THE TRANSMISSION MECHANISM TO BARTER

by

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September 2003

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Abstract

This paper addresses the issue of what has caused barter among industrial firms in Russia. Particularly, it proposes a theoretical framework to determine whether barter is the result of credit rationing or firms' optimal choice, and based on that, conduct a multivariate VAR analysis to inquire into the empirics of the phenomenon.

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

Keywords: Barter, money, credit, interest rate, VAR, unit roots, transmission mechanism.

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I. INTRODUCTION

The Russian monetary policy of the 1990s can be summarized as follows: a loose monetary policy causing the high inflation episode during the early stage of the transition, followed by a tight monetary policy until the ruble crisis in 1998. In fact, after the third quarter of 1993, money growth rate and real money balances decreased, reflecting the decline in seigniorage. On the other hand, from 1994 on, government debt steadily increases until 1998. The seigniorage for debt substitution policy is abandoned after the 1998 Russian crisis. Figure 1 shows real money balances and government debt to banks throughout this period to illustrate that policy. This policy was the scenario for the rise and fall in barter transactions in Russia during the 1990s.

According to the Russian Economic Barometer, the number of barter transactions in industrial sales in Russia increased from 5-10% in 1992 to 50-60% in 1998, and then falls to 10-20% in 2002. A number of theories have been written to explain the phenomenon. Some of them claim that structural factors cause barter in Russia. Blanchard and Kremer (1997) argue that it is a consequence of disorganization. Gaddy and Ickes (2002) propose the virtual economy: choose to barter to evade the official economy. Marin and Schnitzer (1999) criticize the virtual economy. Prendergast and Stole (1999, 2001a, and 2001b) state that barter allows market segmentation, which increases firms' profit.

Although structural factors can explain a share of total barter transactions, the high correlation with a number of monetary variables suggests that a monetary explanation can better explain the rapid changes in barter indicators. This is emphasized in a number of empirical works like Bevan et al (2001), Brana and Maurel (2000), Commander et al (2000), Linz and Krueger (1998), and Makarov and Kleiner (2000). One particular open question is whether bartering is the result of firms' choice or is imposed to them. In a tight credit market, credit rationing may arise as lenders choose not to increase interest rates and credit supply in order to hedge themselves against increasing risk. Rationed firms thus may respond by switching to barter or other alternative transaction technology. On the other hand, if lenders respond by increasing interest rates, output decreases, and firms with access to barter technology may "choose" to barter if the cost of this alternative transaction technology is lower than the cost of borrowing. Huang et al (2002), and Noguera (2002a, b) emphasize how barter can rise as an alternative to a costly credit market. This paper conducts a VAR analysis to test whether the rapid changes in the share of barter transactions in Russia during the 1990s result from firms' optimal decision or credit rationing. Section II provides the necessary theoretical background. Section III proposes the econometric model. Section IV deals with the data and inquires about unit roots. Section V shows and interprets results. This includes Granger causality and impulse response function analyses. Section V concludes.

II. SOME THEORETICAL BACKGROUND

Consider a firm i with an indivisible project, which yields a return R_i^s with probability q_i if the project succeeds, and a return R^f if the project fails. Suppose that the firm borrows financial resources for a real value of L^f to undertake the project, which repays at a real

interest rate r if the project succeeds, and the available return R^f if it fails. The firm's expected return is

$$E(\pi_i^l) = q_i\left[R_i^s - (1+r)L^f\right].$$

On the other hand, if the firm barters, it faces a barter cost per transaction τ, and the expected return becomes

$$E(\pi_i^b) = q_i R_i^s + (1-q_i)R^f - C(\tau), \qquad C' > 0,\ C'' > 0.$$

Assume that $C(\tau) > L^f$ and $R_i^s > C(\tau) > R^f$, for all i. A firm i borrows if $E(\pi_i^l) > E(\pi_i^b)$. This occurs if

$$(1) \qquad q_i < \frac{C(\tau) - R^f}{(1+r)L^f - R^f}.$$

Let r_b denote the cutoff interest rate that makes the right-hand side expression equal to one, then

$$r_b = \frac{C(\tau)}{L^f} - 1$$

If $r < r_b$, inequality (1) holds, all firms conduct cash transactions and the credit demand is constant and equal to L^f. Yet, if $r > r_b$, a number of firms quit the credit market, choose to barter and the demand for credit decreases[1]. Thus, the demand for credit can be written as

$$L^d = \begin{cases} L^f & \text{if } r < r_b \\ \mu(r)L^f & \text{Otherwise} \end{cases},$$

where $\mu(r) \leq 1$, and $\mu'(r) < 0$. On the other hand, in the presence of risk, it is a well-known result that the supply for loans function (L^S) is a concave curve[2] that reaches a maximum at some interest rate level $r = r^*$. Equilibrium is illustrated in Figures Two. In

[1] Noguera (2002b) formalize this argument.
[2] See Stiglitz and Weiss (1981), and De Mezza and Webb (1987).

