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## Feedback to the ECB's monetary analysis: the Bank of Russia's experience with some key tools

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### FEEDBACK TO THE ECB'S MONETARY ANALYSIS

### THE BANK OF RUSSIA'S EXPERIENCE WITH SOME KEY TOOLS

Alexey Ponomarenko, Elena Vasilieva  
and Franziska Schobert



In 2012 all ECB  
publications  
feature a motif  
taken from  
the €50 banknote.



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## **Abstract**

The paper investigates to what extent some basic tools of the ECBs monetary analysis can be useful for other central banks given their specific institutional, economic and financial environment. We take the case of the Bank of Russia in order to show how to adjust methods and techniques of monetary analysis for an economy that differs from the euro area as regards, for instance, the role of the exchange rate, the impact of dollarization and the functioning of sovereign wealth funds. A special focus of the analysis is the estimation of money demand functions for different monetary aggregates. The results suggest that there are stable relationships with respect to income and wealth and to a lesser extent to uncertainty variables and opportunity costs. Furthermore, the analysis also delivers preliminary results of the information content of money for inflation and for real economic development.

**Keywords:** Money demand, transition countries, cointegration analysis, inflation, real economic activity

**JEL:** E41, E52, E58

## **Non-technical summary**

Tools and techniques of the ECB's monetary analysis can give valuable input to the conduct of monetary policy at other central banks, if institutional, economic and financial differences are taken into account. We take the case of the Bank of Russia and analyze the changing role of money in its monetary policy. The Russian economy differs from the euro area as regards, for instance, the role of the exchange rate, the impact of dollarization and the functioning of sovereign wealth funds. In the core part of our paper we derive stable money demand functions for different monetary aggregates that are related to income and wealth and to a lesser extent to opportunity costs and uncertainty. Estimations of narrower aggregates that only include components denominated in national currency seem to be more stable than broader aggregates. One interpretation of this result is that monetary developments are driven by factors that go beyond the usual money demand factors, such as the money creating function of the sovereign wealth funds in case of Russia. This, however, also complicates the interpretation of monetary overhangs and the policy implications that could be drawn from them. Eventually, it should be kept in mind that the concept of monetary overhangs are a starting point for an analysis that focuses on changes in the stocks rather than other analyses that commonly focus on changes in the flows. Additionally, we present results that deliver some information content of money for inflation and real economic development. As in case of the ECB's regular monetary assessment we measure money-based inflation risk indicators and compare the performance of different monetary aggregates with naïve and univariate inflation models as well as inflation models with alternative economic variables. The results are promising, though we leave it for future analysis to assess their performance over time. The results of the information content of money for real economic developments is fairly limited, however, in line with results for the euro area, the narrow monetary aggregate seems to perform relatively better compared to broader aggregates.

## 1. Introduction

Monetary analysis at central banks has different meanings across the world and over time. Some parts of the world may still focus on quantitative targets for (base) money and thereby may blur the meaning of operational and intermediate targets and indicators or reference values. The ECB, in contrast, clarifies in its two pillar strategy that it uses the monetary pillar to collect information on medium to long term risks to price stability by focusing on the analysis of money and credit aggregates. It thus ensures a “full information approach” that may otherwise be dominated by the analysis of cyclical movements of the economy and the information on short-term risks. Monetary analysis at the ECB has been an evolutionary process during which tools and techniques have developed as described in Papademos and Stark (2010). This process has been monitored by other central banks that set up new strategies for an autonomous monetary policy that focuses on internal price stability rather than on stable exchange rates. We describe the Bank of Russia’s experience in this respect and to what extent some key tools of monetary analysis as practiced by the ECB can be useful for it. On the one hand, the Bank of Russia may benefit from tools that are already regularly used in the ECB’s monetary assessment. The composition of drivers behind money stock growth indicates that the Russian economy is evidently prone to exogenous money supply shocks. Identifying these shocks and their macroeconomic consequences is an important practical task for day-to-day monetary policy analysis. The models developed to interpret monetary developments that constitute an essential part of the ECB’s monetary analysis seem particularly suitable for this task. On the other hand, simply copying the tools would not be advisable as the economic and financial environment in Russia differs to some extent from the euro area. Both financial sectors have in common that they are rather bank-based than capital market-based. Financial markets in Russia, however, are less deep and liquid compared to the euro area and money might be the most important financial store of value for a large share of the population. Furthermore, high inflationary and hyperinflationary periods are closer in the collective memory than in the euro area and foreign money has often served as a safe haven. Currency substitution, or, in its broader definition, “dollarization” has inertia and monetary aggregates that include foreign denominated components should behave differently to those that do not. External nominal anchors have dominated monetary policy in the past and exchange rate developments have triggered rapid reactions of money holders. Last but not least, Russia is an oil exporting economy and sovereign wealth funds help to buffer the impact of commodity price fluctuations and to save financial resources for future generations during normal times. During turbulent times they can also function as crisis tools and provide additional funding. Their behavior can significantly influence

money creation and thereby, may be understood as exogenous factors or supply side factors that influence monetary developments beyond the usual money demand factors.

We acknowledge these differences in our study and focus on some key tools of ECB monetary analysis as described in chapters 3 and 4 of Papademos and Stark (2010) which we apply to the Russian case. We start with a brief review of the role of money at the Bank of Russia's monetary policy since the early 1990s and a description of monetary developments – broken down in components and counterparts – in section 2 and 3. Section 4 forms the core of the paper, as it presents money demand estimations for different monetary aggregates. In section 5 we analyse the information content of money for inflation and real economic activity and in section 6 we conclude.

## **2. The role of money in Bank of Russia's monetary policy - A review**

The main stages of evolution of the conduct of monetary analysis and its role in the Bank of Russia's (CBR) monetary policy framework may be provisionally described by several different periods. They highlight the role of money in an economic environment which suffered from periods of price and financial instability and shifted from a fixed to a managed exchange rate regime.

**Early 1990s.** The CBR already paid serious attention to monetary analysis and the developments of monetary aggregates as early as the first steps to liberalize the economy were taken in the early 1990s. The transition from a planned to a market economy caused drastic structural shifts in both the real and the financial sector in Russia. In these circumstances the CBR's monetary policy was conducted against the background of hyperinflation that followed the lifting of price regulation, deep recession of the real sector, depreciation of the national currency and high macroeconomic uncertainty. The CBR had to find a balance between restraining inflation and supportive measures aimed at preventing the collapse of the real economy and the domestic financial system.

According to the “Guidelines for the Single State Monetary Policy” in early the 1990s averting hyperinflation by limiting extraordinarily high money growth (see Table 1) had become one of the priority objectives of the CBR's monetary policy together with other tasks such as stabilizing the financial system and the exchange rate. In the Federal Law “On the Central Bank of the Russian Federation (Bank of Russia)”, that was passed in 1990 for the first time, setting targets for money supply growth was indicated as one of the principal tools and methods of the Bank of Russia monetary policy<sup>1</sup>.

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<sup>1</sup> This clause is still present in the Federal Law “On the Central Bank of the Russian Federation (Bank of Russia)”, article 35.

During this period the efforts to achieve macroeconomic stability have generally been framed in the context of IMF-supported programs. These programs had several components (the exchange rate regime, monetary and exchange rate policies, fiscal policy and structural reforms) and implied setting intermediate targets for a number of macroeconomic (including monetary) variables regarded as nominal anchors. An underlying relationship between money growth and inflation projected in the program was a key assumption, although in practice a much more eclectic set of macroeconomic theories and modeling techniques was used to provide analytical support for the policy design (see Ghosh et al. (2005)). The CBR also studied closely the strategies of other central banks, including the monetary targeting strategy of the Deutsche Bundesbank.

The CBR's monetary policy was conducted by setting limits for the growth of the narrow monetary base<sup>2</sup> and other positions of the aggregated central bank's balance sheet in the Monetary program. This included strict limits on direct loans of the CBR to the government and the commercial banks. Setting limits for money supply growth was formulated in terms of the monetary aggregate M2 (national definition) that "includes all cash and non-cash funds of resident non-financial and financial institutions (except for credit institutions), and private individuals in rubles."<sup>3</sup> Quarterly targets for CBR's balance sheet indicators were set and mostly fulfilled. According to these plans money growth was to be stabilized and subsequently slowed down. Although the CBR changed its interest rates and the reserve requirements during this period its most important tool had undoubtedly been the volume of loans provided to commercial banks and the government.

Obviously setting the adequate quantitative target for money growth was extremely complicated during the period of transition. High uncertainty and volatility of the main macroeconomic indicators caused rapid fluctuations of the demand for money. The situation was hampered even further by the lack of statistical data. Nevertheless, using elements of monetary targeting in the CBR's monetary policy helped to cope with hyperinflation, stabilized the situation in the financial sector and prevented a systemic banking crisis.

**The period of 1995 - 1998.** Starting from 1995 the CBR's monetary policy framework changed considerably. Direct CBR's loans to the government were discontinued. The exchange rate was used as the nominal anchor and an exchange rate band was introduced and defended by

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<sup>2</sup> The monetary base (narrow definition) consists of the currency issued by the CBR (including cash in vaults of credit institutions) and required reserves balances on ruble deposits with the CBR.

CBR, External and Public Relations Department, Press-releases, Monetary Base (narrow definition), 01.07.2011.

<sup>3</sup> Money supply (national definition) "is defined as the sum of funds in the Russian Federation currency, intended for use as payment for goods, work and services and for the accumulation of savings by resident non-financial and financial organizations (except for credit ones) and individuals".

CBR Bulletin of Banking Statistics No 5 (216), 2011, pp. 233-234.



the CBR till the crisis of 1998. Domestic price stability was also mentioned as the monetary policy objective and the prevalent role of monetary expansion in determining inflation rates over the medium-term was acknowledged<sup>4</sup>.

The Monetary Program still included reference growth rates for the narrow monetary base, CBR's net foreign assets and net credit to the government and commercial banks, although its parameters were no longer viewed as strict targets. Under this framework combined with the exchange rate policy the CBR managed to bring inflation rates down to annual 11% and money growth to 30% in 1997, although the state of the financial sector was still far from healthy as problems with illiquidity and nonpayment of enterprises persisted, which led to wide usage of barter and monetary surrogates.

The CBR's analytical work in the area of monetary analysis in the 1990s was mainly focused on analyzing money demand, money velocity and money multiplier dynamics. Different components of money stock (including foreign currency denominated ones) as well as the sources of money growth were monitored. When foreign currency denominated deposits were legalized the CBR started to compile and report in 1995 the dynamics of a broader monetary aggregate - broad money (or M2X)<sup>5</sup>.

The **crisis of 1998** which was due to unsustainable public finance in Russia and capital outflows from emerging countries, hit the Russian economy hard and determined the need to change the CBR's monetary policy. On the one hand the CBR had to keep the monetary stance to prevent depreciation of the national currency and combat rising inflation. On the other hand the dire problems in the financial sector and dysfunctions of the payment system called for liquidity providing measures. In September 1998 the CBR abandoned the fixed exchange rate peg, allowed the ruble to depreciate sharply, and declared the transition to a managed floating exchange rate regime.

**The period of 1999-2008.** In 1999 the objective of CBR's monetary policy was formulated as achieving stable economic growth in a low inflation environment. Yet, as the capital inflows (mainly originating from the rise of oil and gas prices) increased the CBR's commitment shifted towards exchange rate management. Since 2003 a target for real exchange rate appreciation was declared together with an inflation target. In 2005 the CBR introduced a bi-currency basket consisting of USD and euro (with current weights of 0.55 and 0.45 accordingly) as its operational target. In order to prevent the ruble's excessive appreciation the CBR had to

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<sup>4</sup> CBR, Guidelines for the Single State Monetary Policy in 1997, p. 23.

<sup>5</sup> "Broad money comprises cash issued by the Bank of Russia (excluding cash in vaults of the Bank of Russia and credit institutions), funds held by residents (individuals and organizations other than credit institutions) in settlement, current and deposit bank accounts denominated in rubles and foreign currencies, precious metals and all interest accrued on deposit operations".

CBR, Guidelines for the Single State Monetary Policy in 2010 and for 2011 and 2012, p. 11.

conduct substantial foreign exchange interventions that became an important liquidity-providing factor. In an environment of strong capital inflows and relatively high oil prices, the Russian economy grew strongly. Since 2000 and until mid-2008 the annual growth rates of M2 were above 30%.

Although the relationship between money and inflation in a relatively low inflationary environment was now less evident and the CBR no longer attempted to target money growth, the monetary aggregates retained the role as inflation risk indicators and were monitored closely. Every year the CBR published the references for M2 growth as well as the parameters of the Monetary Program in the “Guidelines for the Single State Monetary Policy”. These estimates conform to the scenarios of macroeconomic development produced by the Ministry of Economy. Yet, in practice, the actual outcomes may deviate from these projections significantly. The analysis of causes and consequences of these deviations provides valuable information and is part of the analytical work in the area of monetary analysis. At this stage the aspects of monetary analysis related to extracting information from monetary developments in order to assess the current monetary stance (as opposed to making the projections of monetary indicators contained in the Monetary Program) started to gain importance. Naturally the relevant tools employed by the ECB for this purpose formed the basis of the analytical framework.

Money growth projections are traditionally formulated in terms of the M2 aggregate (national definition) as well as the general discussion about the monetary developments in Russia. Therefore the money demand studies conducted at the CBR originally concentrated on modeling this indicator. But as the role of monetary analysis expanded beyond the production of such projections the need to explore the properties of other monetary aggregates and their linkages with other macroeconomic variables became apparent. In fact, the dynamics of broader aggregates that include foreign currency denominated assets are less prone to fluctuations arising due to changing currency preferences and are therefore easier to interpret. Foreign currency deposits, but also cash in foreign currency serves as a store of value and as a safe haven during turbulent times.

**The period after 2008.** In recent years the CBR has adjusted the priority of its monetary policy objectives. This was partially a result of the crisis of 2008 which highlighted the impact of financial sector imbalances on the real sector.

In 2008 the CBR declared in the “Guidelines for the Single State Monetary Policy” that lowering and subsequently maintaining low inflation is the main monetary policy objective<sup>6</sup>. Starting from 2009 the monetary policy horizon was extended to 3 years. The CBR also declared

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<sup>6</sup> CBR, Guidelines for the Single State Monetary Policy in 2008, I. Medium-term monetary policy principles, p. 3

the gradual transition to a flexible exchange rate regime<sup>7</sup>. In 2010 the CBR declared that it will pay special attention to the broad analysis of money and credit developments for the purposes of financial stability and underscored the important role of credit and asset price developments in identifying financial imbalances. In the “Guidelines for the Single State Monetary Policy in 2011 and for 2012 and 2013” it is noted that “... the Bank of Russia will pursue monetary policy by considering the situation on the financial markets and the risks arising from growth in monetary aggregates, credits and asset prices. It will pay special attention to a more comprehensive analysis of trends in monetary and credit indicators, to ensure that its timely actions in monetary policy and banking regulation and supervision help prevent imbalances in the financial sector of the economy, and thereby not only bring down inflation, but also maintain financial stability and a state of overall macroeconomic equilibrium.”<sup>8</sup>

In the “Guidelines for the Single State Monetary Policy in 2012 and for 2013 and 2014” there is an intention declared to complete the transition to inflation targeting regime within a 3 years period<sup>9</sup>. At the same monetary analysis will retain its prominent role in identifying inflation risks in the medium and long-run. The CBR will also pay close attention to money, credit and asset prices developments for the purpose of maintaining financial stability<sup>10</sup>. As outlined by the CBR’s First Deputy Chairman Alexey V. Ulyukaev: “If you have rapid money growth you will most likely get high inflation or you could get the growth of asset prices, for example of housing or equities, that is not reflected in inflation measures... We should cross-check inflation targeting with monetary analysis approach. Methodologically that is what our colleagues in the ECB call two-pillars” (Ulyukaev (2011)).

Monetary analysis at the CBR therefore does not only look at price but also at financial stability, since financial imbalances have been more closely connected to high inflationary periods in Russia than in developed economies during the recent past.

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<sup>7</sup> CBR, Guidelines for the Single State Monetary Policy in 2009 and for 2010 and 2011, I. Medium-term monetary policy principles, p.4

<sup>8</sup> CBR, Guidelines for the Single State Monetary Policy in 2011 and for 2012 and 2013, I. Medium-term monetary policy principles, pp. 3-4.

<sup>9</sup> CBR, Guidelines for the Single State Monetary Policy in 2012 and for 2013 and 2014, I. Medium-term monetary policy principles, p. 3.

<sup>10</sup> ---/--, p.4

Table 1: Monetary aggregate M2 and CPI (annual growth, %)<sup>11</sup>

	<b>CPI</b>	<b>M2</b>
<b>1992</b>	<b>2500</b>	<b>670</b>
<b>1993</b>	<b>840</b>	<b>410</b>
<b>1994</b>	<b>220</b>	<b>200</b>
<b>1995</b>	<b>130</b>	<b>130</b>
<b>1996</b>	<b>21,8</b>	<b>30,8</b>
<b>1997</b>	<b>11,0</b>	<b>29,8</b>
<b>1998</b>	<b>84,4</b>	<b>21,3</b>
<b>1999</b>	<b>36,5</b>	<b>57,5</b>
<b>2000</b>	<b>20,2</b>	<b>61,0</b>
<b>2001</b>	<b>18,6</b>	<b>39,9</b>
<b>2002</b>	<b>15,1</b>	<b>32,4</b>
<b>2003</b>	<b>12,0</b>	<b>50,4</b>
<b>2004</b>	<b>11,7</b>	<b>35,8</b>
<b>2005</b>	<b>10,9</b>	<b>38,5</b>
<b>2006</b>	<b>9,0</b>	<b>48,7</b>
<b>2007</b>	<b>11,9</b>	<b>43,5</b>
<b>2008</b>	<b>13,3</b>	<b>0,8</b>
<b>2009</b>	<b>8,8</b>	<b>17,7</b>
<b>2010</b>	<b>8,8</b>	<b>31,1</b>

In Table 1 a comparison between annual rates of money growth and inflation already suggests that the link is rather medium to long term, a short term link is fairly difficult to establish. Empirical analyses also suggest that there should be a long-run link and that the link is closer for high-inflation regimes as discussed in Papademos and Stark (2010), chapter 1.<sup>12</sup> We therefore assess their co-movement for a very long time sample and by applying filtering techniques in order to capture the trend movements and to eliminate the cyclical fluctuations. For this purpose we compile a historical dataset that although somewhat eclectic (see Annex C for data sources description) in our opinion provides an insight on inflation and money growth

<sup>11</sup> CBR, Annual Reports.

