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Monetary policy rules and their application in Russia

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This paper examines the Bank of Russia behaviour in post crisis period. Special attention is devoted to econometric modelling of monetary policy rules of various types. Standard model is modified in a number of ways and estimated with the use of alternative econometric techniques (GMM, OLS and TSLS methodology). One of the modifications is set in the form of a system of two simultaneous equations, describing dynamics of intervention on foreign currency market and sterilisation of excess liquidity by the Bank of Russia.

Empirical results support preliminary assumptions made on the basis of qualitative analysis of terms and principles of monetary and exchange rate policy in 1999-2003. Thus, interest rate policy of the Central Bank has had rather adaptive format, while management of base money dynamics possessed pronounced stabilising pattern. Another major finding lie in the fact that despite officially declared priority of anti-inflation policy major efforts of the Bank of Russia were turned to the regulation of the exchange rate. There are some reasons to suggest that the Central Bank intervened in the exchange market with the aim to affect not only the smoothness of the exchange rate but also its level.

Keywords. Russia, monetary and exchange rate policy, monetary policy rule, intervention, sterilisation.

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NON-TECHNICAL SUMMARY

According to traditions, practice, the economic theory and the legislation the primary goal modern central banks face is to be the control and regulation of monetary and financial flows with a view to assure stability of the purchasing power of national currency, i.e. low and predictable inflation. The central bank carrying out these functions does it best as an agent of society and monetary authorities.

Successful performance of the central bank is enforced by adherence to well-defined and precise principles, i.e. the policy focus is an achievement of set target parameters and providing quite certain reaction to standard situations. Numerous researches covering different countries confirmed that in practice central banks do follow some sort of pre-set rules in response to macroeconomic shocks.

The main task faced by the authors was to find out if such a rule exists in the case of Russia. What are the objectives that the Central Bank of Russia follows in practice while regulating monetary sphere? Do they coincide with the officially declared ones? Which objective is of the higher priority? To put it another way, this work was aimed at econometric modelling of monetary policy rule and studying its characteristics. Such a rule interrelates quantitative changes of the key monetary policy rule of the Central Bank in response to the deviation of target macroeconomic variables from their prescribed path.

The search for a descriptive rule in the case of Russia is of great interest. On the one hand, the Bank of Russia does try to follow announced targets (before the crisis 1998 the Central Bank was focused upon growth rate of money supply and the nominal exchange rate; after the crisis the focus shifted towards inflation fighting). On the other hand, when it is necessary, the Bank of Russia deviates from declared targets and in this case its policy can be treated as rather discretionary.

It should be noted that the work was not limited to formal modelling of monetary policy rule, but was extended to include in-depth studying of its features. Thus, the standard rule was modified to incorporate into reaction function exchange rate as a target variable in addition to commonly used inflation and output dynamics. Such a move was made due to a very strong influence of exchange rate behaviour on monetary sector, the processes of financial stabilisation and inflation. Indeed, stabilisation program of the Government in 1995-1997 was to a large extent based on the stability of the exchange rate. In the post crisis period, despite officially announced floating regime, the Central bank continued to closely monitor and influence the exchange rate dynamics. Accounting for this specific feature of Russian economy we going to extend the classic form of monetary policy rule and include additional target variable - the real exchange rate – as an adjunct to commonly used inflation and output gaps.

The second distinction from the standard approach consists in the selection of the instrument or the operational target of the monetary policy. The majority of Central Banks uses interest rates in the

place of official operational monetary policy tool. In the case Russia, rate of refinancing – the key interest rate of any Central Bank – used to have rather nominal status. This is because the refinancing mechanism doesn't play any significant role in the economy and the Central Bank seems to have no incentives to make it working. Moreover, in post crisis period the interest rate policy of the Bank of Russia as a whole has been of limited significance and was low efficient. The Central Bank officially adopts a growth target for money supply (aggregate M2) as an intermediate anchor to its policy.

Finally, it should be noted that the August crisis of 1998 brought about a major shift in terms and principles of monetary policy. In this sense use of the same econometric equations for two periods – before and after the crisis – is incorrect. Therefore the period under investigation is limited to post crisis years 1999-2003.

Formalised monetary policy rule was estimated with the use of various econometric techniques. The reason behind it is that every single methodology was subject to a number of serious weaknesses (in part due to very short time period under consideration and low quality of some data series). Consequently, estimated dependencies could be rather rough approximations or even fallacious. Usage of alternative methods allowed checking the validity of results and making objective conclusions.

At first monetary policy rule was estimated with the use of standard techniques, namely GMM and OLS methodology. On the second stage the Central Bank behaviour was modelled as a system of two simultaneous equations for interventions and sterilisation. These are two main instruments used to regulate exchange rate dynamics and liquidity of the money market. Note, that monetary policy rule of that form was elaborated to better fit the situation observed in the case of Russia and so far did not have analogue in literature.

Extensive studies produced the following outcome. Despite very complicated post-crisis situation and influence of various factors monetary and credit policy of the Bank of Russia was not discretionary, and in contrast, was based on quite precise reference points. We cannot assert that the Central bank followed the rules obtained in this research. At the same time stability of correlation in different specifications (GMM, OLS, TSLS) allows to declare with confidence, that monetary policy of the Bank of Russia depended on target values and actual dynamics of three macroeconomic indicators – inflation, GDP and exchange rate. Such approach fully complies with the theory and practice of monetary regulation.