Figure 2a, the loan function reaches a maximum at an interest rate r^* that is less than the cutoff interest rate r_b, ($r^* \leq r_b$). The credit demand is constant and, if it is low enough say L_0^f, all firms obtain a loan and there is no barter. Yet, if it is too high, greater than L_1^f, lenders do not respond to the increasing demand, there is credit rationing and a barter economy emerges. In this case, there is no correlation between fluctuations in barter transactions and the real interest rate, but between barter and the variable that is causing the credit market constraint.

Consider Figure 2b, where $r^* > r_b$. If the interest rate is below r_b, there is no barter. Yet, if the equilibrium interest rate at point *A* where $r_b < r < r^*$, lenders respond an increasing demand for credit with higher interest rates, and barter results from firms' choice. In this case the increasing interest rate is what directly causes bartering and both variables must be correlated. On the other hand, if the credit demand increases to L_1^f, some firms barter because of credit rationing, but some others because they choose to do it; thus, barter must be correlated with the interest rate and also with the variables causing the credit market constraint.

III. THE MODEL

From the discussion in the previous section, we identify three possible cases in which a tight monetary policy results in an increase of the barter activity. In each case, the transmission mechanism allows to identify whether barter results from firms' choice, credit rationing or both. For the purpose of illustrating the argument, in every case we assume that increasing government indebtedness is making the credit market tighter. First, the interest rate increases, and firms responds by switching to barter to lower transaction costs (Point *A* in Figure 2b). Second, there is credit rationing; interest rates do

not respond to monetary policy and firms have no other choice but to barter; instead, barter should respond directly to government debt (Figure 2a). Third, there is a mixed equilibrium. Interest rates increase with a tighter credit market making some firms switch to barter, yet other firms are simply subject to credit rationing; barter is correlated with both interest rates and government indebtedness (Point *B* in Figure 2b).

Thus, by identifying the transmission mechanism from monetary policy to barter, we can also determine what makes firms barter. For that purpose, we conduct a VAR analysis with five endogenous variables: barter share (*B*), output (*Q*), inflation rate (π), real interest rate (*R*), and the real depreciation rate (*e*). We also include two exogenous variables: the money growth rate (θ) and government debt (*L*). Then, the Granger causality tests and impulse response functions allow identifying the transmission mechanism and thus the causes of barter in Russia. We use the following model:

(2a) $$B(t) = \sum_{i=1}^{T} \chi_{bi} B_{t-i} + \sum_{i=1}^{T} \delta_{bi} Q_{t-i} + \sum_{i=1}^{T} \alpha_{bi} \pi_{t-i} + \sum_{i=1}^{T} \beta_{bi} R_{t-i} + \sum_{i=1}^{T} \varphi_{bi} e_{t-i} + \sum_{i=0}^{T} \phi_{bi} L_{t-i} + \sum_{i=0}^{T} \varepsilon_{bi} m_{t-i} ,$$

(2b) $$\pi(t) = \sum_{i=1}^{T} \chi_{\pi i} B_{t-i} + \sum_{i=1}^{T} \delta_{\pi i} Q_{t-i} + \sum_{i=1}^{T} \alpha_{\pi i} \pi_{t-i} + \sum_{i=1}^{T} \beta_{\pi i} R_{t-i} + \sum_{i=1}^{T} \varphi_{\pi i} e_{t-i} + \sum_{i=0}^{T} \phi_{\pi i} L_{t-i} + \sum_{i=0}^{T} \varepsilon_{\pi i} m_{t-i} ,$$

(2c) $$Q(t) = \sum_{i=1}^{T} \chi_{qi} B_{t-i} + \sum_{i=1}^{T} \delta_{qi} Q_{t-i} + \sum_{i=1}^{T} \alpha_{qi} \pi_{t-i} + \sum_{i=1}^{T} \beta_{qi} R_{t-i} + \sum_{i=1}^{T} \varphi_{qi} e_{t-i} + \sum_{i=0}^{T} \phi_{qi} L_{t-i} + \sum_{i=0}^{T} \varepsilon_{qi} m_{t-i} ,$$

(2d) $$R(t) = \sum_{i=1}^{T} \chi_{ri} B_{t-i} + \sum_{i=1}^{T} \delta_{ri} Q_{t-i} + \sum_{i=1}^{T} \alpha_{ri} \pi_{t-i} + \sum_{i=1}^{T} \beta_{ri} R_{t-i} + \sum_{i=1}^{T} \varphi_{ri} e_{t-i} + \sum_{i=0}^{T} \phi_{ri} L_{t-i} + \sum_{i=0}^{T} \varepsilon_{ri} m_{t-i} ,$$

