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Demand for money during transition: the case of Russia

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BARRY HARRISON * and YULIA VYMYATNINA** Demand for Money During Transition: The Case of Russia[1]. **Working paper Ec-01/05.**

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Abstract:
During the transition to a market economy in Russia, the Bank of Russia assumed responsibility for setting and implementing monetary policy. As transition progressed, this involved establishing annual declining target rates for inflation and intermediate targets for the growth rate of M2 money aggregate. This paper tests the stability of long run and short run demand for money in Russia using M1 and M2 money aggregates. We find some evidence of stability, but the adjustment lag is relatively long and money demand functions demonstrate signs of instability over the period. We conclude that targeting interest rates could be a better policy option for the Bank of Russia.

Keywords: transition; demand for money.

JEL classification numbers: E41.

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1. Introduction

The empirical properties of the demand for money function, including its predictability and interest rate and income elasticities, provide critical inputs in the formation of monetary policies in many countries. Judd and Scadding (1982) have argued that ‘a stable demand function for money means that the quantity of money is predictably related to a small set of key variables linking money to the real sector of the economy’ (pp 993). In many countries therefore, a stable demand for money plays a crucial role in the conduct of monetary policy because it enables a policy driven change in money aggregates to have predictable influences on output, interest rates and ultimately prices. Bernanke and Mishkin (1997) have further argued that a successful policy of inflation targeting also requires a stable demand for money function. Sriram (2001) provides a recent survey of the evidence on demand for money functions.

Most studies of the demand for money focus on developed countries. By comparison, emerging economies in general and transition economies in particular have received less attention in the literature. One reason for this is that the process of transition from plan to market is a relatively recent phenomenon beginning in the early 1990s and, for many countries, still far from complete. The nature of transition is complex involving simultaneous dislocations in economic behaviour and major changes in multiple aspects of the economic system. This makes empirical investigations difficult since it raises serious questions about the reliability of data, especially in the early phase of transition.

In this paper we focus on the long-run and short-run demand for money functions in Russia. Russia is an important case of transition being the largest of all the transition economies of the former Soviet Union. The speed of reform places Russia between the fastest reforming economies of Central and Eastern Europe and the slowest reforming economies of Central Asia and the Caucuses Region. Russia also provides a particularly interesting case study because of all the economies of the former Soviet Union it experienced the most severe consequences of the Asian financial crisis of 1997 which precipitated the Russian financial crisis of August 1998. This resulted in a serious structural break in demand for money functions.

After the crisis, the Bank of Russia assumed responsibility for the conduct of monetary policy and started to publish its ‘General foundations of the state monetary policy’. In these foundations, a declining inflation target for the end of each year has been set since 1999 with a target rate of growth for M2 (cash in circulation with non-banks and deposits of domestic currency held by resident non financial organisations and individuals) as the intermediate goal. This choice of target variables implicitly suggests that the Bank of Russia assumes a causal relationship between inflation and the growth of M2 – though the financial crisis of 1998 might well have caused some instability in this relationship. Moreover, the Bank of Russia still publishes its intermediate target growth rate for M2 and the behaviour of this aggregate is therefore an important leading indicator for the conduct of monetary policy in Russia. In our paper we estimate its effectiveness as an intermediate target.

The remainder of this paper is organised as follows. Section 2 provides an overview of the issues relevant to money demand and a summary of the major developments in Russia's monetary policy during the period 1999 – 2004. In section 3 we discuss issues associated with our selection of variables, explain our data and set out our methodology for testing the demand for money in Russia. In section 4 we report our results and section 5 provides a summary and conclusions. The detailed econometric results are summarised in the appendix.

2. Money Demand Monetary Policy and

Monetary theory usually assumes that the main motive for demanding money is to carry out transactions and the main factors influencing demand for money are the level of economic activity (usually approximated by GDP) and nominal interest rates. Using GDP as a proxy for the overall level of transactions implies that the demand for money is examined in terms of its relationship with the level of final transactions. Money is assumed to have a zero own rate of return and the nominal rate of interest proxies the return on other assets forgone by holding money. The higher the nominal rate of interest, the lower the incentive to hold money balances since the opportunity cost of doing this is inversely related to the return on other assets.

Accordingly, the basic money demand function is usually expressed in the form:

$$M / P = L(\underset{+}{Y}, \underset{-}{i}) \qquad (1)$$

where M is nominal money balances, P is the price level, Y is real GDP and i is the nominal interest rate.

Central Banks like the Bank of Russia that have chosen inflation targeting in the presence of a floating exchange rate have two policy instruments at their disposal, and the choice of primary instrument depends on the transmission mechanism operating in the economy. The instruments are the rate of growth of some money aggregate and the official interest rate. With money growth as the policy instrument, the transmission mechanism is assumed to be directly from money to prices. In this scenario an increase in money growth leads to excess money balances at the ruling price level and encourages increased consumption and investment. (If the demand for money is stable, it also leads to a lower rate of interest.) As aggregate demand rises and assuming conditions of constrained aggregate supply, inflation rises. (Howells and Bain, 2003) Equilibrium is restored when the demand for money has risen sufficiently to absorb the higher nominal money stock. In this transmission mechanism the stability of money demand is central in relating changes in the application of the policy instrument to the desired outcome in terms of aggregate output and, under constrained aggregate supply, inflation. The transmission mechanism also works in reverse but asymmetries exist between expansionary and restrictive monetary impulses. The general conclusion is that expansionary money growth has a more powerful effect than a restrictive approach due to commercial banks' loyalty to their customers. (Palley, 1994)

The transmission mechanism with the alternative policy instrument might be generally described as changes in the official interest rate resulting in changes in market interest rates, asset prices and changes in the expectations of economic agents including expectations over future changes in the exchange rate. All these processes influence domestic and foreign demand, which impacts on aggregate demand with a less certain outcome for the rate of inflation.

