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ESTIMATION OF THE MONEY DEMAND FUNCTION IN RUSSIA

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ESTIMATION OF THE MONEY DEMAND FUNCTION IN RUSSIA

In this paper following Ball (2012) I estimate the demand function for narrow money aggregate M1 in Russia for 2003-2012. I show that after inclusion of cash foreign exchange and relevant interest rate the money demand is stable in the long- and the short-run and estimated long-run elasticities and short-run dynamics of the money demand yields sensible values for the simple functional form. I also show that most of the short-run volatility of the money holding can be attributed to the slow speed of adjustment of the demand not to the unexplained shocks.

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1. Introduction

Estimation of money demand function has been one of the most important topics in macroeconomics for a long time. In particular, it is important for the question of the optimal design of monetary policy. Poole (1970) showed that the choice of instrument crucially depend on the short-run stability of the money demand. The paper of Goldfield (1973) has laid the framework for empirical research. He showed that there is a simple long-run relationship implied by the theory and short-run dynamics is well described by the partial adjustment mechanism. At the same time, later research proved that short-run volatility of the demand for M1 cannot be explained by the simple model (Friedman, 1988). The recent paper by Ball (2012) shows that the proper choice of the explanatory variables allows to explain both long-run and short-run movement of M1. In this paper I redo the exercise of Ball for Russian data and confirm most of his finding for the US economy.

There are not many papers examining money demand in Russia. Bahmani-Oskooee and Barry (2000) estimate the demand function for M2 using inflation and exchange rate as measures of the opportunity costs of holding money. They argue that there is a stable long-run cointegrating relationship but estimated vector error correction model implies short-run instability. Oomes and Ohnsorge (2005) estimate long-run dynamics of the effective broad money (EBM) aggregate (ruble M2 together with foreign exchange cash and deposits in Russian banks). They show that this aggregate demonstrates the most stable long-run dynamics and cointegrating relationship includes only three variable – real balances of the EBM, industrial production and weighted average of bank deposit rates. They did not estimate the short-run behavior. Korhonen and Mehrotra (2010) report stable long-run and short-run vector error correction model for ruble M2 aggregate using inflation and exchange rate as proxy for opportunity costs for the period 1999-2006. Mehrotra and Ponomarenko (2010) estimate long-run demand for Ruble M2 and show that GDP and real wealth both enter cointegrating relationship. They also report that crisis of 2008 breaks the relationship and the system becomes unstable after 2008.

In this paper I estimate the demand for narrow monetary aggregate. Following the papers of Oomes and Ohnsorge as well as Feige (2003) and Fridman and Verbitsky (2001) both of which show that there is a large degree of currency substitution in Russia as a measure of narrow money I take the sum of ruble M1 and foreign cash holdings by the public. Following Ball

(2012), who showed that if the opportunity costs are measured as a difference on return to M1 and near-money there is a simple stable partial adjustment model for the money demand in the US I take the difference between deposit rates on time deposits and demand deposits in Russian banks as the proxy for the interest rate. I show that estimation results based on the Russian data is quite close to those reported by Ball.

Next section introduces the basic model, explains the data used and presents results. Third section concludes.

2. The model

Following Ball (2001) I postulate the following long-run cointegrating relationship

$$\ln\left(\frac{M}{P}\right) = c_0 + c_1 \ln(Y) - c_2 \ln(i) \quad (1)$$

where M is a money stock, P – price level, Y – income, and i – nominal interest rate. I concentrate on estimation of the demand for narrow monetary aggregate and consider M1 as a measure of money. Ball (2012) argues that proper interest rate in this case is the return on “near-money” – i.e. the difference between interest rate on time and demand deposits. As a measure of income I take seasonally adjusted real GDP and as a measure of price level – consumer price index.