(2e) $$e(t) = \sum_{i=1}^{T} \chi_{ei} B_{t-i} + \sum_{i=1}^{T} \delta_{ei} Q_{t-i} + \sum_{i=1}^{T} \alpha_{ei} \pi_{t-i} + \sum_{i=1}^{T} \beta_{ei} R_{t-i} + \sum_{i=1}^{T} \varphi_{ei} e_{t-i} + \sum_{i=0}^{T} \phi_{ei} L_{t-i} + \sum_{i=0}^{T} \varepsilon_{ei} m_{t-i} ,$$

where *T* is the number of lags. Table 1 summarizes how the transmission mechanism helps identify the reasons for bartering.

IV. DATA AND UNIT ROOTS

We use data for Russia for the following seven variables: barter share (B), inflation rate (π), output (Q), the real interest rate (R), the real depreciation rate (e), government debt (L) and money growth rate (θ). The indicator is chosen based mainly on data availability. We use the annualized percentage growth of the Consumer Price Index as a measure of the inflation rate π, and the percentage growth of M2 as a measure of the money growth rate θ. The data source for both variables was the Russian Economic Trends until December 1993, and the International Monetary Fund (International Financial Statistics) from January 1994 on, line 92264.XXZF for CPI and the sum of money and quasi-money (lines 92234ZF and 92235ZF) for M2.

We choose the real exchange rate against the US dollar as a proxy variable for the real exchange rate e, and the industrial index as a proxy for output Q. The source for both variables is the Russian Economic Trends. We use the total government debt to banks as a proxy to nominal government indebtedness. The source is Russian Economic Trends. Then, this variable is deflacted by the consumer price index as measured above to obtain a measure of the real government indebtedness, L.

To measure barter activity B, we use the barter share of total transactions for Russian industrial firms reported by the Russian Economic Barometer. As a proxy for the real interest rate R, we use the quotient between the nominal interest rate and the inflation rate. As indicator of inflation we use the increase in the consumer price index (IFS/IMF), and for the nominal interest rate, we use the money market rate (IFS/IMF) from February 1995 on, and before that date, we estimate the money market rate using a regression between the money market rate and the current and three lags of the GKO rate.

We use that data from May 1993 to March 2002 to conduct a number of unit root tests. All variables are in measured in logs, except for the inflation and money growth rates, which are in percentage. As a criterion to determine the existence of unit roots, we follow the algorithm suggested by Ender (1995, page 257). First compute the following regression:

$$\Delta y_t = a_0 + a_2 t + \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-1-i} + \varepsilon_t ,$$

where p is the number of lags. This regression includes a trend or a drift plays. Table 2A shows the coefficients γ and the t-stats of the Augmented Dickey-Fuller tests for unit roots for the variables in levels. The critical value for 95% confidence for the null hypothesis of no unit root is –3.45. Thus, we accept the alternative hypothesis that the inflation, real interest and money growth rates are stationary or integrated of order one. The table also shows the F-stats for the null that $a_2 = 0$ given that $\gamma = 0$ for the remaining regressions. In all cases, the null is rejected, and so we conclude that barter share, output, exchange rate and real government debt have at least one unit root with 5% significance.

Table 2B shows the results of the augmented Dickey-Fuller test for barter share, output, exchange rate and government debt in first differences. In each case, the regression computed has a drift and a trend; then we repeat the exercise. The null of unit root is rejected in each case except for output. The augmented Dickey-Fuller test for the second difference of output rejects the null of unit root. Results are shown in Table 2C. Therefore, we conclude that inflation, real interest and money growth rate are integrated of order zero, barter share, exchange rate and real government debt are integrated of order one, and output is integrated of order two.

V. ESTIMATIONS AND IMPULSE RESPONSE FUNCTIONS

To test for Granger causality we run VAR regressions using five endogenous variables, barter share, inflation, output, real interest and real exchange rate, and two exogenous variables: real government debt and money growth. Based on the unit root analysis, we include inflation, real interest and money growth rates in levels; barter share, real exchange rate and government debt in first differences; and output in second differences. We also use an intercept in each equation, and compute the F-statistics to test the null hypothesis that there is not Granger causality [See Hamilton (1994), page 305]. We use data from July 1993 to March 2003. We find that the lower the number of lags, the lower both Akaike information and the Schwartz Bayesian criteria, which means that the model has a very short memory. We chose two lags for each equation. This is the lowest number of lags that do not show autocorrelation in any of the regressions. Table 3 shows the computed F statistics for the null that the variable shown in the top row Granger causes the variable in column. The critical value for rejection of the null hypothesis is 3.087.

