ESTIMATING THE DEMAND FOR MONEY IN THE RUSSIAN ECONOMY FACTORING IN THE DEVELOPMENT OF BANKING TECHNOLOGIES

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This paper presents an attempt to find a stable cash demand function in Russia in the period of 2000 thru 2010. The authors assume that the demand for the M0 monetary aggregate in Russia has recently been substantially influenced by the advancement of payment innovations, namely bank payment cards. Traditional money demand models can't explain how innovations influence the demand for money. Therefore, this paper presents a modern monetary theory approach towards the "money" issue which can explain the existence of a wide range of payment instruments, i.e., innovations. Additionally, the paper presents the results of estimations of equations of the demand for the M0 monetary aggregate factoring in indicators of payment innovations.

1. Traditional approaches towards the money demand analysis

The demand for money is a key component of many macroeconomic theories. Traditionally, the existence of money was explained by the functions money fulfills: money is a medium of payment, exchange, and saving. However, money is not the sole asset that can fulfill the above listed functions, which makes it more difficult to incorporate money into theoretical, economic models. The demand for money and its determinant factors are studied as part of the

liquidity preference theory of Keynes J. M.[1], Baumol-Tobin models[2], Whalen E. L[3].

A wide class of models based on macroeconomic preconditions and allowing the money demand to be incorporated into general equilibrium models has been developed in the economic theory. The conclusions obtained on the basis of such models rely upon solution of certain optimization problems which describe the behavior of economic agents under certain constrains and are therefore considered more reliable. A few of such macroeconomic approaches are worth describing.

The first approach – cash-in-advance models – was suggested by Clover R.[4] and implies incorporation of the requirement into the agent behavior model, under which all goods and services in the economy only can be purchased for cash and payment effected at the moment of transaction. Generally, the condition under which each household spends all its current money holdings on goods in each period is the sole equilibrium in such an economy.

The second approach, factoring in the demand for money-in-utility function, was offered by Sidrauski M.[5] He assumes that the well-being of a representative family at any time is described by a utility function which depends on real consumption and services created by real money held by a household. For the sake of simplicity, the flow of such services is assumed to be proportional to the real monetary stock. Solution of the agent's optimization problem given budget constraints allows functions of the demand for goods and real money to be produced, depending on total wealth, anticipated inflation and net public transfers to the private sector.

Money demand's insensitivity to the interest rate is often peculiar to cash-in-advance models. Alternative money-holding costs as unearned interest return (or inflation, like in the Sidrauski model) can be incorporated into money-in-utility function models. This makes the demand for money depend on interest while economic agents seek to optimize their money holdings.

In the models which factor in shopping time, the existence of money can be explained by money's ability to save economic agents' shopping time *(shopping-time model*)[6]. From this point of view money can be regarded as an intermediate good intended to reduce the shopping time. In shopping models, the demand for money positively depends on the volume of transactions (consumption) and negatively depends on the interest rate. Additionally, the demand for money is positively influenced by growth in the shopping time vs. the leisure time, because money is supposed to reduce shopping costs. Comparing with cash-in-advance models and money-in-utility function models, the need to spend time on shopping will reduce the time spent on leisure and, possibly, work. Consequently, it results in lower earnings and consumption. The recently reduced number of online purchases which are often paid using bank cards facilitates the reduction of both

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[1] *Keynes J. M.* The General Theory of Employment, Interest and Money. N. Y.: Harcourt; Brace, 1936.

[2] *Baumol W. J.* The Transactions Demand for Cash: An Inventory Theoretic Approach // Quarterly Journal of Economics. 1952. Vol. 66. No 4. P. 545 - 556; *Tobin J.* The Interest-Elasticity of Transactions Demand For Cash // Review of Economics and Statistics. 1956. Vol. 38. No. 3. P. 241 - 247.

[3] *Whalen E.L.* A Rationalization of the Precautionary Demand for Cash // Quarterly Journal of Economics. 1966. Vol. 80. No 2. P. 314 - 324.

[4] *ClowerR. W.* A Reconsideration of the Microfoundations of Monetary Theory // Western Economic Journal. 1967. Vol. 6. P. 1 - 8; *Grandmont J.M., Younes Y.* On the Role of Money and the Existence of a Monetary Equilibrium // Review of Economic Studies. 1972. Vol. 39. P. 355 - 372; *Lucas R. E.* Equilibrium in a Pure Currency Economy // Models of Monetary Economies / J. H. Karaken, N. Wallace (eds.), Federal Reserve Bank of Minneapolis. 1980. P. 131 - 145.

[5] *Sidrauski M.* Rational Choice and Patterns of Growth in a Monetary Economy // American Economic Review. 1967. No 57. P. 534 - 544. At the same time, more earlier discussions of money-in-utility function models can be found in the paper of Patinkin D. *(Patinkin D.* Money, Interest, and Prices: An Integration of Monetary and Value Theory. 2nd ed. N. Y.: Harper & Row, 1965).

