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MONEY DEMAND: THE GUIDE TO MONETARY POLICY IN RUSSIA, 1997-2020

Abstract:

We estimate a short-run demand function, using the quarterly data available for modern Russian market - on the one-quarter basis for 1997-2020. Empirical results provide a stable money demand function that explains the short-run money velocity movement. The approach is based on econometric models and dynamic least square methods evaluation within the Akaike criterion applied for the authors' choice of leads and lags. The prior innovation related to model comparison of interest rates in money demand function – from research-common money market rate to interbank market rate, amplifying proxy better-fitted for the Russian market.

Keywords:

Monetary policy, money demand, money velocity, income elasticity, interest semi-elasticity

JEL Classification: E41, G28, C50

1 Introduction

For about semi-century, researchers undertook a broad empirical effort to accumulate evidence of stability for money demand function worldwide. The stability of money demand function plays a crucial role in conducting monetary policy, being the fundamental prerequisite to apply money aggregates as intermediate objectives along with interest rates or inflation targeting.

Among the vast majority of changes in global financial markets, financial innovation plays a crucial role alongside regulatory shifts and technological progress to lead the corresponding transformation of the money demand function. Certainly, crisis cases pro-vide significant shifts, being accompanied by two mutually self-reinforcing factors that reduce economic activity, flights-to-liquidity and increases in risk premia (Anderson et al., 2016). These factors require consistent overestimation of its functional stability. And there is no excuse for any regional financial market.

While economists achieve a relative consensus toward the stability of long-term money demand function, the instability for short-run modification on a variety of markets still produces controversy (Ball, 2002). The time frame applied reflects the further contradiction of economic indicators chosen for the particular analysis. According to Goldfeld et al. (1973), the evidence from the annual data tends to favor money aggregate M2 over M1, long over short-term interest rates, and wealth over current income, whereas practitioners working with quarterly data tend to the opposite.

Originally stated money aggregates (M1, M2, M3, etc.) include changes gathering from financial innovations. Although, research controversy could occur from the strand of simple sum aggregation toward techniques such as Barnett's monetary service indices (or divisia aggregates) and currency-equivalent indices (see Barnett, 1980; Rotemberg et al., 1991). Meanwhile simple-sum money aggregates are still the dominant indicators of money balances in the economy.

Moreover, through applying different estimating techniques, sample data, and measurement method, scholars argue of accordance between common theoretical assumptions and empirical evidence received on various markets. One of them is the income elasticity of money demand. Akerlof and Milbourne (1980) stated that while empirical studies show quite low levels in a short run and rather high income-elasticity for a long-run money demand function (e.g. Chow, 1966; Laidler, 1966), theoretical models (such as Fisher, 1911; Tobin, 1956; Baumol, 1952; Miller and Orr, 1966) report the reverse relation.

This study aims to define significant determinants along with an estimation of short-run money demand function in Russia. Regarding country-specific features of the money demand function, we focus on the Russian market to study significant determinants of money demand to guide both researchers, practitioners and regulators on a relatively young and emerging market. Research serves to test the behavior of money demand on national level and to justify further accordance to shifts in interest rates and income.

On the one hand, we adopt a widespread functional form of money demand to provide our study, but on the other – suggest the final mode of money demand function to be adjusted for the

Russian market. Our approach is based on calibrating models through the criterion Akaike (AIC) for leads-and-lags specification embed to the Dynamic ordinary least square methods (DOLS).

In the following chapters, we discuss methods, initial data sample, empirical results and, finally, present our conclusion.

2 Methodology

2.1 Theoretical and Econometric Models

Anderson et al. (2016) marked the canonical model of the demand for broad, liquid money, as developed during the 1980s, and represented velocity as a function of its opportunity cost. For instance, the MPS (MIT-Penn-Social Science Research Council) econometric model was originally estimated for the US market in the equation which common formula could be expressed as follows:

