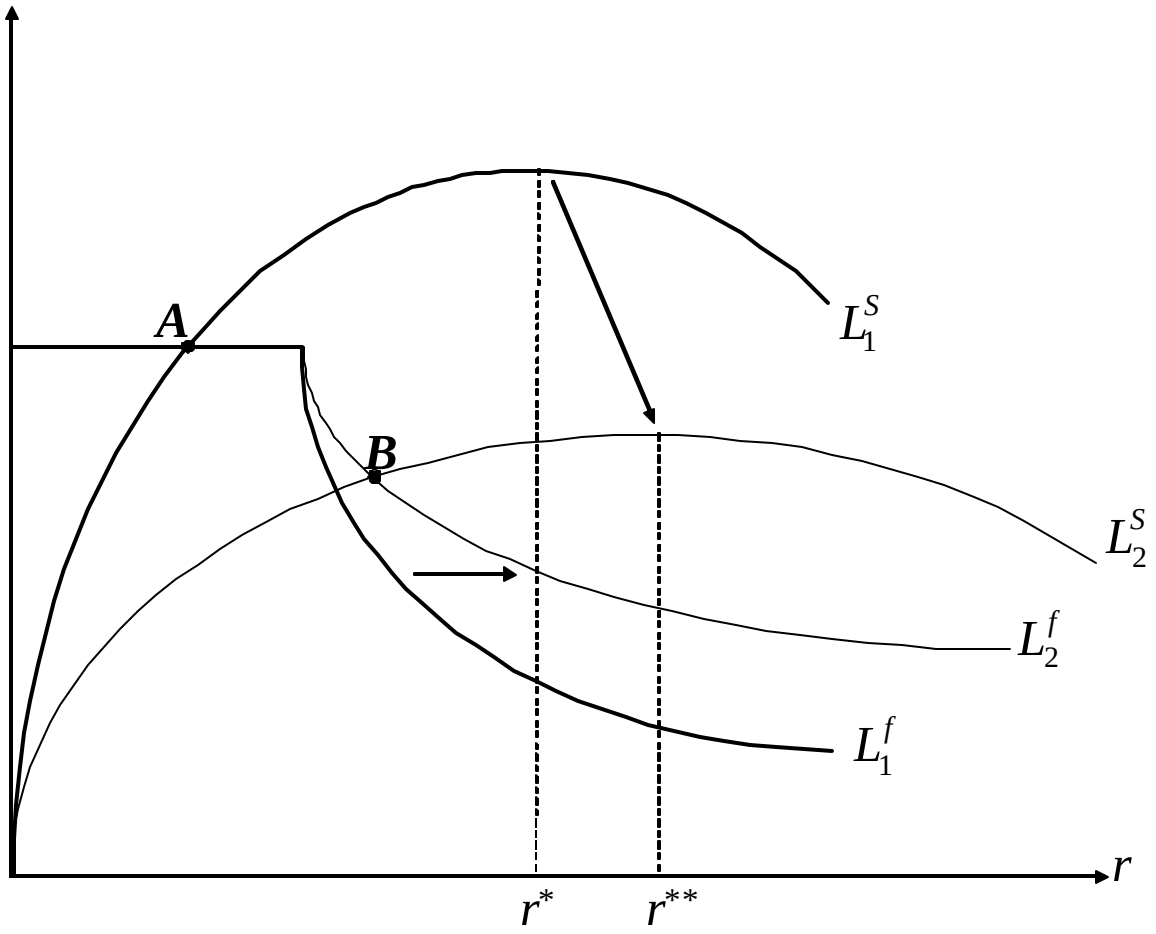


FIGURE 4

Barter and Credit Rationing: Involuntary Barter