[6] *McCallum B.T., Goodfriend M.S.* Theoretical Analysis of the Demand for Money // Economic Review, Federal Reserve Bank of Richmond January. 1988. February. P. 16 - 24; *Croushore D.* Money in the Utility Function: Functional Equivalence to a Shopping-Time Model // Journal of Macroeconomics. 1993. Vol. 15. P. 175 - 182; *Correia I., Teles P.* Is Friedman Rule Optimal When Money Is an Intermediate Good? // Journal of Monetary Economics. 1996. Vol. 38. P. 223 - 244; *Hueng C.J.* Money Demand in an Open-Economy Shopping-Time Model: An Out-of-Sample-Prediction Application to Canada // Journal of Economics and Business. 1999. Vol. 51. P. 489 – 503.

the shopping time and the demand for cash. However, the volume of broad monetary aggregates is very likely to increase due to growth in the debt associated with credit cards.

However, the foregoing approaches rather postulate than explain the existence of the demand for money, by using different types of restrictions for this purpose (e.g., cash payment restriction) and assumptions (in particular, on the usefulness of money or liquidity services). In other words, the introduction of money into the economic agent's optimization problem automatically gives rise to withdrawal of the money demand function and gives no answer to why agents use money. It is the search and matching theory that makes it possible to explain the existence of money.

2. A modern view on the monetary theory

A new and intensively growing section of the economic theory, called a new monetarism, has been developed over the past few years[7]. The new monetarism is intended to study such fields of the economics as the monetary theory and politics[8], banking business, and financial intermediation, as well as payments[9]. A search and matching approach (hereinafter referred to as "the search and matching theory" (agents seeking each others)) has been extensively developing to study monetary processes within this line of research. The search and matching theory is based on the concept that an overwhelming majority of transactions consummated in the real world is exposed to different types of bottlenecks, imperfections which are normally referred to as *frictions*. Within the approach under review such frictions constitute a fundamental and integral part of the economy. Judging by its name, the search and matching theory is focused on market imperfections deriving from economic agents' search for a partner for transaction. The search process is therefore exposed to costs. In other words, the search and matching theory explicitly studies the difficulties which economic agents (sellers and buyers) encounter in order to find each other. The search and matching theory models which are used to study macroeconomic issues constitute general equilibrium models in which a single or more types of searching agents interact.

According to Brunner and Meltzer., "one of the oldest unresolved problems of monetary theory is to explain the use and holding of money"[10]. The difficulties associated with explaining the existence of the demand for money are related to that money is not a common consumer amenity and useful only, indirectly, as an instrument for buying such amenities. Unlike other characteristics (a medium of payment and saving), this key feature of money as medium of exchange can't be reflected as part of conventional models. The role of money as a mean of exchange must be simulated explicitly while conventional macroeconomic models don't cover the exchange process. New monetarists believe that no substantial transition in the monetary theory is possible, unless different monetary processes are simulated explicitly. Such a simulation gives rise to a conclusion that money is relevant, because it allows the effects of fundamental economic imperfections to be smoothed.

Moreover, the existence of money is considered as a mean to overcome different types of frictions which interfere with the exchange process. An important goal of the search and matching theory in the field of monetary economy is to answer the question of which specific frictions determine the significance of

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[7] See: *Williamson S., Wright R.* New Monetarist Economics: Models // Handbook of Monetary Economics. 2nd ed. / B. Friedman, M. Woodford (eds.). Amsterdam: Elsevier, 2010.

[8] See: *Jones R.* The Origin and Development of Media of Exchange // Journal of Political Economy. 1976. Vol. 84. P. 757 - 775; *Kiyotaki N., Randall W.* On Money as a Medium of Exchange // Journal of Political Economy. 1989. Vol. 97. P. 927 - 954.

[9] See: *Diamond D., Dybvig P.* Bank Runs, Deposit Insurance, and Liquidity // Journal of Political Economy. 1983. Vol. 91. No 3. P. 401 - 419; *Diamond D.* Money in Search Equilibrium // Econometrica. 1984. Vol. 52. No 1. P. 1 - 20; *Freeman S.* The Payments System, Liquidity, and Rediscounting // American Economic Review. 1996. Vol. 86. P. 1126 - 1138.

[10] *Brunner K., Meltzer A.H.* The Uses of Money: Money in the Theory of an Exchange Economy // American Economic Review, December 1971 Vol. 61. December. P. 784 - 805.

money. In this context, money is important as long as it helps achieve allocation of resources which otherwise couldn't be accessible to agents[11]. Additionally, the search and matching theory tends to understand to which extent the simplicities underlining the traditional theoretical models have an effect on the consistence of conclusions obtained in such models, as well as the consistence of empirical research based on this theory.

Within the search and matching theory microeconomic structure of the economy is simulated explicitly, and therefore its use opens more options to in-depth understanding of functioning of the monetary system. Furthermore, the search and matching theory is rather a supplement to than set against the traditional macroeconomics, tending to fill up some of its gaps and giving answers to the questions which simply can't be formulated within traditional models. The traditional macroeconomics is commonly interested in answers to (reasonably practical) questions about economic policy: what can be done politically in a specific economic situation and what effects taken decisions may have. Instead, the search and matching theory is looking for the answers to "why?" questions: for instance, what money, different foreign currencies, different monetary systems exist for.