Using official interest rate changes, the monetary authorities gain more channels of policy transmission and are less constrained by the assumption of a stable demand for money function. This probably explains the findings of recent research which demonstrates that most Central Banks currently adjust interest rates rather than money growth (Borio, 1997). However, this policy instrument implicitly assumes well-developed banking and financial systems which might not be the case for some economies in transition.

2.1 Overview of monetary policy in Russia in 1995-2004

Since the fiscal policy in the early period of transition was very vague, and Federal Government of Russia experienced sever budget deficit, monetary aggregates expanded at a high rate due to large-scale credits to the government. In April 1995 the new Law on the Central Bank of Russia was approved, it declared that Bank of Russia should be independent in its formulation of monetary policy, and direct lending to government was prohibited. These legal changes allowed Bank of Russia to introduce exchange rate band in July 1995. It should be stressed however, that independence of the Bank of Russia has been rather declarative in nature, since in the same Law on the Central Bank of Russia it is stated that one of its main tasks is "to elaborate and pursue in collaboration with the Government of the Russian Federation a single state monetary policy" (article 4, Federal Law #86). Fiscal policy was also tightened, and this led to the reduction of rate of growth of the credit to government in 1995 – 1998.

In August 1998 facing financial crisis, Bank of Russia tried to prevent liquidity crisis in the system of commercial banks and to escape legal procedures leading to bankruptcy of major commercial banks. In particular, on the 24th of August 1998 it lowered rate of obligatory reserves from 11% to 10% for all commercial banks, and to 7% for Sberbank. In a week (September 1st, 1998) the rate of reserves was decreased to 5% for Sberbank and commercial banks with more than 40% of assets invested in GKO, and to 7,5% for commercial banks with 20-40% of assets in GKO. Two months later (December 1st, 1998) the rate of reserves was unified to 5% for all commercial banks.

In its country report on Russia in 2000, the IMF staff stressed that after the crisis the Bank of Russia was reluctant to use market-based instruments of monetary policy (interest rate management on different types of refinancing operations, Bank of Russia bonds etc.) to ensure the liquidity position of the banking system and relied instead on the reserve requirement rate, which was increased on four occasions by the mid 2000 (from 5% to 10% at its height) (Balino, 1998; IMF, 2000).

The main aim of the Bank of Russia's monetary policy since 1999 is an annual consecutive decrease in the rate of inflation. In its official statement in the 'General foundations of the state monetary policy' (1999 – 2005), the Bank of Russia stresses that inflation from year to year should be lower and that this is to be achieved through monetary methods designed not to restrict continued economic growth with higher levels of investment and consumption. The disinflation process "is chosen to progress in very a smooth way, since analysis of disinflation practices in other countries suggests that only smooth and consistent disinflation policies give the best results"[2]. Despite this, only in 2003 was the Bank of Russia successful in meeting the inflation target of 12% - though some doubts on the reliability of the data provided raise questions about the reliability this achievement. (see Table 1.)

Apart from its main aim, every year the Bank of Russia sets as an intermediate goal of monetary policy, a target rate of growth for M2. At the same time, already in its 'General foundations of the state monetary policy on 2003' the Bank of Russia mentions that even though its intermediate goal is to control M2 growth, the effectiveness of this control in relation to the main aim is diminishing since, along with decreasing inflation, the short-term statistical inter-relation between inflation and M2 is weakening. As its operational goal, the Bank of Russia seeks to control growth of the monetary base. Notwithstanding there is some doubt that the Bank of Russia has complete control over growth of the monetary base since by law all Russian exporters are obliged to sell a certain proportion of the foreign currency they receive to the Bank of Russia within two weeks of receipt. This makes it difficult for the Bank to retain control over the monetary base which fluctuates with export (most notable oil) prices. This, together with the weakening relationship between inflation and M2 growth, implies that the Bank of Russia would be well advised to seek out alternative instruments of policy in pursuit of its aims.

[2] CBR: "General foundations of the state monetary policy on 2003", p. 19, http://www.cbr.ru

Table 1. Dynamics of inflation, monetary aggregates and interest rates

Year	**Inflation target***	**Real inflation****	**M0 growth****	**M2 growth****	**Rate of refinancing*****
1992	--	2508,8%		494,8%	60%
1993	--	839,9%		409,3%	139,3%
1994	--	215,1%		199,9%	180,6%
1995	--	131,3%		125,8%	185,8%
1996	--	21,8%		33,7%	104,3%
1997	--	11%	27,3%	29,7%	32,5%
1998	--	84,4%	20,1%	6,1%	52,8%
1999	--	36,5%	64,9%	62,8%	57,2%
2000	18%	20,2%	73,7%	60,3%	33,2%
2001	12-14%	18,6%	22,3%	38,9%	25%
2002	12-14%	15,1%	39,2%	34,1%	22,2%
2003	10-12%	12%	50,5%	55%	18,4%
2004	8-10%	11,7%	24,7%	22,6%	13,5%

*Source: «General foundations of the state monetary policy on 2000, 2001, 2002, 2003, 2004»

**Source: Bank of Russia http://www.cbr.ru

***Weighted average, source: Bank of Russia, http://www.cbr.ru

As can be seen from the above, the Bank of Russia uses mostly instruments to control the monetary base (direct control over monetary base and required reserve ratio) in line with the orthodox theory's suggestions on monetary policy conduct. Other possible instruments, like refinancing ratio, are used only to adjust to the prevailing state of affairs in the economy.