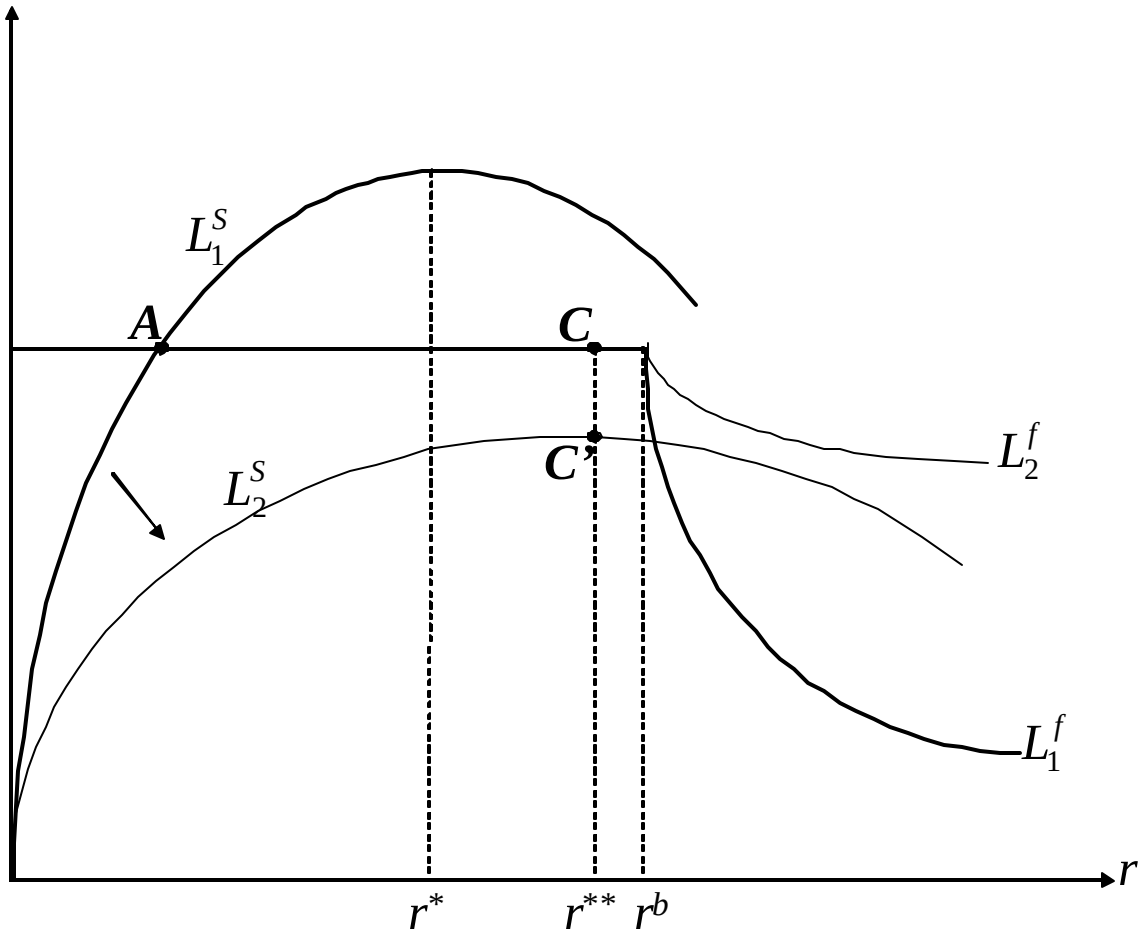


FIGURE 5

Barter and Credit Rationing: Voluntary and Involuntary