Economics of payments[12] which studies payment systems and payment relations is a relatively new line of the new monetarism. Economics of payments helps understand the mechanisms of different instruments which allow real resource costs associated with the exchange process between agents to be reduced.

The model described by Kiyotaki N. and Randall W.[13] is one of the underlying models of the monetary search and matching theory. The authors analyze an economy in which agents are specialized in production and consumption of goods. Agents meet on a random basis in the market. This implies that trade deals must be bilateral and satisfactory for both parties. Consequently, certain goods endogenously become a medium of exchange, i.e., commodity money emerges in the economy. The authors then formally show that introduction of paper money in the economy definitely improves individuals' well-being. Let's make a detailed examination of another underlying payment economics model – the Lagos-Wright exchange model[14]. Time is assumed to be discrete and infinite within the model under review. Each period is conventionally divided into two sub-periods: 'day time' and 'night time'. Transactions are consummated and each agent finds a trade partner on a random basis with an a probability in a decentralized market during the day time. Since transaction settlement in the day time market is associated with agent-partner search, the traded good is called the search good. Furthermore, during the day time certain agents which are called buyers want to consume but can't produce while other type of agents which are called sellers can produce but don't want to consume. This creates the so called double-coincidence-of-wants problem which is the key reason for frictions in the economy.

Regular trading in the night time market is associated with a considerably smaller number of frictions and all agents can produce and consume the so called general good. It is important that both economically produced goods can't be carried from one to another sub-period of time and therefore can't be a medium of payment[15]. Therefore, settlement of transactions in the day time market would be

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[11] Money is not significant and therefore simply isn't existing in the Walrasian economy: virtually, a randomly taken good plays the money's role as a unit of measurement. The absence of information problems and other market imperfections leads to that money are of no interest as a medium of exchange under such an approach.

[12] *Nosal E., Rocheteau G.* The Economics of Payments // FRB of Cleveland Policy Discussion Paper. 2006. No 14; *Nosal E., Rocheteau G.* Pairwise Trades, Asset Prices, and Monetary Policy // FRB of Chicago Working Paper. 2009.

[13] *Kiyotaki N., Randall W.* On Money as a Medium of Exchange // Journal of Political Economy. 1989. Vol. 97. P. 927 - 954.

[14] See: *Lagos R., Wright R.* A Unified Framework for Monetary Theory and Policy Analysis // Journal of Political Economy. 2005. Vol. 113. P. 463 - 488.

[15] The concept leads to the Samuelson model (see *Samuelson P.* An Exact Consumption-Loan Model of Interest with or without the Social Contrivance of Money // Journal of Political Economy. 1958. Vol. 66. No 6. P. 467 - 482): "In it [our world] nothing kept. All ice melted, and so did all chocolates"; *Samuelson P.A.* An Exact

impossible in the absence of any intertemporal instrument (medium) of exchange, because the seller wouldn't have incentives to produce the search good which the buyer wants to purchase.

One-period utility functions of buyers and sellers are assumed to be so that agents aren't be able to reach the top utility level, if they only produce and consume conventional goods for themselves and deny exchange. Different payment instruments as well as equilibrium distributions deriving from their use are analyzed within the described medium.

In particular, the exchange issue can be addressed through lending. Pairs formed in the day time market are assumed to exist throughout the entire period and consummate transactions in the night time market. This allows buyers to draw debt instruments during the day time and repay these at night time. At night time, buyers produce conventional goods and pass them to the producer to "pay for" the search good which was consumed during the day time. There is no other way to consummate transactions, because the economy has no assets (e.g., money) which may be used for this purpose. Credit economy needs debt repayment mechanisms to be able to exist. A system of recordkeeping of all transactions and arrangements can be one of such mechanisms. If at least a single agent refuses to discharge its obligations, an exchange-based economy will cease to exist and agents find themselves in the state of autarky which is characterized by a lower level of well-being.

Supposing that credit transactions can't be settled for any reason, then another medium of exchange would be needed. Paper money which is useless by itself may serve as such a medium. Money is significant in such an economy, i.e., agents couldn't achieve certain distributions without money. Sellers and buyers meet in a random way to settle a transaction in the day time market, and the buyer pays paper money for the search good. At night time, when competition is perfect, the seller may use this money to buy conventional goods which must be produced by the buyer.

A formal analysis shows that distribution of benefits within such an economy is absolutely the same as it is within a credit economy having the system of transaction recordkeeping. In other words, money is "memory". Money contains information about agent's previous bona fide (mala fide) behavior as partner for transactions settlement. If the buyer refuses to produce a conventional good at night time, he will not receive money from the seller for the good and be able to buy the search good the next morning. Thus, the buyer having subsequent opportunity to buy desired goods with the earned money serves as incentive to produce goods for the buyer in a monetary economy.

While the search and matching theory has been widely applied in the monetary theory, it has not yet been substantially, empirically employed for monetary policy analysis and other practical issues. Empirical research of the demand for money has long been drawn on the traditional theory, addressing mostly the monetary policy tasks.