However, Russia has its specific features. Until recently the basic tools of monetary regulation were interventions on the currency market on the one hand, and sterilisation arrangements on the other hand. The situation was complicated by the fact that two government bodies - the Central Bank and the Ministry of Finance – performed the latter function simultaneously, though with different intensity at various times.

In practice, effectiveness of above named operations as monetary instruments aimed at influencing the level of liquidity in the economy and keeping under control inflation development turned out to

be rather low. The analysis of monetary base shows sizeable and persistent jumps and falls in its dynamics. Our calculations confirm that increase of efficiency of monetary management would require the Central Bank to expand its set of monetary policy tools and enhance the role of interest rates.

Certain steps in the specified direction already have been made. However, till now the Central bank did not manage to use in full measure recently adopted tools. Nevertheless, 2003 in the certain sense can be considered as a turning-point.

One more distinctive feature of the Russian situation is special attention paid by the Central Bank to the movements of the exchange rate in addition to two standard target parameters – inflation and gross national product. Dynamics of the rouble/US dollar exchange rate appears as one of target variables in monetary policy rule and acts as the determining factor in the equation describing the behaviour of Bank of Russia on the currency market.

Such a situation is typical to countries with the high level of openness of economy (i.e. oriented on the export and having significant share import forming in the consumption). And Russia can be referred to their number. Not accidentally, in line with the primary goal of maintenance of a low rate of inflation exchange rate management has always been one of the key responsibilities of the Central Bank.

More important is the fact that Central bank has repeatedly made statements on priority of inflation fighting. As far as exchange rate is concerned, its official position was rather discreet: standing up against upward pressure on the Rouble caused by record high oil prices - a factor temporary in nature, the Bank of Russia allowed its strengthening in accordance with fundamental factors.

Results of the analysis, however, allow coming up with a little bit different conclusions. Steady and apparent dependence of regulating actions of the Central bank upon dynamics of the exchange rate, and specification of the equations for interventions illustrating that it is exchange rate policy that was in the centre of attention of monetary authorities while regulation of monetary sphere and inflation was of secondary importance, give the basis to assume, that in practice, scales of intervention of the Central bank in dynamics of the exchange rate were not limited to smoothing of fluctuations, and frequently appeared more significant.

The question arises, if such a policy is justified? In equations built for inflation and GDP the exchange rate do not enter as an explanatory variable. At the same time, such result can be the consequence of drastic changes of the situation and tendencies on international currency market observed over the last one year and a half. This assumption is based on our previous findings. Down to recent time dynamics of the exchange rate of rouble in relation to US dollar served one of the key variables influencing on money market and inflation.

As far as economic growth is concerned, here the dependence on the exchange rate is even more complex. Strengthening of the Rouble, first, reduces the relative prices for the import goods, secondly, reduces costs of the Russian manufacturers using import raw materials, component parts, and equipment, and, thirdly, increases purchasing capacity of domestic demand. Besides, real

appreciation of the Rouble causes an overflow of liquid resources from the sectors that are subject international competition to sectors oriented on domestic market. Thus, the net effect of real appreciation of the currency can be positive as well as negative.

Preliminary research conducted by the experts of the EEG revealed that net winners of stronger Rouble turned out to be industries oriented on local market, using import components and not facing fierce competition on the part of import. Exporters, in contrast, lose. Manufactures of services and construction sector which are classical examples of non-tradable goods, certainly, win from stronger Rouble.

But even those sector which elasticity of output with respect to the real exchange rate is negative, proved to be sensitive to factors underlying strengthening of the Rouble and in certain instances growth of output in response to higher domestic demand associated with the appreciation of the currency may dominate.

In particular, influence of growth of reserves (or increase in outflow of the capital) affects manufacture by virtue of two reasons – real easing of rouble and decrease in internal demand. Reduction of internal demand in real terms renders so strong negative effect on output, that it blocks the positive factors connected to weaker Rouble (decrease in a competition with import goods on domestic market, growth of profitability of mineral resource sector). In result rather appreciable reduction of recorded both in processing, and in export-oriented industries is observed.

Thus, the policy of restraining real appreciation of the Rouble by means of escalating reserves has significant by-effects that have to be taken into account. Nevertheless, high volatility of the exchange rate has apparent negative effect on long-term economic growth. Therefore fluctuations of the Rouble rate connected to short-term changes in volume and direction of capital flows and prices for oil, need to be smoothened, while accumulation of disbalance and development of crisis situation have to be avoided.

Two basic conclusions that can be made based upon the results of this project are the following:

- First, through the entire period of 1999-2003 monetary policy of the Bank of Russia was based upon active regulation of money supply, while interest rate regulation was rather adaptive in nature. Moreover the set of monetary tools was limited to interventions on foreign exchange market and sterilisation of excess liquidity through deposit operations. Such a regime proved to be of low efficiency. The Central bank should take additional steps forward in expanding monetary policy tools and increasing the role of interest rates to raise efficiency of its work and, in particular, to strengthen the control over a money market and dynamics of inflation.
- Second, despite formally declared priority of inflation fighting in practice major efforts of the Central bank were devoted toward exchange rate regulation. Furthermore, there are some reasons to suggest that the Central Bank intervened in the exchange market with the aim to affect not only the smoothness of the exchange rate but also its equilibrium level. At the same time, expediency of sizeable interference of the Central bank in dynamics of a rouble exchange rate can be put under doubt. Smoothing of sharp fluctuations and maintenance of stable

dynamics of the exchange rate in the long-run, certainly, remains among the primary goals of the Bank of Russia, but influence on the level of the real exchange rate with a purpose of its depreciating is hardly justified. Thus, the Central bank can be suggested to define its position with respect to the exchange rate regulation and examine mid- and long-term consequences of its operations on foreign exchange market.