Barter Coexist

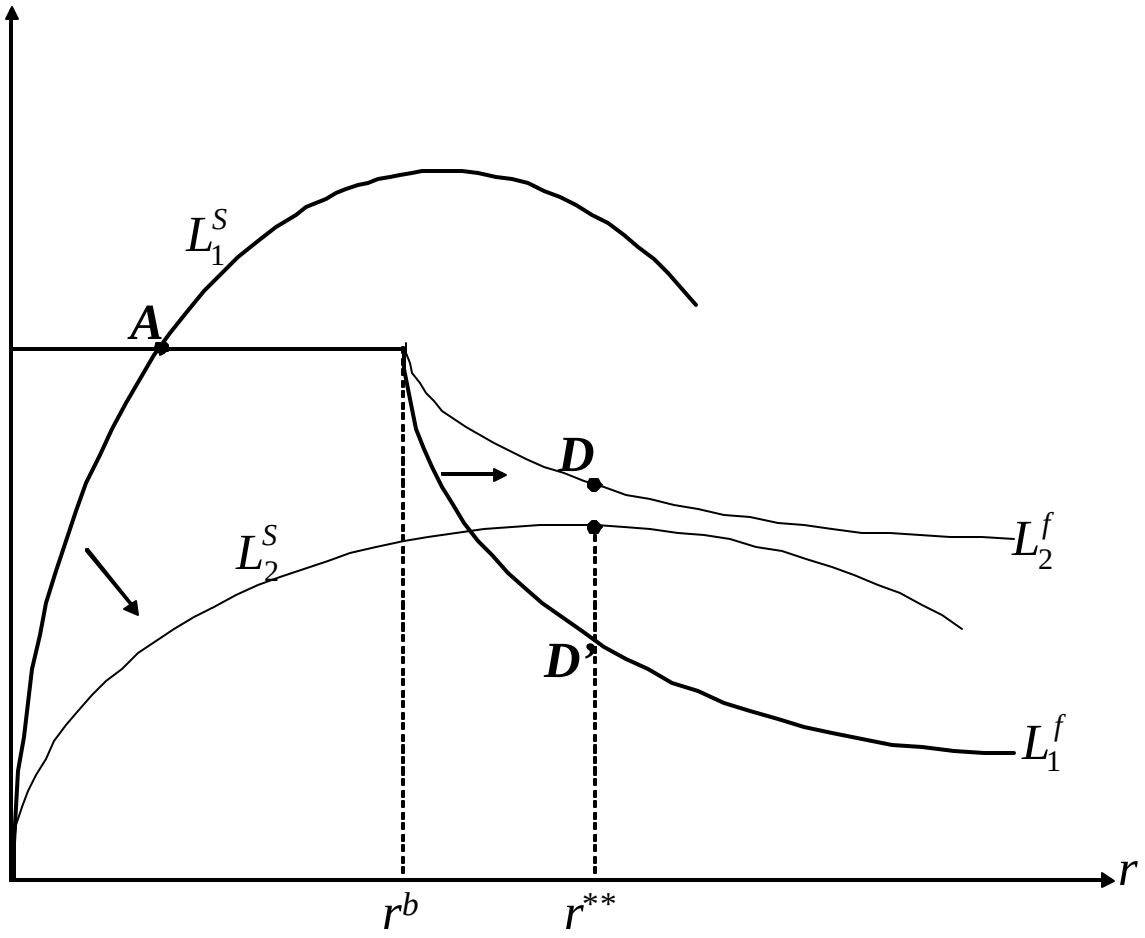
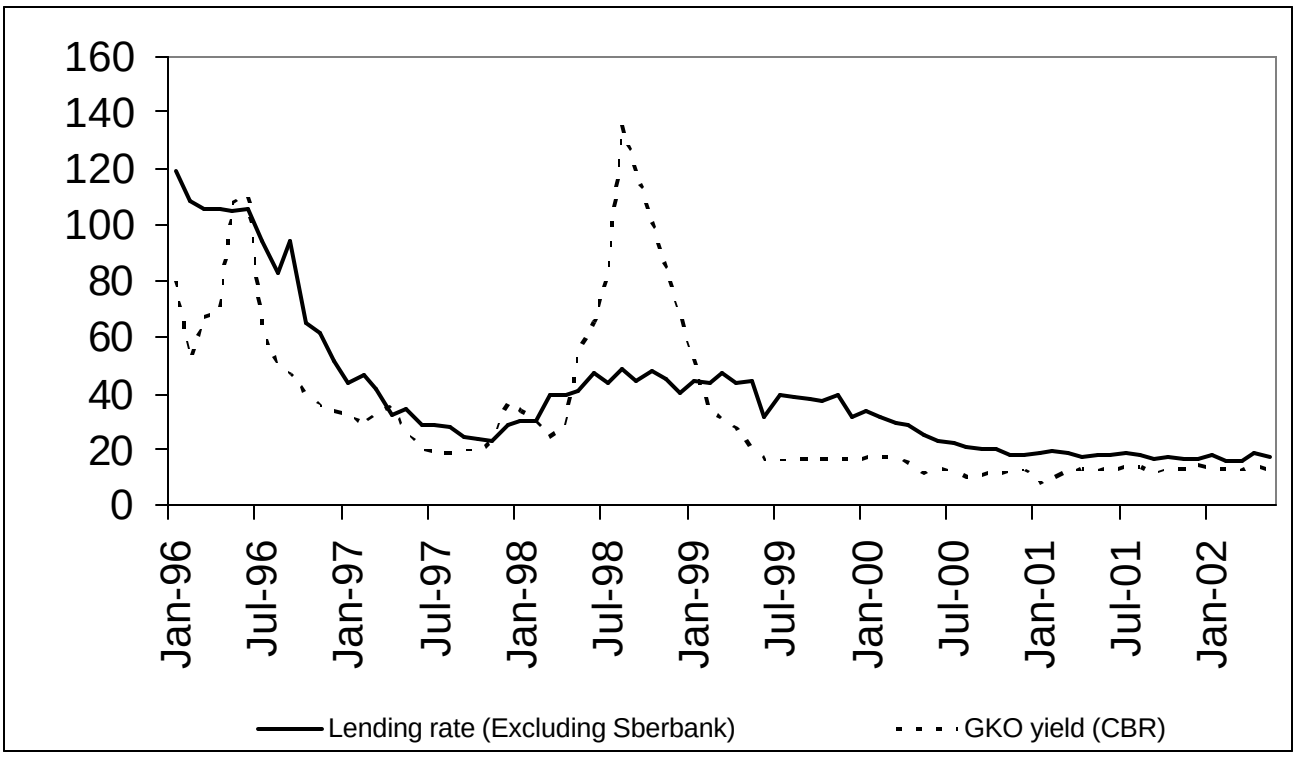