From the tests we make the following conclusions: inflation Granger causes barter share and interest rate; the real interest rate Granger causes barter share, output and real exchange rate; real government debt Granger causes barter share; and money growth rate Granger causes inflation. It is noteworthy that while innovations to the interest rate affect barter activity, only inflation seems to Granger cause real interest rate. Yet, as we will shortly see, inflation affects real interest negatively, and the effect of real interest on barter is positive; on the other hand, inflation in Russia was decreasing while barter activity was increasing during the 1990s. Thus, a puzzle arises since being real interest an endogenous variable, what determines real interest so as it can affect barter activity. To

solve the puzzle, we consider a structural break around February 1995. There are reasons to think about that. First, observe in Figure 1 that government debt is negligible before July 1994, when the government started to change seigniorage for debt as source of government finance. Also, average inflation decreased from a roughly average of 500% before that date to an average of 50% afterward. If inflation is as high as 500%, the adjustment process is very quick, and can be even almost instantaneous; thus, changes in the money growth rate can barely affect real variables. On the other hand, lower inflation gives room to rigidities and a slower adjustment process of the real interest and real exchange rates. Thus, including a monetary policy variable without considering this structural break would cause a misspecification that weakens Granger causality tests. We extend the model to include a dummy variable, which is equal to zero before February 1995, and equal to the money growth rate from that date on. Results on Granger causality are shown in Table 4. Results enhance all previous Granger causality findings shown in Table 3, but in addition show that the money growth rate Granger causes the real interest and real exchange rates.

Figure 3 shows the impulse response functions for those cases where Granger causality is detected. The Granger causality analysis and the impulse functions together allow important conclusions. First, innovation in inflation causes an increase in barter activity. This result is not new and is the usual explanation to the barter activity in other episodes like the German and Hungarian hyperinflation of the XX century. However, this does not seem to be the case of Russia during the 1990s, since during that period, inflation in Russia decreased as barter activity increased. We also find that barter is affected through the real interest rate and real government debt. In fact, from the Granger

causality tests and the impulse response functions, innovation in either variable directly causes an increase in barter activity. The interest rate channel means that some firms have chosen to barter because of the high credit cost, and the real government debt channel means that, for other firms, barter has been a Hobson choice, that is, the only choice they has since they are subject to credit rationing. On the other hand, only innovations in the money growth rate make the real interest rate to increase. In summary, the monetary constraint policy made the real interest rate increase fostering firms to switch into barter; yet it also caused credit rationing and some other firms were forced to barter. This the mixed equilibrium case illustrated by point B in Figure 2b.

The VAR analysis conducted also allow other conclusions that typically appear in monetary models like innovations in money growth make inflation and real exchange rate temporary increase, innovations in the real interest rate make output and the real exchange rate temporary decrease, and innovation in inflation makes the real interest rate temporary decrease. Figure 4 illustrate the dynamic of causality works in this model.

VI. CONCLUSION

Despite the small sample available, this VAR exercise provides strong evidence of what has caused barter in Russia during the 1990s. Credit rationing explains an important share of barter transactions. The result that increasing government debt does affect neither interest rates nor output in the short-run is a typical symptom of credit rationing. Yet, it directly affects the share of barter transactions among industrial firms, which means that firms have chosen to barter because of the increasing rationing in the credit market.

On the other hand, we also find that many firms have chosen to barter because of the high cost of credit. The econometric exercise conducted shows clear evidence of the

interest rate channel. A restrictive monetary policy made interest rate increases, and the higher interest rates foster firms to barter. Barter can be seen as an alternative choice to bankruptcy, especially for those firms that were subjected to credit rationing. It seems less clear whether this was the case of those firms that chose to barter. Yet, solving this puzzle is a matter of further research.

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TABLE 1
BARTER AND THE TRANSMISSION MECHANISM

Firms' Choice:				
Increase in Government debt or Increase in expected exchange or or decrease in θ	⇒	increase in *R*	⇒	increase in *B*
Credit Rationing:				
Increase in Government debt or Increase in expected exchange or or decrease in θ	⇒	increase in *B*		
and				
increase in *R*	⇒	no effect on *B*		
Firms' Choice and Credit Rationing:				
Increase in Government debt or Increase in expected exchange or or decrease in θ	⇒	increase in *R*	⇒	increase in *B*
and				
Increase in Government debt or Increase in expected exchange or or decrease in θ	⇒	increase in *B*		