$$\ln\frac{\boldsymbol{DD}}{\boldsymbol{XGNP\$}} = \boldsymbol{\mu_0} + \boldsymbol{\mu_1}\cdot\ln\frac{\boldsymbol{DD_{-1}}}{\boldsymbol{XNP\$}} + \boldsymbol{\mu_2}\cdot\ln(\boldsymbol{RTB}) + \boldsymbol{\mu_3}\cdot\ln(\boldsymbol{RS}) + + \boldsymbol{\mu_4}\cdot\ln\frac{\boldsymbol{XGNP}}{\boldsymbol{N}} + \boldsymbol{\mu_5}\cdot\ln\frac{\boldsymbol{RDISC}}{\boldsymbol{RDISC_{-1}}} \quad (1)$$

where *DD* denotes demand deposits at commercial banks measured as the two-month average surrounding the end of the quarter; *XGNP$* is the Gross national product (GNP) in current dollars; *XGNP* is GNP in 1958 dollars; *RTB* is the Treasury bill rate; *RS* is the average offering rate on time and savings deposits at commercial banks and thrift institutions; *N* is the US population; *RDISC* is the Federal Reserve discount rate.

Enzler et al. (1976) add the MPS money-demand equation – with GNP and two interest rates as principal explanatory variables – is consistent with the abovementioned models of Baumol (1952), Tobin (1956), and Miller and Orr (1966), which emphasize the transactions demand for money.

In a broader sense, real money demand (M^d/P) is often depicted as a liquidity function (L^d) of various interest rates (i) and income (Y) levels:

$$(\frac{M^d}{P}) = L^d(Y, i) \quad (2)$$

Notably one of the most common functional form of liquidity function $L^d(Y, i)$ for real money demand (M^d/P) presented in Zarembka (1968):

$$L^d(Y, i) = a \cdot Y \cdot e^i \quad (3)$$

Therefore, empirical studies covering money demand estimation basically rely on its logistic functional form (Bae et al., 2004; Bae et al., 2006; Ball, 2001; Ball, 2012; MCallum and Goodfriend, 1988):

$$\ln\left(\frac{M^d}{P}\right) = b_0 + b_1\cdot\ln(Y) + b_2\cdot i\ , \quad (4)$$

where M^d denotes nominal amount of money balances; *P* is a price level; *Y* is a scale -variable applied to proxy level of economic activity such as real GDP; *i* is a nominal interest rate which measures the opportunity cost of holding money. The parameter b_1 is income-elasticity of money demand and b_2 is "semi-elasticity" of money demand for interest rate.

Demand function (3) for real money (M^d/P) could be simply transformed to a demand function for nominal money M^d:

$$\ln(M^d) = c_0 + c_1 \cdot \ln(Y) + c_2 \cdot i + c_3 \cdot \ln(P) \quad (5)$$

In correspondence to equation (4) the initial econometric model of the money demand function is

$$\ln M_t^d = \alpha_0 + \alpha_1 \cdot \ln Y_t + \alpha_2 \cdot i_t + \alpha_3 \cdot \ln P_t + \varepsilon_{6t} \quad (6)$$

While choosing research method to evaluate our initial model (6) we should consider limits on macroeconomic data available on Russian market. Comparing data availability and time intervals (monthly, quarterly or yearly) present for each variable with the urgency of robust fitting required, we select the Dynamic ordinary least square method, DOLS).

Moreover, in contrast to ordinary least square method (OLS), DOLS provides relatively smaller biases for the quarterly-data-models constructed Meanwhile, DOLS could be applied only if residuals ε_{6t} is stationary in model (6) being preliminary estimated by ordinary least square method (OLS).

Afterwards DOLS algorithm provides further transformation of initial model (6) to final econometric model within *q*-number of lags and *p*-number of leads incorporated for independent variables used *(Y, P, i*):

$$\ln M_t^d = \beta + \beta_1 \cdot \ln Y_t + \beta_2 \cdot i_t + \beta_3 \cdot \ln P_t + \sum_{j=-q}^{p} \left[\left(\beta_{1j} \cdot \Delta Y_{t-j} \right) + + \left(\beta_{2j} \cdot \Delta i_{t-j} \right) + \left(\beta_{3j} \cdot \Delta P_{t-j} \right) \right] + \varepsilon_{7t}, \quad (7)$$

where M_t^d is a nominal amount of money balances measured by money aggregates at time t; P_t is a price level in the economy at time t; Y_t is a proxy for income level in the economy (real GDP) at time t; and i_t is the opportunity cost of holding money at time t; *q* is a number of lags; *p* is a number of leads.