1. LITERATURE SURVEY

An upsurge in research aimed at imitating monetary policy practices noted in the past decade was encouraged by work conducted by Taylor in 1993 (Taylor, 1993). His simple monetary policy rule offered a surprisingly well description of the actual behaviour of the federal funds rate. In subsequent years a numerous researches conducted for different countries proved that in practice central banks do follow some sort of pre-set rules in response to macroeconomic shocks.

Such rules are not taken literally. The rule-like behaviour, as it is specified in McCallum (1997), simply suggests an implementation of a contingency formula for instrument settings that has been selected to be generally applicable for an indefinitely large number of decision periods as oppose to period-by-period dynamic optimisation on the part of the monetary policy.

To say it another way, the policy rule is thought as a formula that specifies instrument settings that are designed to keep a target variable close to it specified target path.

The most fashionable target variable for the monetary authority is the inflation rate. Other leading target-variable choices are aggregate spending magnitudes such as GDP. As to the instrument some short-term interest rate is usually utilised.

The simple Taylor Rule specifies the central bank's policy rate as a linear function of actual or expected inflation and of the actual or expected output gap (that is, a measure of the deviation of output from capacity or trend output).

$$R_t = \bar{r} + \Delta p_t^a + \alpha_1(\Delta p_t^a - \pi^*) + \alpha_2 \tilde{y}_t . \qquad (1)$$

Here R_t is the short-term nominal interest rate that the central bank in question uses as its instrument or "operating target," i.e., the interest rate over which it exerts control at a daily or weekly frequency. Next, $\bar{r}$ is the long-run average real rate of interest, Δp_t^a is an average of recent inflation rates (or a forecast value), and π^* is the central bank's target inflation rate. Finally, $\tilde{y}_t$ is a measure of the output gap, the percentage difference between actual and capacity output values.

In Taylor (1993) the measure used for Δp_t^a is the average of GDP deflator inflation rates over the past four quarters, while capacity output is represented by a linear trend for the log of real GDP fit to quarterly observations for the years 1985-1992. In Taylor (1999), the Hodrick-Prescott (HP) filter is used instead to generate residuals from "trend" that are taken to represent $\tilde{y}_t$. The rule suggests, of course, that monetary policy should be tightened (by an increase in R_t) when inflation exceeds its target value and/or output exceeds capacity.

Subsequent applications of the Taylor rule have modified or extended formula (1) in several ways. Some have used proxies for expected future inflation in place of Δp_t^a while others have done

something similar for $\tilde{y}_t$ or used $\tilde{y}_{t-1}$ instead. A special case of the Taylor rule, where the weight on the output gap is zero, is 'inflation targeting', in which the policy rate responds only to expected inflation.

One widely adopted modification of the Taylor rule is to permit partial adjustment of the central bank's rate, i.e. to include R_{t-1} on the right-hand side as a determinant of R_t; this adjustment is intended to reflect the practice of interest rate smoothing, which is widely believed to be prevalent in the behaviour of many central banks.

An important line of investigation has been pioneered by Orphanides (1998), who has attempted to base rule calculations on values of Δp_t (inflation) and $\tilde{y}_t$ that were actually available to central bank policymakers at the time that historical instrument settings were chosen. Orphanides recognises that current-period values for $\tilde{y}_t$ could not be known until after the end of period t, and also emphasises the fact that macroeconomic data is often substantially revised after its initial reporting.

The rule proposed by McCallum (1993) used base money instead of interest rate as the instrument and nominal income growth target.

$$\Delta b_t = \Delta x^* - \Delta v_t^a + \beta(\Delta x^* - \Delta x_{t-1}) \qquad (2)$$

Here Δb_t is the change in the log of the adjusted monetary base, i.e., the growth rate of the base between t-1 and t periods. The term $\Delta x*$ is a target growth rate for nominal GDP, Δx_t being the change in the log of nominal GDP. This target value $\Delta x*$ is specified as $\pi^* + \Delta y*$, where $\Delta y*$ is the long-run average rate of growth of real GDP. The second term on the right-hand side of (2), Δv_t^a is the average growth of base velocity. This term is intended to reflect long-lasting changes in the demand for the monetary base that occur because of technological developments or regulatory changes (presumed to be permanent); it is not intended to reflect cyclical conditions. These conditions are responded to by the final term, which prescribes that base growth is adjusted upward (i.e., policy is loosened) when Δx_{t-1} falls short of $\Delta x*$.

The main open economy alternative to simple rule for closed economy due to Taylor was introduced by Ball (1999). It is based on a Monetary Conditions Index (MCI) as an instrument – a weighted average of interest rate and exchange rate instead of the interest rate only. Also on the right side of the rule, inflation is replaced by 'long-run inflation', a variable that filters out the transitory effect of exchange rate movements.

Search for monetary policy rule in the case of Russia was first made by Drobyshevsky and Kozlovskay (2002). Following Clarida, Gali and Getler (1998) authors used GMM methodology. They focused entirely on short-term interbank rate as an instrument and did not investigate any alternatives (deposit rate, base money). Drobyshevsky and Kozlovskay managed to catch adequate response of interest rate on inflation and exchange rate developments but failed to incorporate output variable into the model. Another weakness of the above named work is low reliability of

estimated coefficients due to the very short period (covering only three years from 1999 to 2001) and most likely inadequate set of instruments (see chapter Validity of Instruments).

Formal models, set of target variables as well as their potential or desired values examined by the authors in this research differ from those used by Drobyshevsky and Kozlovskay. However, general conclusions are similar.