TABLE 2A
AUGMENTED DICKEY-FULLER TESTS FOR UNIT ROOTS
Variables are in levels

	Unit Root	Coeff.	t-stat	F-stat	Lags	Regression
Barter share	Yes	0.97	-1.66	1.50	1.00	Drift and no trend
Inflation rate	No	0.93	-3.52	0.00	12.00	Drift and trend
Output	Yes	0.92	-2.25	3.76	1.00	Drift and trend
Real Interest Rate	No	0.83	-3.71	0.00	1.00	Drift and trend
Real Exchange	Yes	0.96	-2.00	2.24	11.00	Drift and trend
Government Debt	Yes	0.98	-0.66	1.69	1.00	Drift and trend
Money Growth	No	0.91	-3.81	0.00	1.00	Drift and trend

TABLE 2B
AUGMENTED DICKEY-FULLER TESTS FOR UNIT ROOTS
Variables are in First Difference

	Unit Root	Coeff.	t-stat	F-stat	Lags	Regression
Barter share	No	-0.42	-8.92	0.00	1.00	Drift and trend
Output	Yes	0.87	-2.74	5.14	12.00	Drift and trend
Real Exchange	No	0.39	-6.20	0.00	1.00	Drift and trend
Government Debt	No	-0.34	-9.13	0.00	1.00	Drift and trend

TABLE 2C
AUGMENTED DICKEY-FULLER TESTS FOR UNIT ROOTS
Variables are in Second Difference

	Unit Root	Coeff.	t-stat	F-stat	Lags	Regression
Output	No	-0.50	-3.96	0.00	12.00	Drift and trend

TABLE 3
PAIRWISE GRANGER CAUSALITY TESTS
Computed F statistics for variable in top row Granger causes the variable in first column

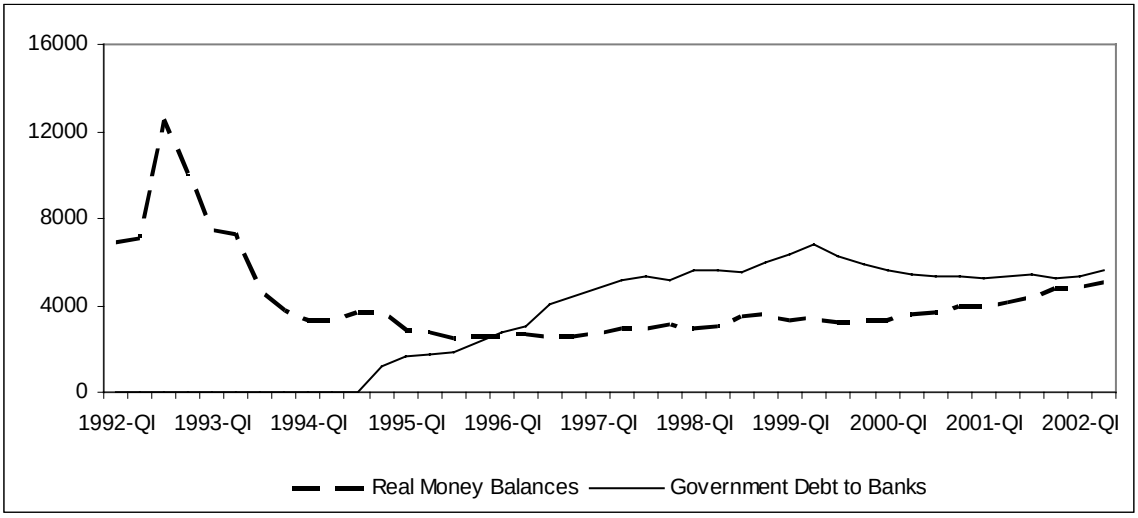
	Barter Share	Inflation rate	Output	Real interest	Real exchange	Govt. debt	Money growth
Barter Share	--	8.38	0.01	7.87	1.04	7.29	0.60
Inflation	0.76	--	1.82	2.08	0.21	0.26	5.17
Output	0.77	1.91	--	3.62	0.31	0.03	1.43
Real interest	0.08	4.63	0.53	--	0.34	0.38	1.69
Real exchange	0.28	1.77	0.93	4.85	--	1.66	1.04

TABLE 4
GRANGER CAUSALITY TESTS INCLUDING A DUMMY
Computed F statistics for variable in top row Granger causes the variable in first column

	Barter Share	Inflation rate	Output	Real interest	Real exchange	Govt. debt	Money growth	Money growth (Dummy)
Barter Share	--	9.80	0.03	9.13	0.76	5.17	0.84	2.13
Inflation	0.66	--	1.96	1.82	0.15	0.38	5.05	0.33
Output	0.77	1.71	--	3.69	0.34	0.04	1.25	0.17
Real interest	0.06	5.19	0.46	--	0.80	0.26	2.16	4.79
Real exchange	0.04	0.85	1.58	3.91	--	0.44	0.32	3.71