To define number of lags and leads to be included in models calibrating for DOLS methodology, we apply the threshold of the Akaike criterion. As a result, we included two lags (*q=2*) and zero leads (*p=0*) to our final model, based on preliminary econometric tests. The rational of the choice relies on limits of data, first, and risk of additional multicollinearity created through excess lags-and-leads configuration.

Therefore, the equation of our final econometric model is as follows:

$$\ln M_t^d = \gamma_0 + \gamma_1 \cdot \ln Y_t + \gamma_2 \cdot i_t + \gamma_3 \cdot \ln P_t + \gamma_4 \cdot \Delta Y_{t-1} + \gamma_5 \cdot \Delta Y_{t-2} + \varepsilon_{8t}, \quad (8)$$

where M_t^d is a nominal amount of money balances measured by money aggregates at time t; P_t is a price level in the economy at time t; Y_t is a proxy for income level in the economy (real GDP) at time t; and i_t is the opportunity cost of holding money at time t.

2.2 Data Sample

This study operates quarterly data for the Russian market on maximum length-available time interval - from 1997:Q1 to 2020:Q1.

To measure amount of money in the economy we address three money aggregates: a) cash M0 and broad money M2 in national definition (data of the Bank of Russia, BoR data); and b) narrow money M1 (data of the Organization of Economic Cooperation and Development, OECD data). In accordance to such class of models real Gross Domestic Product (GDP) is basically used to indicate income level. The reason is twofold. Application of nominal GDP could add additional biases to factor estimates, on the one hand, and decrease robustness of models. Thus, we do also refer to real GDP (data of the Russian Federal State Statistics, Rosstat data).

Commonly, opportunity cost of holding money applied in money demand functions is altering through short-term interest rates. Following OECD page meaning, these are the rates at which short-term borrowings are effected between financial institutions or the rate at which short-term government paper is issued or traded in the market. We implement OECD data for short-term interest rates in Russia, based on three-month money market rates available with a typical standardised names of "money market rate" and "treasury bill rate". This particular indicator underlies our study as a rate of opportunity cost of holding money. To enlarge the scope of market specific features in Russia, we add a short-term interbank rate MIACR aggregated through the Bank of Russia data.

Price level in the economy composes by consumer price index of the Russian Federal State Statistics data.

The variables composition for models along with names and brief description are presented at the table 1.

Table 1: Variables of the models

Mark	Name	Description	Unit of measure	Data source
M0	Money aggregate M0	Cash coins and currency	Billions of Rubles	Bank of Russia
M1	Money aggregate M1	Narrow money M1: cash and checking or demand deposits.	Billions of Rubles	OECD

M2	Money aggregate M2	Broad money M2 (in national definition): cash and checking or demand deposits within so-called "near money" such as savings deposits, money market securities, mutual funds, and other time deposits.	Billions of Rubles	Bank of Russia
GDP	GDP in real prices	Gross domestic product in real prices	Billions of Rubles	Rosstat
CPI	Consumer Price Index	Consumer Price Index	Ratio or percentage	Rosstat
MM	Money Market Rate	Short-term money market rate	Ratio or percentage	OECD
IB	Interbank Rate MIACR	MIACR is a short-term average weighted interbank rate of lending for banks, providing in rubles by the largest Russian bank from Moscow region.	Ratio or percentage	Bank of Russia

Source: Author

3 Results and Discussion

To check admissibility of DOLS application the initial model (6) should be tested on stationarity of residuals. Therefore, firstly, we provide preliminary OLS evaluation of model (6) differentially for each money aggregate applied - M0, M1 and M2, both for MIACR interbank rate (IB) and money market rate (MM).