<sup>12</sup> See, for example, Rolnick and Weber (1997) De Grauwe and Polan (2005) or Benati, (2009)

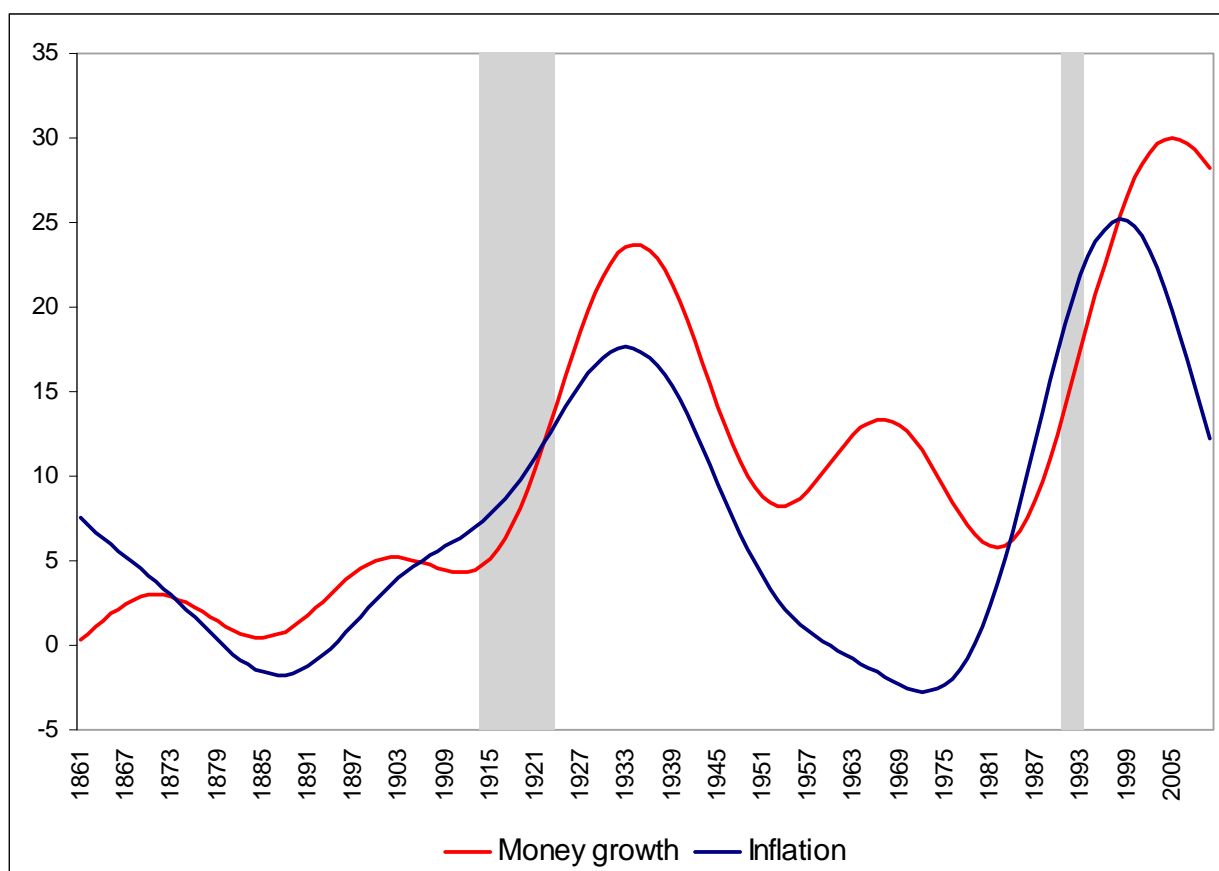
developments in Russia during the time span of 1861-2010. This period however includes two episodes of hyperinflation: the first one associated with the First World War and the Russian Revolution of 1917 and the second one with the dissolution of the Soviet Union. As we do not consider these developments relevant for the objective of analyzing long-run trends in money and inflation, we deliberately remove these outliers from the data by means of the TRAMO-SEATS pre-adjustment procedure making use of a manually set sequence of deterministic variables over the periods of 1914-1923 and 1991-1993 and then apply the asymmetric Christiano-Fitzgerald filter to extract long-run trends from the data. As in Benati (2009) we extracted the components with a frequency of oscillation over 30 years.

In Figure 1 we demonstrate the close co-movement of the two series, at the same time, the charts also suggest, however, that the strength of the correlation may be influenced by the monetary regime and the hyperinflationary regimes which - though filtered – still remain to have a strong influence. During the pre-soviet period the money growth and inflation rates seem to move closely. During the soviet period of regulated prices, however, a substantial gap between money growth and inflation persisted in 1960s and 1970s<sup>13</sup>. The post-soviet period of the Russian economy was characterized by relatively high growth rates of both money and prices.

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<sup>13</sup> Interestingly, some researchers point out that the monetary overhang accumulated by the late 1980s was one of the reasons that triggered hyperinflation spiral once prices were liberalized (see e.g. Kim (1999)).

Figure 1: Long-run components of money growth and inflation, % (data over shaded periods were cleaned of outliers)



### 3. Monetary developments in Russia

#### 3.1 Types of monetary aggregates in Russia and their measurement

Definitions of monetary aggregates spread from narrow, i.e. more liquid aggregates to broader aggregates that also include less liquid components which rather serve the store of value than the transactional purposes of money. Moreover, definitions are influenced by the financial environment and the behavior of money holder, for example, financial institutions apart from credit institutions may also serve monetary purposes and some financial products have become so money-near that they should be included in the definition of money. While this has driven considerations for defining monetary aggregates in the euro area, broader Russian monetary aggregates rather reflect the importance of foreign currency denominated components.<sup>14</sup> M2 (national definition) is the major aggregate for the analysis and policy formulation at the CBR.

<sup>14</sup> Since 2011 the CBR started to publish the data on deposits in national and foreign currency divided by different sectors (financial institution (except credit organizations), public non-financial organizations, other non-financial organizations and households) in the Banking System Survey. This information provides a basis for further enhancing of monetary analysis by using the data on sectoral money holdings. See also “Sectoral structure of money holdings” (CBR, “Quarterly Inflation Review” 2011, Q1, pp. 24-26).

Broad money (M2X), however, include foreign currency denominated components (FC). This aggregate differs substantially in size and development from the aggregates that include only components denominated in national currency (NC). Over the last decades the Russian economy was subject to significant fluctuations of the demand for foreign currency. The flows between ruble and foreign currency denominated assets were particularly drastic during the periods of instability which impacted significantly on monetary aggregates. The recent crisis is one of the most evident illustrations and shows the need to analyze broader aggregates that partly consist of foreign currency denominated assets.

The data on the monetary aggregates M2 in national currency are published by the CBR since 1997. The statistical sources are selected liabilities of the monthly consolidated balance sheets of Russian credit institutions and the Bank of Russia.

Two components are singled out as part of the monetary aggregate M2 (national definition)<sup>15</sup>:

**The monetary aggregate M0 (cash in circulation)** includes banknotes and coins in circulation less currency holdings (cash vaults) of the Bank of Russia and credit institutions.

**Non-cash funds in national currency** comprise the balances of funds kept by non-financial and financial institutions (except credit institutions) and private individuals in settlement, current, deposit and other demand accounts, including plastic card accounts, and time deposits opened with banks in the Russian Federation currency and accrued interest on them. Non-cash funds that are accounted for in similar accounts in credit institutions whose license has been recalled are not included in the composition of the non-cash funds.

The M1 aggregate can also be calculated from the liabilities of the consolidated balance sheet of the banking system. In our study we construct the **M1 aggregate**, which includes cash in circulation outside the banking system and transferable deposits which include current and other demand accounts (including bank card payment accounts) opened by the Russian Federation residents (organizations and individuals) with the Bank of Russia and operating credit institutions in national currency<sup>16</sup>.

Analyzing national currency monetary aggregates may be not sufficient since financial dollarization is an important feature of the Russian economy (see Ponomarenko et al. (2011) for review). The hyperinflation that occurred in the early 1990s and the major depreciation events (most importantly, the currency crisis of 1998) increased the demand for reserve currency. Money holders however may use money for different purposes. Cash in foreign currency (mostly the USD), for example, served routinely for both transactional and store of value functions in the

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<sup>15</sup> CBR Bulletin of Banking Statistics No 5 (216), 2011, pp. 233-234

<sup>16</sup> Data source: CBR, Banking System Survey.

1990s. Following macroeconomic stabilization and the increase of confidence in the banking system the role of foreign cash has declined substantially but bank deposits denominated in foreign currency are still popular as a store of value. The shifts of currency preferences are common reaction to exchange rate fluctuations and increase of economic uncertainty.

The measure of money stock used by the CBR that includes foreign currency denominated deposits is the **broad money (M2X) aggregate**. The statistical data for this indicator was published in the Monetary Survey from 1995 to 2000 and in the Banking System Survey thereafter. Broad money comprises all the components of M2 and foreign currency denominated deposits.<sup>17</sup>

In this study we also construct the monetary aggregate M2Y which includes foreign cash holdings in the non-financial sector. The M2Y aggregate is not published by the CBR and as it includes cash denominated in foreign currency the accuracy of its measurement is limited. In this study we use the indirectly measured foreign cash holdings reported in the International Investment Position of the Russian Federation and Balance of Payments of the Russian Federation<sup>18</sup>. In Table 2 we summarize the components of the different monetary aggregates used in this study.

Table 2 Components of monetary aggregates

<b>Liabilities</b>	<b>M0</b>	<b>M1</b>	<b>M2</b>	<b>M2X</b>	<b>M2Y*</b>
Currency in circulation	X	X	X	X	X
Demand deposits in NC		X	X	X	X
Time and saving deposits in NC			X	X	X
Deposits in FC				X	X
Cash in FC					X

\*-authors' definition

In our study we also use M2X and M2Y which we adjust for valuation effects of foreign currency denominated components (M2X\_ADJ and M2Y\_ADJ). It may be sensible to do that for the purposes of monetary analysis since the fluctuations caused by the changes in the exchange

<sup>17</sup> "Broad money liabilities include three components: currency outside banking system, transferable deposits and other deposits. *Currency outside banking system* includes currency issued by the Bank of Russia into circulation less currency holdings (cash vaults) of the Bank of Russia and credit institutions. *Transferable deposits* include current and other demand accounts (including bank card payment accounts) opened by the Russian Federation residents (organizations and individuals) with the Bank of Russia and operating credit institutions in national currency. *Other deposits* include the Russian Federation residents (organizations and individuals) time deposits and other funds in national currency attracted by the Bank of Russia and operating credit institutions, and also all types of deposits in foreign currency, precious metals and interest accrued."

CBR Bulletin of Banking Statistics, No 5 (216), 2011, p. 233.

<sup>18</sup> We use the item "Cash foreign currency/Other sectors" from the International Investment Position of the Russian Federation and the Balance of Payments of the Russian Federation.



rate are not linked to any real transactions and could therefore be misleading.<sup>19</sup> On the other hand the wealth effect caused by these re-evaluations could still have some macroeconomic impact. We therefore analyze both types of aggregates. These were estimated as follows:

First the growth rates were adjusted:

$$\Delta_{adj} = w * \Delta r + (1-w) * \Delta f / e ,$$

where  $w$  is the share of ruble denominated components at the end of previous period,  $\Delta r$  – growth rate of ruble denominated components,  $\Delta f$  – growth of foreign currency denominated components and  $e$  – ruble's depreciation against the bi-currency basket. The base index is then constructed using adjusted growth rates.

### **3.2 Evolution of different monetary aggregates and counterparts**

Figures 2 and 3 show the evolution of different monetary aggregates in Russia since 1998. In Russia distinguishing between monetary aggregates that include and exclude money denominated in foreign currency is particularly useful. As previously discussed attributing the store of value function mainly to deposits in foreign currency and the transactional function to foreign cash would simplify the microeconomic behavior of different money holders.

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<sup>19</sup> Russian monetary statistics so far cannot disentangle changes from transactions as it is the case for monetary data in the Eurosystem.

Figure 2. Monetary aggregates (y-o-y growth,%)

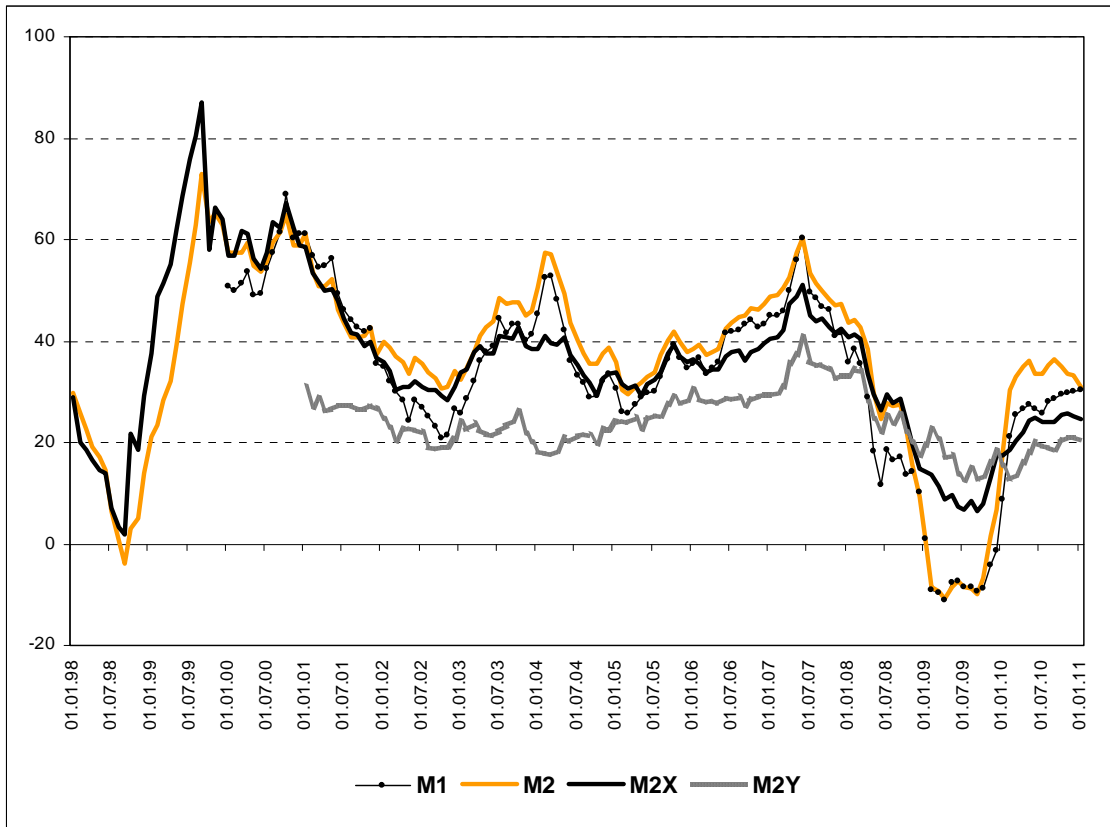


Figure 3. Headline and adjusted monetary aggregates (y-o-y growth, %)

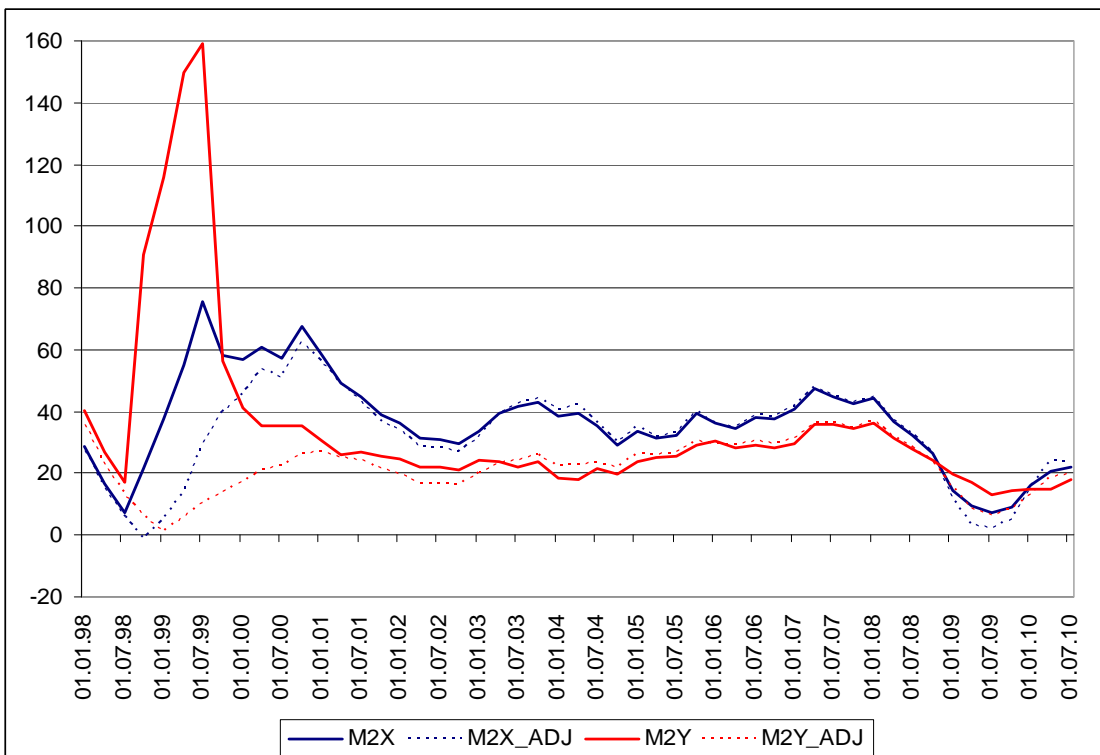
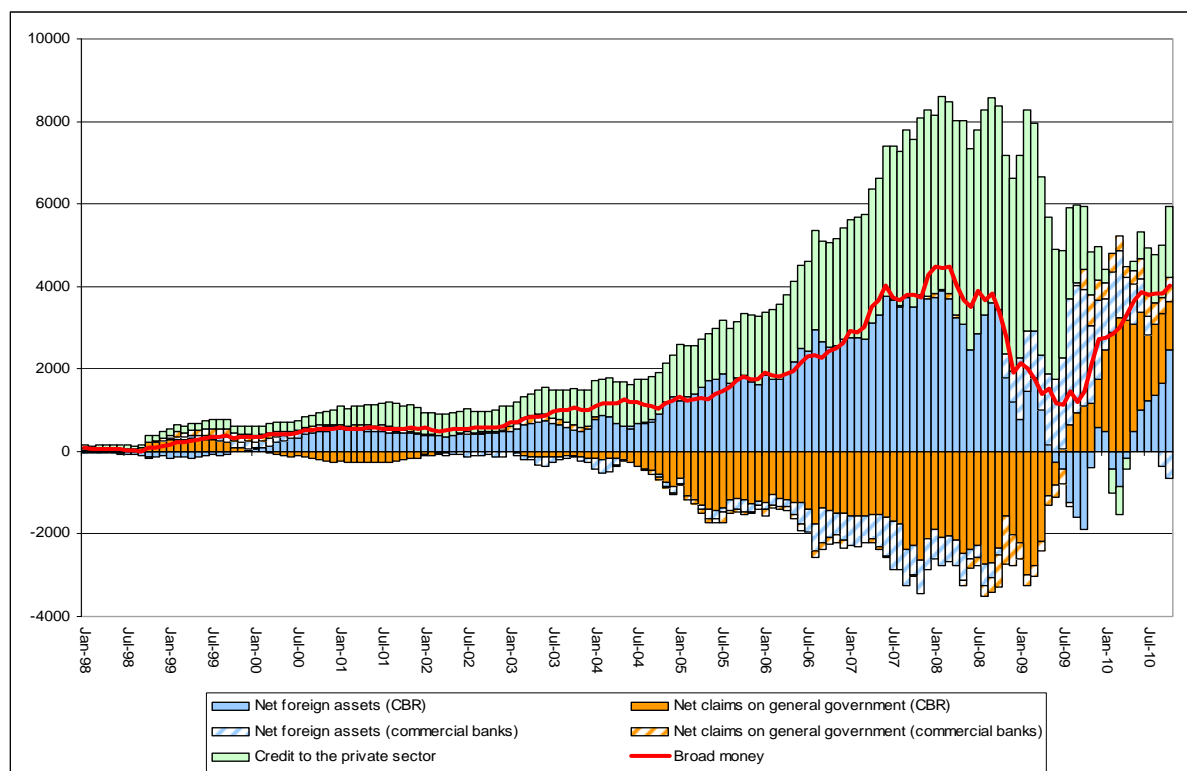


Figure 4. Money and its counterparts (annual changes, bln. rubles)



Looking at the evolution of the counterparts of Russian broad money (M2X) in Figure 4 reveals domestic and external driving forces of monetary developments. The most important counterparts of money growth have been the CBR's foreign assets, the CBR's net claims on the government and banks' credit to the non-financial sector. Changes of the CBR's net foreign assets are generally the key driving force of changes in M2X. Changes of net claims to the general government (CBR) reflect the workings of the sovereign wealth fund, since international inflows of foreign currency are partly deposited in a sovereign wealth fund held on the CBR's balance sheet. The presence of significant exogenous growth sources means that the link between money and credit growth may not be very close – we will discuss the drivers behind different episodes of money growth later in this chapter. It also means that nominal money stock may be driven by factors totally unrelated to money demand fundamentals. This does not mean however that the money demand relationship is non-existent (as money growth may trigger the adjustment of other macroeconomic variables towards new equilibrium) or that it is of no practical use. The composition of drivers behind money stock growth indicates that the Russian economy is evidently prone to exogenous money supply shocks (as opposed to endogenously driven money demand shocks). Identifying these shocks and their macroeconomic consequences is a crucial task for monetary analysis. Using money demand models to assess the degree of correspondence between realized money growth and macroeconomic fundamentals could be regarded as one of the methods of such identification.