3. Payment technology changes and stable money demand hypothesis

While empirical analysis methods of the demand for money have changed in time, the research goal has remained the same – find functional relationship between the amount of real money and basic macroeconomic indicators which characterize economic activity of the population and alternative value of money holding. Furthermore, stability test of an obtained equation is the key research

Consumption-Loan Model of Interest with or without the Social Contrivance of Money // Journal of Political Economy, University of Chicago Press. 1958. Vol. 66. P. 467.

aspect, because, following Milton Friedman[16], the demand for money constitutes an extremely stable function[17]. It is important to search for a stable money demand equation, because low inflation is the ultimate goal of most central banks. However, in case of unstable money demand function, there is no way for monetary aggregate management to attain stability in prices. The stable money demand issue was most pressing in the 1970s. The use of standard money demand specifications obtained unstable equations[18]. This was a reason why a series of central banks in developed countries began to use interest rates rather than money supply as an instrument of their policy[19].

The issue of traditional money demand equation was identified by Goldfeld S. et. all[20], whose paper became one of the most credible and recognized research in this field. Goldfeld and his co-authors evaluated the demand for M1 money and inferred that the money demand function is unstable. Moreover, the forecasts made on the basis of the model showed much bigger monetary aggregate values than real ones. The foregoing research triggered a great deal of research aimed at searching for a stable specification of the money demand equation. The disappearance of a stable money demand equation was thought to be associated with the emergence and proliferation of different financial and payment innovations, the emergence of substitutions of traditional money, and enhancement of the payment technology.

The easiest way to factor in financial innovations is incorporation of a time trend into the money demand regression as proxy reflecting the development of money management methods which became possible through new technologies in the financial sector[21]. Incorporation of an additional variable – the latest peak (extremely high) value of the interest rate[22]– into models became another method of adjusting standard money demand equations, which was widely used[23] late in the 1970s and in the 1980s.

The development of payment systems gave rise to changes to the demand for money. Dotsey M.[24] suggests that most of the money management methods which firms use in order to optimize the resources in demand deposits, includes electronic transfer of idle resources to interest-bearing overnight accounts. This is the reason why the number of electronic means of transfer is expected to be proxy for innovations (the scope of application of advanced financial technologies). The approach based on electronic transfers shows that the level of use of innovations

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[16] *Friedman M.* The Quantity Theory of Money, a Restatement // Studies in the Quantity Theory of Money / M. Friedman (ed.) Chicago, Ill: University of Chicago Press. 1956.

[17] In particular, Friedman wrote that stability means сохранение вида of function linking the quantity of money with variables which determine such quantity. According to Friedman, the quantity theory must restrict and present explicitly those variables which should be empirically introduced into the function. Increasing the quantity of variables considered as essential means empirical evisceration of a suggested hypothesis, as there after all is no difference whether the money demand function is considered very unstable or absolutely stable but depending on a great quantity of variables. *(Фридмен М.* Количественная теория денег. М.: Эльф-пресс, 1996). [Friedeman M. The Quantity Theory of Money. M. Elf-Press, 1996].

[18] *Goldfeld S.M.* The Case of the Missing Money // Brookings Papers on Economic Activity. 1976. Vol. 7. P. 683 - 740.

[19] Over the last few years the FRS has been using interest rates as an instrument, whereas the ECB relies on both interest rates and monetary aggregate benchmarks.

[20] *Goldfeld S.M.* The Case of the Missing Money // Brookings Papers on Economic Activity. 1976. Vol. 7. P. 683 - 740.

[21] *Lieberman C.* The Transactions Demand for Money and Technological Change // Review of Economics and Statistics. 1977. Vol. 59. P. 307 - 317.

[22] Respective arguments are provided in the paper of Duesenberry J. *(Duesenberry J.* The Portfolio Approach to the Demand for Money and Other Assets // Review of Economics and Statistics. 1963. Vol. 45 (supplement). P. 9 - 24) .

[23] A good illustration of it is the papers of Goldfeld S. *(Goldfeld S.M.* The Case of the Missing Money // Brookings Papers on Economic Activity. 1976. Vol. 7. P. 683 - 740), Enzler J. et al. *(Enzler J., Johnson L., Paulus J.* Some Problems of Money Demand // Brookings Papers on Economic Activity. 1976. P. 261 - 280), Simpson T. and Porter R. *(Simpson T., Porter R.* Some Issues Involving the Definition and Interpretation of the Monetary Aggregates // Federal Reserve Bank of Boston Conference Series. 1980. Vol. 23. P. 161 - 234), as well as Cagan P. *(Cagan P.* Monetary Policy and Subduing Inflation // Essays in Contemporary Economic Problems: Disinfftation / W. Fellner (project director). Washington: American Enterprise Institute, 1984. P. 21 - 53). There are different methods of technical incorporation of the latest peak value variable of the interest rate into a model. The easiest way is to supplement a regression with the variable of the ratio of the interest rate's current value to its latest peak value.

[24] *Dotsey M.* The Use of Electronic Funds Transfers to Capture the Effects of Cash Management Practices on the Demand for Demand Deposits: A Note // The Journal of Finance. 1985. Vol. 40. No 5. P. 1493 - 1503.

simultaneously depends on changes to both costs related to the use of financial innovations and respective benefits. Factoring in the variable of the number of electronic transfers allowed Dotsey to obtain a stable equation of the demand for demand deposits.