FIGURE 1

Real Money Balances and Government Debt to Banks in Russia



Source: IFS/IMF (real money balances)

Russian Economic Trends (Government Debt to Banks)

FIGURE 2a

Barter When Firms Choose to Do It

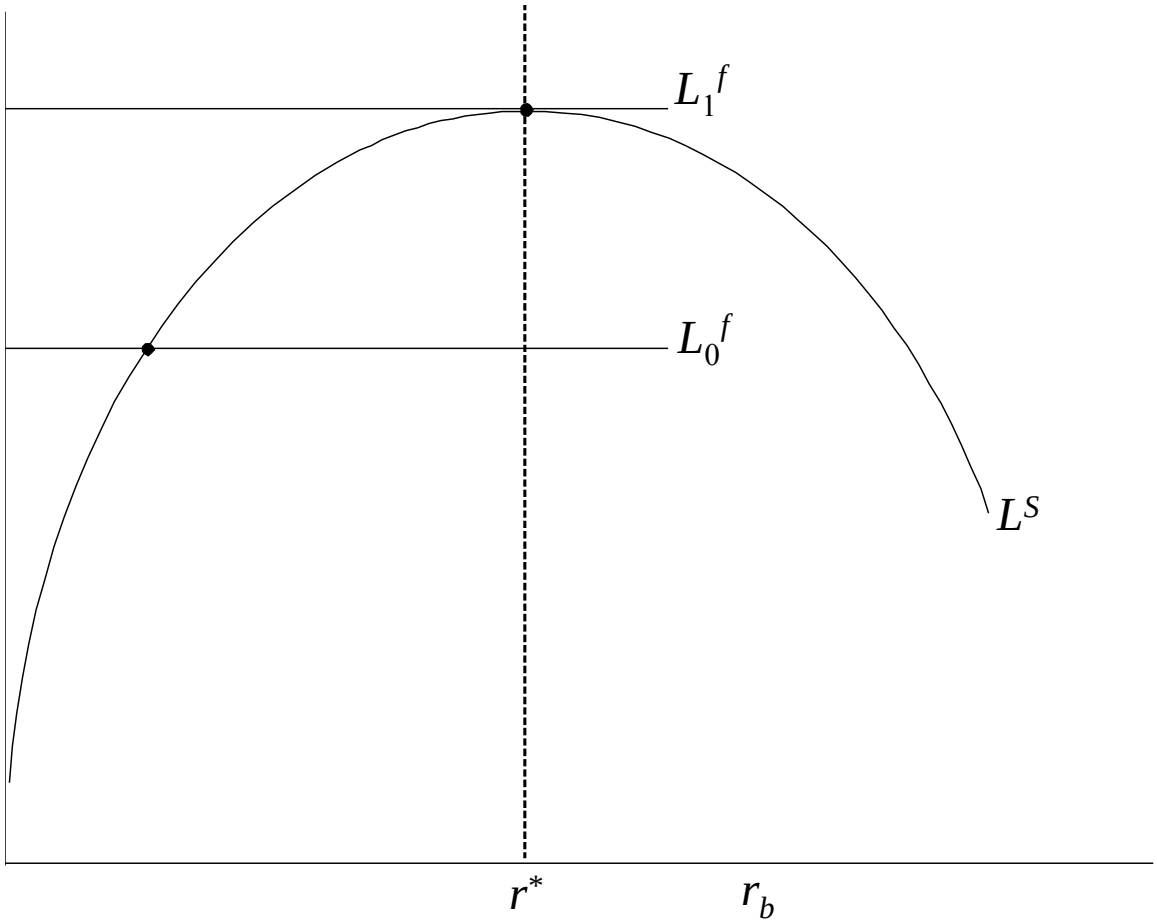


FIGURE 2b

Barter When There is Credit Rationing

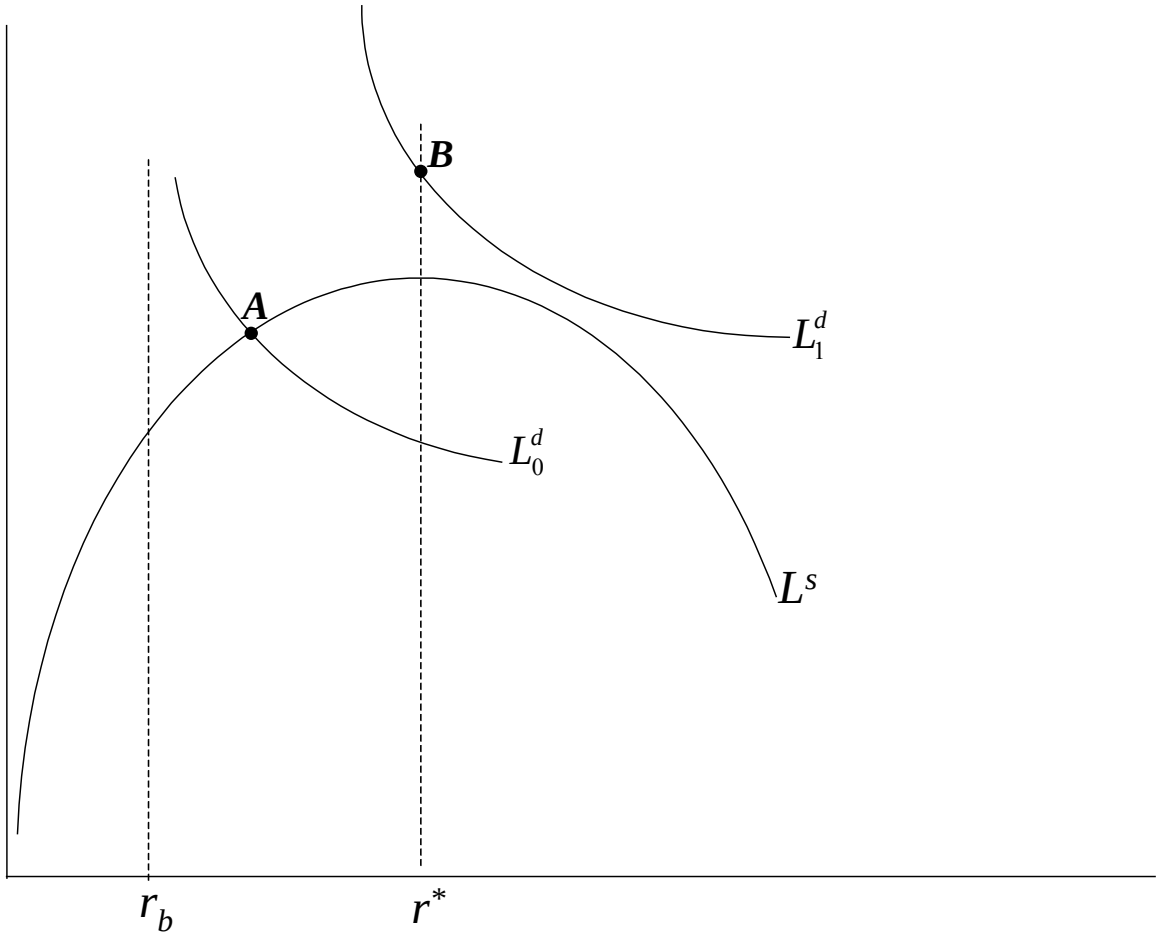
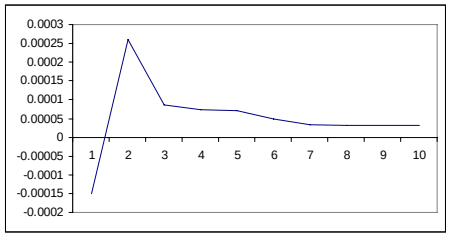
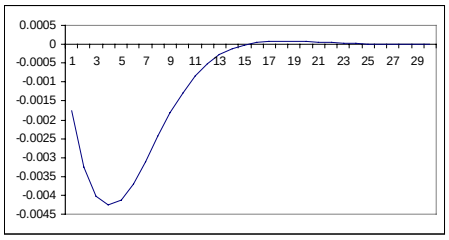