3. Literature Review and Choice of Variables

During the transition process the effectiveness of monetary policy is seriously compromised because of difficulties in identifying the channels through which monetary policy operates. One reason for this is that external liberalisation and an internal inflationary environment facilitates and encourages currency substitution. To some extent, foreign money replaces the role of domestic money both as media exchange and as a store of value. In countries with high inflation this latter function of money becomes increasingly important because foreign money provides a higher degree of purchasing power stability and is therefore more desirable than domestic money. As a direct consequence of this, the money supply might, to some extent, become endogenous and increase the instability of money demand making it difficult for the authorities to implement effective monetary policy actions. In the case of Russia, for example, Friedman and Verbetski (2001) find evidence of high rates of substitution for the period 1995-2000, with elasticity of substitution between the Russian rouble and US dollar being between 2 and 3. Such evidence casts serious doubt on the stability of demand for domestic money in transition economies.

The evidence on demand for money functions in transition economies is ambiguous. Bahmani-Oskooee and Barry (2000) find that the demand for money in Russia which includes income, inflation rate and exchange rate variables was unstable in the 1990s. For Hungary and Poland, Buch (2001) finds that the long run elasticity values in the money demand function have the expected sign and some evidence of stable demand for money functions. Cuthbertson and Bredin (2001) find that for the Czech Republic a predictable relationship exists between money balances, real income and inflation and that the coefficients have the expected signs. Sløk (2002) finds a significant money demand relationship in 22 Mongolian regions over the period 1993-1999. Payne (2003) finds a stable demand for money function for Croatia with the opportunity cost variables having expected signs. Slovova (2003) has shown that in Bulgaria in the aftermath of the hyperinflation, the currency board successfully stabilised the demand for money.

In the following sub-sections we shortly explain our choice of variables.

3.1 Money stock

A large literature exists on the most appropriate choice of money stock, but it has been argued (see Laidler (1993)) that, because of the evolving financial system and institutional framework, broad money is more likely to yield a stable demand for money function. It therefore provides a superior measure with which to evaluate the long run impact of changes in monetary policy. Since in Russia the financial system remains largely unstable and fragile, the results might be different, and in our paper we use two definitions of monetary aggregates – M1 and M2 to check which delivers the most stable relationship and whether any relationship identified is meaningful. It should be stressed that we escape the problems with currency substitution since the M1 and M2 aggregates do not include foreign currency deposits.

3.2 Scale variable

In models of money demand, a scale variable is used as a measure of transactions relating to economic activity. Many variables might serve this purpose, but the most commonly used variables are GNP and GDP. One problem with using GNP or GDP as a scale variable is that they weight all transactions equally and take no account of how 'money intensive' transactions are. Goldfeld and Sichel (1990) have argued that that no firm evidence exists to support the view that categorising GNP (GDP) into its components yields any improvement in the behaviour of money demand. However, GDP (or GNP) data have a major drawback in that the frequency of their collection is usually quarterly, and in Russia first estimates of these data have been unreliable to the point of requiring substantial subsequent adjustment. In this study we use data on total trade as our scale variable since they better reflect the total value of transactions made over any given period and these data are available on a monthly basis with less subsequent adjustments.

3.3 Opportunity Cost Variables

Typically, the opportunity cost of holding money has two components: the own rate of return on money and the return on alternative assets. It has sometimes been argued (see Laidler (1993)) that the own rate of return on money can be ignored. Following Friedman (1956) the real rate of return on assets is usually proxied by the expected rate of inflation. Inflation implies a fall in the real value of money, but the real value of assets is maintained. When expectations of inflation are particularly strong, this provides a powerful incentive to switch out of money into real assets. Rates of interest on deposits are also included as an opportunity cost variable, especially for the less broad aggregates of money demand, as in this case the less liquid deposits represent an alternative form of holding money. Moreover, for countries experiencing financial instability, the effects of currency substitution are relevant in testing the stability of money demand functions. In this case the nominal exchange rate represents an opportunity cost of holding domestic money and foreign currency represents the alternative asset.

In this study we include two variables, the nominal exchange rate and an index of inflation expectations, to proxy the opportunity costs of holding money. In the case of transition economies with undeveloped financial markets, it is difficult to identify a reliable variable capturing the rate of return on real assets, other than inflation expectations. In the case of Russia, data on deposit interest rates are unsuitable, since during the observation period the method of various interest rates aggregation was changing, and besides, for most of the period in question, commercial banks offered depositors a nominal rate of interest which implied a negative real rate of interest on deposits. We use two proxies for expected inflation: inflation from the previous period on the assumption that inflation expectations are formed adaptively and are backward looking, and inflation expectations as measured by the consumer inflation expectations index. The latter is produced by the Development Centre and is constructed on the basis of survey information and better represents the actual expectation of inflation for the coming period.

We used monthly data for the period July 1995 – July 2004. The starting period was chosen since at approximately this time the coherent monetary policy was introduced.

- M1 (currency in circulation and demand deposits), Bank of Russia;
- M2 monetary aggregate, national definition (currency in circulation and demand and time deposits in national currency), Bank of Russia;
- CPI (consumer price index, December 2000 = 100), Bank of Russia;
- EPI (expected inflation index as measured by Development Centre on the basis of survey information), Development Centre;
- ERA – average monthly exchange rate RUR/USD, Bank of Russia;
- TTR – total trade, State Statistical Committee.