2. MONETARY POLICY OF THE BANK OF RUSSIA

Achieving and preserving price stability is considered to be the main objective of any central bank. This goal at the most corresponds to the interests of the economy as a whole and capabilities of the monetary authorities. Recognition of this fact led to a major shift in the pattern of monetary policy. Over the past 20 years several tens of countries all over the globe, various in depth and model of economic development turned to inflation targeting monetary policy framework.

Success of anti-inflationary policy depends on a number of factors, which in their turn are subject to parameters of macroeconomic situation present in the country and its specific features. Thus, developed countries, where production is oriented primarily towards domestic market operate in a different way than small, export oriented developing economies. The former may allow disengaging themselves from exchange rate dynamics while targeting inflation and economic growth, the later – may not.

Divergences in patterns of monetary policies also rest upon the choice of instruments (intermediate goal) used by different central banks. Monetary authorities in industrial countries employ interest rates in the place of the instrument. Developing economies and countries in transition still rely mainly on monetary targeting, which is the consequence of underdevelopment and low efficiency of their financial sectors and banking systems.

The Central Bank of Russia also adheres to the policy of monetary targeting. In recent years it has actively been employing elements of inflation targeting. However, the intermediate target is invariantly set in the form of money supply growth. Formally, aggregate M2[1] is used, though the Central Bank has more power to monitor base money development. Indeed, dynamics of these two aggregates were very close to each other, at least in the post crisis period.

As far as interest rate policy of the Bank of Russia is concerned, it has been conducted in crippled format and lacked efficiency. Two factors behind it are absence of well developed and competitive financial market and shortage of monetary policy tools available to the Central Bank.

Thus, the rate of refinancing has had largely nominal status. Right after the crisis of August 1998 it was set at 60 per cent. Gradual reduction of the rate of refinancing began in 2000. During the year it

[1] The M2 aggregate is the volume of cash in circulation (outside the banks) and balances in national currency in the settlement and current accounts and deposits of resident non-financial enterprises, organizations and individuals. It does not include foreign-currency deposits.

was adjusted five times and as a result cut to 25 per cent. This reduced the main rate by more than half, and was possible thanks to the notable decline in inflation and interest rates, and stabilisation of the foreign exchange market in 1999 and 2000. Monetary policy softening was aimed at stimulating credit activity of the banking system, and thus giving additional impetus to economic development.

At the end of 2000, for the first time after the crisis, the refinancing rate was brought into line with macroeconomic situation, although representative gap between two rates – of refinancing and inflation – was preserved (at that time inflation amounted to 20 per cent). Nominal status of the refinancing rate was also conserved.

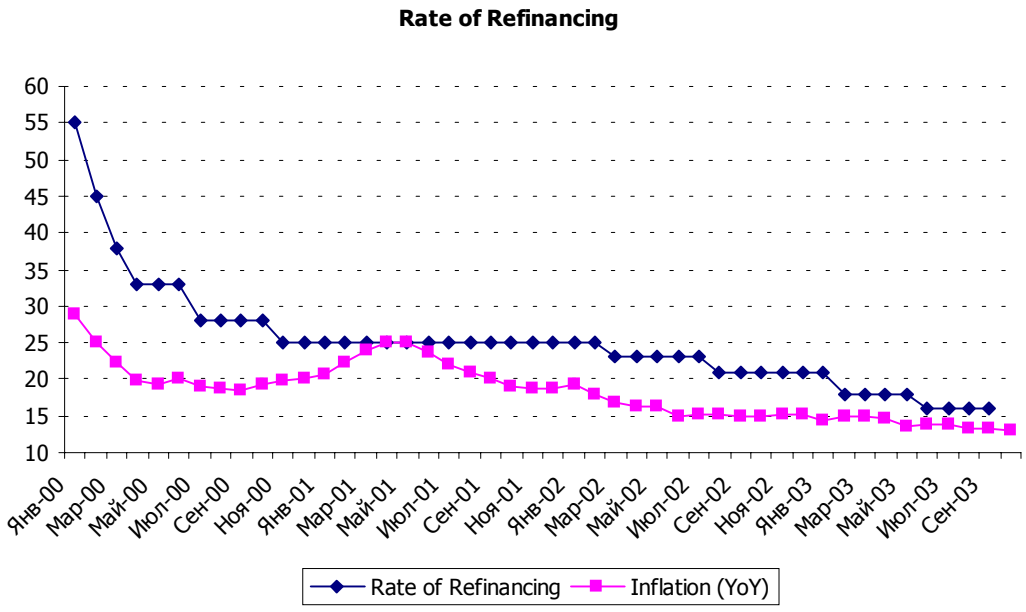

Fig. 1. The rate of refinancing and inflation dynamics in 2000-2003.

In the course of 2001 the main rate stayed unchanged and next adjustment down was made in 2002. That year reduction by another four percentage points let the rate of refinancing to fall to 21 per cent. However, economic meaning of the rate has not changed much. Unlike Central Banks in other countries, the Bank of Russia has not been conducting refinancing of commercial banks.

Interest rates on the government securities market usually moved ahead of the refinancing rate, and the later only consolidated the achieved reduction of the formers, but did not really shape them. The rate of refinancing did have effect on commercial banks deposit rates, however can not be named the main factor behind their dynamics, as long as banks follow broad macroeconomic situation and state of the money market when set household deposit rates.