FIGURE 6

Lending Rate and Yield to Government Bonds



Source: Russian Economic Trends.
Lending Rate excludes the Sberbank
Yield to Government Bonds is the GKO yield given by the CBR

FIGURE 7

Mechanism Channels to Barter

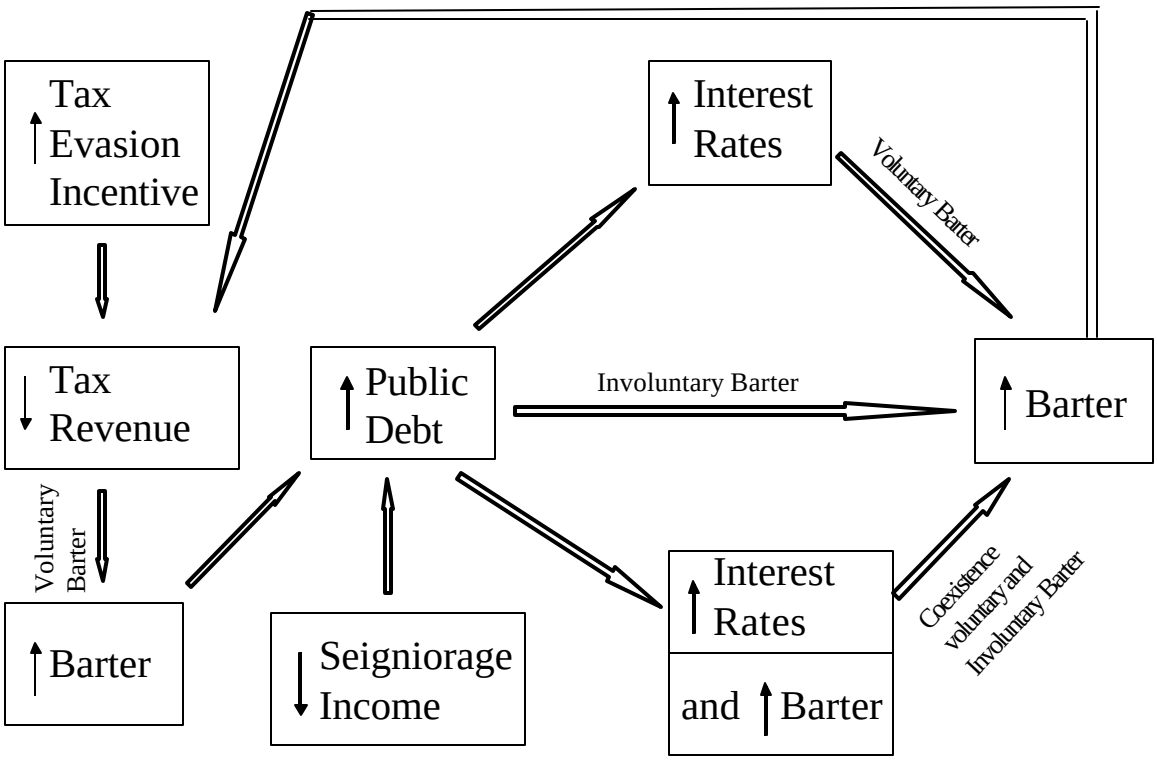
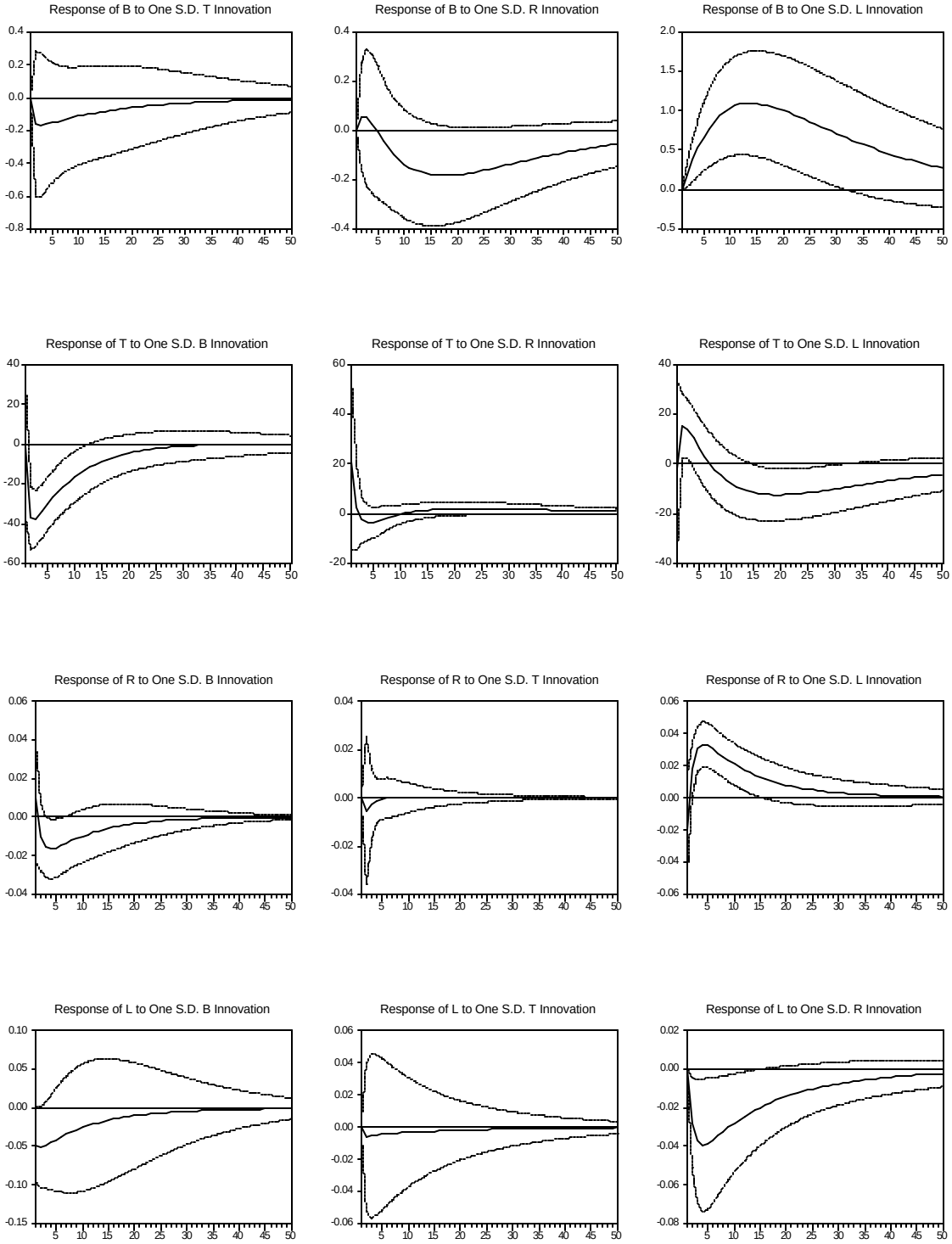


FIGURE 8

IMPULSE RESPONSE FUNCTIONS



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