Results including robust estimates for OLS-variables are as follows:

a) Model M0-MM (OLS):

$$\ln \overline{M0} = \underset{(2,20)}{-41,03} + \underset{(0,22)}{5,00} \cdot \ln \overline{GDP} - \underset{(0,84)}{1,05} \cdot \overline{MM} + \underset{(2,07)}{0,67} \cdot \ln \overline{CPI} \quad (9)$$

R^2=0,93; SE=0,37; DW=1,81; DF = -4,97

b) Model M0-IB (OLS):

$$\ln \overline{M0} = \underset{(3,05)}{-37,90} + \underset{(0,31)}{4,65} \cdot \ln \overline{GDP} + \underset{(1,52)}{1,96} \cdot \overline{IB} + \underset{(3,68)}{1,46} \cdot \ln \overline{CPI} \quad (10)$$

R^2=0,86; DW=1,83; SE=0,36; DF = -3,34

c) Model M1-MM (OLS):

$$\ln \overline{M1} = \underset{(2,27)}{-40,70} + \underset{(0,23)}{4,97} \cdot \ln \overline{GDP} - \underset{(0,86)}{1,01} \cdot \overline{MM} + \underset{(2,52)}{0,89} \cdot \ln \overline{CPI} \quad (11)$$

R^2=0,93; DW=1,76; SE=0,37; DF = -4,62

d) Model M1- IB (OLS):

$$\ln \overline{M1} = \underset{(2,97)}{-37,82} + \underset{(0,30)}{4,66} \cdot \ln \overline{GDP} + \underset{(1,48)}{1,67} \cdot \overline{IB} + \underset{(3,65)}{1,81} \cdot \ln \overline{CPI} \quad (12)$$

R^2=0,87; DW=1,77; SE=0,35; DF = -3,29

e) Model M2-MM (OLS):

$$\ln \overline{M2} = \underset{(2,47)}{-48,39} + \underset{(0,25)}{5,87} \cdot \ln \overline{GDP} - \underset{(1,02)}{0,14} \cdot \overline{MM} + \underset{(1,29)}{0,43} \cdot \ln \overline{CPI} \quad (13)$$

R^2=0,92; DW=1,70; SE=0,45; DF = -3,34

f) Model M2- IB (OLS):

$$\ln \overline{M2} = \underset{(3,72)}{-45,12} + \underset{(0,37)}{5,51} \cdot \ln \overline{GDP} + \underset{(1,90)}{3,92} \cdot \overline{IB} + \underset{(4,41)}{0,81} \cdot \ln \overline{CPI} \quad (14)$$

R^2=0,86; DW=1,75; SE=0,44; DF = -3,01

Subsequent checks of preliminary OLS models (9)-(14) for stationarity, based on Dickey-Fuller (DF) tests, proved the evidence for DOLS application to our final econometric model. Under the chapter 2.1. of our paper, we add two lags with no leads to real GDP variable in final configuration of equation.

Following empirical results of DOLS estimation in accordance to specification of (9) achieved aside for M0, M1 and M2, distinguishing two modifications - for MIACR interbank rate (IB) and short-term money market rate (MM):

g) Model M0-MM(DOLS):

$$\ln \overline{M0} = \underset{(1,00)}{-42,83} + \underset{(0,12)}{5,24} \cdot \ln \overline{GDP} - \underset{(0,41)}{1,22} \cdot \overline{MM} + \underset{(0,51)}{0,35} \cdot \ln \overline{CPI} - \underset{(0,25)}{1,08} \cdot \Delta GDP_{-1} - \underset{(0,20)}{2,08} \cdot \Delta GDP_{-2} \quad (15)$$

h) Model M0-IB(DOLS):

$$\ln \overline{M0} = \underset{(1,00)}{-38,39} + \underset{(0,10)}{4,74} \cdot \ln \overline{GDP} + \underset{(0,49)}{1,12} \cdot \overline{IB} - \underset{(1,27)}{8,12} \cdot \ln \overline{CPI} - \underset{(0,20)}{1,53} \cdot \Delta GDP_{-1} - \underset{(0,16)}{2.02} \cdot \Delta GDP_{-2} \quad (16)$$

i) Model M1-MM(DOLS):

$$\ln \overline{M1} = \underset{(1,01)}{-42,74} + \underset{(0,12)}{5,24} \cdot \ln \overline{GDP} - \underset{(0,41)}{1,22} \cdot \overline{MM} + \underset{(0,52)}{0,56} \cdot \ln \overline{CPI} - \underset{(0,26)}{1,00} \cdot \Delta GDP_{-1} - \underset{(0,21)}{2,10} \cdot \Delta GDP_{-2} \quad (17)$$

j) Model M1-IB(DOLS):