Refinancing mechanism did not work and the Central Bank of Russia was not eager to launch it. First of all, there was permanent excess of liquidity in the economy, and money market rates were an order of magnitude lower than the Central Bank rate. More over, neither the banking system nor the real sector of the economy was ready to effectively allocate and apply credit resources.

The rate of refinancing obtained functional status only in the beginning of 2003. The Bank of Russia reduced it by another 2 percentage points to 18 per cent and set it even with the overnight credit and currency swap rates. Thus, the above named operations started to be conducted at the rate refinancing. As far as the banking system is concerned, it still experiences excess of short term liquidity and refinancing, though formally initiated by the Central Bank, is not claimed by banks.

The Bank of Russia rate has only indirect influence on credit rates and credit activity in the economy. The rate of refinancing plus three percentage points is some sort of upper bound for credit rates. Having exceeded it the enterprises lose the ability to charge interest to expenses and have to pay additional taxes. Therefore, corporate sector is not willing to borrow at a higher rate. At the same time, for commercial banks refinancing rate is not decisive, especially taking into account high risks present in the economy.

All in all consecutive reduction of the refinancing rate did have effect on the financial market and the economy as a whole, however, rather qualitative. The Central Bank moves shaped and consolidated positive expectations, as far as demonstrated by themselves the Bank of Russia confidence in favourable macroeconomic situation and irreversibility of disinflation process.

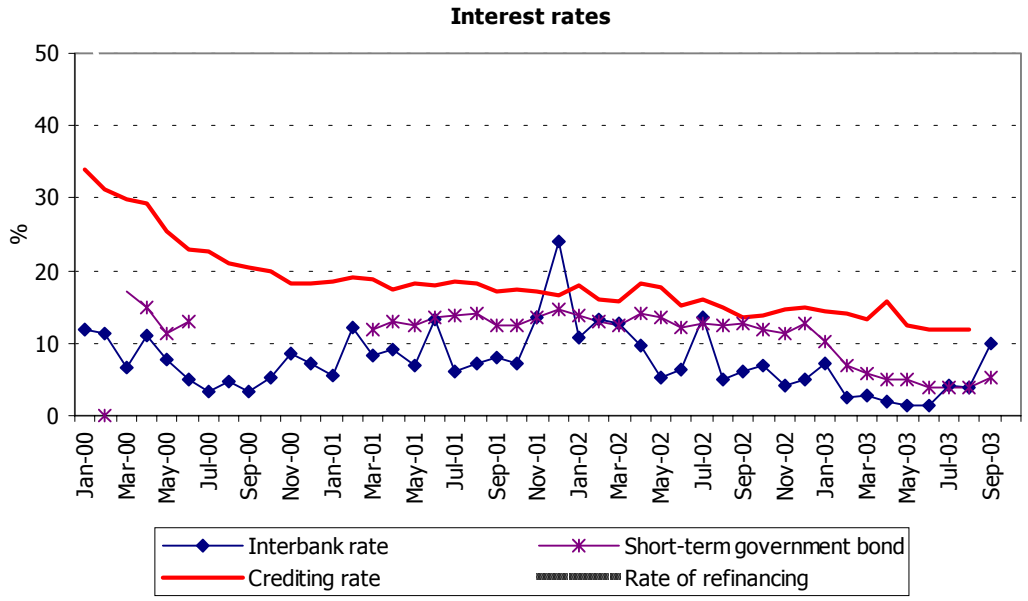

Fig. 2. Dynamics of main interest rates in 2000-2003.

Open market operations with government securities have not been carried out up until the beginning of 2003 for the lack of marketable securities in the Central Bank portfolio. Partial reorganisation of the portfolio took place in February 2003. Then government papers in the amount of 30 billion roubles were restructured into marketable bonds and the Central Bank finally resumed operations on local debt market. As an exception, at the end of 2001 the Bank of Russia offered single issues of Bank of Russia bonds. There were three auctions and all of them failed. Market participants showed no interest in this instrument. Total amount of rouble funds borrowed by the Central Bank

from the market made less than 1 billion roubles out of 7.5 billion roubles face value of these three issues.

Over the years 1999-2003 norms of required reserves were adjusted only two times, namely in the middle and at the end of 1999. Henceforth reserve requirements stayed unchanged, irrespective of the stance of money market, nature of inflationary process, and tasks faced by the Bank of Russia.

Table 1. Reserve Requirements[2]

Date	For funds borrowed from legal entities in Roubles and in foreign currency	For funds borrowed from individuals in Roubles	For funds borrowed from individuals in foreign currency
19.03.99 - 09.06.99	7	5	7
10.06.99 - 31.12.99	8.5	5.5	8.5
01.01.00 - 31.03.04	10	7	10

Source: The Central Bank of Russia

Over the whole post crisis period deposit rate was the only properly operational interest rate employed by the Central Bank. Deposit operations were used with different degree of intensity to mop up excess liquidity from the money market. Most actively this instrument was utilised in 2000 and 2002. During the most of 2001 attractiveness of deposit operations was low. Two factors behind that were gradual reduction of deposit rates in the course of 2000 and acceleration of inflation in the beginning of 2001. The Central Bank began to make steps to activate deposit operations only in the second half of the year. Despite numerous upward adjustments deposit rates still stayed below interbank rates and interest rates on government debt market. Thus the Central Bank moves did not have desired effect. Amount of funds placed by the commercial banks on deposit with the Bank of Russia has not increased, but dropped further. On the threshold of 2001 and 2002 the Bank of Russia raised deposit rates once again. The move was aimed at sterilising excess liquidity and neutralising (at least partially) splash of speculative demand for foreign currency, typical for the end of the year – beginning of the next year. Although, investment in dollars retained priority, while deposit operations attracted attention of commercial banks only in the beginning of 2002.