In the early 1990s the transformation from the planned economy in Russia was followed by galloping inflation, a deep recession, a depreciation of the national currency and large permanent government budget deficits. Money growth rates were extremely high. The new Russian banking sector<sup>20</sup> at that time was just emerging and could not provide efficient financial intermediation. In these circumstances the CBR's credit to the government, to commercial banks as well as to selected non-financial enterprises was practically the only source to satisfy money demand. The direct monetization of the government budget deficit played an important role in money growth.

As the direct CBR's credit provision to the government was discontinued in 1995 the growth rates of monetary aggregates in 1996-1997 as well as inflation rates were much lower as compared to earlier 1990s. Due to initially successful exchange rate stabilization<sup>21</sup> the ruble aggregates grew faster than broader aggregates.

In 1998 prior and during the crisis broad money (M2X) growth rates slowed down even further to almost 2% annually, while M2 growth was negative. The ruble's depreciation during the crisis however triggered the return of dollarization.

The following two years after the Russian crisis of 1998 were characterized by rapid broad money (M2X) growth rates (50-60% annual) that were in line with fast economic recovery and high inflation rates. The government budget deficit was monetized immediately after the crisis, but since 2000 the budget turned into surplus.

In 2001-2002 money growth rates slowed down in line with the deceleration of GDP and inflation, yet the annual growth rate of monetary aggregates was never below 28-30%. During this period the changes of CBR's foreign assets began to play the major role as a source of money growth, as the CBR started to manage the exchange rate in conditions of rising commodities prices. The growth of credit to the real sector by commercial banks also picked up during this period.

These processes intensified in the following years and M2 growth reached annual 55% (M2X growth amounted to annual 40%) in the beginning of 2004. The ruble's appreciation discouraged dollarization and increased the demand for ruble denominated money. The slow down of M2 growth in the second half of 2004 was mainly associated with the so-called "banks

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<sup>20</sup> The soviet banking system had to undergo a drastic transformation before coming to its present state. Until the end of 1980s the banking system consisted of the Gosbank (the State Bank) of the Soviet Union which main objectives were monetary emission, loans provision to enterprises, settlement services among other functions. Although there was a small number of other state banks that specialized in working with particular industries the largest part of centrally planned loans were provided via the Gosbank. The only bank that could accept deposits from households was the State Saving Bank, but this bank could not provide loans. In the late 1980s the first commercial banks were created and in 1990s the two level banking system consisting of the Central Bank of the Russian federation and commercial banks was officially established. Yet, until the mid-1990s the CBR continued to provide loans to the government and non-financial enterprises.

<sup>21</sup> In 1995 the CBR started to manage the exchange rate within a floating band.

credibility crisis” which caused the outflow from bank deposits into alternative assets (mainly into foreign cash, which is reflected in the broadest M2Y aggregate which remained largely unaffected).

Another important occurrence in 2004 was the creation of the sovereign wealth fund (the so-called Stabilization Fund which was reorganized into Reserve Fund and National Welfare Fund in 2008) within the Russian public finance framework. This institution proved to be very important for monetary developments and has affected the dynamics of money stock ever since. The main source of the sovereign wealth fund’s formation is taxes on oil and gas extraction and custom duties on oil exports. These funds are placed onto special accounts of the Federal treasury in the CBR and are managed by the CBR. From 2005 till late 2008 the budget was in large surplus mainly due to high oil and gas prices, which determined the accumulation of reserves on the sovereign wealth fund’s accounts effectively containing money growth<sup>22</sup>. Changes in net foreign assets held at the CBR and net claims on the general government held at the CBR are the driving counterparts of M2X since 1998. They reflect the functions of the sovereign wealth fund in an oil rich economy. Its stabilizing effects, for example, are reflected in increasing positive contributions of CBR’s net claims on general government after the crisis in 2008 that largely determined the recommencement of M2X growth. This reflects the buffering function of the sovereign wealth funds.

The period preceding the financial crisis was characterized by particularly intense monetary expansion. By the beginning of 2007 M2 grew with an annual rate of 60%, M2X with 50% and M2Y with 40%. The credit growth also accelerated to 50-55% annually. Apart from credit growth, the growth of the CBR’s foreign reserves had been another driver of money stock growth. The latter was caused not only by the financial inflows originating from the current account but also those that originated from the capital account as both Russian banks and nonfinancial corporations were borrowing abroad. The dynamics of money demand fundamentals were strong (GDP grew by annual 7.5% on average in 2005-2007 and the ruble’s appreciation encouraged de-dollarization), although it is not clear if these high money growth rates were fully justified. The growth of asset prices also increased sharply during this period.

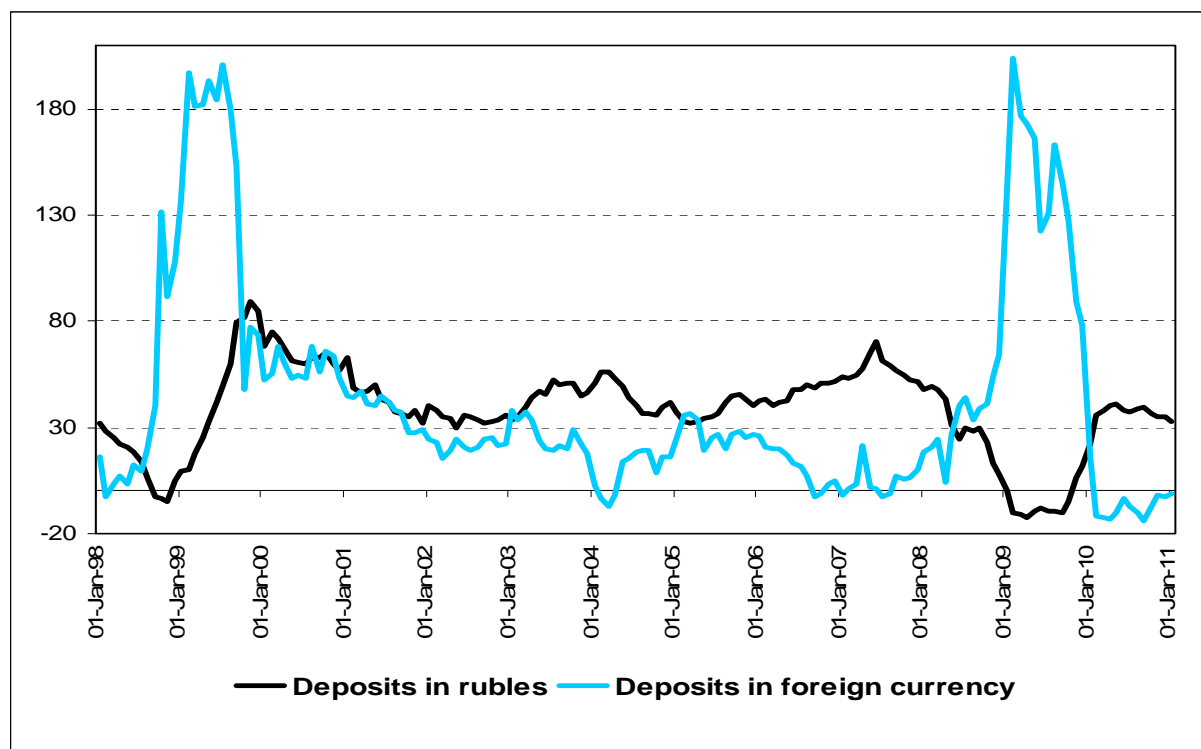
As the financial crisis manifested itself in the Russian economy in autumn 2008 the dynamics of monetary aggregates changed abruptly and slowed down rapidly. The ruble aggregates were the ones to display largest contraction as the demand for foreign currency

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<sup>22</sup> Although the CBR also used liquidity absorbing tools (such as bond issuance) the absorption through fiscal mechanisms had clearly the most important impact on the monetary stance.

increased in the conditions of ruble's depreciation expectations<sup>23</sup>. The decline of broader monetary aggregates was not as dramatic but M2X and M2Y growth slowed down nonetheless.

Figure 5: Deposits in rubles and foreign currency (annual growth, %)



Commodity prices decreased and the turmoil on the international financial markets contributed to an abrupt stop of capital inflows into the Russian economy. Furthermore, the ruble's depreciation and ensuing demand for foreign assets contributed to capital flows reversal. The CBR's attempts to contain the depreciation required a significant decrease of foreign reserves impacting significantly on the ruble's monetary aggregates. The loss of access to foreign borrowing, the contraction of deposits, interest rates increases as well as the decline of the demand for loans during the severe recession caused decreasing growth rates of loans. Loans growth turned negative in early 2010 and contributed to the contraction of money.

On the other hand the fiscal stimulus package and the ensuing budget deficit were financed mostly from the sovereign wealth funds. The growth of net claims on the government was therefore an important source of money growth. After the gradual depreciation of the ruble was completed in early 2009 the ruble was again on an appreciating trend, supported by the recovery of commodities prices. Although the CBR's exchange rate policy was more flexible by now (its main objective being the smoothing of exchange rate fluctuations not containing the trend developments determined by fundamentals) the ensuing foreign exchange purchases played a certain role in the recommencement of money growth. As a result money growth was relatively

<sup>23</sup> The deposits denominated in foreign currency doubled in 2008 and banks' net sales of foreign cash to the households amounted to 47 bln. USD, which was the highest number since 2000.

high throughout 2010. Ruble aggregates grew particularly fast supported by the de-dollarization processes after the ruble's exchange rate started to appreciate once again.

#### 4. Money demand models

An important aspect of empirical properties of monetary aggregates is the existence of a stable money demand function. The money demand function is a fundamental relationship that captures the interactions between money and other important economic variables such as income and wealth. The role of opportunity costs is influenced *inter alia* by the depth and breadth of financial markets and the degree of substitution between domestic and foreign currencies. Thus the robust relationship between monetary aggregates and other macroeconomic variables can help to explain and interpret monetary developments. From a normative perspective, money demand models are a starting point for developing benchmarks of the level or growth of money. In this study we are able to analyze money demand for different monetary aggregates as described in section 3.

Previous studies on money demand functions in Russia (e.g. Oomes and Ohnsorge (2005); Korhonen and Mehrotra (2010); Mehrotra and Ponomarenko (2010)) report stable money demand relationships over the pre-crisis period. In our study we will examine if there is still a robust relationship when 2009-2010 observations are added to the sample and we will check that for different monetary aggregates. Interestingly, Oomes and Ohnsorge (2005) also conducted their estimates for several monetary aggregates and found, based on the confidence intervals width and the recursive estimates of cointegrating vectors' coefficients that the M2Y money demand function was the most stable while narrower ruble aggregates did not produce stable relationships. We compare these findings with more recent results.

#### Model specification and data issues

Our specification of the long-run real money demand in the log linear form is:

$$(m-p) = \beta_0 + \beta_1 y + \beta_2 w + \beta_3 OC + \beta_4 unc, \quad (1)$$

where  $m-p$ ,  $y$  and  $OC$  are the monetary aggregate deflated by the price level, the scale variable and the vector of opportunity costs accordingly. Modern money demand studies (e.g. Greiber and Setzer (2007); Beyer (2009)) also control for wealth effect (which as discussed in Mehrotra and Ponomarenko (2010) may be important for Russia) by adding a real wealth variable into the money demand function. Another addition to the traditional specification could

be an uncertainty variable as in e.g. Greiber and Lemke (2005), which could also be relevant for emerging economies (see Özdemir and Saygili (2010)) particularly when attempting to model crisis developments. Recent studies by de Bondt (2009) and Seitz and Von Landesberger (2010) include both wealth and uncertainty indicators into the money demand function. Therefore we add real wealth ( $w$ ) and uncertainty ( $unc$ ) variables into our model. We estimate four different models with real M1, M2, M2Y and M2Y<sup>adj</sup> as money stock variables. We do not report the results for real M2X and M2X<sup>adj</sup> as we fail to find any meaningful money demand relationship for these aggregates. This result is somewhat puzzling. One possible explanation is that the developments of the M2X aggregate are affected by changes of preferences between foreign cash holdings and foreign currency denominated bank deposits. These changes may be difficult to model formally (at least when based only on money demand fundamentals).

We follow Mehrotra and Ponomarenko (2010) and use real asset price index as a proxy for real wealth. The index is the weighted<sup>24</sup> average of housing and equity prices indices. Housing wealth may be viewed as constituting a significant part of households' wealth. The 2002 national census found only about 3% of households rent a house or an apartment and that about 20% of households owned a secondary dwelling (mainly for seasonal use). Equities are not a significant component of household financial wealth, but their price can be viewed as a proxy for corporate wealth. As discussed in Mehrotra and Ponomarenko (2010) the rapid growth of asset prices in Russia in 2005-2007 could have positively affected transactions demand for money as transactions in asset markets increased. The increase in wealth due to the growth of asset prices may also be associated with increased demand for other liquid assets (including money) that are part of the wealth portfolio.

We have tested various indicators of uncertainty (e.g. unemployment rate, oil price volatility, government budget balance). Based on the models performance and following Greiber and Lemke (2005) who propose stock market volatility as one possible indicator of uncertainty we selected the variance of RTS index returns over rolling periods of 180 days as the metric for uncertainty. Interestingly the interplay between this variable and various monetary aggregates may be different. Increasing uncertainty is generally associated with growing precautionary demand for money, but in case of Russia may also result in additional demand for foreign currency denominated assets at the expense of ruble money stock. Therefore the positive effect on the demand for money may be more pronounced in case of broad monetary aggregates.

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<sup>24</sup> Similarly to Gerdesmeier et al. (2009) the weights are inversely proportional to the variables' volatility, i.e.  $\Delta \text{Asset prices} = \sigma_{sp}/(\sigma_{sp} + \sigma_{hp}) \Delta \text{Housing prices} + \sigma_{hp}/(\sigma_{sp} + \sigma_{hp}) \Delta \text{Equity prices}$ , where  $\sigma$  is the standard deviation of the respective variable. The resulting weights equaled 0.86 for housing and 0.14 for equity prices and seem economically meaningful and consistent with weights used in Mehrotra and Ponomarenko (2010).



The choice of the opportunity cost indicator is quite complicated in the case of Russia. The relative underdevelopment of the financial market precludes the use of money market interest rates for this purpose. On the other hand the exchange rate fluctuations were identified as important money demand determinants in Russia by all previous studies as well as in other emerging market economies (see e.g. Dreger et al. (2006)). Interestingly national currency depreciation can be considered as opportunity cost only for holding ruble aggregates since interflows between ruble and foreign currency nominated deposits would not affect broad money measures. In fact national currency depreciation would increase the implied ruble yield of foreign currency denominated components of broad aggregates. Another opportunity cost indicator that may be considered (as in e.g. Korhonen and Mehrotra (2010)) is the inflation rate. This leaves us with a range of variables that could be potentially used to proxy for opportunity costs/own yield. Including all these simultaneously into the estimated relationship is hardly plausible due to time series' length limitations. Instead we choose more parsimonious approach and construct aggregate opportunity costs/own yield measures.

The own yield of ruble components is measured by the interest rate on households' long-term ruble time deposits. The own yield of foreign currency components is the weighted average of interest rates on euro and USD deposits (with time-varying weights equal to those in the CBR's bi-currency basket<sup>25</sup>) plus ruble's depreciation against the bi-currency basket over the two last quarters, which presumably proxies the exchange rate expectations. The aggregate yield of return is the weighted average (with weights proportional to the shares of ruble and foreign currency deposits in the total amount of deposits) of ruble and foreign currency components' yields. All opportunity costs variables are in quarterly terms.

For money demand functions with M1 we use the aggregate yield of return as the *OC* variable and expect the  $\beta_3$  coefficient to be negative, since M1 does not include appreciably remunerated components. For money demand functions with M2 we use the exchange rate depreciation against the bi-currency basket over the two last quarters as a proxy of the spread between ruble and foreign currency components' yields and also expect the  $\beta_3$  coefficient to be negative<sup>26</sup>. For money demand functions with M2Y we use the spread between the aggregate

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<sup>25</sup> While the structure of foreign currency deposits in Russia is unavailable, other subsidiary indicators justify the use of bi-currency basket's weights for this purpose. The bi-currency basket is the operational target of the CBR and consists of the combination of USD and euro with time-varying weights.

<sup>26</sup> While the most obvious choice for M2 model would be to use the spread between ruble and foreign currency components' yields this approach did not produce meaningful results (the  $\beta_3$  coefficient had the "wrong" sign). The reason for that could be behind extremely high ruble interest rates in 1999-2000 (that determined the highly positive values of the spread). Taking into account the state of financial markets and the lack of confidence in the domestic banking system at that time, these interest rates might be not fully representative as an attractive alternative to foreign currency assets. We therefore decided to disregard these interest rates. In other periods the spread was mostly determined by the exchange rate fluctuations, as the interest rates remained stable, so there were no big differences between the two indicators.

yield of return and the realized two quarters CPI inflation rate and expect the  $\beta_3$  coefficient to be positive. The overall dynamics of the resulting aggregate indicators over tranquil periods are mostly determined by changes of interest and inflation rates, but largest variations are due to exchange rate fluctuations (most notably in 1999 and 2008-2009).

We use GDP as a scale variable and the GDP deflator to calculate money and wealth variables in real terms. All variables except *OCs* and *unc* are in logs. The time sample under review is 1999Q1-2010Q2 which gives us 46 quarterly observations. The order of integration of the variables is determined based on the results of Phillips-Perron, KPSS and ADF-type test which controls for possible structural break over the crisis period (Lanne et al. (2002)) unit root tests (Table A1 in Annex A). Despite some indication from the Phillips-Perron test that *M2Y*, *M2Y<sup>adj</sup>* and *y* could be trend stationary we assume that with possible exception of *OCs* and *unc* all variables are I(1) and we therefore proceed with the cointegration analysis. This decision was supported by the test for the stationarity of the variables within cointegrated VAR conducted at later stages (Table A2 in Annex A).

### Cointegration analysis

As a starting point of our analysis we refer to the most commonly applied method in testing for cointegration proposed by Johansen (1996). The procedure efficiently includes the short-run dynamics in the estimation of the long-run model structure in the system of equations framework. We use the conventional VEC model of the form:

$$\Delta x_t = \Pi x_{t-1} + \Gamma_1 \Delta x_{t-1} + \dots + \Gamma_p \Delta x_{t-p} + CD_t + \varepsilon_t, \quad (2)$$

where  $x_t$  is a ( $K \times 1$ ) vector of endogenous variables and the  $\Gamma_p$  are fixed ( $K \times K$ ) coefficient matrices. We further assume that  $\varepsilon_t$  follows a white noise process with  $E(\varepsilon_t) = 0$ . When some or all of the  $K$  endogenous variables are cointegrated, the matrix  $\Pi$  has reduced rank  $r$ .  $D_t$  contains the deterministic terms outside the cointegrating vector, and  $C$  is the coefficient matrix associated with the deterministic terms. In our set-up the model includes unrestricted constant and seasonal dummy variables. The lag length was set to 4<sup>27</sup>.

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<sup>27</sup> Most of the traditional information criteria would indicate that a longer lag length is preferable. But for the reasons of parsimony given the short time sample and given the quarterly data used we limit the lag length to four. Later we examine to what extent the lag length choice influences the cointegrating vectors.