According to Hafer R. W.[25], proliferation of payment innovations has blurred much of the distinction between different types of transaction deposits. Under this hypothesis, changes in the demand for money in the United States in the middle of the 1970s can be explained by simultaneous shift of the money demand level (a constant term in the money demand equation). This concept was reflected in the following research[26] which explains the increased demand for money in the 1980s by the fact that the M1 monetary aggregate began to contain interest-bearing transaction accounts. In this context, the demand for M1 began to satisfy not only the transactional motive, but also the saving one. However, the effect of introduction of financial innovations continued, weakening the demand for money.

Speaking of the effect of the use of bank cards on agents' demand for cash, there is evidence[27] showing that the number of electronic transfers at points of sales is small, but it has a significantly adverse effect on the demand for cash; the number of ATMs has a weaker but significant and positive effect.

Innovations in the field of money payments may have a significant effect on monetary processes in the country and, consequently, the central bank's ability to carry out an efficient monetary policy. We presented above the analysis of international practices in researching the demand for money for the purpose of subsequent modeling an equation of the demand for money in Russia. Papers analyzing the demand for money in Russia[28] often show money demand instability, structural changes, and discontinuities of the demand function. We expect that modeling of the demand for money in Russia factoring in innovations used in the payment practice may improve stability of the money demand function.

4. An illustration of money demand estimation in Russia

Estimation of the traditional model of the demand for the M0 monetary aggregate based on Russian data, which implies that the demand for money is only determined by agents' economic activity and alternative cost of money holding, shows that the respective cointegration ratio can't be obtained or the equation is unstable[29]. In this section we would like to test the hypothesis[30] on whether payment innovations have a significant effect on the demand for money in Russia and whether obtained equations can be considered stable. To do this, it is important to factor in the indicator of payment innovations in the traditional money demand model. There is no way to obtain a uniform indicator of changes in the payment

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[25] *Hafer R. W.* The Demand for Transactions Deposits: Was there a Shift in the Relationship? // Journal of Macroeconomics. 1982. Vol. 4. No 3. P. 363 - 370.

[26] *Miller S.M.* Money demand instability: has it ended? // Economics Letters. 1989. Vol. 30. No 4. P. 345 - 349.

[27] *Drehmann M., Goodhart C., Krueger M., Boldrin M., Rose A.* The Challenges Facing Currency Usage: Will the Traditional Transaction Medium Be Able to Resist Competition from the New Technologies? // Economic Policy. 2002. Vol. 17. No 34. P. 193 - 227.

[28] *Choudhry T.* Another Visit to the Cagan Model of Money Demand: The Latest Russian Experience // Journal of International Money and Finance. 1998. Vol. 17. No. 2. P. 355 - 376; *Buch C. M.* Russian Monetary Policy — Assessing the Track Record // Economic Systems. 1998. Vol. 22. No 2. P. 105 - 145; *Banerji A.* Money Demand // Russian Federation: Selected Issues and Statistical Appendix // IMF Staff Country Report. 2002. No 02/75; *Oomes N., Ohnsorge F.* Money Demand and Inflation in Dollarized Economies: The Case of Russia // Journal of Comparative Economics. 2005. Vol. 33. P. 462 - 483; *Vymyatnina Y.* Monetary Policy Transmission and CBR Monetary Policy // Return to Growth in CIS countries — Monetary Policy and Macroeconomic Framework / L. Vinhas de Souza, O. Havrylyshyn (eds.), Berlin: Springer, 2006; *Korhonen I., Mehrotra A.* Money Demand in Post-Crisis Russia: De-Dollarisation and Re-Monetisation // BOFIT Discussion Papers. 2007; *Дробышевский С., Козловская А* Внутренние аспекты денежно-кредитной политики России // Научные труды ИЭПП. 2002. № 45Р [Drobyshevsky S., Kozlovskaya A. Internal aspects of the monetary policy in Russia // IET's Research Works. 2002, No. 45R]; *Дробышевский С., Кузьмичева Г., Синельникова Е., Трунин П.* Моделирование спроса на деньги в российской экономике в 1999 - 2008 гг. // Научные труды ИЭПП. 2010. № 136Р. [*Drobyshevsky S., Kuzmicheva G., Sinelnikova E., Trunin P.* Modeling the demand for money in the Russian economy in 1999-2008 // IET's Research Works. 2010, No. 136R].

[29] A broad spectrum of models in terms of a wide range of indicators used as regressors were estimated as part of this research .

[30] Tests are conducted within the obtained models only.

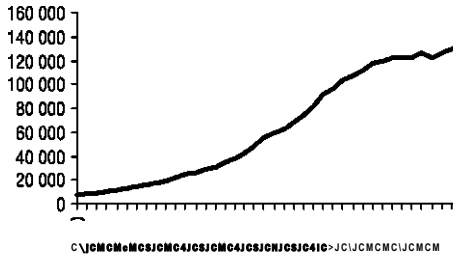
technology. At present, some of the payment innovations which are introduced in the developed countries are quite not well proliferated or in no use in Russia. As shown above, the trend variable of the interest rate's latest peak value, different indicators of the number and volume of large payments or indicators describing proliferation and use of payment cards can be used as proxy for new payment technologies. The issue related to ever growing proliferation of bank cards, a close substitute of cash, in Russia will be examined in details below, because only bank card statistics are available for Russia.