We used this data to construct the real money balances as nominal ones divided by the CPI. We took natural logs of the following variables to reflect growth rates: M1R, M2R, TTR, ERA, CPI, EPI and for CPI and EPI the corresponding index of inflation was calculated as the log-difference.

3.4. Empirical methodology

We test for the existence of both a short run and long run stable demand for money function using data from the Russian economy. We use three different monetary aggregates with two separate indicators of inflation expectations as a measure of the opportunity cost of holding money. Long-run money demand functions were estimated using vector error correction (VEC) models. Prior to this, we checked for the existence of cointegrating vectors using the Johansen procedure. Maddala and Kim (1999, p29) have argued that for high frequency data, the ADF test is the most appropriate for checking the order of integration and we All time series involved were found to be of the same order of integration using the ADF test shown to be the most appropriate for high-frequency data (Maddala and Kim, 1999, p. 129). In cases where the VEC estimated a cointegrating vector, the corresponding one-period lagged error correction term was included at the second stage in our estimation of the short run demand for money function.

The sort-term money demand functions were estimated following the general autoregressive distributive lag representation of the form:

$$A(L)\Delta LMR_t = c + EC_{t-1} + B(L)\Delta LTTR + D(L)\Delta LERA + F(L)\Delta INF + M12 + \varepsilon_t \quad (2)$$

where ΔLMR is the first difference of the logarithm of real money balances corresponding to different definitions of the monetary aggregates, $\Delta LTTR$ is the first difference of the logarithm of total trade, $\Delta LERA$ is the first difference of the logarithm of the average monthly exchange rate, EC_{t-1} is the error correction term, $M12$ is a centred seasonal dummy for December, (included because all time series exhibit peaks in December), $A(L), B(L), D(L), F(L)$ are lag polynominals, and ε_t is an error term. We use a general to specific approach to reduce the number of regressors and drop those that are insignificant provided that this did not result in the residuals becoming autocorrelated. To test for this we used the Breusch-Godfrey serial correlation test, and the Akaike Information Criterion was used to select the regression that we ultimately estimate.

We have chosen a specification of the model with real money balances as the dependent variable, which imposes price homogeneity onto the model. This has the advantage that there are less severe econometric problems associated with using real rather than nominal balances as the dependant variable (see Johansen (1992) and Boughton (1981)).

The estimated short-term money demand functions were then checked for stability of the coefficients using the Chow breakpoint test with October 1998 as a breakpoint. The breakpoint was chosen on the basis of prior examination of the time series, which demonstrated the change of tendency in Octover 1998, two months after the crisis. When the Chow breakpoint test could not be performed due to insufficient observations, CUSUM and CUSUMQ tests were used to judge the stability of our estimated relationships.

4. Empirical results

The data were checked for their order of integration and we find that LM1R, LM2R, LTTR and LERA are I(1) series, while ΔEPI and ΔCPI are I(0) series.

The monthly average exchange rate was checked for the order of integration with the use of the Perron 'additive outlier' integration test, since the dynamics of this time series exhibits a break in August 1998 at the time of the financial crisis in Russia. However, the results of the Perron test confirmed that LERA is an I(1) process with a shock of pulse type, rather than stationary with a shock of step type.

The Johansen procedure was run to test for cointegration between monetary aggregates in real terms and logarithms of total trade and the monthly average exchange rate. For all monetary aggregates the presence of cointegration was confirmed, indicating the possibility of significant long-term money demand functions. We then used a VEC model to estimate the appropriate cointegrating relationships given below.

$$LM1R = 0.535553 + 1.677821 * LTTR - 0.365036 * LERA$$

$$LM2R = 1.092684 + 1.960677 * LTTR - 0.580033 * LERA$$

All variables in our cointegrating relationships have the expected signs. We find a direct relationship between real money balances and total real transactions and an inverse relationship between real money balances and the average exchange rate. As expected, income elasticity and the exchange rate elasticity are higher for the M2 aggregate than for the M1 aggregate.

Impulse response analysis was further performed in order to trace the dynamics of responses of real money balances to innovations in the average exchange rate and total transactions. The results were also used to pick up the approximate number of lags for the estimation of short-run money demand functions so as to allow for the possible accommodation of the long-run influence of shocks. The results of our impulse response analysis are presented on Figures 1-4.

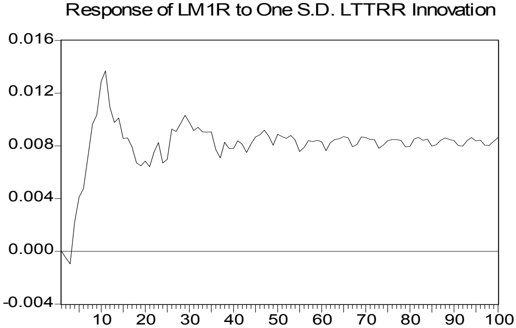

Figure 1. Response of LM1R to one standard deviation innovation in LTTR.

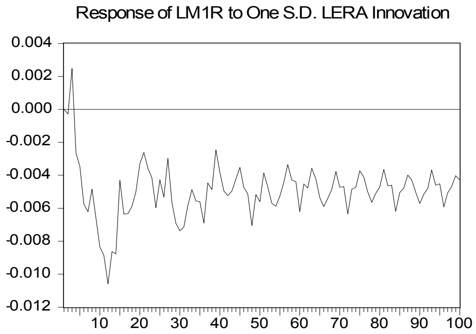

Figure 2. Response of LM1R to one standard deviation innovation in LERA.