Table 3. Cointegration test results: Barlett corrected trace statistic (p-value)

Model	Rank			
	0	1	2	3
M1	88.45 (0.00)	48.44 (0.04)	22.69 (0.26)	9.94 (0.29)
M2	70.81 (0.04)	43.67 (0.12)	24.67 (0.17)	6.23 (0.67)
M2Y	89.93 (0.00)	40.52 (0.20)	31.28 (0.03)	13.96 (0.08)
M2Y <sup>adj</sup>	85.47 (0.00)	40.62 (0.20)	26.33 (0.12)	13.50 (0.10)

The tests as shown in Table 3 confirm the possibility of cointegration in all models since the rank of zero is rejected. Although there is some indication that the matrix  $\Pi$  may have rank 2 in the M1 model for the sake of economic interpretability we proceed by assuming 1 cointegrating relationship in all the models. The recursively estimated eigenvalues and Hansen and Johansen (1999) fluctuations tests confirm the stability of cointegrating relationships<sup>28</sup> (Figures A2-A3 in Annex A). Admittedly there is considerable uncertainty regarding this specification choice that could potentially bias the model's performance as well as the results of characteristics tests. An alternative way to proceed (assuming a cointegration rank of 2) would be to identify the second cointegrating vector (such as long-run wealth growth relationship in Beyer (2009)) in addition to the money demand relationship and examine its relevance in the comprehensive system of the simultaneous equations framework. This kind of analysis however was not undertaken in this study.

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<sup>28</sup> At this stage we concentrate on the analysis of long-run relationship and therefore excluded the short-run part from the stability tests. The performance of short-run money demand models are discussed elsewhere in this paper.

Table 4. Tests for weak exogeneity of variables: F-statistic (p-value)

<i>Variable</i>	<i>Model</i>			
	M1	M2	M2Y	M2Y <sup>adj</sup>
M	11.50 (0.00)	4.09 (0.04)	0.15 (0.70)	0.05 (0.82)
Y	30.15 (0.00)	1.85 (0.17)	5.12 (0.02)	6.37 (0.01)
W	0.10 (0.76)	15.04 (0.00)	8.16 (0.00)	9.72 (0.00)
OC	0.09 (0.77)	0.73 (0.39)	63.15 (0.00)	53.43 (0.00)
UNC	0.40 (0.53)	3.16 (0.08)	0.06 (0.81)	0.37 (0.54)

Null hypothesis: variable is weakly exogenous

Although the analysis of the dynamic relationship between money and other macroeconomic variables is beyond the scope this paper we may also examine the weak exogeneity tests based on the reviewed VEC model and show the test results in Table 4. There are notable differences in the results for different models: while the weak exogeneity of narrower ruble aggregates is rejected, the developments in the broader aggregates seem to be unaffected by the adjustment resulting from the cointegration relationship. This result may contradict to the conventional theory associated with the money multiplier concept that would presume narrow aggregates to be exogenous and broader ones to be endogenous. Yet these findings may be in line with the peculiarities of money supply factors in Russia. We will further discuss the performance of the models in explaining money stock developments later in this paper.

Instead of affecting money the adjustment occurs through other variables such as GDP or real wealth. The results for OC variables are mixed – they seem to be weakly exogenous in the M1 and M2 models and endogenous in M2Y and M2Y<sup>adj</sup> models.

The cointegration vectors are estimated by the simple two-step estimator (S2S). As Brüggemann and Lütkepohl (2005) show, this estimator produces relatively robust estimates in short samples. The lag length is set to 4. Most of the cointegrating vectors estimated using different lag lengths were relatively robust (Tables A3-A6 in Annex A)

We cross-check the results obtained with S2S method by estimating the cointegration vectors using Fully Modified-OLS (Philips and Hansen (1990)) in a parsimonious single equation set-up. We use pre-whitening with the lag length determined by Schwarz criteria and Barlett kernel with the cut-off determined by the automatic Andrews (1991) procedure.

The cointegration vectors are estimated in the presence of unrestricted constant and seasonal dummy variables. The results are shown in Table 5.

Table 5. Cointegration vectors (t-statistics)

Variable	Estimation method	Model			
		M1	M2	M2Y	M2Y <sup>adj</sup>
M	S2S	1	1	1	1
	FM-OLS	1	1	1	1
Y	S2S	-1.65 (-37.3)	-2.38 (-20.2)	-0.38 (-4.09)	-0.63 (-12.3)
	FM-OLS	-1.76 (-12.6)	-2.6 (-13.1)	-0.61 (-1.68)	-1.05 (-4.85)
W	S2S	-0.47 (-13.8)	-0.34 (-3.49)	-0.88 (-11.2)	-0.67 (-15.5)
	FM-OLS	-0.48 (-4.45)	-0.29 (-1.68)	-0.54 (-1.81)	-0.23 (-1.31)
OC	S2S	2.07 (13.1)	3.73 (9.15)	-3.47 (-5.34)	-1.62 (-4.89)
	FM-OLS	0.93 (3.17)	0.84 (1.25)	2.18 (2.13)	-0.4 (-0.72)
UNC	S2S	-118 (-8.25)	-45.1 (-1.81)	-67.4 (-2.13)	-128.5 (-7.61)
	FM-OLS	-8.4 (0.48)	-44.7 (-1.21)	-152 (-3.16)	-109.8 (-3.86)

The parameters estimated with S2S method are statistically highly significant and economically meaningful. The growth of GDP and real wealth increases money demand. Interestingly, there are striking differences in income elasticities between the models. The M1 and M2 models retain the feature of high income elasticity, which was also reported in all the previous money demand studies for Russia. This peculiarity is usually associated with ongoing institutional changes such as financial deepening and the return of confidence in the national currency. In the cases of M2Y and M2Y<sup>adj</sup> however the income elasticities are lower, while the parameters for wealth are somewhat higher. The sum of the income and wealth parameters is only slightly higher than unity<sup>29</sup>. In fact these results are consistent with the parameters reported in Greiber and Setzer (2007) for the euro area and the US and in Seitz and Von Landesberger (2010) for the euro area. These results seem to be thought provoking as they show how differently monetary developments in Russia could be interpreted when different money stock measures are used. The opportunity costs variables all have the expected signs. The increase of uncertainty has a positive effect on money demand. As could be expected it seems to be less evident in case of ruble aggregates.

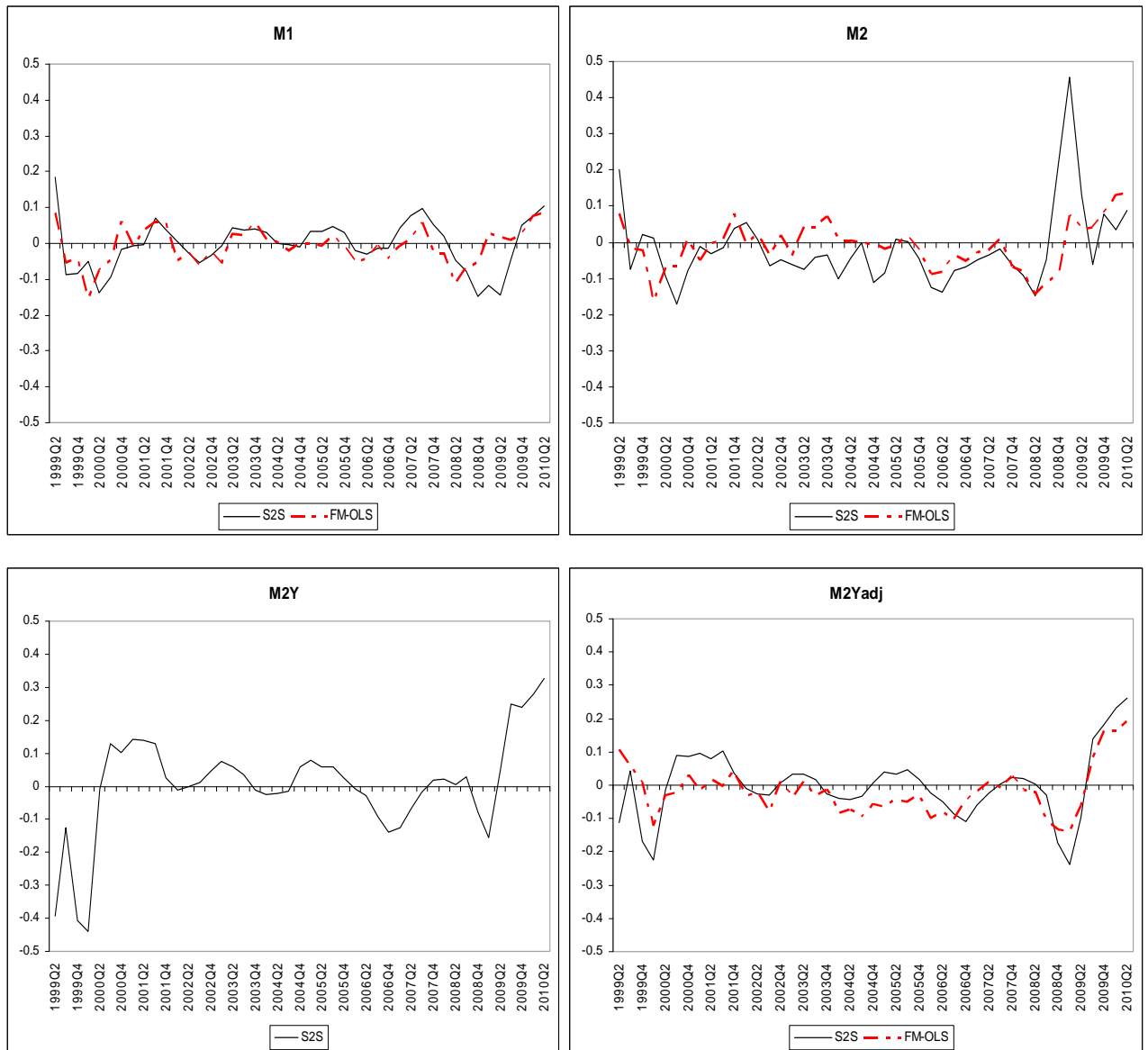
These findings are generally confirmed by FM-OLS estimates for M1, M2 and M2Y<sup>adj</sup> models, although the uncertainty variable in the M1 model and OC variables in M2 and M2Y<sup>adj</sup>

<sup>29</sup> The sum of coefficients equals 1.26 and 1.3. Interestingly, Oomes and Ohnsorge (2005) report the income elasticity of 1.2 for M2Y money demand function without wealth.

models are statistically insignificant. Nevertheless we proceed with further analysis of this cointegration vectors as they are economically meaningful. We exclude the FM-OLS cointegration vector for the M2Y model that displays the “wrong-signed” OC variable coefficient.

In order to test the robustness of the results we estimate the cointegration vectors recursively to check if the point estimates remain stable as the post-crisis observations are added into the sample (Figures A7-A10 in Annex A). The recursive estimates of income and wealth elasticities are relatively stable in all models irrespectively of the estimation method (with the exception of income elasticity in S2S M2Y model which was insignificant if estimated using only pre-crisis sample). The OC and uncertainty recursive coefficients displayed considerable fluctuations but still seemed meaningful in the models for ruble M1 and M2 aggregates. The recursive estimates of OC variable coefficient in M2Y and M2Y<sup>adj</sup> models reveal, however, that the OC variables only started to enter the cointegration relationship with the “right” sign after the large number of post-crisis observations had been added to the estimation sample. This result may indicate that the relationship between broader monetary aggregates and OCs is more complex than implied by this money demand relationship or that the financial returns indicators do not fully represent the OCs in the Russian economy. On the other hand given the limited variation of OCs before the crisis and relatively short time sample we can not rule out the possibility that adding the observations characterizing the opposite phase of the economic cycle was just necessary to disentangle the true effect of OCs on money demand.

Figure 6. Monetary overhangs<sup>30</sup>



We may examine monetary overhangs derived from the cointegrating relationships as the measures of excess liquidity and as shown in Figure 6. The choice of cointegration vector's estimation method does not seriously change the outcome here. With the exception of fluctuations in the beginning of the sample and the hikes of S2S M2 overhang in early 1999 and 2009 (determined by the sharp exchange rate depreciation episodes) the overhangs' dynamics seem meaningful. They fluctuate evenly around zero, pick up in 2006 before plummeting to some very low levels in 2008-2009. Then, as money growth picked up while money demand fundamentals' (particularly real asset prices) remained weak the monetary overhangs climbed to unprecedented high levels, in particular for M2Y and adjusted M2Y.

<sup>30</sup> The monetary overhangs were computed (using seasonally adjusted data) as demeaned error correction terms from the estimated cointegration relationships.

## Error correction models

The short-run money demand models are formulated as conventional ECMs of the form:

$$\Delta(m-p)_t = \alpha_0 + \alpha_1 ec_{t-1} + \sum_{j=1}^2 \alpha_{2j} \Delta(m-p)_{t-j} + \sum_{j=1}^2 \alpha_{3j} \Delta y_{t-j} + \sum_{j=1}^2 \alpha_{4j} \Delta w_{t-j} + \sum_{j=1}^2 \alpha_{5j} \Delta OC_{t-j} + \sum_{j=1}^2 \alpha_{6j} \Delta unc_{t-j} + \sum_{i=1}^3 \sigma_i D_{it} + \varepsilon_t \quad (3)$$

where  $ec$  is the error correction term and  $D_i$  are the seasonal dummy variables. The equations include two lags of real money growth. The short-run part of the equations also contains up to two lags of first differences of other explanatory variables (these are eliminated if the respective t-statistics are smaller than 1.67). Conventional tests do not find serial correlation or ARCH effect in the equations' residuals. The  $\alpha_1$  coefficients as given in Table 6 are of most interesting as they show that real money growth adjusts in accordance with the cointegrating relationship.

Table 6. ECMs'  $\alpha_1$  loading coefficients (t-statistics)

Estimation period	Cointegration vector	Model			
		M1	M2	M2Y	M2Y <sup>adj</sup>
1999Q1-2008Q2	S2S	-0.39 (-3.84)	-0.05 (-0.88)	0.05 (1.59)	-0.03 (-0.44)
	FM-OLS	-0.47 (-3.61)	-0.23 (-2.11)	-	-0.4 (-4.00)
1999Q1-2010Q2	S2S	-0.24 (-2.82)	0.01 (0.11)	0.07 (2.25)	-0.02 (-0.56)
	FM-OLS	-0.28 (-2.37)	-0.03 (-0.35)	-	-0.24 (-3.17)
1999Q1-2010Q2 (with dummy variables)	S2S	-0.31 (-3.70)	-0.05 (-0.98)	0.06 (1.93)	-0.01 (-0.16)
	FM-OLS	-0.41 (-3.44)	-0.19 (-2.19)	-	-0.2 (-2.65)

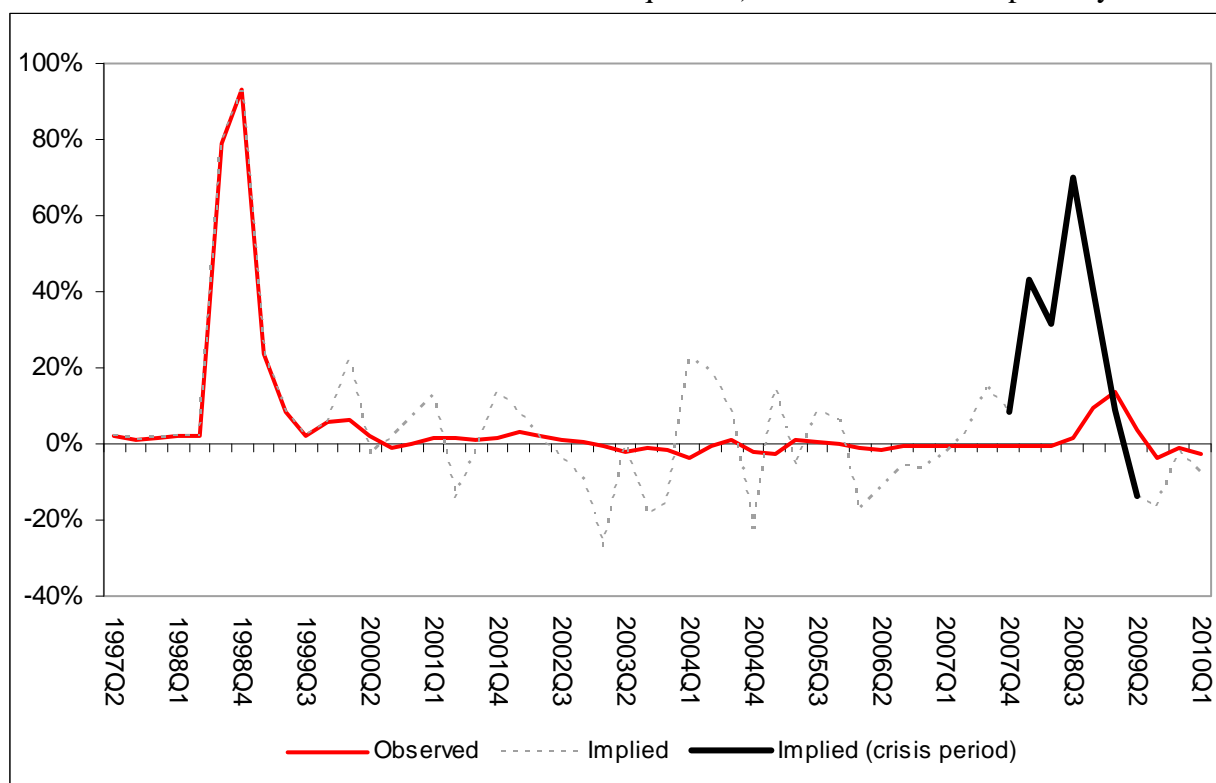
At first we estimate the ECMs on the pre-crisis period prior to 2008Q3. The loading coefficient in the M1 and M2 models is large and statistically highly significant (although the FM-OLS cointegrating vector is clearly more relevant for short-run M2 developments than S2S estimates). Quandt-Andrews breakpoint tests indicate that the models are stable over this sample. When the post-crisis observations are added to the time sample the loading coefficients deteriorate notably (although in case of M1 it is still significant). The recursive estimates of loading coefficients show that their instability coincided with crisis developments (Figure A11 in Annex A). We therefore also examine the ECMs' estimates with the period of 2008Q3-2009Q1



covered with dummy variables. Under this set-up the estimates of the loading coefficient do not change significantly in comparison with the pre-crisis sample estimates.

This result could be expected given the drastic and unpredictable fluctuations of money stock during the most severe phase of the crisis. The rapid return of dollarization, for example, could not be captured by the exchange rate variable since ruble's depreciation expectations were much stronger than implied by the gradual CBR controlled depreciation rates. If we assume that the model's error during the crisis was due to the error in measuring exchange rate expectations we may illustrate this by solving the model for  $M2^{31}$  back and finding the exchange rate variable value that implied no error in the model's estimate of money stock. Over most of the sample this estimate would have no economical meaning. Yet, during the depreciation episode this estimated exchange rate variable's value could be used to assess these unobserved expectations.

Figure 7. Exchange rate expectations: observed proxy (the average quarterly ruble's depreciation over the last two quarters) and the estimate implied by the model



The results of this exercise as shown in Figure 7 indicate that the expected ruble's depreciation which would be consistent with the intensity of dollarization was higher than the actually realized one. In fact the market participants seemed to expect the depreciation similar to the one that took place during the previous crisis of 1998.

<sup>31</sup> We used the FM-OLS model for M2 estimated over the 1999Q1 – 2008Q2 time sample.

The results of ECMs' estimation for broader aggregates are more ambiguous. In contrast to ruble aggregates the broader M2Y and M2Y<sup>adj</sup> seem to be unaffected by the cointegrating relationship (at least by those estimated with the S2S method). The  $\alpha_1$  estimates are statistically insignificant under any set-up and in case of M2Y the loading coefficient is positive which is clearly implausible. We believe that this difference arises from the fact that the nominal volumes of ruble aggregates are quite sensitive to changes of transactional needs and opportunity costs fluctuations (as households are eager to switch between currencies or between cash and bank deposits). There are however fewer means for nominal volumes of broad aggregates to adjust as their dynamics is only partially determined by demand driven processes (i.e. financial intermediation) and there are virtually no assets outside M2Y aggregate that are widely used for savings purposes. There still is the chance that the real money stock would adjust due to the increase of the price level, but given the relatively short period under review and the scope of nominal money supply shocks that took place during this period it is unsurprising that such adjustment could go unnoticed by the econometric model. Yet, we can not rule out the possibility that broad aggregates may be driven by money demand completely as the ECM based on FM-OLS cointegration vector estimate for M2Y<sup>adj</sup> performs satisfactorily and is not drastically affected by the crisis.