Table 1. Dickey-Fuller test for real balances, income and interest rate.

variable	t-statistics	5% critical value
ln(M/P)	-0.83	-2.95
ln(Y)	-1.64	-2.95
ln(i)	-2.23	-2.95

Dickey-Fuller test shows that the hypothesis of unit root cannot be rejected for variables in equation (1) (see table 1). Therefore, I estimated cointegrating relationship using Johansen procedure and the dynamic OLS suggested by Stock and Watson. In both cases the hypothesis of cointegration is rejected. This may be due to the fact that currency substitution is still widespread in Russia (Feige (2003) and Fridman and Verbetsky (2001) estimate the share of foreign cash in total cash holding more than 80% in 2001) and public holds a significant share of liquidity in foreign exchange. This share fluctuated with substantial downward trend following the dynamics of the exchange rate and other macroeconomic variables. Therefore, it seems natural (Oomes and Ohnsorge (2005) did the similar thing) to include cash foreign exchange into the monetary aggregate. To account for foreign cash holdings I used the data for foreign cash held by the public from Balance of Payments and International Investment Position provided by the Bank of Russia. Fig. 1 presents the share of foreign exchange in the total sum of ruble M1 and foreign cash. The share fell down until the middle of 2008 with the steady appreciation of Ruble from 31.8 roubles for 1 USD in the beginning of 2003 to 23.2 in the middle of 2008 but then picked up during the large devaluation in the end of 2008 – beginning of 2009. The following appreciation and stabilization of the exchange rate around 30 rubles per USD led to the recovery of the downward trend and now this share (although it may be underestimated by the Bank of Russia) is about 6%. I corrected the measure of money by adding the ruble value of this holding to the M1 data provided by the Bank of Russia. Since 2003 Bank of Russia also provides the data for interest rates on deposits of different maturity so I took the difference between the rate on time and saving deposits and the demand deposit as a measure of opportunity costs of holding money. Table 2 presents results of estimation of cointegrating relationship using Jochansen test on the quarterly data from 2003 to 2nd quarter of 2012. Trace test indicates 1 cointegrating relationship at 2% level.

Table 2. Jochansen cointegration test for long-run relationship

variable	ln(M/P)	constant	ln(Y)	ln(i)
coefficient	1	-4.05	1.09	-0.40
st. error			0.14	0.08

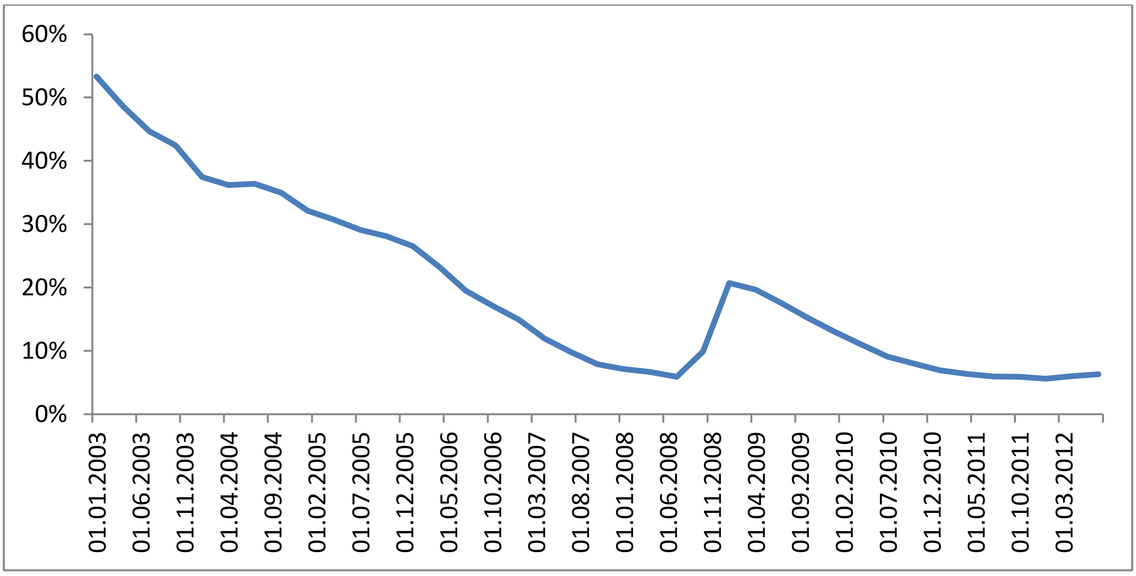

Fig. 1. Share of foreign cash holdings in the total narrow money aggregate

The estimated long-run relationship is the following

$$\ln\left(\frac{M}{P}\right) = 4.05 + 1.09\ln(Y) - 0.40\ln(i) \qquad (2)$$

Both of the estimated elasticities are highly significant and have the correct signs. Income elasticity is close to 1 (the hypothesis of it being equal to 1 cannot be rejected) as predicted by Sidrauski money in utility function model and interest elasticity is negative and close to 0.5 – the value predicted by Baumol-Tobin money demand model. The fact that the estimated cointegrating relationship has significant and sensible coefficients implies that there is in fact stable long run relationship between money stock, GDP and interest rate after the correct measure of money is taken into account. It also implies that foreign currency in fact is still used in Russia as liquid asset also to a lesser extent that in the beginning of 2000s. Fig. 1 plots the share of foreign exchange in the total liquid money stock used for estimation.