$$\ln \overline{M1} = \underset{(0,99)}{-38,48} + \underset{(1,00)}{4,76} \cdot \ln \overline{GDP} + \underset{(0,48)}{1,00} \cdot \overline{IB} - \underset{(1,28)}{7,99} \cdot \ln \overline{CPI} - \underset{(0,21)}{1.46} \cdot \Delta GDP_{-1} - \underset{(0,16)}{2.03} \cdot \Delta GDP_{-2} \quad (18)$$

k) Model M2-MM(DOLS):

$$\ln \overline{M2} = \underset{(1,31)}{-50,91} + \underset{(0,13)}{6,13} \cdot \ln \overline{GDP} - \underset{(0,41)}{0,17} \cdot \overline{MM} + \underset{(0,68)}{0,04} \cdot \ln \overline{CPI} - \underset{(0,33)}{1,22} \cdot \Delta GDP_{-1} - \underset{(0,27)}{2,48} \cdot \Delta GDP_{-2} \quad (19)$$

l) Model M2-IB(DOLS):

$$\ln \overline{M2} = \underset{(1,40)}{-45,99} + \underset{(0,14)}{5,64} \cdot \ln \overline{GDP} + \underset{(0,69)}{2,90} \cdot \overline{IB} - \underset{(1,79)}{11,00} \cdot \ln \overline{CPI} - \underset{(0,29)}{1,86} \cdot \Delta GDP_{-1} - \underset{(0,22)}{2,46} \cdot \Delta GDP_{-2} \quad (20)$$

More detailed DOLS empirical results for (15) - (20) are presented at the tables 2 and 3.

Table 2: Empirical results (for money market rate models)

Variable	(15) M0-MM (DOLS)	(17) M1-MM (DOLS)	(19) M2-MM (DOLS)
Intercept	-42,83***	-42,74***	-50,91***
	(1,00)	(1,01)	(1,31)
GDP	5,24***	5,19***	6,13***
	(0,12)	(0,10)	(0,13)
CPI	0,35	0,56	0,04
	(0,51)	(0,52)	(0,68)
Money Market Rate	-1,22**	-1,05*	-0,17
	(0,41)	(0,41)	(0,53)
Interbank Rate	-	-	-
ΔGDP(-1)	-1,08***	-1,00***	-1,22***
	(0,25)	(0,26)	(0,33)
ΔGDP(-2)	-2,08***	-2,10***	-2,48***
	(0,20)	(0,21)	(0,27)
Observations	88	86	88
F-statistics	962,6	910,6	751,6
Adj. R^2	0,98	0,98	0,98
SE	0,18	0,18	0,24
DW	1,24	1,21	1,00
Chi^2	0,60	1,39	2,73
VIF	1,67	1,67	1,68
AIC	-45,49	-43,12	3,44

Note: *Standard errors in parenthesis; +p<0,1; *p<0,05; **p<0,01; ***p<0,001.*
Source: Author.

Econometric tests provided statistical significance of single models constructed for cash (M0), narrow money (M1) and broad money (M2), both for MIACR rate and short-term (one-quarter) money market rate. So as relevance of real GDP to be included in money demand function specifications, from (15) to (20). This fact led to the evidence of stable money demand function on Russian market from 1997 to 2020.

Table 3: Empirical results (for interbank rate models)

Variable	(16) M0-IB (DOLS)	(18) M1-IB (DOLS)	(20) M2-IB (DOLS)
Intercept	-38,39***	-38,48***	-45,99***
	(1,00)	(0,99)	(1,40)
GDP real	4,74***	4,76***	5,64***
	(0,10)	(0,10)	(0,14)
CPI	-8,12***	-7,99***	-11,00***
	(1,27)	(1,28)	(1,79)
Money Market Rate	-	-	-
Interbank Rate	1,12*	1,00*	2,89***
	(0,49)	(0,48)	(0,69)
∆GDP(-1)	-1,53***	-1,46***	-1,86***
	(0,20)	(0,21)	(0,29)
∆GDP(-2)	-2,02***	-2,03***	-2,46***
	(0,16)	(0,16)	(0,22)
Observations	75	73	75
F-statistics	760,7	753,9	581,5
Adj. R^2	0,98	0,98	0,98
SE	0,13	0,13	0,18
DW	1,64	1,53	1,29
Chi^2	2,55	2,39	1,83
VIF	1,60	1,62	1,63
AIC	-85,38	-84,46	-34,74

Note: *Standard errors in parenthesis; +p<0,1; *p<0,05; **p<0,01; ***p<0,001.*
Source: Author.