We can summarize our findings as follows. The long-run money demand relationship may be established for M1, M2, M2Y and M2Y<sup>adj</sup> aggregates. The parameterization of these relationships is notably different, although it is impossible to discriminate between them from a theoretical viewpoint since all sets of parameters might be plausible under certain assumptions. Contrarily to Oomes and Ohnsorge (2005) the narrowest M1 aggregate performs at least as good as the broader aggregates. In fact the recursive estimates of the cointegration vector of M1 money demand relationship seems to be more stable than those estimated for broader monetary aggregates in which cases the robustness is questionable. The short-run model of the demand for M1 is obviously the best performing, while M2Y developments seem to be ambiguously affected by the money demand relationship. Although given the exogenous nature of the sources of nominal money growth in Russia and the underdevelopment of the alternative financial assets that could be used for savings purposes beyond those included into M2Y this last finding seems plausible.

## 5. The information content of money for inflation and for real economic developments

As described in Papademos and Stark (2010), chapter 4, extracting the signal in monetary developments is an essential piece of information for policy-makers, though it may be difficult at times because of the short-term volatility of monetary aggregates. A key issue for central banks aiming to maintain price stability is the information content of money for future inflation. Understanding the behaviour of loans and monetary aggregates during the business cycles, however, can add useful insights for analyzing driving forces of real economic activity. In this part we present two models that shed some light on these questions in case of Russia.

### 5.1 Money-based inflation risk indicators

We use money-based inflation risk indicators in order to assess the long-run link between monetary growth and inflation. Thus, the assessment of risks to price stability should rather focus on the persistent or lower frequency movements of the monetary developments, or – to repeat the wording of the ECB here – on the “underlying monetary growth”. As outlined in Papademos and Stark (2010, p. 209) and as recognized by the ECB’s two pillar strategy it is important to stress that money alone is insufficient for collecting information on future price developments. Money, nevertheless, is a necessary component and a starting point is to use a reduced-form inflation forecast equation in the spirit of Stock and Watson (1999). As applied by Nicoletti-Altamari (2001) or Hofmann (2008) and described in Fischer et al.(2008) we use an augmented autoregressive equation for forecasting consumer price inflation,  $\pi$ , at time  $t+h$  with the information embodied in monetary indicators  $x$  at point  $t$ :

$$\pi_{t+h}^k = \beta_0 + \beta_1(L)\pi_t + \beta_2(L)x_t + \varepsilon_{t+h} \quad (4)$$

In case of Russia and similar to Papademos and Stark (2010, p. 220, 221), we use quarterly data and capture the idea of „underlying money growth“ with two smoothing measures:

First, the key explanatory variable is the (weighted) average of monetary developments over several periods as implied by  $\beta_2(L)$ . The number of lags, just as in case of  $\beta_1(L)$ , are selected using the Schwartz information criterion (with a maximum of 3).<sup>32</sup>

Second,  $k$  denotes the number of quarters over which the inflation term is calculated in annualised terms. A specification with  $k=4$  would generate point forecasts for annual CPI

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<sup>32</sup> The selection of the lags in a purely data dependent manner implies that the precise specification of a model can change from one forecast to the next. The disadvantage of more difficult comparability between forecasts is accepted in order to have a less complex model.

inflation at any specific horizon chosen for  $h$ , while  $k > 4$  represents annualised inflation over a period longer than one year, and thus, can be seen as a smoothing measure. In this study  $k$  ranges between 4 and 6 for the chosen six-quarter-ahead forecasts in order to produce indicators that are informative about the medium-term trends in inflation.

These trends will influence developments at horizons well beyond 12 quarters ahead, thus indicating a time horizon, at which inflation ultimately becomes a monetary phenomenon according to the ECB's monetary analysis.

We also test the performance of alternative explanatory variables under the same model set-up. We use a number of readily available variables from the categories of economic indicators that are often regarded as important inflation determinants in Russia (see e.g. Oomes and Dynnikova (2006)): quarterly GDP growth, GDP gap (recursively calculated with Hodrick-Prescott filter,  $\lambda=1600$ ), quarterly growth of nominal effective exchange rate (NEER) and quarterly growth of ruble oil prices. Additionally we test the performance of tri-variate economic indicators model including both GDP and NEER growth as regressors that may be regarded as a proxy for a Phillips curve relationship.

Table 7 presents the results of the accuracy of the forecasts for the model based on different monetary aggregates, their median forecast, economic indicators models and the pure autoregressive model for inflation (AR). It is expressed as the ratio between the Root Mean Squared Error for the money-based forecasting model (RMSE) and the Root Mean Squared Error of the Random Walk (RMSE\_RW) for different monetary aggregates in Russia. As suggested in Hofmann (2008) we also report the results of Diebold and Mariano (1995) test (with HAC correction) on the equality of the forecast errors.

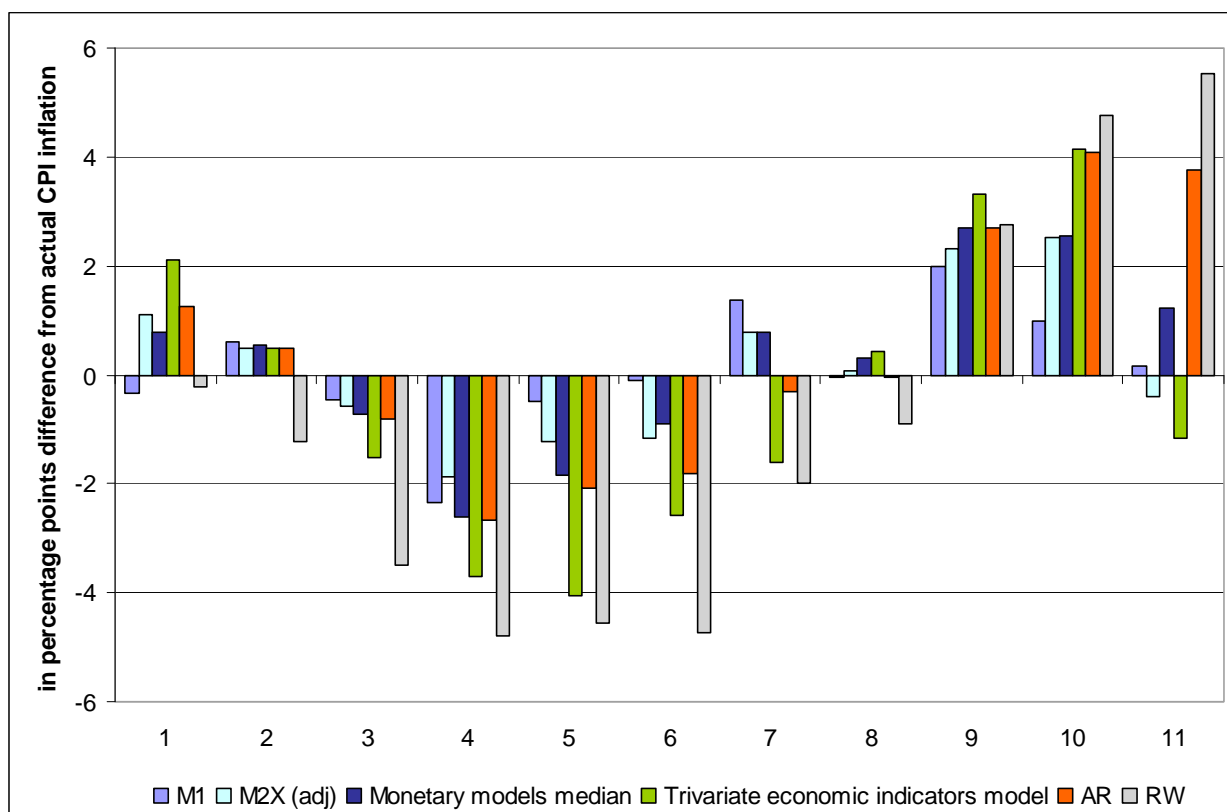
Table 7: RMSE/ RMSE\_RW (p-values of the tests of the hypotheses that RMSE=RMSE\_RW in parentheses)

	k=4	k=5	k=6
M1	<b>0.51</b> (0.1)	<b>0.42</b> (0.04)	<b>0.3</b> (0.01)
M2	<b>0.88</b> (0.62)	<b>0.59</b> (0.02)	<b>0.45</b> (0.01)
M2X	<b>0.37</b> (0.03)	<b>0.36</b> (0.02)	<b>0.51</b> (0.01)
M2X adjusted	<b>0.59</b> (0.06)	<b>0.44</b> (0.02)	<b>0.38</b> (0.01)
M2Y	<b>0.96</b> (0.3)	<b>0.84</b> (0.01)	<b>0.67</b> (0.05)
M2Y adjusted	<b>0.84</b> (0.03)	<b>0.89</b> (0.39)	<b>0.77</b> (0.02)
Median forecast of monetary models	<b>0.4</b> (0.01)	<b>0.4</b> (0.02)	<b>0.44</b> (0.01)
Δ GDP	<b>1.17</b> (0.57)	<b>0.83</b> (0.05)	<b>0.69</b> (0.05)
GDP gap	<b>1.04</b> (0.59)	<b>1.05</b> (0.6)	<b>0.87</b> (0.00)
Δ NEER	<b>0.79</b> (0.23)	<b>0.82</b> (0.09)	<b>0.74</b> (0.02)
Δ GDP, Δ NEER	<b>0.83</b> (0.2)	<b>0.67</b> (0.1)	<b>0.72</b> (0.05)
Δ Oil prices	<b>0.98</b> (0.62)	<b>0.89</b> (0.01)	<b>0.92</b> (0.27)
AR	<b>0.82</b> (0.07)	<b>0.69</b> (0.02)	<b>0.62</b> (0.02)

Based on this measure most of the money-augmented inflation forecasts improve the accuracy compared to the Random Walk and autoregressive model and also outperform the economic indicators. The most informative monetary aggregates are M1 and M2X (both adjusted and unadjusted). In general monetary models seem to perform better when forecasting on longer horizons.

Figure 8 shows the errors of the six-quarter-ahead forecast for k=6 compared with the actual CPI inflation outcomes for selected approaches.

Figure 8: Forecast Errors of Inflation Indicators for Russia (2007Q4 – 2010Q2)



1	2006Q2 – 2007Q4	5	2007Q2 – 2008Q4	9	2008Q2 – 2009Q4
2	2006Q3 – 2008Q1	6	2007Q3 – 2009Q1	10	2008Q3 – 2010Q1
3	2006Q4 – 2008Q2	7	2007Q4 – 2009Q2	11	2008Q4 – 2010Q2
4	2007Q1 – 2008Q3	8	2008Q1 – 2009Q3		

The forecast errors of the money-augmented models are relatively small compared to the alternative models for most periods. The fact that monetary models performed relatively well may reflect certain complications in forecasting inflation in Russia with traditional economic variables. For instance while oil price growth is cost increasing factor<sup>33</sup> it is also an important income factor and is usually associated with reduced inflation due to ruble's appreciation. Extracting relevant information from (quite volatile) output growth rates in conditions of ongoing transformation of the economy (due to both the emerging market nature of the Russian economy and its susceptibility to external shocks) may also be challenging. In this context money-based inflation risks indicators may prove particularly useful. It should, however, be taken in mind that the forecasting exercise is restricted to a fairly short and special time window due to the availability of data.

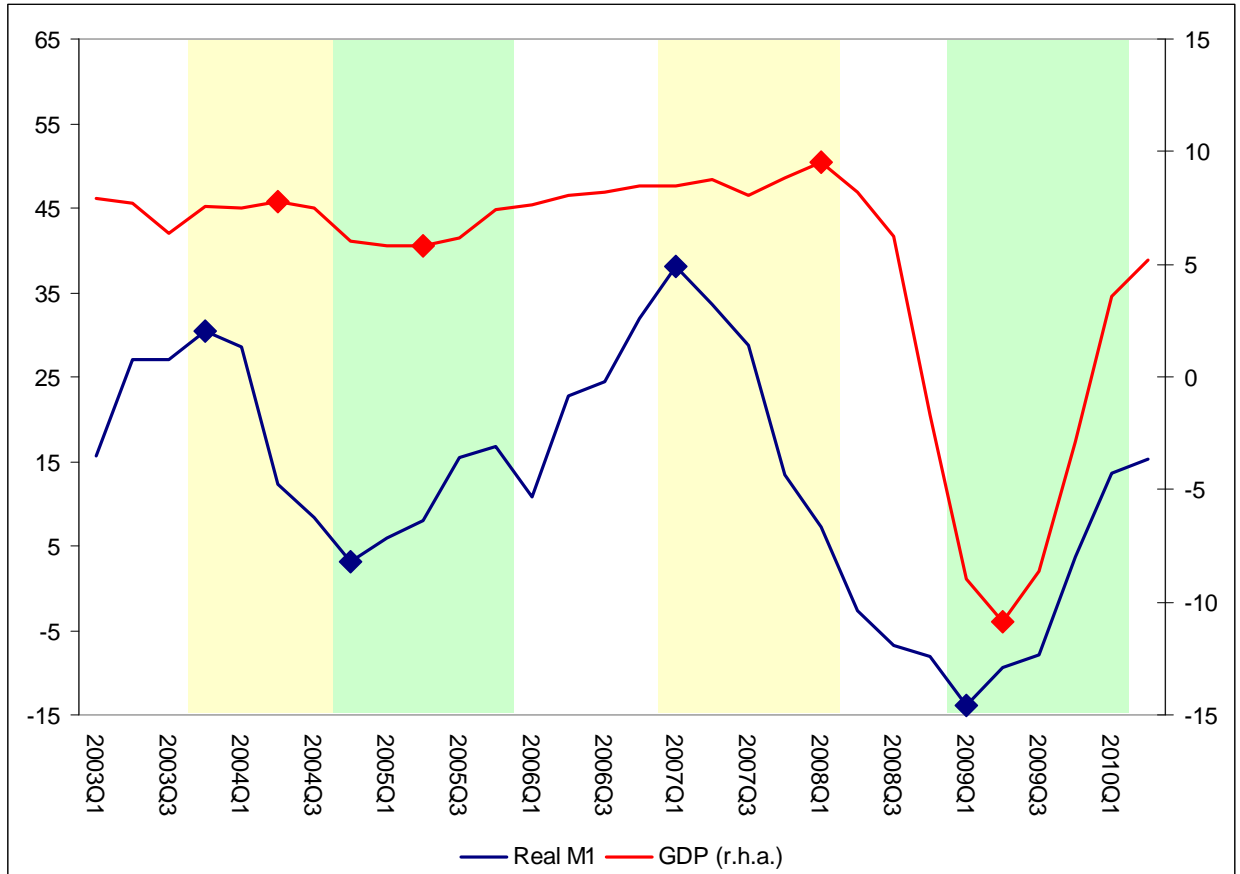
<sup>33</sup> Interestingly the link between world oil prices and (monopolized and regulated) domestic fuel market's prices may be less evident in Russia.

## **5.2 The informational content of money for real economic developments**

Using money as an information variable for real sector developments is another important aspect of analyzing monetary aggregates. In Brand et al. (2003) narrow money, here M1, seems crucial for cyclical developments in the euro area compared to other macroeconomic and financial variables commonly used for forecasting real economic activity. Interestingly, this is in contrast to most studies conducted for the U.S. Thus, we investigate this question for Russia. The robust relationship between money and real growth may prove valuable for the purposes of assessing the general trends of the real sector developments as well as for more specific short-term forecasting. Indeed, some central banks underscore the importance of the close link between money and actual spending in their routine analytical work (see e.g. Bank of England (2008) or ECB (2008)).

The exploration of the link between money and credit aggregates and economic activity has also intensified when attempting to explain drastic GDP fluctuations in Russia. In fact the analysis of the linkage between the turning points in output and real money stock dynamics conducted at the ECB (2008) seems to be perfectly applicable for Russia. As shown on Figure 9 over the last decade every turning point in the annual growth rates of real M1 was followed by the turning point in the annual growth rates of real GDP within the next 4 quarters.

Figure 9: Real M1 and real GDP annual growth rates (%) and turning points<sup>34</sup>



This type of analysis however makes use of only several observed episodes. We will also examine to what extent the monetary aggregates can be used to forecast the real sector developments in a more linear fashion.

### Model specification and data issues

Our empirical approach is closely related to Brand et al. (2003). We formulate the regression of the form:

$$\Delta y_t = \alpha_0 + \alpha_1 \Delta_4 m_{t-1} + \alpha_2 oil_t + \alpha_3 \Delta_4 reer_t + \alpha_4 \Delta y_{t-1} + \alpha_5 \Delta y_{t-2} + \varepsilon_t, \quad (5)$$

where  $\Delta y$  is the change of seasonally adjusted GDP and  $\Delta_4 m$  is the 4 quarters change of the real monetary aggregate (deflated with GDP deflator). As the model with M2Y has a “wrong” (negative)  $\alpha_1$  coefficient we exclude it from further analysis. We add real ruble oil prices (*oil*)

<sup>34</sup> The turning points were identified as local maxima/minima on the rolling window periods of 9 quarters.



and the 4 quarters changes of the real effective exchange rate (*reer*) as control variables<sup>35</sup> that are commonly used to explain GDP fluctuations in Russia (see e.g. Rautava (2009)). The lagged changes of GDP prevent the autocorrelation in the residuals. All variables are in logs. The time sample was set to 1999Q1-2006Q4. The Phillips-Perron and KPSS unit root tests yield conflicting results as Phillips-Perron test suggests that annual changes of monetary aggregates may have unit roots (Table B1 in Annex B). However based on the visual observation of the time series and given that there is no possibility of spurious regression since the left hand-side variable is clearly stationary we proceed by estimating the regression.

## Results

First we examine the in-sample performance of the models. For this purpose we compute one step ahead static forecasts. Following Fischer et al. (2008) we use the mean squared forecast error (MSFE) as the criteria. We also formulate the benchmark models to assess the usefulness of taking into account the monetary aggregates. As in Fischer et al. (2008) these are the simple autoregressive models (AR) and the naïve random walk forecast (RW). The third benchmark model (X) equals the model as stated in equation (3), but excludes the monetary indicator.

Table 8. In-sample forecasting performance

	MSFE	MSFE/MSFE <sup>AR</sup>
AR	0.00007713	<b>1.00</b>
RW	0.00010732	<b>1.39</b>
X	0.00003282	<b>0.43</b>
M1	0.00003143	<b>0.41</b>
M2	0.00002816	<b>0.37</b>
M2X	0.00003210	<b>0.42</b>
M2X_adj	0.00003103	<b>0.40</b>
M2Y_adj	0.00003190	<b>0.41</b>

On the in-sample period the models with money are performing better than naïve models, although their MSFE is only marginally smaller than MSFE of the X-model that does not include money as shown in Table 8. In fact the statistical significance of money in these equations is rather low, with only M2 being significant at the 5% level. We then proceed by making the out-of-sample static forecasts over the period of 2007Q1-2010Q2. As in Fischer et al. (2008) we report both components that determine the MSFE, the standard deviation of the forecast and the forecast bias

<sup>35</sup> The conventional choice of the control variable for this regression are yield spreads. Adding the spread between interest rates on loans and deposits and real interest rate on loans produces counterintuitive results (positive coefficients) and we therefore removed them.

Table 9. Out-of-sample forecasting performance

	MSFE	MSFE/ MSFE <sup>AR</sup>	Bias	Standard deviation
AR	0.00057	<b>1.00</b>	-0.011	0.005
RW	0.00064	<b>1.11</b>	0.005	0.020
X	0.00072	<b>1.26</b>	-0.016	0.009
M1	0.00054	<b>0.95</b>	-0.014	0.010
M2	0.00050	<b>0.88</b>	-0.015	0.012
M2X	0.00066	<b>1.16</b>	-0.016	0.010
M2X_adj	0.00076	<b>1.33</b>	-0.017	0.012
M2Y_adj	0.00082	<b>1.44</b>	-0.018	0.011

Over the out-of-sample period only M1 and M2 models are performing better than naïve benchmarks. Yet, the models that include M1, M2 and M2X perform notably better than the X model which does not include money. These results should be interpreted with caution as the analyzed time sample includes the crisis developments and may therefore not be fully representative. Table 10 shows the results when excluding the period of 2008Q3 – 2009Q2 (i.e. the period of recession) from the sample.