Many researchers (Goldfield and Sichel (1990), Judd and Scadding (1982) and others) noted that although real balances, income and interest rate are cointegrated the short-run dynamics of the money demand is unstable in the sense that the difference between actual and predicted values of money quite substantial and volatile. Ball (2012) argues that interest rate suggested in his paper helps to overcome the instability of short-rum specification.

To estimate the short-run dynamics of the money demand I used the partial adjustment model which assumes that the actual money holding differ from predicted by long-run relationship due to two reasons. First, the desired holding is equal to predicted plus some zero-mean taste shock. This shock is assumed to follow stationary autoregression. Second, the actual holding is equal to the weighted average of previous period holding and the desired holding. This behavior is optimal if agents suffer quadratic losses from both adjusting money and deviation from the desired holding (Ball (2012). I estimated the partial adjustment model using two-step procedure proposed by Duca (2000). The actual holding of money can be written as

$$\ln\left(\frac{M_t}{P_t}\right) = c + \lambda\left(\ln\left(\frac{M_t}{P_t}^*\right) + \nu_t\right) + (1-\lambda)\ln\left(\frac{M_{t-1}}{P_{t-1}}\right) \quad (3)$$

$$\nu_t = \rho\nu_{t-1} + \varepsilon_t \quad (4)$$

where $M_t/P_t{*}$ is long-run predicted value and ν_t is money demand shock. The two-step procedure suggests taking the difference $\ln(M_t/P_t) - \rho \ln(M_{t-1}/P_{t-1})$ from (3) and using (4) writing it as

$$\ln\left(\frac{M_t}{P_t}\right) = c(1-\rho) + (1+\rho-\lambda)\ln\left(\frac{M_{t-1}}{P_{t-1}}\right) - \lambda(1-\rho)\ln\left(\frac{M_{t-2}}{P_{t-2}}\right) + \lambda\left(\ln\left(\frac{M_t}{P_t}^*\right) - \ln\left(\frac{M_{t-1}}{P_{t-1}}^*\right)\right) + \lambda\varepsilon_t \quad (5)$$

Equation (5) is estimated by non-linear least squares with $\ln(M_t/P_t{*})$ taken from the estimated cointegrating relationship (2). Table 2 presents results of the estimation.

Table 3. Estimates of the short-run partial adjustment model

Variable	Speed of adjustment λ	persistence of shock ρ
Coefficient	0.22	0.33
Standard error	0.07	0.17

R^2=0.98 DW=1.87

Coefficient λ which reflects the speed of adjustment is highly significant and similar to reported by Ball to US (0.20). It implies that it takes roughly 4 quarters for money demand to go half of the fundamental long-run shock. So the speed of adjustment is quite slow. The coefficient ρ is marginally significant but the estimation which assumes white noise process for ν_t leaves residual with significant first-order correlation and I chose to use the AR(1) specification. AR(2) specification also does not improve the fit.

The variance of the error in the partial adjustment model which stands for unexplained money demand shock represents only 11% of the total variance of the difference between actual and predicted fundamental long-run values of money holdings. This implies that the discrepancy of the actual money demand and its fundamental value is mostly due to the slow adjustment not the unexplained shocks to taste or technology. Ball (2012) reports very similar result for the US. Fig. 2 depicts the log of actual velocity together with its values predicted by the long-run fundamental and the partial adjustment models. It shows that the partial adjustment model matches the actual data quite well. It also shows that while the fall of income and rise of interesrt rates following the 2008–2009 crisis were quite large and the fundamental value of velocity jumped by 20%, the actual velocity did not increase that much because of the slow adjustment and the relatively fast recovery which put the long-rum value back to its downward trend by 2010.