According to model (15), income elasticity equals 5,24 and interest semi-elasticity is -1,22. It reflects for every basis point increase of money market rate the consistent drop in cash demand on 1,22 percent.

Statistically significant impact exists both for income level and interest rate. The assumption of positive relation between cash demand and income through real GDP proxy has been proved. Same as the opposite linkage of cash demand and interest rate (money market rate). Similar results achieved for narrow money M1 and broad money M2 – in models (17) and (19), respectively.

Meanwhile income elasticity in models (17) and (19) equals 5,19 and 6,13, respectively. Interest semi-elasticity in model (17) assessed -1,05 and reaches – 0,17 in model (19). The latter model depicting dynamics of broad money M2, which structure is less sensitive to money market rate changes in Russia.

Model (16) states income elasticity of 4,74 and interest semi-elasticity on 1,12 level. Income and interest rate are still having a statistically significant impact on cash demand. Here is Income positively reflects on cash demand, meaning basics of the higher the income, the higher money demand. Although MIACR rate in model (16) possesses a smaller influence on money demand rather than short-term money market rate in model (15). Moreover, the linkage of MIACR and cash demand is positive. This result could be presumably interpreted through specifics of

MIACR rate being the short-term rate for interbank lending providing by the largest Russian banks from the Moscow region. Similar evidence received for model (18) and model (20) – on MIACR modification for narrow money M1 and broad money M2, respectively.

Income elasticity of model (18) and model (20) equals 4,76 and 5,64, respectively. Interest semi-elasticity in model (18) ranges 1,00, while reaches 2,89 in model (20). Considering model (20) constitutes dynamic of broad money M2, the stronger sensitivity to MIACR rate changes serves as evidence for better-fitted proxy of opportunity cost of money holding in Russian financial market.
Should MIACR rate is a cost of short-term lending for Russian banks (provided by the largest Russian banks from the Moscow region), it subsequently defines the volatility of cost of fund acquisition in the banking system. We account our choice on country features of the Russian market, where bank deposits are still the most dominant investment tool popular accepted for savings. Hence, the dynamics of cost of banking fund acquisition determines the opportunity cost of holding money in Russia.
Thus, we build our study both on a short-term money market rate common for international research of money demand, so as on interbank rate – targeted to check country-market features of the Russian financial system.

However, there are still discussion concerns toward transformation of subjective behavior on financial markets on different stage of economic cycles. And for most, psychological reaction on macroeconomic instability that led to massive run from national currency to foreign one. In other words, research interest extends beyond single economic justification to the psychological factors leading to shrinking money functions of national currency to medium of exchange. This topic poses new questions that require conducting further research within proxies capable to indicate transformation in financial behavior on markets during the crisis.

4 Conclusion

Empirical results presented in this study provide evidence toward stability of demand function in Russia for cash money M0, narrow money M1 and broad money M2, over the 1997:Q1 to 2020:Q1 period. Income elasticity, based on real GDP, overcomes the level of 4 in every model specification. It represents a strong lack of monetization in the Russian economy that supports suggestion of consumer savings transformation – from foreign currency to the Russian rubles.

Moreover, we argue short-term interbank rate is a better-fitted proxy for opportunity cost of holding money to be included in money demand function on the Russian financial market. It depicts the country-specific features of MIACR rate, being the cost of short-term lending for Russian banks (provided by the largest Russian banks from the Moscow region). Therefore, MIACR influences the volatility of cost of fund acquisition in the entire banking system. Also, the prevalence of bank deposit as a major investment tool popular accepted for savings should be accounted an additional country-specific feature on the Russian market. And, hence, the dynamics of cost of banking fund acquisition lead the opportunity cost of holding money in Russia.

Finally, the stability of money demand functions constructed for cash money M0, narrow money M1 and broad money M2, delivering the evidence for Bank of Russia to accurate application of money aggregates into the monetary policy alongside interest rates and inflation targeting.

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