Table 10. Out-of-sample forecasting performance (excluding recession)

	MSFE	MSFE/ MSFE <sup>AR</sup>	Bias	Standard deviation
AR	0.00005	<b>1.00</b>	-0.001	0.002
RW	0.00038	<b>7.21</b>	0.016	0.012
X	0.00009	<b>1.75</b>	-0.004	0.006
M1	0.00007	<b>1.34</b>	-0.004	0.006
M2	0.00010	<b>1.92</b>	-0.006	0.006
M2X	0.00009	<b>1.66</b>	-0.005	0.006
M2X_adj	0.00012	<b>2.28</b>	-0.006	0.008
M2Y_adj	0.00013	<b>2.49</b>	-0.006	0.008

The results of the out-of-sample forecast over the relatively calmer periods indicate that the models' performance is not impressive as none of them was able to outperform the autoregressive model. The M1 and M2X models are still forecasting better than the X model meaning that money developments contain some useful information beyond that contained in the control variables.

Summarizing, we find only limited usefulness of using monetary aggregates to forecast GDP growth over the pre-crisis period in the linear model framework. The performance of the estimated models generally deteriorates during the crisis and post-crisis periods and is worse compared to naive models. Yet, the models which contain money seem to perform better than the one that does not. This is particularly so when the periods of recession are included, although to what extent this finding is representative remains unclear. As could be expected the best performing monetary aggregate appears to be M1.

## **6. Conclusions**

Tools and techniques of the ECB's monetary analysis can give valuable input to the conduct of monetary policy at other central banks, if institutional, economic and financial differences are taken into account. We take the case of the Bank of Russia and analyze the changing role of money in its monetary policy.

In the core part of our paper we derive stable money demand functions that are related to income and wealth and to a lesser extent to opportunity costs and uncertainty. Estimations of narrower aggregates that only include components denominated in national currency seem to be more stable than broader aggregates. It signals that monetary developments are influenced by factors that go beyond the usual money demand factors, such as the buffering function of the sovereign wealth fund in case of Russia. This makes the interpretation of monetary overhangs and the policy implications that can be drawn from them more complex since the impact of the sovereign wealth fund on monetary development is already a policy reaction. Eventually, it should be kept in mind that the concept of monetary overhangs are a starting point for an analysis that also focuses on changes in the stocks rather than analyses that solely focus on changes in the flows. Additionally, we show how money demand functions can be used to derive implied exchange rate depreciation expectations as compared to actual exchange rate depreciation.

In the last section, we present results that deliver some information content of money for inflation and real economic development. As in case of the ECB's regular monetary assessment we measure money-based inflation risk indicators and compare the performance of different monetary aggregates with naïve and univariate inflation models as well as inflation models with alternative economic variables. The results are promising, though we leave it for future analysis to assess their performance over time. The results of the information content of money for real economic developments is fairly limited, however, in line with results for the euro area, the narrow monetary aggregate seem to perform relatively better compared to broader aggregates. This, however, should not be seen as a negative feedback to the ECB style monetary analysis

since monetary aggregates are rather used as an indicator for the turning points in real GDP at the ECB. During our sample period this purposes is actually served fairly well for Russia.

We conclude that the ECB style monetary analysis gives valuable input to the analysis at the CBR. Monetary analysis, however, is an evolutionary process, so within an economy over time as well as across economies changes of the economic and financial environment have an impact on the analysis and on the policy conclusions that can be drawn from it. The case of Russia furthermore highlights that monetary analysis should not be minimized to a purely technical exercise, but that it needs and enforces institutional knowledge of the financial sector.

## References

- Andrews, DWK (1991) Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation. *Econometrica*, 59, 817–858
- Bank of England (2008) Money, credit and deleveraging, Inflation Report, August, p.16
- Benati, L. (2009) Long-run evidence on money growth and inflation, Working Paper Series, No. 1027, ECB
- Beyer, A. (2009) A stable model for euro area money demand: revisiting the role of wealth, Working Paper Series, No. 1111, ECB
- Brand, C., Reimers, H.-E. and Seitz, F. (2003) Forecasting real GDP: what role for narrow money? Working Paper Series, No. 254, ECB
- Brüggemann, R. and Lütkepohl, H. (2005) Practical problems with reduced-rank ML estimators for cointegration parameters and a simple alternative. *Oxford Bulletin of Economics & Statistics* 67, 673-690
- De Bondt, G.J. (2009) Euro area money demand: empirical evidence on the role of equity and labour markets, Working Paper Series, No. 1086, ECB
- De Grauwe, P. and Polan, M. (2005) Is inflation always and every where a monetary phenomenon? *Scandinavian Journal of Economics*, 107(2), pp. 239-259
- Diebold, F. and Mariano, R. (1995) Comparing predictive accuracy. *Journal of Business and Economics Statistics* 13, 253–263.
- Dreger, C., Reimers, H.-E. and Roffia, B. (2006) Long-run money demand in the new EU Member States with exchange rate effects, Working Paper Series, No. 628, ECB
- ECB (2008) The informational content of real M1 growth for real GDP growth in the euro area, *Monthly Bulletin*, October, pp. 16-18
- Gerdesmeier, D., Reimers, H.-E. and Roffia, B. (2009) Asset price misalignments and the role of money and credit, Working Paper Series, No. 1068, ECB
- Ghosh, A., Christofides, C., Kim, J., Papi, L., Ramakrishnan, U., Thomas, A. and Zalduendo, J. (2005) The Design of IMF-Supported Programs, IMF Occasional paper 241
- Greiber, C. and Lemke, W. (2005) Money demand and macroeconomic uncertainty, Discussion Paper Series, No. 26, Deutsche Bundesbank
- Greiber, C. and Setzer, R. (2007) Money and housing: evidence for the euro area and the US, Discussion Paper Series, No. 12, Deutsche Bundesbank
- Fischer, B., Lenza, M., Pill, H. and Reichlin, L. (2008) Money and monetary policy – the ECB experience 1999-2006, in Beyer, A. and Reichlin, L. (eds.) *The role of money – money and monetary policy in the 21<sup>st</sup> century*, ECB, Frankfurt am Main, pp. 102-175

- Hansen, H. and Johansen, S. (1999) Some Tests for Parameter Constancy in Cointegrated VAR models, *Econometrics Journal* 2, 306-333
- Hofmann, B. (2008) Do monetary indicators lead euro area inflation? Working Paper Series, No. 867, ECB
- Johansen, S. (1996) *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models*, 2<sup>nd</sup> ed., Oxford: Oxford University Press
- Kim, B.-Y. (1999) The Income, Savings, and Monetary Overhang of Soviet Households, *Journal of Comparative Economics*, Volume 27, Issue 4, December, Pages 644-668
- Nicoletti-Altimari, S. (2001) Does money lead inflation in the euro area, Working Paper Series, No. 63, ECB.
- Korhonen, I. and Mehrotra, A. (2010) Money demand in post-crisis Russia: De-dollarisation and re-monetisation, *Emerging Markets Finance and Trade*, 46 (2), 5 - 19
- Lanne, M., Lütkepohl, H. and Saikkonen, P. (2002) Comparison of unit root tests for time series with shifts, *Journal of Time Series Analysis*, Vol. 23, pp. 667-685
- Mehrotra, A. and Ponomarenko, A. (2010) Wealth effects and Russian money demand, Discussion Paper Series, No. 13, BOFIT
- Oomes, N. and Dynnikova, O. (2006) The Utilization-Adjusted Output Gap: Is the Russian Economy Overheating? IMF WP/06/68
- Oomes, N. and Ohnsorge, F. (2005) Money demand and inflation in dollarized economies: The case of Russia, *Journal of Comparative Economics*, 33(3), 462-483, September
- Özdemir, K.A. and Saygili, M. (2010) Economic Uncertainty and Money Demand Stability in Turkey, Working Paper Series, No. 10/15, Central Bank of the Republic of Turkey
- Papademos, L.D. and Stark, J. (2010) Enhancing Monetary Analysis, European Central Bank
- Phillips, P. C. B. and Hansen, B. E. (1990) Statistical inference in instrumental variables regression with I(1) processes, *Review of Economic Studies* 57, 99–125
- Ponomarenko, A., Solovyeva, A. and Vasilieva, E. (2011) Financial dollarization in Russia: causes and consequences, Discussion Paper Series, No. 36, BOFIT
- Rautava, J. (2009) A forecasting model for Russia's economy. BOFIT Online No. 10
- Rolnick, A.J. and Weber, W.E. (1997) Money, inflation, and output under fiat and commodity standards, *Journal of Political Economy*, 105(6), pp. 1308-1321
- Seitz, F. and Von Landesberger, J. (2010) Household money holdings in the euro area: an explorative investigation, Working Paper Series, No. 1238, ECB
- Stock, J.H. and Watson, M. (1999) Forecasting inflation, *Journal of Monetary Economics*, Vol. 44, pp. 293-335

Ulyukayev, A. (2011) Izmeneniya v politike Tsentralnogo banka RF, Ekonomicheskaya politika № 3, pp. 19-24 (*in Russian*)

# Annex A

Figure A1. Variables used in the model

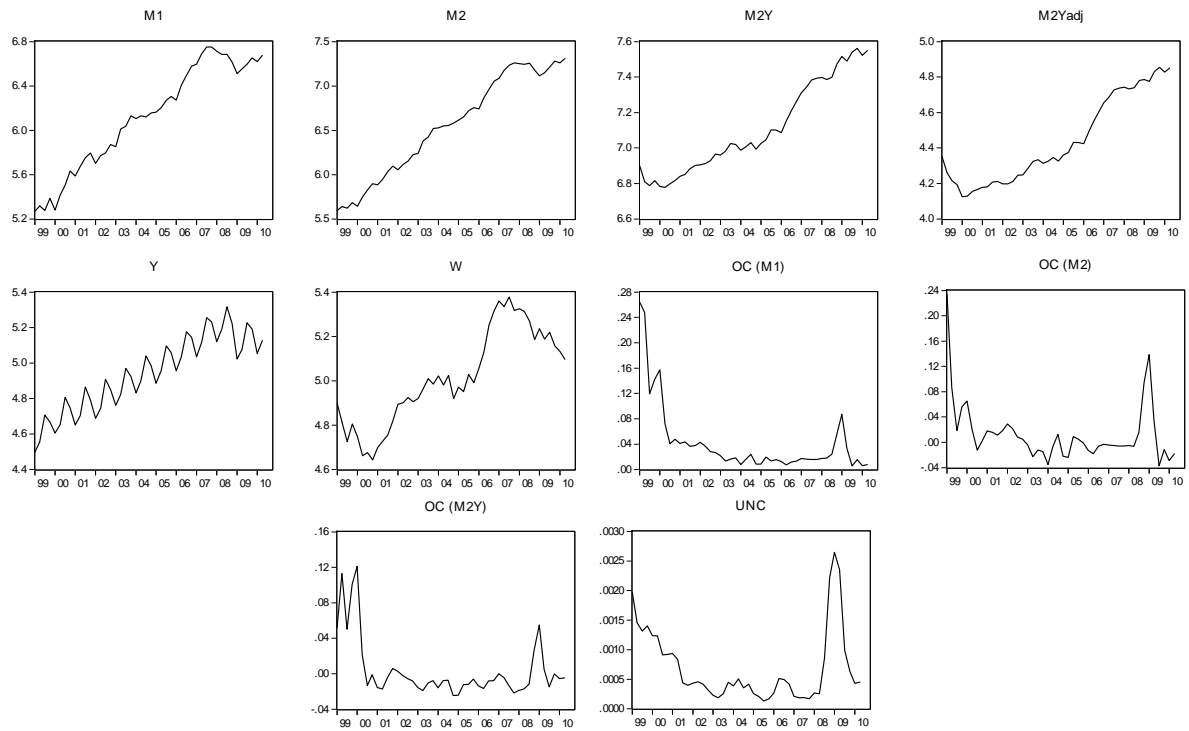


Table A1. Results of the unit root tests

(for PP and KPSS tests the bandwidth is determined by automatic Andrews (1991) procedure; the unit root test with structural break is conducted in the presence of seasonal time dummy variables and the shift type dummy variable in 2008Q4 (the impulse type dummy variable when the variables are in differences) with lag length set to 4)

<i>Variable</i>	<i>Test specification</i>	<i>PP test statistic (p-value)</i> Null hypothesis: variable has unit root	<i>KPSS test statistic</i> Null hypothesis: variable is stationary	<i>ADF type unit root test with structural break (Lanne et al. (2002)) test statistic</i> Null hypothesis: variable has unit root
M1	Levels (constant)	-0.68 (0.84)	0.45*	-1.78
	Levels (constant and trend)	-1.80 (0.69)	0.16**	-2.73
	1 <sup>st</sup> differences (constant)	-7.47 (0.00)	0.14	-3.64**
M2	Levels (constant)	-0.49 (0.88)	0.66**	-1.4
	Levels (constant and trend)	-1.78 (0.70)	0.17**	-2.15
	1 <sup>st</sup> differences (constant)	-5.88 (0.00)	0.14	-3.06**



M2Y	Levels (constant)	1.00 (0.99)	0.67**	-0.22
	Levels (constant and trend)	-3.95 (0.02)	0.15**	-0.77
	1 <sup>st</sup> differences (constant)	-5.16 (0.00)	0.49**	-2.9**
M2Y <sup>adj</sup>	Levels (constant)	-0.00 (0.95)	0.58**	-0.13
	Levels (constant and trend)	-6.78 (0.00)	0.14*	-0.29
	1 <sup>st</sup> differences (constant)	-5.30 (0.00)	0.48**	-3.42**
Y	Levels (constant)	-2.00 (0.29)	0.44*	-1.26
	Levels (constant and trend)	-4.82 (0.00)	0.18**	-2.9*
	1 <sup>st</sup> differences (constant)	-6.63 (0.00)	0.04	-3.24**
W	Levels (constant)	-0.99 (0.75)	0.42*	-2.2
	Levels (constant and trend)	-1.41 (0.85)	0.14*	-2.29*
	1 <sup>st</sup> differences (constant)	-6.84 (0.00)	0.18	-3.14**
OC <sup>M1</sup>	Levels (constant)	-7.06 (0.00)	0.41*	-3.56**
	Levels (constant and trend)	-5.49 (0.00)	0.16**	-0.2
	1 <sup>st</sup> differences (constant)	-6.56 (0.00)	0.42*	-4.13**
OC <sup>M2</sup>	Levels (constant)	-21.3 (0.00)	0.31	-1.65**
	Levels (constant and trend)	-20.0 (0.00)	0.16**	-0.81
	1 <sup>st</sup> differences (constant)	-6.82 (0.00)	0.37	-4.75**
OC <sup>M2Y</sup>	Levels (constant)	-2.83 (0.06)	0.31	-3.94**
	Levels (constant and trend)	-2.97 (0.15)	0.16**	-0.36
	1 <sup>st</sup> differences (constant)	-8.15 (0.00)	0.06	-5.28**
UNC	Levels (constant)	-2.67 (0.09)	0.15	-3.09**
	Levels (constant and trend)	-2.56 (0.30)	0.15*	-1.29
	1 <sup>st</sup> differences (constant)	-4.35 (0.00)	0.13	-2.58

\*\* – rejection of the null at 5%-level

\* – rejection of the null at 10%-level

Figure A2. Recursively estimated eigenvalues with 95% confidence bands (for fixed short run dynamics)

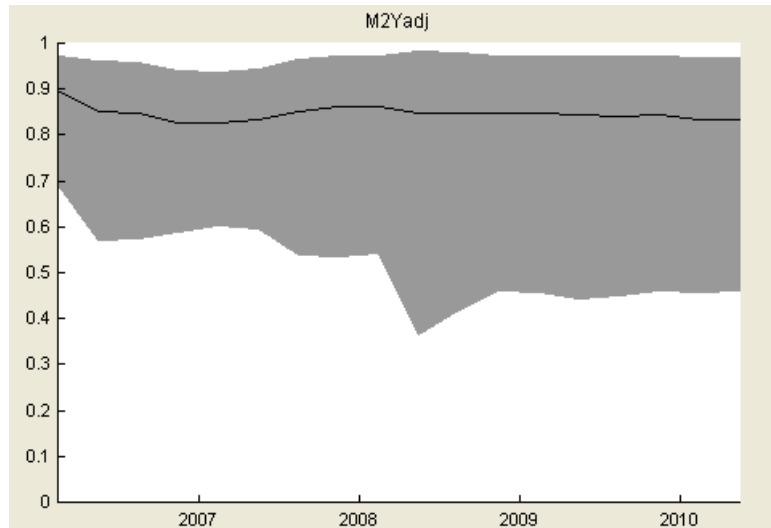
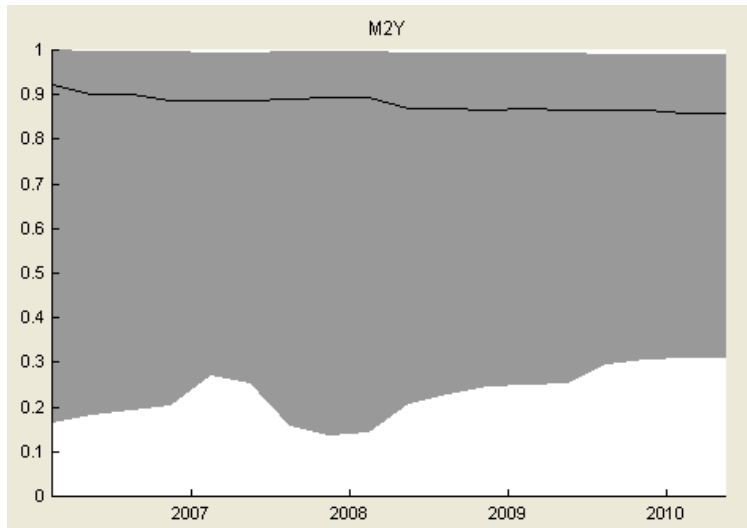
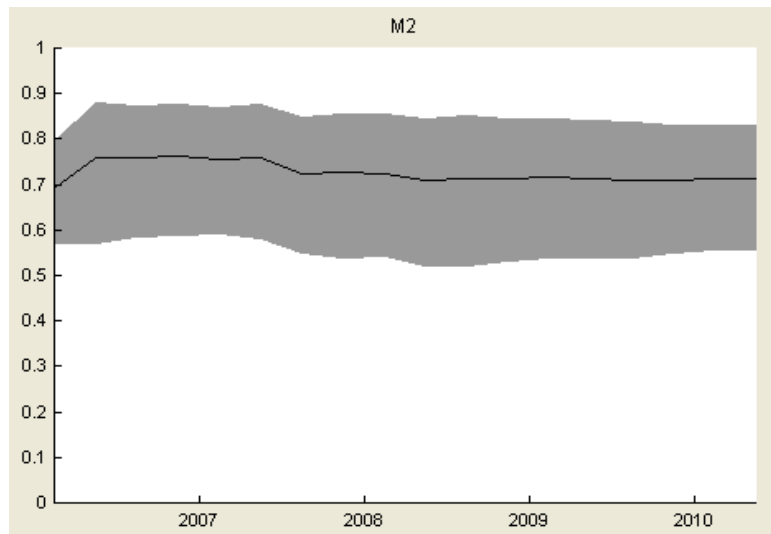
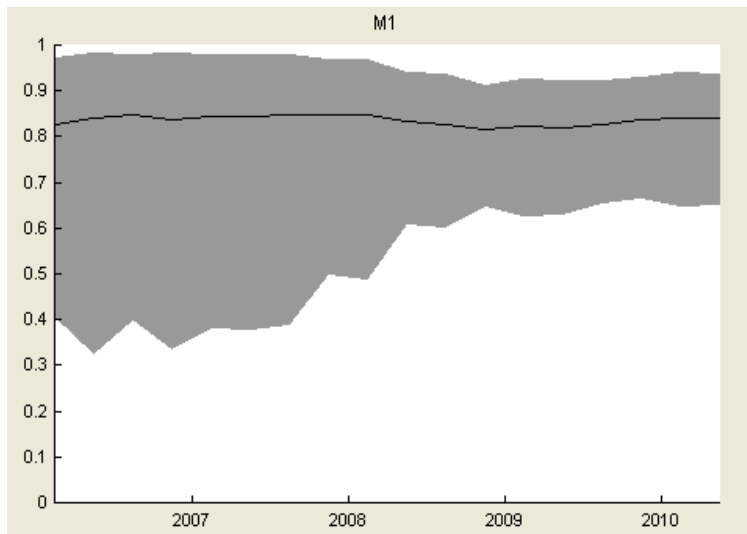