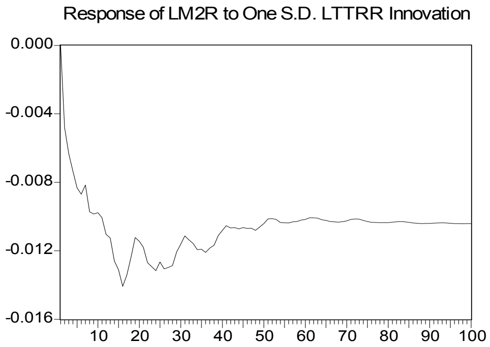

Figure 3. Response of LM2R to one standard deviation innovation in LTTR.

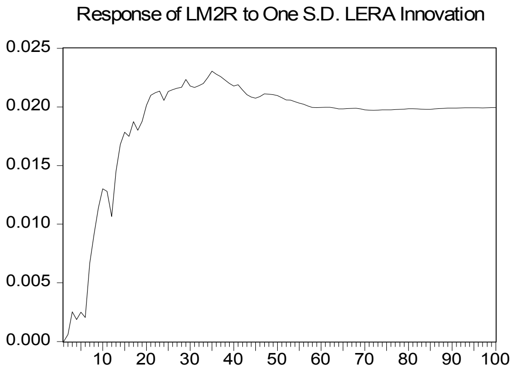

Figure 4. Response of LM2R to one standard deviation innovation in LERA.

Figures 1 – 4 show that in general, innovations to the average exchange rate are more quickly absorbed than innovations to total transactions. The time lags are 2 years and 2.5 years respectively for LM1R; and 3 years and 3 years respectively for LM2R. Shocks to total transactions eventually result in lower demand for money in the case of the LM2R aggregate and a higher eventual demand for money in the case of the LM1R aggregate. The opposite is true for shocks to the exchange rate. It is interesting to note that after about three and a half years, the LM2R aggregate totally absorbs the shocks and delivers a relatively smooth demand for real money balances function compared to the LM1R aggregate. This observation supports the choice of the M2 aggregate as an intermediate target of monetary policy for the Bank of Russia. But it also identifies a relatively long lag of about three and a half years before money demand adjusts to an external shock.

To evaluate our short term demand for money functions, the following lag lengths were adopted: 15 for LM1R, and 18 for LM2R. These allow for differences in adjustment as demonstrated by the impulse response functions and give a sufficient number of observations for our estimates of demand for money functions. For each of the money aggregates we estimated equation (2) with our different proxies for expected inflation in order to compare the results, and to check whether the backward-looking inflationary expectations form a good approximation as compared to explicitly measured inflationary expectations. All short-run money demand functions were estimated in first difference form of the corresponding monetary aggregates to account for the order of integration.

The results obtained from estimating our short-run money demand functions are summarised in Tables 2 and 3. Detailed results of these estimates are given in the appendix (Tables A1 – A4).

Table 2 shows that the short-run money demand function for real money balances as measured by the M1 aggregate is better estimated by using the consumer inflationary expectations index as a proxy for expected inflation. The number of parameters in the final regression is smaller and most have the expected signs predicted by monetary theory. However, for the regression including ΔCPI as a measure of expected inflation, all lagged differences of total transactions have a negative sign – a definite contradiction of the predictions of conventional monetary theory! Furthermore, as clearly illustrated in Figure 6, the model incorporating the consumer inflationary expectations index out performs the model incorporating ΔCPI in fitting the actual data - especially in terms of upward and downward dynamics. Interestingly, both models show better fitted results for the beginning and end of the estimation period which indirectly shows the proclivity of demand for money to instability. However, the model with the consumer price index as a measure of inflation expectations includes an error correction term which is statistically significant at the 5 per cent level, and also has the expected (negative) sign. The implication is that this model bridges the short-run demand for money function and the long-run demand for money function and might therefore provide a better guide to the short-term response of money demand to external shocks.

Table 2. Short-run money demand function for LM1R aggregate

	Inflationary expectations measured by ΔEPI	**Inflationary expectations measured by ΔCPI**
Initial number of parameters	60	60
Eventual number of parameters	22	25
Akaike information criterion	-4.422169	-4.518536
Breusch-Godfrey serial correlation LM test (p-value)	0.625996 (0.812073)	0.441521 (0.939068)
Lags of ΔLM1R (signs)	2(+)*, 4(+)*, 8(-)*, 9(-)*, 10(-)*, 11(-), 12(+)*	2(+)*, 4(+)*, 8(-)*, 9(-), 10(-)*, 11(-), 12(+)*
Lags of ΔLTTR (signs)	0(-)*, 1(+), 2(-)*, 6(+), 9(+), 10(+)*	0(-)*, 2(-)*, 5(-), 8(-)*
Lags of ΔLERA (signs)	0(-)*, 1(+)*, 3(-)*, 5(-)*, 7(+)	1(-)*, 7(-)*, 8(+)*, 12(-), 15(+)*
Lags of ΔPI (signs)	3(+)*, 8(-), 11(+)	0(-)*, 1(-)*, 3(+)*, 8(+)*, 9(+), 14(+)*, 15(+)*
Error correction term (sign)	Not present	(-)*
Constant (sign)	(+)*	(+)*
December centred dummy	Not present	Not present
Chow breakpoint test for October 1998	1.121348 (0.356697)	CUSUM and CUSUMQ tests were run (see Figure. 6)

* Indicates parameter significance at 5% level.