Information on different indicators describing operations conducted using bank cards[31] is published in the Bank of Russia's Bulletin of Banking Statistics and contains data on the quantity of bank cards and the dynamics of cash withdrawals and payments for goods (works, services) effected using bank cards on and outside the territory of the Russian Federation. Data on the number of bank cards are presented as of the 1st day of a month following the reported quarter. The data on volumes of operations conducted using bank cards are published for the reported quarter.

Let's introduce the following notations[32]:

- *M0* – the M0 monetary aggregate in nominal terms, billions of rubles;
- *P* – price level (underlying CPI by 1995);
- *REALM* 0 = *M0/P* – the M0 monetary aggregate in real terms;
- *RGDP* – real GDP;
- *DEPOSIT* – interest rate on retail deposits which is calculated by the Bank of Russia
- *BCNUMBER* – the number of issued bank cards, thousands of units;
- *BCCASH* – volume of cash withdrawals effected using bank cards on the territory of the Russian Federation, millions of rubles;
- *BCPAY* – volume of payments for goods (works, services) effected using bank cards on the territory of the Russian Federation, millions of rubles.

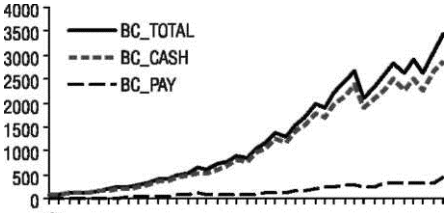
Statistics on bank card indicators describing proliferation of payment innovations have been available since Q3 2000. There is no publicly available data on earlier periods[33]. Fig. 1 presents the data on the number of issued bank cards, about half of which are recognized as active[34].



Data source: Bank of Russia.

Fig. 1. **The number of issued bank cards, Q3 2000 – Q3 2010** (thousands of units)

Fig. 2 shows a breakdown of the volume of payments effected using bank cards among cash withdrawals and payments for goods and services, as well as total volume of operations conducted using bank cards. It shows that cash withdrawals are dominating[35].



[31] For more information, please see the Bank of Russia's materials on the bank card market in Russia, e.g., "The Review of the Russian Payment Card Market in 2009" (2010).

[32] The research drew on the data from the materials of the Bank of Russia and the Federal State Statistics Service (Rosstat). The research period terminates by the availability of data on real GDP at the moment of payment settlements.

[33] The data on the division of bank cards into debit cards, credit cards, and prepaid cards have been available on the Bank of Russia's official website since 01.01.2008.

[34] Active cards refer to cards which were used for at least a single cash withdrawal and/or payment for goods and services, including customs charges, within the reporting quarter. *(Data source:* Bank of Russia.)

[35] To compare: in Germany cash withdrawals using bank cards account for more than a half of all operations conducted using bank cards, whereas in France, Belgium and Canada bank cards are used more often to pay for goods and services. *(Data source:* Bank for International Settlements, www.bis.org.)Доклад «Рынок безналичных розничных платежей в России: выгоды и перспективы развития» (2009) [The Report on "The non-cash retail payment market in Russia: advantages and development prospects" (2009)], www.csr.ru.

Following is the hypothesis of the effect of bank cards on the demand for money: growth in volume of payments for goods and services using (both debit and credit) bank cards weakens the demand for cash as traditional medium of payment. However, wide usage of payment cards is accompanied by growth in the number of ATMs. On the one hand, proliferation of ATMs (under otherwise equal conditions) shrinks average cash balances on hand of economic agents, because it becomes possible for agents to frequently use ATMs to withdraw small amounts of cash for current needs. On the other hand, availability of ATMs (also under otherwise equal conditions) stimulates the use of cash as medium of payment, driving out non-cash payments, because cash becomes more easy to access. In certain situations payments only can be effected because of availability of an ATM. Such situation also include:

Data source: Bank of Russia.

Fig. 2. **Volume of cash withdrawals, payments for goods (works, services) and total volume of operations conducted using banks cards, Q3 2000 – Q3 2010** (millions of rubles)

- payments effected at sites where bank cards are accepted as medium of payment, or such cards are accepted beginning with a certain transaction amount;
- payments effected at "questionable" sites, when the buyer is concerned about possible fraudulent actions against his payment card.

Therefore, there are factors which make cash payments very attractive. Additionally, payment practice and agents' preferences may favor cash as a more convenient medium of payment. In this context, bank cards represent an e-wallet rather than a medium of payment for such agents. These conclusions for Russia are supported by the results of a research conducted by the Center for Strategic Research Foundation (CSR)[36]. Indeed, it is above all 'payroll' and 'social' projects (compulsory crediting of wages and pensions to bank cards against individual's preferences) that are responsible for wide proliferation of bank cards today in Russia.

Additionally, the development ATMs (or multifunctional terminals which are statistical equivalent to ATMs) has recently been having an effect on the following factors. Factor 1 – expansion of electronic payment systems represented by enhanced ATMs which are, besides traditional functions, designed for payment for a great deal of services (payments for housing and community amenities, mobile phone bills, etc.). Factor 2 is related to the fact, that in attempt to make loans more attractive, banks install their ATMs (which can be used for repaying loans) at locations which are convenient for customers. Additionally, the existing trend shows that every commercial building (premises) should have at least a single ATM.