In 2002 interest rate policy of the Central Bank underwent a major modification. First of all, profitability of deposit operations was substantially reduced, while time structure was shifted from short towards longer-term deposits. Thus, in the second quarter of 2002 the Bank of Russia took unexpected step – in the face of huge amount of excessive rouble liquidity on the market it undertook sizeable reduction of deposit rates – by 4-5 percentage points in the case of short-term

[2] The percentage ratio of required reserves to a credit organization's liabilities and the procedure for depositing reserves with the Bank of Russia are established by the Bank of Russia Board of Directors.

deposits (up to two weeks) and by 1 percentage points in the case of longer-term deposits (one and three months).

Deposit rates were further reduced in August – by 1-2 percentage points. What is important, the amount of funds placed by commercial banks on deposit with the Central Bank did not lessened but even grew.

It also needs to be pointed out that the Bank of Russia efforts aimed at altering the term structure of deposits did have effect. In the beginning of 2002 the share of one- and three-month deposits amounted to only 10-12 per cent, while in July-August it jumped two times to 22 per cent. As a result of this shift quality of deposit operations as a tool of sterilisation has increased. However, money market was still far from being stable and the problem of effective sterilisation of excess roubles remained.

Most important steps aimed at extending the set of available monetary policy tools and resuming refinancing of commercial banks were made by the Central Bank in September-November 2002. Thus, the Bank of Russia returned to operations of direct PEPO and launched reverse REPO (in such a deal, the Central Bank auctions securities on the terms of their buy-back to be effected on a date and at a price fixed in advance). The former operations have been carried out on continuing basis twice a day since November 2002, while the later became regular only in 2003.

Also, overnight currency swaps were introduced. In these deals the Central Bank purchases foreign currency for roubles from banks by "today" payments at an official rate and resales it by "tomorrow" payments. According to the CBR's press release, "the difference in a selling rate and a basic rate will depend on present-day problems of the monetary policy." The measure was aimed at preventing cyclical liquidity shortages that sent the interbank interest rates to sky-high levels and helping banks with short-term liquidity management.

Concurrently deposit mechanism was further adjusted. The Bank of Russia started to hold deposit auctions with Moscow banks and regional banks that have agreements with it. A unified fixed interest rate of 3 per cent was set for all deposit with a maturity of up to one week. Longer-term deposits were terminated.

In conclusion it is necessary to tell some words about monetary policy of the Central Bank in 2003. In this period it had a set of more efficient that ever before tools and used them on a constant basis. In the first half of 2003 high level of spare liquidity on the market has caused a priority of sterilising actions.

Rouble funds withdrawn from the market over the period from February and till May with the help of deposit operations and operations of reverse modified REPO amounted to 141 Rouble billion (or US$ 3,7 billion). Note that, growth of volumes of sterilisation occurred on a background of radical decrease in interest rates from about 9 % in January up to 2,5 % in May. From the point of view of inflation fighting interest rate policy of Bank of Russia was not quite adequate. In theory interest rates of the Central bank should have been increased to mop up all excessive liquidity from the market and obtain full control over inflation. However, low rates on the world capital market did

not give the Central bank an opportunity to establish its interest rates, being guided exclusively by the dynamics of monetary aggregates and inflation as high rates could provoke inflow to the country of additional volumes of currency in the form of foreign capital and aggravate a situation on the foreign exchange market and further on a chain in monetary sphere.

Anyhow, but, by May profitability of the Rouble instruments has reached the minimal values and demand for them has sharply fallen. Since June, the regularity REPO operations was reduced. Out of 6-8 auctions announced in practice only 1-2 auctions a month were carried out, but even then interest of banks was the lowest. The demand of deposit operations also has considerably decreased. As a result from June and till September the reverse process, namely, decrease in the Central bank liabilities to the banking sector was observed.

Let's note, that the dynamics of reserves during this period was replaced on the opposite. After the accelerated growth during the most part of the first half of the year, in June-September reserves experienced a reduction, having lost in total US$ 2,8 billion. Outflow of funds from accounts of commercial banks with the Bank of Russia has neutralised falling reserves, that becoming the main source of growth of money supply during this period.

Thus, finally the situation has turned for the better. By the time when opportunity to effectively regulate money market was exhausted and the Bank of Russia lost control over money and inflation dynamics, situation changed and process of de-sterilisation appeared to be completely adequate to new conditions.

Below in the table dynamics of base money during the post-crisis period and the main sources of growth of money in economy are given:

Table 2. Base money dynamics (billion of roubles)

	1999	2000	2001	2002	2003
Base money growth	114	195	198	218	268
Net International Reserves	128	534	358	496	546
Net Domestic Assets	-14	-339	-162	-278	-278
of which:					
Net Credit to Enlarged Government	33	-190	-64	-22	-243
Net Credit to Banks	-22	-82	0	-68	27
OIN	-25	-67	-98	-188	-62

Overview of terms and principles of monetary policy in 1999-2002 allows us to conclude that during this period monetary regulation relied upon intervention and sterilisation as monetary tools. Introduction of new instruments did raise the importance of domestic interest rates as a monetary policy instrument and reduce the influence of the exchange rate. However, it happened only at the end of 2002, while over the most of post crisis period interest rate policy of the Central Bank has been rather adaptive in nature and had very little in common with both money market and real economy interest rates, say nothing about inflation dynamics.