Figure 7 suggests that it is difficult to opt for one short-run M2 demand function over another since both have similar predictive power, and both perform badly over roughly the same time frame. Moreover, as Table 3 shows, they have the same number of regressors and are almost equal on the Akaike Information Criterion. However, the model using ΔCPI as an indicator of inflation expectations suffers from two major drawbacks. First, it has an error correction term which is statistically significant and has a positive sign. This suggests the possibility of inherent instability in the model and might indicate departure from long-term equilibrium rather than movement toward it. Secondly, most of the parameters have the wrong sign compared to those predicted by conventional monetary theory; most notably all lagged differences of total transactions have negative estimated coefficients! Apart from this, the Chow breakpoint test demonstrates parameter instability at the 10 per cent significance level. This, combined with the fact that the graphs of the fitted and actual values for both models demonstrate larger discrepancies towards the second half of the estimation period, suggests that the short-run demand function for real M2 balances can be considered unstable.

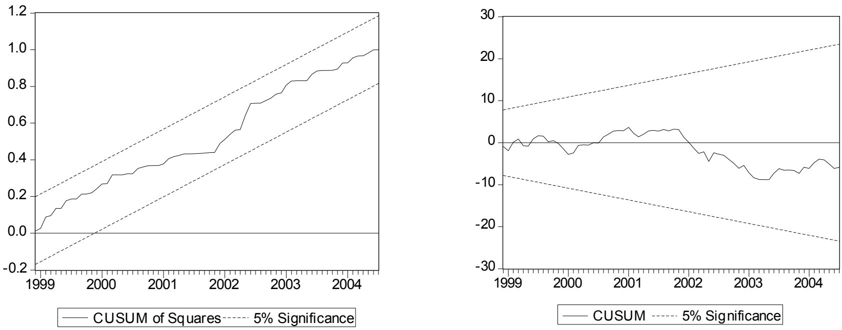

Figure 5. Results of CUSUM and CUSUMQ stability tests for ΔLM1R short-run money demand function with ΔCPI as inflationary expectations.

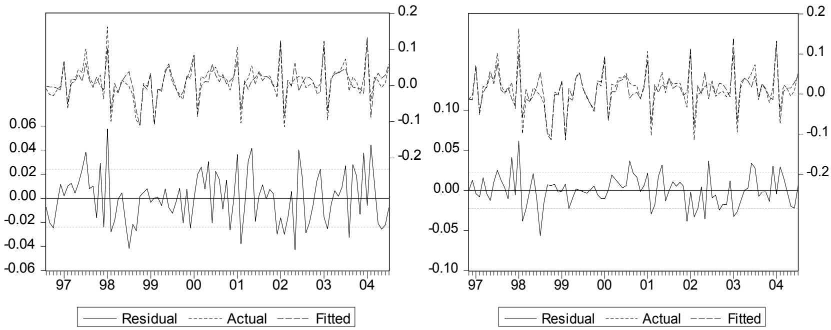

Figure 6. Actual, fitted and residual graphs for the two short-run models of M1 money demand (left with the ΔEPI measure of expected inflation, right with ΔCPI measure of expected inflation).

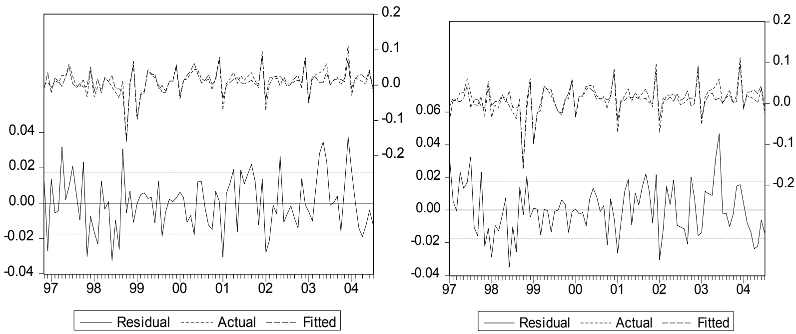

Figure 7. Actual, fitted and residual graphs for the two short-run models of M2 money demand (left with the ΔEPI measure of expected inflation, right with ΔCPI measure of expected inflation).

5. Conclusions

We have investigated the demand for money in Russia using different money aggregates and incorporating different proxies for the expected rate of inflation. Our analysis raises several interesting points concerning the conduct of monetary policy by the Bank of Russia.

- Long-run models of demand for real money balances for different monetary aggregates can be constructed with theoretically coherent signs for the relevant variables. All of the long-run models estimated exhibit relatively long adjustment periods after innovations to the underlying variables, lasting about three and a half years before any shock is fully accommodated. In particular, our long-run model for M2R demand demonstrates a slightly more smooth adjustment pattern after approximately 3 years onwards. This might be an argument in favour of using M2 growth as an intermediate target of monetary policy though, of course, the authorities must also take account of the long adjustment lag.

- Short-run models of demand for real money balances mostly demonstrate stability of the estimated coefficients. However, the positive sign of the error correction term appearing in the short-run model for M2 suggests that there might exist inherent instability in the estimated relations.
- The short-run models of the M1 and M2 money aggregates with inflationary expectations measured by the change in the consumer inflationary expectations index outperform models incorporating changes in the CPI as a proxy for expected inflation. This implies that the Bank of Russia should rely more on the former measure of expected inflation in its estimations of demand for money.
- In setting monetary policy targets the Bank of Russia should account for relatively long lags (almost 2 years) even for short-run demand for money functions. This makes the current practice of setting intermediate targets for M2 growth at the beginning of each year unreliable.
- Since all short-run money demand functions exhibit poor performance for the mid-period, this might suggest that there have been changes in the functional form of the short run money demand function which, as yet, cannot be captured by the existing pool of data.

In general, our results confirm the Bank of Russia's observation that the link between money growth and the real economy has weakened, or at least changed. This suggests that targeting interest rates rather than money growth could be a better policy option for the Bank of Russia.