Figure A3. Recursively estimated statistic of Hansen and Johansen (1999) fluctuations test and 95% critical value (for fixed short run dynamics)

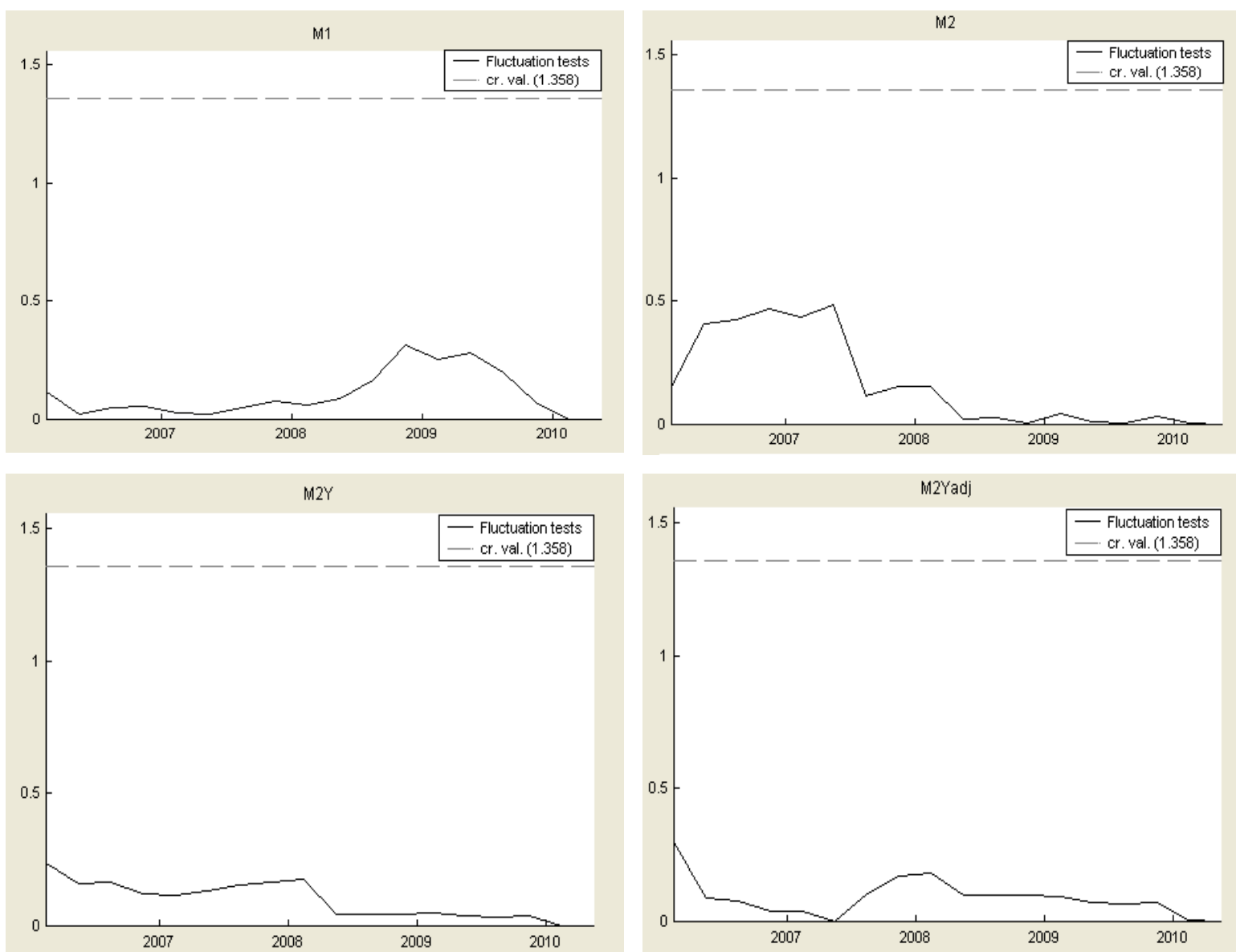


Table A2. Test for stationarity of variables: F-statistics (p-value)

Variable	Model			
	M1	M2	M2Y	M2Y <sup>adj</sup>
M	70.65 (0.00)	46.74 (0.00)	71.53 (0.00)	59.06 (0.00)
Y	71.25 (0.00)	46.55 (0.00)	70.06 (0.00)	60.13 (0.00)
W	67.71 (0.00)	44.33 (0.00)	69.03 (0.00)	53.54 (0.00)
OC	50.06 (0.00)	42.58 (0.00)	31.13 (0.00)	36.57 (0.00)
UNC	33.50 (0.00)	29.00 (0.00)	51.31 (0.00)	51.09 (0.00)

Table A3. S2S cointegration vectors for M1 model (t-statistic)

Variable	Lag length			
	2	3	4	5
M	1	1	<b>1</b>	1
Y	-1.72 (-18.1)	-1.64 (-27.8)	<b>-1.65</b> <b>(-37.3)</b>	-1.59 (-90.8)
W	-0.47 (-6.97)	-0.49 (-11.5)	<b>-0.47</b> <b>(-13.8)</b>	-0.50 (-36.2)
OC	0.82 (2.91)	2.16 (10.8)	<b>2.07</b> <b>(13.1)</b>	2.53 (27.8)
UNC	-32.6 (-1.83)	-122.4 (-9.46)	<b>-118</b> <b>(-8.25)</b>	-172.5 (-24.3)

Table A4. S2S cointegration vectors for M2 model (t-statistic)

Variable	Lag length			
	2	3	4	5
M	1	1	<b>1</b>	1
Y	-2.26 (-12.6)	-2.42 (-19.4)	<b>-2.38</b> <b>(-20.2)</b>	-2.15 (-83.8)
W	-0.52 (-3.72)	-0.35 (-3.42)	<b>-0.34</b> <b>(-3.49)</b>	-0.51 (-25)
OC	3.33 (4.38)	2.84 (5.79)	<b>3.73</b> <b>(9.15)</b>	4.89 (60.6)
UNC	-50.9 (-1.52)	-16.8 (-0.69)	<b>-45.1</b> <b>(-1.81)</b>	-127.6 (-23.9)

Table A5. S2S cointegration vectors for M2Y model (t-statistic)

<i>Variable</i>	<i>Lag length</i>			
	2	3	4	5
M	1	1	<b>1</b>	1
Y	-0.82 (-2.26)	-0.37 (-3.08)	<b>-0.38</b> <b>(-4.09)</b>	-0.38 (-18.2)
W	-0.56 (-1.99)	-0.87 (-9.09)	<b>-0.88</b> <b>(-11.2)</b>	-0.72 (-38.4)
OC	-1.82 (-1.32)	-1.31 (-2.73)	<b>-3.47</b> <b>(-5.34)</b>	-1.27 (-6.42)
UNC	-17.3 (-0.21)	-68.2 (-2.4)	<b>-67.4</b> <b>(-2.13)</b>	-10.8 (-1.45)

Table A6. S2S cointegration vectors for M2Y<sup>adj</sup> model (t-statistic)

<i>Variable</i>	<i>Lag length</i>			
	2	3	4	5
M	1	1	<b>1</b>	1
Y	-1.44 (-6.97)	-0.69 (-9.15)	<b>-0.63</b> <b>(-12.3)</b>	-0.56 (-47)
W	0.05 (0.31)	-0.61 (-9.92)	<b>-0.67</b> <b>(-15.5)</b>	-0.75 (-68.6)
OC	-2.27 (-2.75)	-1.3 (-4.03)	<b>-1.62</b> <b>(-4.89)</b>	-3.87 (-39.3)
UNC	-112.9 (-2.4)	-116.4 (-6.59)	<b>-128.5</b> <b>(-7.61)</b>	0.43 (0.1)

Figure A7. Recursive estimates of M1 money demand model's cointegration vector ( $\pm 2$  S.E.)

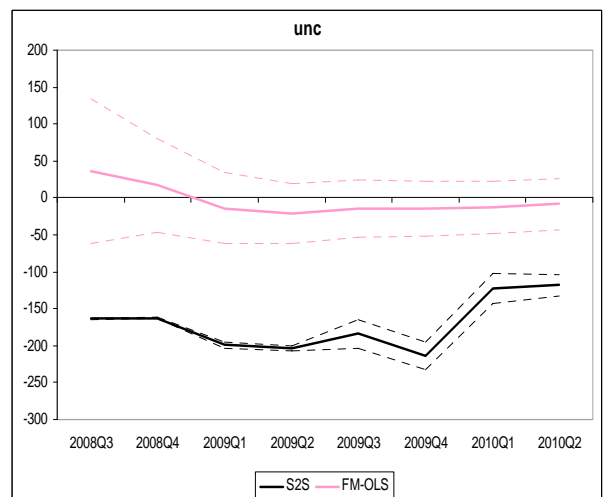
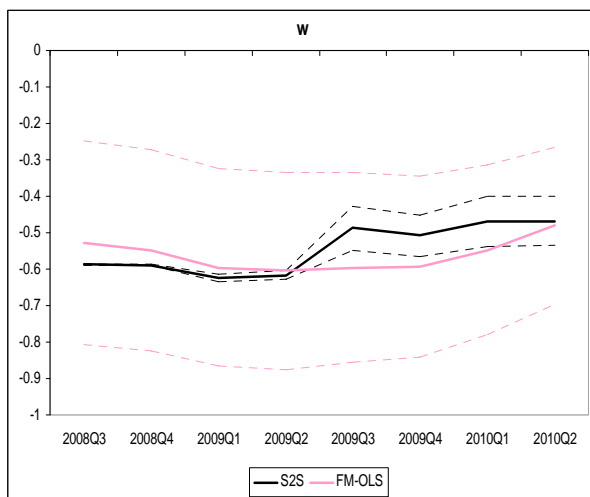
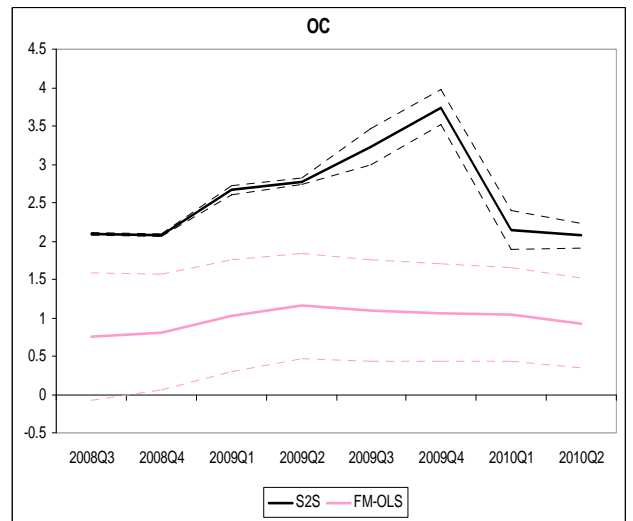
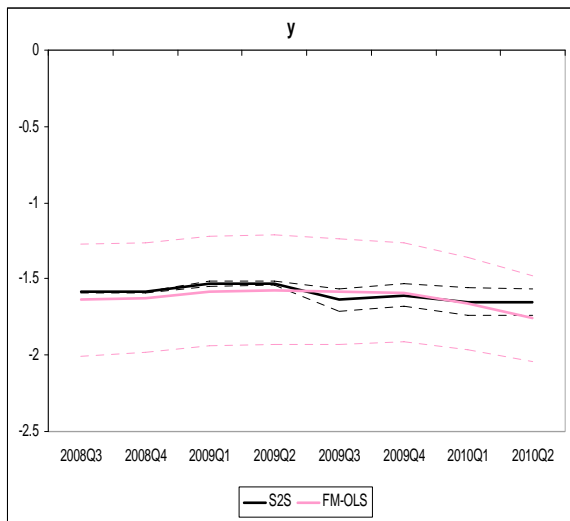


Figure A8. Recursive estimates of M2 money demand model's cointegration vector ( $\pm 2$  S.E.)

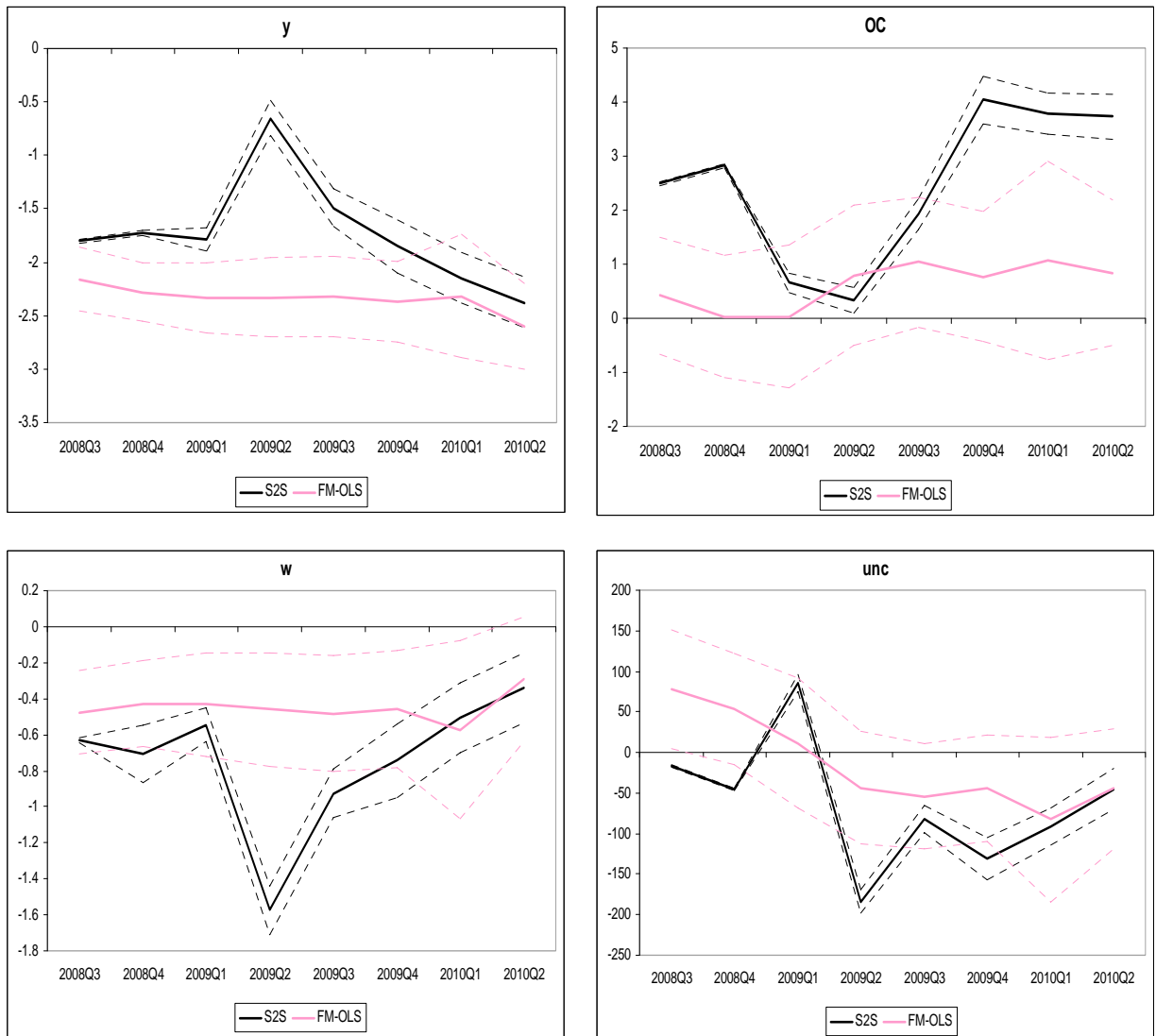


Figure A9. Recursive estimates of M2Y money demand model's cointegration vector ( $\pm 2$  S.E.)

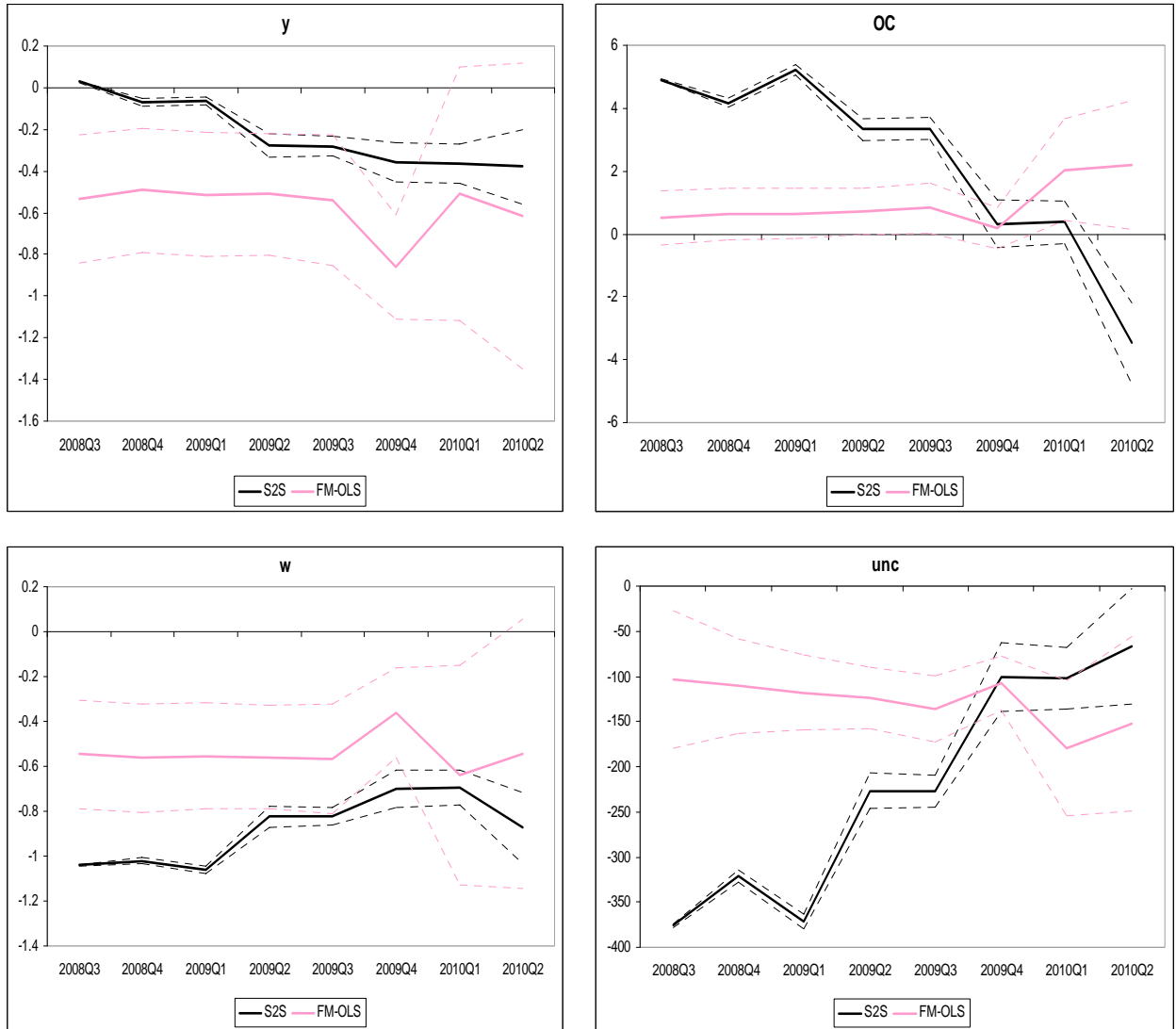




Figure A10. Recursive estimates of M2Y<sup>adj</sup> money demand model's cointegration vector ( $\pm 2$  S.E.)