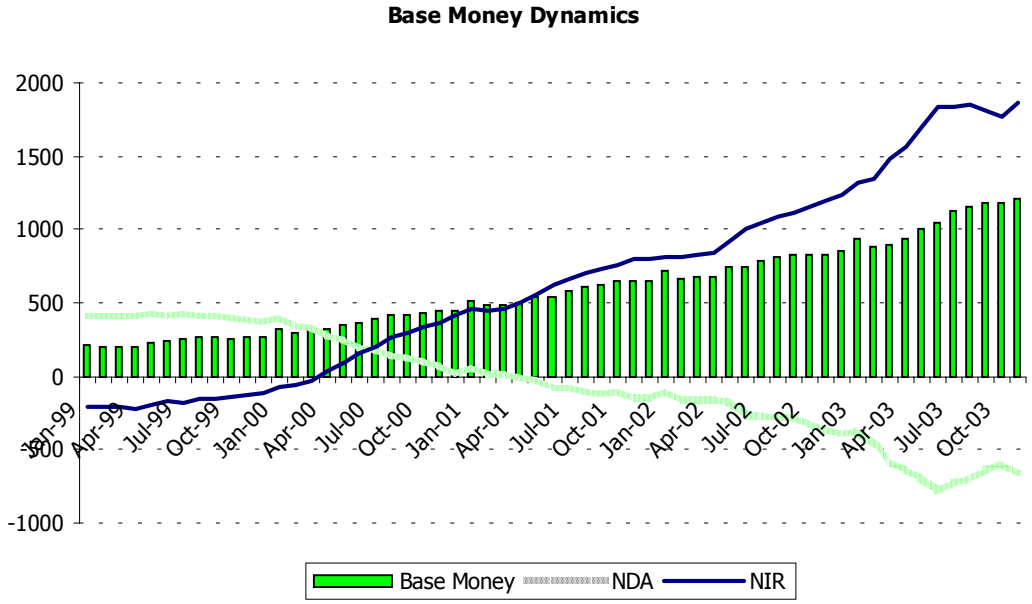

Fig. 3. Base money dynamics by components in 1999-2003.

To support this idea, below is the quotation from the Monetary Policy Guidelines for 2003:

> *"In the absence of mature and competitive financial market and well-developed banking system, influence of monetary policy tools on inflation is still weak. The Central Banks' interest rates do not have adequate effect on interbank market. The later remains to be narrow due to mutual distrust among banks. This factor coupled with the absence of common market for interbank credit and lack of competitiveness in the banking sector reduces the role of the interbank interest rates in shaping deposit and credit rates for banks clientele. On the other hand, credit rate is often not a decisive factor for most of households and companies, since the share of banking credit in total investment is still very low".*

According to Central Bank's official statements, it is going to adopt monetary policy based on interest rate as an instrument only in a few years. Currently, it employs monetary aggregates as intermediate target, while the main instruments used to control their dynamics are purchase and sale of currency and deposit operations carried out by the Bank of Russia and accumulation (reduction) of rouble deposits with the Central Bank by the Government.

Choice of instrument and effectiveness of monetary policy could also be analysed against the background of prevailing mechanism of monetary transmission present in the economy, i. e. in which way the Central Bank's moves affect money market and economy as a whole. There are three main channels: interest rate, credit and asset price.

In the first case, interest rates stand as a conductor. The Central Bank decisions with respect to the amount of liquidity determine the level of interest rates in the economy, which in its turn affects investment and the other components of aggregate demand, and finally GDP. Credit channel works manifold. In particular, there are the following variants: bank credit, balance sheet, cash flow, unexpected changes in price level, household liquidity. Anyway, this channel is more active in

economies with well-developed banking system (where bank credit is used to be the main source of borrowed funds for the real sector of the economy) and operates through the expansion of credit activity. Asset price channel also has a number of modifications. In our case, the most interesting of them is exchange rate channel. This one is well observed in countries with freely floating exchange regimes, when fluctuations of domestic interest rates lead to short-term adjustments in exchange rate. For instance, monetary policy softening would initiate drop in interest rate, which in its turn would cause decrease in demand for local currency and its depreciation. As a result the economy will face growth of export and GDP.

Unfortunately we are not aware about in-depth studies devoted to the analysis of prevailing monetary transmission mechanism in Russia. Very interesting research has been conducted the Institute of Economy in Transition (see Drobyshevsky and Kozlovskay, 2002). However, this work was done as an overview and covered the entire period 1992-2001. Consequently, the post crisis period was given low attention, also due to the lack of data.

At the same time, taking in to account monetary policy pattern and tendencies present in the economy, we dare to suggest that in the case of Russia the most active monetary transmission channel is credit channel. Although its distinctive features is that it operates a roundabout way, passing over the banking system.

Extremely favourable conditions on external market (in particular, sky-high oil prices) and undervalued rouble led to sharp increase in profitability of export oriented sectors. Expansionary monetary policy was the consequence of heavy inflow of foreign currency in the form of export earnings and the government policy of weak rouble (allowing only gradual its revaluation). Huge profitability of oil companies made them to actively invest in both own business and other sectors of the economy.

Exchange rate channel is also present in Russia, however it has its own peculiarities. Thus, the Central Bank operations on foreign exchange market affect first of all the exchange rate itself. Monetary authorities' interventions are aimed at restraining the pace of rouble appreciation. Undervaluation of national currency increases competitiveness of domestic producers on external markets, bringing about growth of net export and GDP. In this case, monetary expansion is a by-product of exchange rate policy.