This is the reason why growth in the number of ATMs with a fixed number of bank cards may facilitate growth in the M0 monetary aggregate. We may infer that it is generally unknown what kind of cumulative effect the number of ATMs has on the M0 monetary aggregate.

The data on the number of ATMs have been available since the beginning of Q1 2008. This is the reason why the number of bank cards and volume of cash withdrawals using bank cards (it is this kind of bank card operations that are dominating in Russia) will be used as proxy variable for the indicator of the number of ATMs in Russia.

The stationarity test's results of the series under review show that the series of logarithms of the real and nominal monetary aggregates have a single unit root, whereas the series of logarithms of real GDP and prices for the period of time under review are near trend stationary. The series deposit interest rate is 1(1) series. The series of the logarithms of *BCNUMBER* and *BCCASH* is near trend stationary while *BCPAY* series is first-order integrated.

[36] Доклад «Рынок безналичных розничных платежей в России: выгоды и перспективы развития» (2009) [The Report on "The non-cash retail payment market in Russia: advantages and development prospects" (2009)], www.csr.ru.

In estimating a wide spectrum of potential models of the demand for the M0 monetary aggregate factoring in payment innovations, we estimated long-term dynamic ratios of the money demand indicator and the aforesaid factors. Furthermore, the respective cointegration ratios were estimated using the least-squares dynamic method (LSDM) which allows the so-called long-term cointegration ratios to be obtained[37]. Factoring in a potential multicollinearity issue, just one indicator of payment innovation is incorporated into each of the models, because the indicators under review are very close to each other. However, the dynamics of the indicator of volumes of payments using bank cards differ from other indicators in slower growth rate.

The first model describes the relationship between the logarithm of real cash, the logarithm of real GDP, deposit rate, and volume of payments for goods and services effected using bank cards[38]:

$$LnREALM0^{EST} = \underset{(-6,12)}{-12,12} + \underset{(7,90)}{2,00}\mathrm{Ln}RGDP - \underset{(-5,76)}{3,30}DEPOSIT -$$

$$- \underset{(-2,477130)}{0,000336}BC\_PAY + \underset{(4,46)}{0,182})1 + \underset{(4,31)}{0,122})2 - \underset{(-8,48)}{0,112})3 + \underset{(4,58)}{0,02}\ TREND. \quad (1)$$

Enclosed in brackets are /-statistics, $R^2 = 0,9$. The remnants of the obtained model are stationary. Stability speaks for the model. The stability is supported by the CUSUM test results and analysis of the recursive coefficients charts.

In addition, the estimated elasticity of the demand for money on earnings equals to 2, whereas semi-elasticity of the demand for money on deposit interest is negative and equals to 3,3 in magnitude. The data support the fact that the volume of payments for goods and services effected using bank cards has a significantly adverse effect on the demand for real M0 money. Semi-elasticity of the demand for money with respect to the *BCPAY* variable is 0.336. This implies that the demand for cash (under otherwise equal conditions) would decline about 0.336% with a Rb 1bn growth in payment for goods and services effected using bank cards. The trend incorporated into the money demand equation is intended to reflect boost in public confidence in the monetary authorities' policy in the period of 2000 thru 2010[39].

The second model explains the relationship between the logarithm of the M0 monetary aggregate, the logarithm of price level, the logarithm of real GDP, interest, and the logarithm of the volume of cash withdrawals effected using bank cards:

$$LnM0^{EST} = \underset{(-4,89)}{-8,91} + \underset{(2,52)}{0,81}\mathrm{LnP} + \underset{(6,58)}{l,54}LnRGDP - \underset{(-1,76)}{l,66}DEPOSIT +$$

$$+ \underset{(2,31)}{0,25}\mathrm{Ln}\ BC\_CASH + \underset{(2,92)}{0,1}\text{Ш} + \underset{(1,97)}{0,06}\mathrm{D}\,2 - \underset{(-3,46)}{0,17}\mathrm{D}\,3. \quad (2)$$

Enclosed in brackets are t-statistics, $R^2 = 0,998$. The remnants of the estimate model are stationary. Our model is supported by the fact that the coefficient with the price logarithm, according to the Wald test, statistically equals to unity at a 5 percent level of significance. The obtained elasticity of the demand for money on earnings equals to 1.54, whereas semi-elasticity of the demand for money on (deposit) interest is negative and equals 1.66 in magnitude. Additionally, the data support the hypothesis of the demand for cash depending positively on the volume of cash withdrawals using bank cards which constitute the proxy variable for the number of ATMs in Russia. Numerical estimation of the respective coefficient, or elasticity (0.25), may give rise to doubts due to a high correlation between the Ln

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[37] *Stock J.H., Watson M.W.* A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems // Econometrica. 1993. Vol. 61. No 4. P. 783 - 820. The method is intended to make dynamic adjustment to the results of the estimation of model's coefficients through the common LSDM.

[38] *D1, D2, D3* are quarterly dummy variables required to factor in determinate seasonality in the data; *TREND* is linear trend.