FIGURE 3
Impulse Response Functions

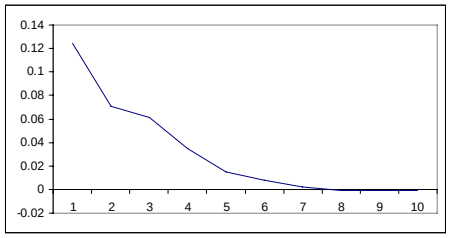
Inflation Granger causes barter share



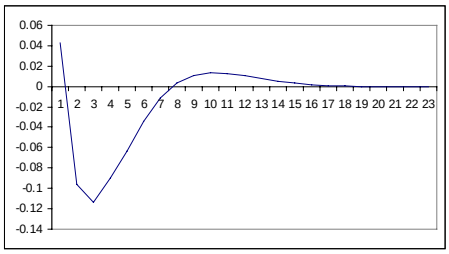
Inflation Granger causes interest rate



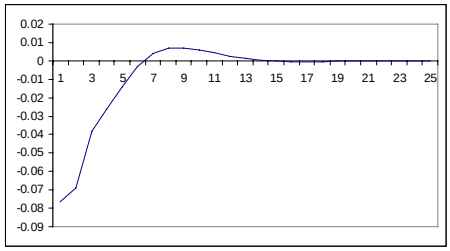
Interest Granger causes barter share



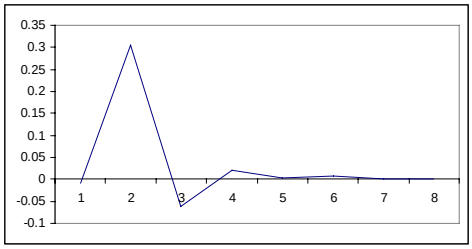
Interest Granger causes output



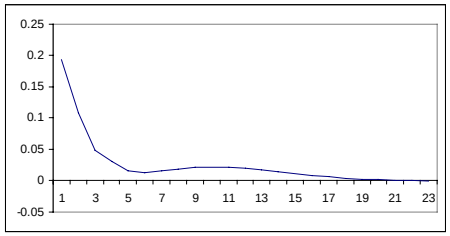
Interest Granger causes real exchange



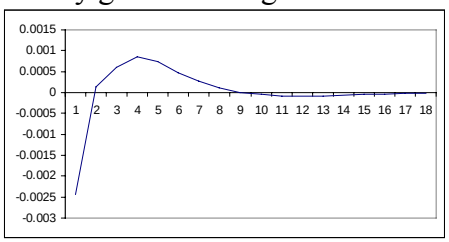
Govt. debt Granger causes barter share,



Money growth Granger causes inflation



Money growth Granger causes real interest



Money Growth Granger causes real exchange

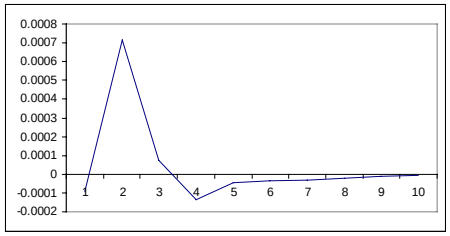
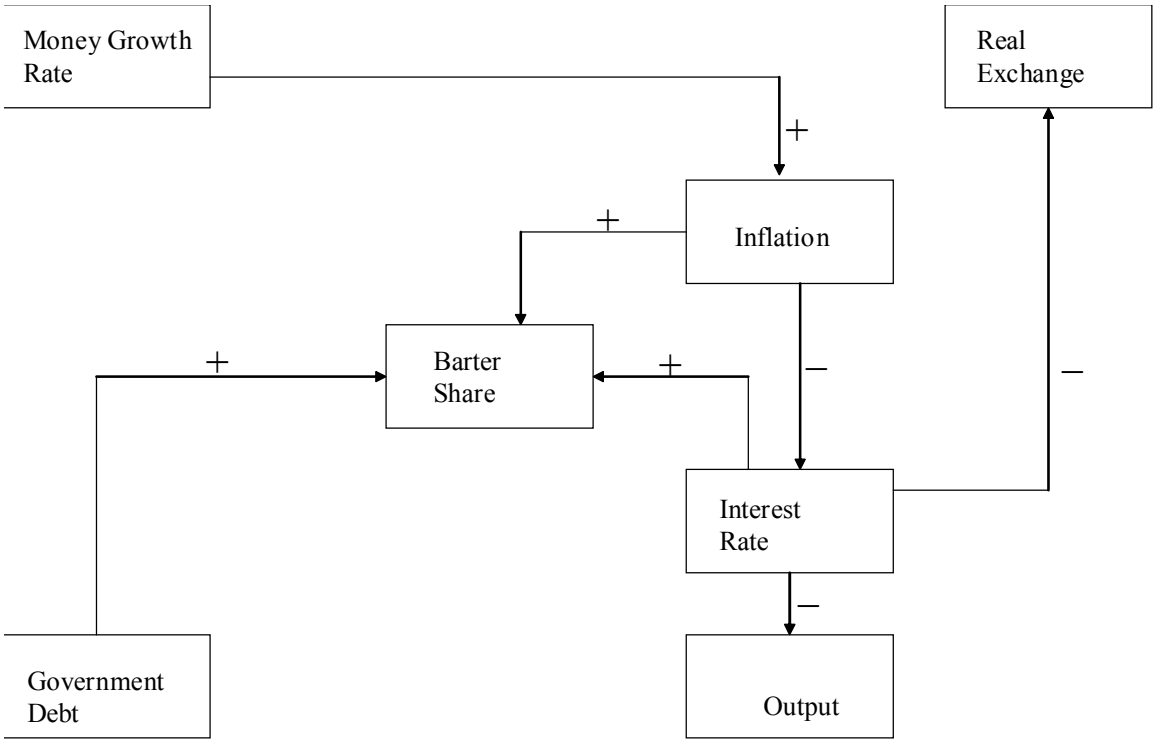



FIGURE 4
Dynamic of Causality