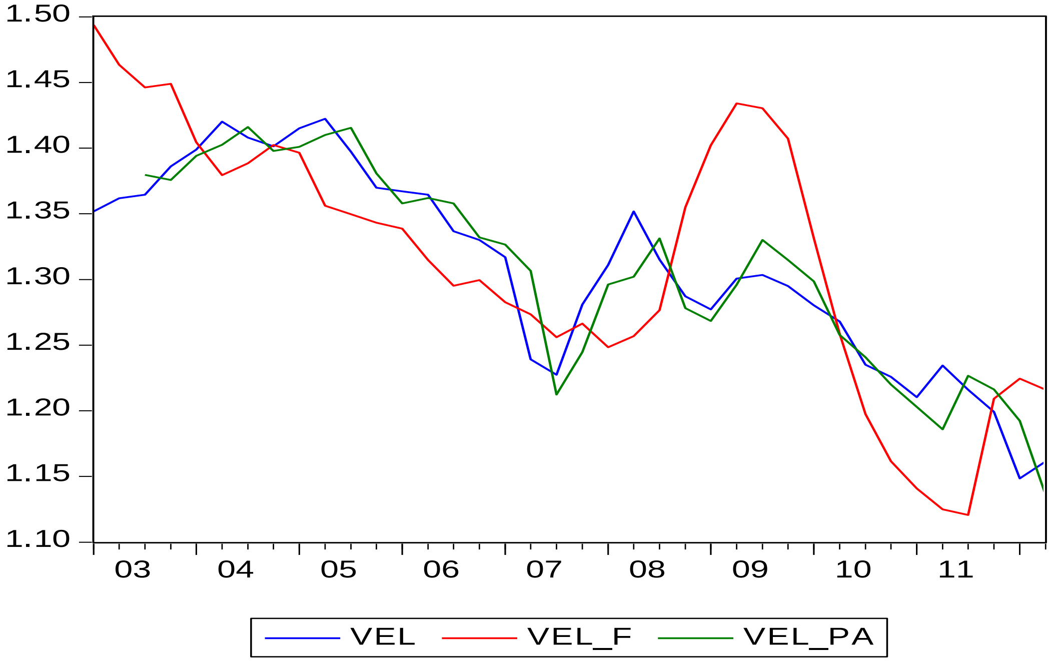

Fig. 2. Actual velocity of M1 and predicted by fundamental and error-correction models.

The alternative method to estimate the short-run dynamics is to use vector error correction (VEC) model (see Duca (2000) and Kohronen and Mehrotra (2010), Mehrotra and Ponomarenko (2010) using Russian data). The general form of the VEC model with one lag is

$$\ln(M_t/P_t)=c_0+c_1(\ln(M_{t-1}/P_{t-1})^*-\ln(M_{t-1}/P_{t-1}))+c_2^*\Delta\ln(M_{t-1}/P_{t-1})+c_3\Delta\ln(Y_t)+c_4\Delta\ln(i_t)+\varepsilon_t \qquad (5)$$

Differencing partial adjustment model (3) and using estimates of long-run relationship (2) yields the same model but with two restrictions on its coefficients (there are only three parameters to estimate with 5 coefficients). Therefore, one can test for validity of partial adjustment model using the simple sum of squares test. The resulted F-statistics is 0.66 with p-value of 0.52 (Ball (2012) reports F-statistics of 0.7 for the US), so one cannot reject the restrictions of the partial adjustment model and therefore there is no need in more complicated VEC model.

3. Conclusions

In this paper I estimated the demand for narrow money in Russia for 2003-2012. I showed that inclusion of foreign cash holding into monetary aggregate results on the simple stable long-run cointegrating relation between real money balances, GDP, and the opportunity cost of holding money measured as the difference between deposit rates on time and demand deposits. I also estimated short-run error correction model which fits the data quite well and suggests that most of the discrepancy of the actual balances from the fundamental value predicted by the cointegrating relationship is due to the slow speed of adjustment of the actual money holdings not to the unexplained shocks to money demand, and so there is in fact stable relationship even in the short-run. It is worth to note that the partial adjustment model describes the dynamics of the money demand during 2008-2009 crises quite well.

At the same time it would be interesting to extend the span of the data back to the 1990's and include the 1998 crisis into the sample to see how well the model will perform there. At the same time the data for two most important variables (the foreign cash holdings and the breakdown of deposit rates by maturities) is not readily available from the Bank of Russia so collecting this data and re-estimation of the model could be one of the possible direction of the further research.

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