[39] For detailed information please see: *Дробышевский С., Кузьмичева Г., Синельникова Е., Трунин П.* Моделирование спроса на деньги в российской экономике в 1999 - 2008 гг. [*Drobyshevsky S., Kuzmitcheva G., Sinelnikova E., Trunin P.* Modeling the demand for money in the Russian economy in 1999 - 2008.]

RGDP and Ln *BCCASH* series (0.89). In this case, however, it is the sign of the estimate rather than the estimate itself that is relevant for us. At the same time, testing model (2) for stability leads to inconsistent conclusions. The CUSUM test supports the stability of the money demand equation, whereas the CUSUM-SQ test and the dynamics of recursive coefficients show the instability of the model. Perhaps, the obtained model can't be considered stable and useful for forward-looking purposes.

Finally, the third model of the demand for cash constitutes a function of price level, real GDP, interest, and the number of bank cards:

$$LnM0^{EST} = \underset{(-7,48)}{-8,89} + \underset{(4,60)}{0,83}\text{LnP} + \underset{(6,46)}{1,29}\text{Ln } GDP - \underset{(-1,87)}{0,2}ADEPOSIT +$$
$$+ \underset{(4,09)}{0,34}\text{Ln } BC\_NUMBER + \underset{(2,37)}{0,07}\text{III} + \underset{(2,59)}{0,051)2} - \underset{(-7,49)}{0,09}\text{D3}. \quad (3)$$

Enclosed in brackets are t-statistics, $R^2 = 0,998$, and the remnants of model (3) are stationary. According to the Wald test results, the hypothesis of the coefficient equaling to unit with the price logarithm is not discarded.

Additionally, elasticity of the demand for money on real GDP also statistically equals to unity. The formal stability tests' results of model (3) support the stability of its coefficients.

In estimating cash demand equation (3), we obtained that semi-elasticity on the (deposit) interest equals to 1.24. Furthermore, evidence was obtained to support the fact that the number of bank cards being the proxy variable for the number of ATMs has a positive effect on the demand for cash.

This can be explained by economic agents' preference to pay cash (or they have no way of paying using bank cards) and use bank cards basically as e-wallets. Numerical estimation of the respective coefficient (0.34) may give rise to doubts because of a 0.90 correlation between the Ln *RGDP* and Ln *BCNUMBER* series. Contensive interpretation of this coefficient may be as follows: the demand for the M0/P aggregate [40] increases by 0.34% (under otherwise equal conditions) in case of a 1% growth in the number of bank cards. Such an interpretation seems to be less than reliable due to a very high value of elasticity. Therefore, in this case, we will rely on the sign of estimation. Perhaps, high values of elasticity for innovation indicators in models (2) and (3) can be explained by their having no trend incorporated into model (1) and reflecting growth in public confidence in the monetary authorities' policy. However, incorporation of the linear trend into models (2) and (3) resulted in regressions with economically uninterpreted estimates. We assume that a more complex trend with discontinuities should be incorporated into models (2) and (3), which is impossible due to insufficiently long interval available for research and relatively big number of explanatory variables in the model. Another explanation of having obtained economically uninterpreted results after the linear trend's incorporation into models (2) and (3) is that the Ln *BCCASH* and Ln *BCNUMBER* series are stationary near the determinate linear trend and by themselves are, to a certain extent, proxy variables for the trend. This is why the linear trend incorporation into the models results in "odd" estimates due to obvious multicollinearity of data, which is not observed in estimating the equation (1).

Conclusion

[40] In this case, one may speak of the demand for real rather than nominal money, because the coefficient, with the price logarithm in model (3), statistically equals to unity and the price indicator may be moved to the left side of the equation.

Modeling the demand for money in Russia factoring in payment innovations has led us to the following conclusions based on different specifications of the demand function.

Model (1) explains the demand for the M0 monetary aggregate by real GDP, interest rate, and the volume of payments for goods and services effected using bank cards. Additionally, the linear trend intended to factor in growth in economic agents' confidence in the monetary authorities' policy was incorporated into the money demand equation. It derives from the model that the demand for cash depends negatively on the volume of payments for goods and services effected using bank cards. It is the stability that speaks for the obtained equations.

Basically, bank cards in Russia can be used for cash withdrawal via ATMs and different types of terminals. Preferential usage of bank cards for this purpose can be explained by agents' preferences, as well as a relatively small number of organizations which accept bank cards for payment amid vigorous growth in the number of ATMs which (under otherwise equal conditions) increases the M0 monetary aggregate. The number of bank cards and volume of cash withdrawals using bank cards were used as proxy of the number of ATMs. Our assumption of a positive effect of proliferation of ATMs on cash is supported by model (2) which explains the demand for the M0 aggregate real GDP, interest rate and volume of cash withdrawals, and model (3) which incorporates the number of bank cards as one of regressors.

The presented results allow one to infer that analysis of the dynamics of the demand for money net of payment innovations in the Russian Federation is incomplete. It is insufficient to integrate indicators of GDP and interest rate into the money demand model for forecasting, including dynamics of prices, because the respective equation is unstable. Therefore, the scope of application of new technologies should be factored in.