Table 3. Short-run money demand function for LM2R aggregate

	Inflationary expectations measured by ΔEPI	**Inflationary expectations measured by ΔCPI**
Initial number of parameters	75	75
Eventual number of parameters	21	21
Akaike information criterion	-5.062144	-5.044815
Breusch-Godfrey serial correlation LM test (p-value)	1.095156 (0.380812)	1.188994 (0.312644)
Lags of ΔLM2R (signs)	10(-)*, 11(+)*, 12(+)*, 14(-)*, 15(+)*	12(+)*
Lags of ΔLTTR (signs)	1(-)*, 5(-), 12(+)*, 13(+)*, 14(+)*, 15(-)	3(-)*, 7(-)*, 8(-)*, 10(-)*, 11(-), 16(-)
Lags of ΔLERA (signs)	0(-)*, 3(-), 6(+), 7(+), 12(+)*, 15(+)*	0(-)*, 4(-)*, 6(+)*, 9(+)*, 10(-)*, 16(-)*, 17(+)*
Lags of ΔPI (signs)	4(-), 7(-)*, 11(-)*, 15(+)*	4(-)*, 10(-), 12(-)*, 17(+)*
Error correction term (sign)	Not present	(+)*
Constant (sign)	Not present	(+)*
December centred dummy	Not present	(+)*
Chow breakpoint test for October 1998	1.696860 (0.063137)	1.703964 (0.063278)

* Indicates parameter significance at 5% level.

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Appendix

Notations

C – constant (intercept);

D_12 – centred seasonal dummy for December;

EC1 – error correction term from the long-run money demand function for M1;

EC2 – error correction term from the long-run money demand function for M2;

DLM1R – first differences of logarithms of real money balances for M1 aggregate;

DLM2R – first differences of logarithms of real money balances for M2 aggregate;

DLERA – first differences of logarithms of average monthly exchange rate;

DTTR – first differences of logarithms of total trade in real terms;

DLEPI – first differences of logarithms of consumer inflationary expectations index;

DCPI – first differences of logarithms of consumer price index.

Table A1. Short-run money demand for M1R with ΔEPI as a measure of expected inflation

Dependent Variable: DLM1R

Method: Least Squares

Sample(adjusted): 1996:08 2004:07

Included observations: 96 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.015928	0.003981	4.001367	0.0001
DLM1R(-2)	0.149703	0.066947	2.236134	0.0284
DLM1R(-4)	0.136867	0.064891	2.109195	0.0383
DLM1R(-8)	-0.176011	0.065154	-2.701453	0.0086
DLM1R(-9)	-0.177165	0.063737	-2.779630	0.0069
DLM1R(-10)	-0.265894	0.069083	-3.848926	0.0002
DLM1R(-11)	-0.135241	0.074998	-1.803253	0.0754
DLM1R(-12)	0.495586	0.062904	7.878484	0.0000
DLERA	-0.249163	0.042657	-5.841041	0.0000
DLERA(-1)	0.153997	0.047354	3.252019	0.0017
DLERA(-3)	-0.150125	0.036627	-4.098744	0.0001
DLERA(-5)	-0.135836	0.042223	-3.217076	0.0019
DLERA(-7)	0.064730	0.037160	1.741933	0.0857
DTTR	-0.305814	0.069682	-4.388680	0.0000
DTTR(-1)	0.132886	0.070305	1.890126	0.0627
DTTR(-2)	-0.193447	0.063982	-3.023446	0.0034
DTTR(-6)	0.084618	0.049504	1.709328	0.0916
DTTR(-9)	0.088473	0.055782	1.586037	0.1170
DTTR(-10)	0.164929	0.057962	2.845479	0.0057
DLEPI(-3)	0.530937	0.205683	2.581336	0.0118
DLEPI(-8)	-0.270229	0.183301	-1.474237	0.1447

DLEPI(-11)	0.331255	0.195818	1.691644	0.0949

R-squared	0.812823	Mean dependent var	0.009574
Adjusted R-squared	0.759706	S.D. dependent var	0.048992
S.E. of regression	0.024016	Akaike info criterion	-4.422169
Sum squared resid	0.042680	Schwarz criterion	-3.834506
Log likelihood	234.2641	F-statistic	15.30232
Durbin-Watson stat	2.037835	Prob(F-statistic)	0.000000

Table A2. Short-run money demand for M1R with ΔCPI as a measure of expected inflation

Dependent Variable: DLM1R

Method: Least Squares

Sample(adjusted): 1996:11 2004:07

Included observations: 93 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.019298	0.004325	4.461453	0.0000
EC1(-1)	-0.105599	0.031824	-3.318222	0.0015
DLM1R(-2)	0.139265	0.067475	2.063939	0.0428
DLM1R(-4)	0.138123	0.065410	2.111652	0.0384
DLM1R(-8)	-0.237362	0.069306	-3.424825	0.0010
DLM1R(-9)	-0.121790	0.065308	-1.864866	0.0665
DLM1R(-10)	-0.154898	0.068375	-2.265417	0.0267
DLM1R(-11)	-0.129061	0.065309	-1.976165	0.0522
DLM1R(-12)	0.469890	0.075681	6.208804	0.0000
DLERA(-1)	-0.280261	0.045431	-6.168926	0.0000
DLERA(-7)	-0.314665	0.135027	-2.330392	0.0228
DLERA(-8)	0.319625	0.132317	2.415599	0.0184
DLERA(-12)	-0.074265	0.038762	-1.915933	0.0596
DLERA(-15)	0.159804	0.044899	3.559201	0.0007
DTTR	-0.229828	0.080160	-2.867133	0.0055
DTTR(-2)	-0.159061	0.057995	-2.742649	0.0078
DTTR(-5)	-0.090891	0.054151	-1.678464	0.0978
DTTR(-8)	-0.126222	0.060976	-2.070019	0.0423
DCPI	-0.185044	0.093041	-1.988833	0.0507
DCPI(-1)	-0.853504	0.099718	-8.559178	0.0000