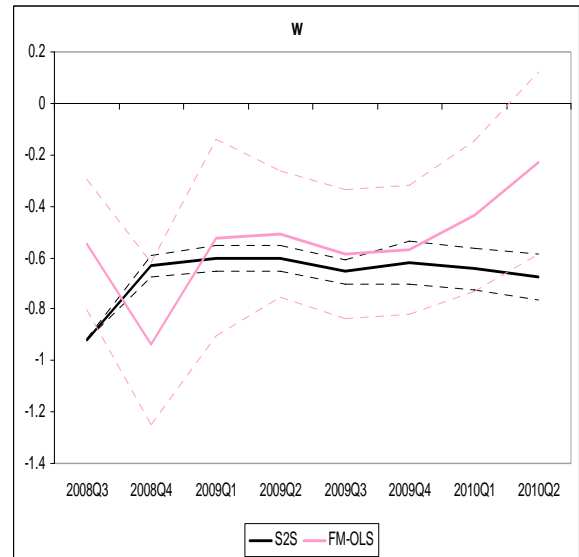
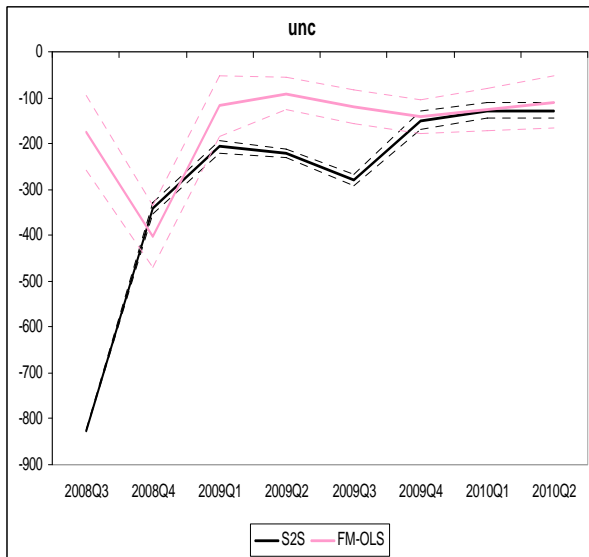
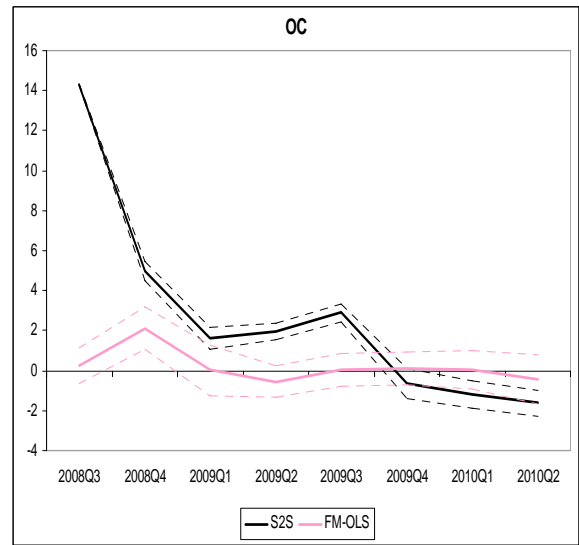
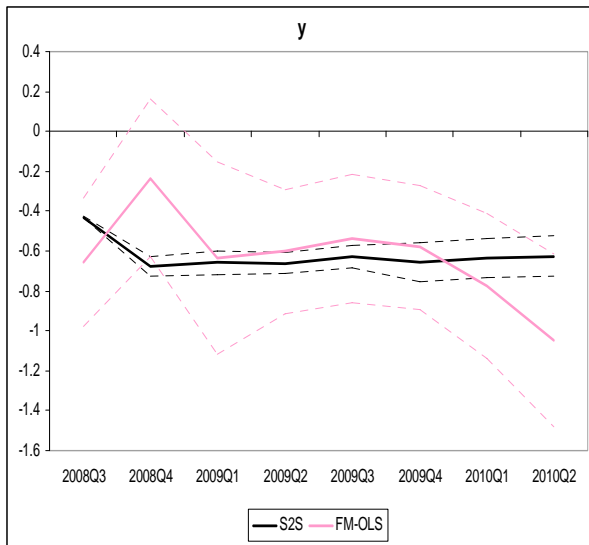
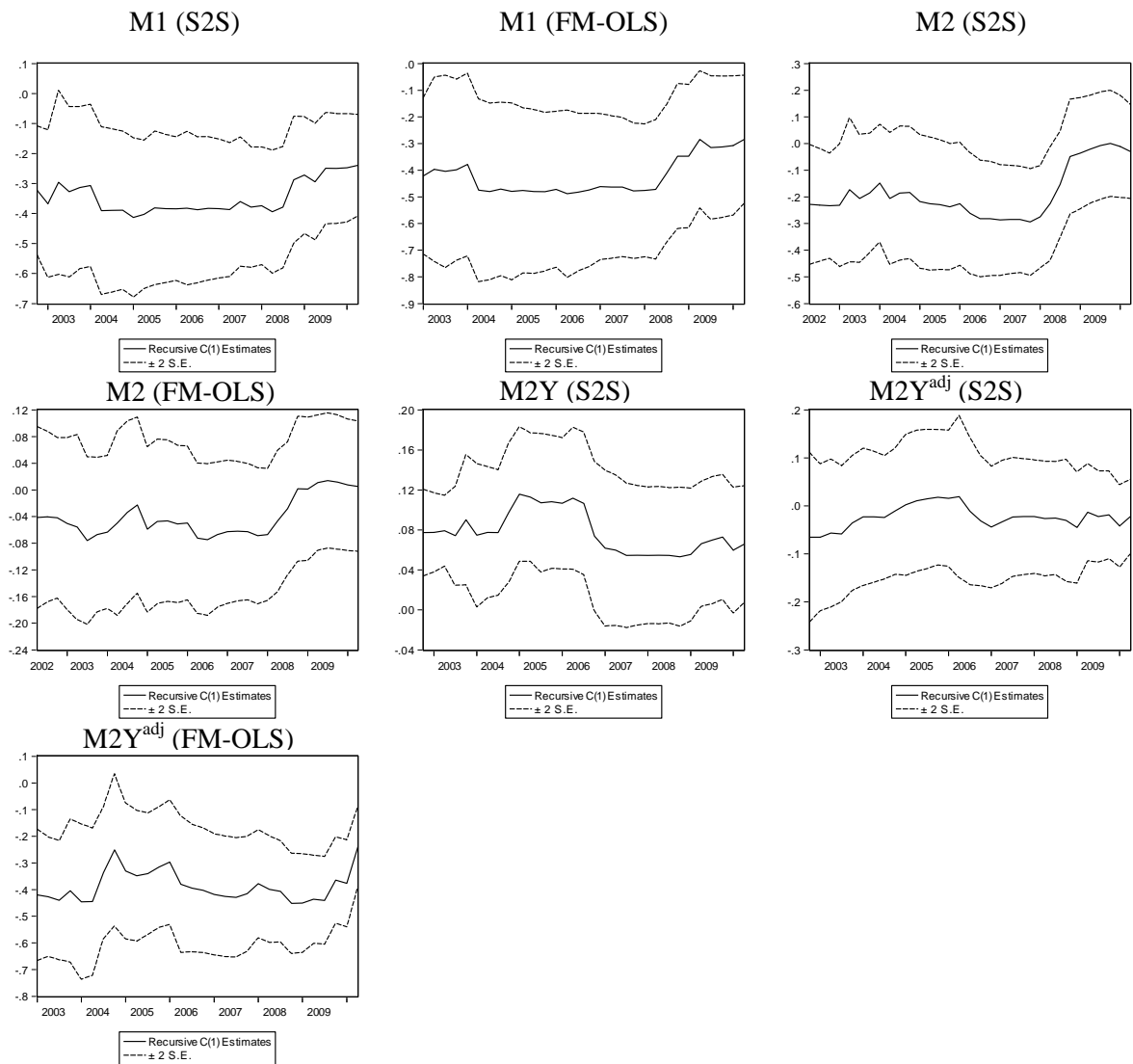


Figure A11. Recursive estimates of ECMs' loading coefficients



## Annex B

Figure B1. Variables used in equation (5) (shaded area = period used for out-of sample forecasts)

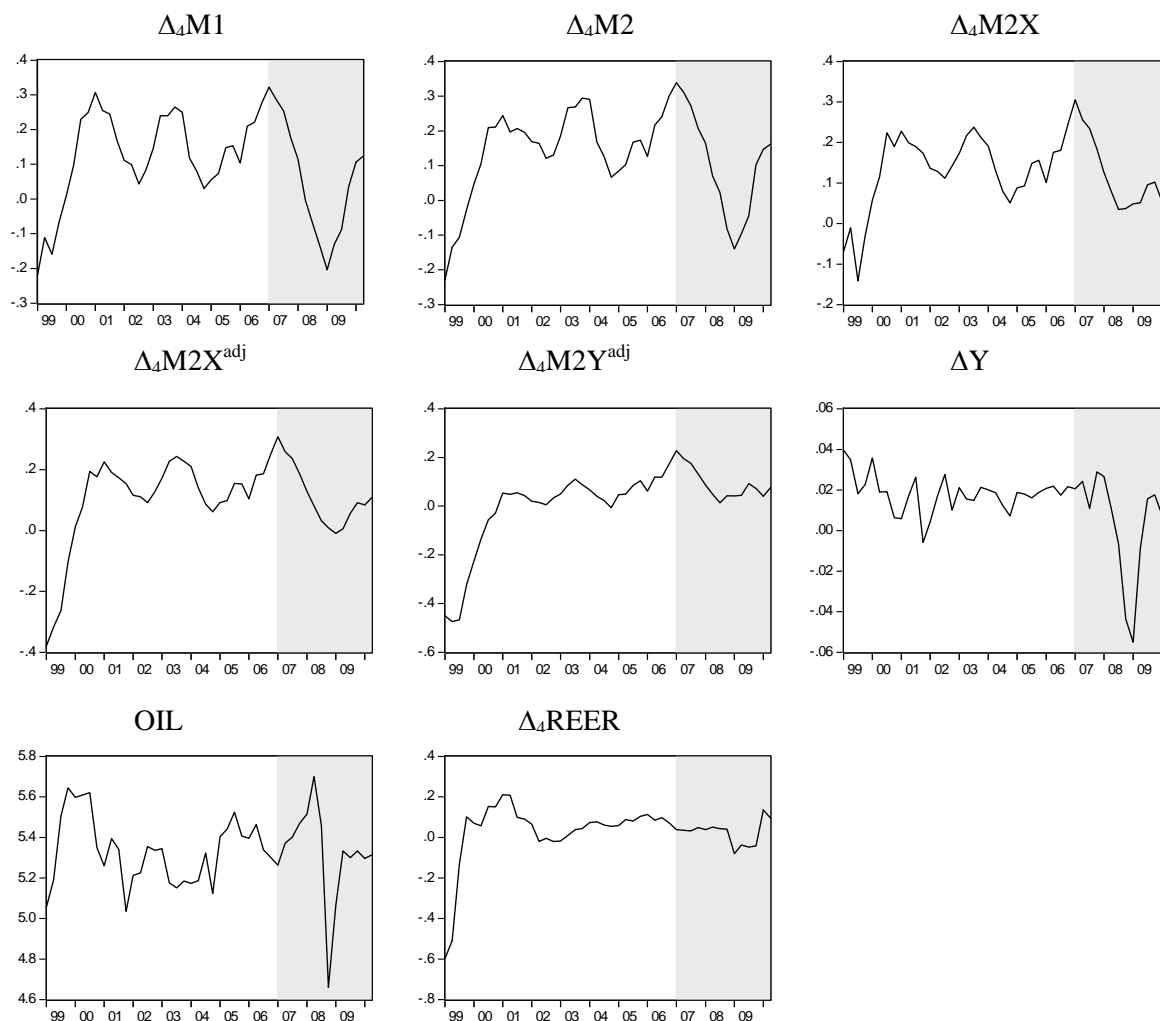


Table B1. Results of the unit root tests (variables in levels, bandwidth determined by automatic Andrews (1991) procedure)

<i>Variable</i>	<i>PP test statistic</i> ( <i>p-value</i> ) Null hypothesis: variable has unit root	<i>KPSS test statistic</i> Null hypothesis: variable is stationary
$\Delta_4M1$	-1.99 (0.29)	0.31
$\Delta_4M2$	-1.84 (0.36)	0.34
$\Delta_4M2X$	-1.75 (0.4)	0.28
$\Delta_4M2X^{adj}$	-3.55 (0.01)	0.35*
$\Delta_4M2Y^{adj}$	-2.6 (0.1)	0.38*
$\Delta Y$	-4.55 (0.00)	0.23
OIL	-3.0 (0.05)	0.12
$\Delta_4REER$	-5.48 (0.00)	0.24

\* – rejection of the null of stationarity at 10%-level

## Annex C

### Historical data

	Money growth (%)	Prices growth (%)
1861	0.1	13.3
1862	-3.2	-5.7
1863	-7.9	-6.9
1864	4.3	4.7
1865	-0.4	5.3
1866	5.4	5.9
1867	-3.2	8.9
1868	4.1	13.2
1869	-1.2	-13.2
1870	0.0	-15.8
1871	8.3	5.5
1872	-0.5	25.2
1873	3.4	2.1
1874	-1.3	-10.9
1875	-1.6	-15.3
1876	2.0	14.4
1877	32.3	29.2
1878	13.6	-10.4
1879	-2.0	28.6
1880	-4.0	16.8
1881	-5.2	-21.0
1882	-5.3	-16.2
1883	-1.4	-10.9
1884	-6.2	1.2
1885	0.8	-5.9
1886	3.8	-3.1
1887	3.2	1.4
1888	0.2	1.8
1889	-4.6	-3.4
1890	-2.3	-3.3
1891	16.2	21.6
1892	1.8	3.0
1893	-0.2	-10.7
1894	-2.3	-15.7
1895	0.7	-6.2
1896	7.4	-0.2
1897	-0.5	16.1
1898	9.5	9.7
1899	3.5	-1.1
1900	8.2	-2.9
1901	-0.4	2.5
1902	3.3	1.4
1903	4.5	-1.5
1904	11.7	3.0
1905	31.2	5.6
1906	-10.2	7.6
1907	-3.0	12.9
1908	-7.3	0.6
1909	6.2	-4.5
1910	3.3	-4.3
1911	7.1	0.2
1912	9.5	7.3

1913	-0.4	-1.5
1914	58.2	13.0
1915	74.3	64.0
1916	55.8	107.0
1917	185.3	500.0
1918	122.1	579.0
1919	267.0	1470.0
1920	419.4	910.0
1921	1400.9	880.0
1922	11271.5	9720.0
1923	182.4	26000.0
1924	124.4	13.9
1925	42.7	10.2
1926	12.5	4.0
1927	17.3	-0.4
1928	20.0	16.7
1929	36.4	8.9
1930	52.2	8.8
1931	30.3	11.1
1932	48.3	12.2
1933	-18.4	42.0
1934	12.7	33.5
1935	25.6	13.3
1936	15.9	46.2
1937	20.7	22.2
1938	26.8	6.8
1939	29.0	10.4
1940	-0.5	15.3
1941	57.1	5.5
1942	32.0	3.9
1943	25.2	3.1
1944	12.5	3.1
1945	14.5	21.5
1946	-10.9	21.5
1947	-79.6	21.5
1948	77.2	21.5
1949	14.1	5.7
1950	22.0	-11.2
1951	2.7	-3.4
1952	7.2	-3.2
1953	5.0	-3.8
1954	19.6	-0.5
1955	2.7	-2.3
1956	16.0	0.1
1957	3.6	-0.1
1958	9.5	2.2
1959	8.5	-0.3
1960	-12.3	-1.3
1961	33.9	-0.6
1962	20.3	0.8
1963	9.0	-3.0
1964	12.3	-0.8
1965	15.4	0.2
1966	17.8	1.5
1967	15.9	-1.0
1968	15.4	-0.8
1969	11.5	3.1

1970	0.3	2.3
1971	9.9	-0.5
1972	10.7	0.3
1973	9.1	-2.0
1974	11.4	-1.8
1975	11.8	0.0
1976	10.6	-1.3
1977	8.4	0.1
1978	6.2	0.7
1979	2.7	0.1
1980	6.7	0.9
1981	1.9	1.3
1982	6.5	4.0
1983	9.2	0.3
1984	6.6	1.0
1985	6.1	0.2
1986	5.5	-1.2
1987	7.8	1.0
1988	14.5	3.4
1989	19.8	4.1
1990	25.6	12.2
1991	18.9	160.0
1992	1690.0	2508.8
1993	790.0	839.9
1994	174.4	215.0
1995	121.1	131.0
1996	28.5	22.0
1997	25.5	11.0
1998	44.1	84.4
1999	41.8	36.5
2000	57.4	20.2
2001	39.4	18.6
2002	30.7	15.1
2003	50.3	12.0
2004	33.8	11.7
2005	30.9	10.9
2006	38.6	9.0
2007	32.9	11.9
2008	2.5	13.3
2009	6.4	8.8
2010	25.4	8.8

## Historical data sources

### Money series.

1861-1916. Credit notes, gold and silver in circulation as reported in the *Gosudarstvennyi bank (kratkyi ocherk deyatel'nosti za 1860-1910 gody)* (reprint by the CBR).

1917-1920. Various currency notes in circulation as reported in *Denisov A., The paper money of the RSFSR, USSR and Russia of 1917-2005 (Part 1)*. Moscow, Dipak, 2004.

1921-1990. Cash in circulation as reported in *Kashin Y. (eds.), Denezhnoe obrashenie v Rossii. Materialy arhivnykh fondov. Vol.3*. Moscow, INTERKRIM-PRESS, 2010.

1991-2010. M0 reported by the CBR.

### Prices series.

1861-1883. Wheat bread prices as reported in *Rykachev A., Tseny na hleb i trud v S.-Peterburge za 58 let. Vestnik finansov №31, 1911*.

1884-1913. Regional markets' retail prices as reported in *Gregory P., Economic growth of Russian Empire (end of XIX – beginning of XX century). New estimates and calculation*. Moscow, ROSSPEN, 2004.

1914-1927. Conjuncture Institute price index for Moscow (1914-1923) and USSR (1924-1927) as reported in *Vainshtein A., Tseny i tsenoobrazovanie v SSSR v vosstanovitel'nyi period. 1921-1928*. Moscow, Nauka, 1978.

1928-1955. GNP deflator as reported in *Bergson A. The Real National Income of Soviet Russia since 1928*, Cambridge: Harvard University Press, 1961. Interpolated into annual data using prices of industrial goods reported in *Bergson A., Bernaut R. and L. Turgeon. Prices of Basic Industrial Products in the U.S.S.R., 1928-50. The Journal of Political Economy, Vol. 64, No 4 (Aug. 1956)*.

1956-1961. State and co-operative retail trade prices index as reported in *Malafeev A., Istoriya tsenoobrazovaniya v SSSR (1917-1963)*. Moscow, Nauka, 1964.

1962-1990. National income deflator as reported in *Kuboniwa M. and Ponomarenko A., Historical Gross Domestic Product in Russia: 1961-1990. Proceedings of the International Workshop on Russian Economic Statistics in Historical Perspective. Institute of Economic Research, Hitotsubashi University, 2000*.

1991-2010. CPI reported by Rosstat.