DCPI(-3)	0.229447	0.076939	2.982192	0.0040
DCPI(-8)	0.940371	0.314691	2.988234	0.0039
DCPI(-9)	0.157317	0.087908	1.789563	0.0780
DCPI(-14)	0.173479	0.075259	2.305082	0.0242
DCPI(-15)	0.297248	0.095170	3.123354	0.0026

R-squared	0.845847	Mean dependent var	0.010544
Adjusted R-squared	0.791440	S.D. dependent var	0.049454
S.E. of regression	0.022585	Akaike info criterion	-4.518536
Sum squared resid	0.034685	Schwarz criterion	-3.837730
Log likelihood	235.1119	F-statistic	15.54667
Durbin-Watson stat	1.866074	Prob(F-statistic)	0.000000

Table A3. Short-run money demand for M2R with ΔEPI as a measure of expected inflation

Dependent Variable: DLM2R

Method: Least Squares

Sample(adjusted): 1996:11 2004:07

Included observations: 93 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLM1R(-10)	-0.349534	0.067743	-5.159739	0.0000
DLM2R(-11)	0.385437	0.096795	3.982001	0.0002
DLM2R(-12)	0.416487	0.073891	5.636483	0.0000
DLM1R(-14)	-0.382966	0.090386	-4.237018	0.0001
DLM2R(-15)	0.633270	0.143693	4.407112	0.0000
DLERA	-0.191440	0.024352	-7.861484	0.0000
DLERA(-3)	-0.038839	0.026368	-1.472983	0.1451
DLERA(-6)	0.050883	0.026857	1.894599	0.0622
DLERA(-7)	0.052546	0.028208	1.862789	0.0666
DLERA(-12)	0.133422	0.027491	4.853325	0.0000
DLERA(-15)	0.139349	0.035070	3.973422	0.0002
DTTR(-1)	-0.184877	0.043728	-4.227839	0.0001
DTTR(-5)	-0.072924	0.036920	-1.975197	0.0521
DTTR(-12)	0.207740	0.051170	4.059822	0.0001
DTTR(-13)	0.187187	0.049438	3.786294	0.0003
DTTR(-14)	0.115677	0.048566	2.381847	0.0199
DTTR(-15)	-0.071634	0.047784	-1.499102	0.1382
DLEPI(-4)	-0.290871	0.168511	-1.726124	0.0886
DLEPI(-7)	-0.639973	0.139946	-4.572990	0.0000
DLEPI(-11)	-0.280185	0.134151	-2.088574	0.0403

DLEPI(-15)	0.432785	0.138433	3.126308	0.0026

R-squared	0.821713	Mean dependent var	0.009954
Adjusted R-squared	0.772189	S.D. dependent var	0.036581
S.E. of regression	0.017460	Akaike info criterion	-5.062144
Sum squared resid	0.021949	Schwarz criterion	-4.490267
Log likelihood	256.3897	Durbin-Watson stat	1.826682

Table A4. Short-run money demand for M2R with ΔCPI as a measure of expected inflation

Dependent Variable: DLM2R

Method: Least Squares

Sample(adjusted): 1997:01 2004:07

Included observations: 91 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.018251	0.002990	6.105023	0.0000
EC2(-1)	0.042175	0.014977	2.815904	0.0063
D_12	0.038344	0.010683	3.589247	0.0006
DLM2R(-12)	0.337262	0.081392	4.143682	0.0001
DLERA	-0.162810	0.027792	-5.858206	0.0000
DLERA(-4)	-0.092642	0.034013	-2.723741	0.0081
DLERA(-6)	0.052402	0.026204	1.999789	0.0494
DLERA(-9)	0.196854	0.090899	2.165638	0.0337
DLERA(-10)	-0.242081	0.094626	-2.558293	0.0127
DLERA(-16)	-0.220700	0.086183	-2.560818	0.0126
DLERA(-17)	0.255071	0.085144	2.995755	0.0038
DTTR(-3)	-0.100209	0.041911	-2.391005	0.0195
DTTR(-7)	-0.110030	0.042450	-2.591993	0.0116
DTTR(-8)	-0.131030	0.040916	-3.202400	0.0021
DTTR(-10)	-0.177309	0.053614	-3.307137	0.0015
DTTR(-11)	-0.093808	0.050662	-1.851641	0.0683
DTTR(-16)	-0.083292	0.043059	-1.934362	0.0571
DCPI(-4)	-0.195637	0.062511	-3.129620	0.0026
DCPI(-10)	-0.375944	0.208028	-1.807175	0.0750
DCPI(-12)	-0.235624	0.062087	-3.795065	0.0003

DCPI(-17)	0.501982	0.193444	2.594974	0.0115

R-squared	0.824169	Mean dependent var	0.010053
Adjusted R-squared	0.773932	S.D. dependent var	0.036976
S.E. of regression	0.017581	Akaike info criterion	-5.044815
Sum squared resid	0.021637	Schwarz criterion	-4.465385
Log likelihood	250.5391	F-statistic	16.40548
Durbin-Watson stat	1.543452	Prob(F-statistic)	0.000000