As far as interest rate policy is concerned, the situation described above allows suggesting that Russian case is the very specific one. Interest rate policy was active in 1995-1998, when the Central Bank open market operations determined interest rates on government securities market and allocation of banks' funds between investment in securities and commercial crediting. In post crisis period capacity of domestic debt market has sharply reduced and the Central Bank operations in this sector of financial market were discontinued. The resumption occurred only in the beginning of 2003.

Based on our analysis of terms and principles of monetary policy in 1999-2003 we will estimate monetary policy rule of the Central Bank in both its standard form (i. e. with different interest rates

being instruments) and specific form, that allows us to account for Russian situation. In the later case we will first investigated monetary policy rule based on the assumption that the Central Bank operates monetary targeting regime and uses monetary base as an instrument. Also we will try to build two separate equations and exploit intervention and sterilisation in the role of instruments.

3. THE FORM OF THE MONETARY POLICY RULE IN CASE OF RUSSIA

On the first stage of our investigation, we constructed the standard form of the rule for small open economies, based on Clarida, Gali, Gertler (1998, 2000) and Cuche (2000), which is just a modification of the classic Taylor rule. There are two equations building the model: a policy rule guiding the central bank's behaviour and a market equation representing the monetary sector of aggregate demand.

The first equation concerns the targeting rule for setting the monetary policy instrument. It feeds back from target or trend deviations of inflation π, real output[3] y and exchange rate *rer*. So, let w_t^* denote the target value for the monetary policy instrument in period t expressed in percentage changes (for interest rate and monetary base) and nominal quantity (for foreign exchange interventions and sterilisation). The target is determined each period as a function of the gaps between expected inflation, real variable and exchange rate and their respective target levels. Specifically:

$$b_t^* = \alpha + \beta(E[\pi_{t,k}|\Omega_t] - \pi^*_{t,k}) + \gamma(E[y_{t,q}|\Omega_t] - y^*_{t,q}) + \delta(E[rer_{t,l}|\Omega_t] - rer^*_{t,l}) \quad (3)$$

where $\pi_{t,k}$ denotes the percent change in the price level between periods t and $t+k$; $\pi^*_{t,k}$ is the Central Bank target for inflation in that period; $y_{t,q}$ is a percent change in real sector variable between period t and $t+q$; $y^*_{t,q}$ is its desired growth rate; $rer_{t,l}$ is percent change in real exchange rate between period t and $t+l$; $rer^*_{t,l}$ is the desired growth rate of the real exchange rate. E is the expectation operator, and Ω_t is the information set at the time the instrument is set. α is, by construction, the desired or long run value of the instrument when inflation, economic activity and exchange rate are at their target levels.

The second equation sets a simple partial adjustment mechanism to relate the actual and target instrument growth:

$$b_t = (1 - \rho)b^*_t + \rho b_{t-1} + \varepsilon_t \quad (4)$$

where $\rho \in [0,1)$ is an indicator of the degree of smoothing of the instrument changes, ε_t is a zero mean exogenous shock, and the instrument target value w^*_t is given by (3). Two different (but compatible) interpretations can be given to the ε shocks. First they may reflect the central bank's failure to keep the instrument at the level prescribed by its rule, as it would be the case in the

[3] Otherwise it is possible to use instead other real variables, such as industrial production or rate of employment.

presence of money demand shocks. Or, alternatively, they may capture deliberate decisions to deviate transitorily form its systematic rule (i.e., true "policy shocks").

Combining the partial adjustment equation (4) with the target model (3) yields the monetary rule equation, which were estimated:

$$b_t = (1-\rho)\alpha + (1-\rho)\beta(\pi_{t,k} - \pi^*_{t,k}) + (1-\rho)\gamma(y_{t,q} - y^*_{t,q}) + (1-\rho)\delta(rer_{t,l} - rer^*_{t,l}) + \rho b_{t-1} + \xi_t \qquad (5)$$

где $\xi_t \equiv -(1-\rho)\{\beta(\pi_{t,k} - E[\pi_{t,k}|\Omega_t]) + \gamma(y_{t,q} - E[y_{t,q}|\Omega_t]) + \delta(rer_{t,l} - E[rer_{t,l}|\Omega_t]\} + \varepsilon_t$.

Taking into account peculiarities of the monetary policy conduction and specificity of problems faced by monetary authorities, we used several alternative aggregates as monetary policy instruments for policy rule estimation. They were different-term deposit interest rates of the Bank of Russia, the interbank interest rate and the monetary base aggregate. Concerning target variables, we used consumer price index of Goskomstat as inflation indicator, the Central Bank data to evaluate real exchange rate dynamics in different specifications (comparing with US dollar on the base of end-of-period and average nominal exchange rates, effective real exchange rate, or constructed real exchange rate used import or export prices as deflators).

As regards economic activity variables, GDP and industry production growth rates were taken on the initial stage. The former gives outright representation of economic dynamic. It has to be noted that industrial sector accounts for only 30% of gross domestic product, while sector of services gives more than 50%. Another problem is that GDP and industrial production do not move uniformly all the time. In some periods economic growth can be lead by the service sector while industrial production, on contrast, can experience stagnation. For this reason it is not quite correct to approximate rate of economic growth by the dynamics of industrial production.

At the same time there are a number of inconveniences associated with GDP index that made difficult use of this aggregate. First of all, index is calculated on quarterly basis only. Official monthly data are not published. They are calculated by the Goskomstat, but only as indicative values. Besides, GDP series is subject to regular revision and refining, and in this sense, data which we have now and use in our calculations, do not correspond to prime numbers that the Central bank based upon while making its decisions. From this point of view, industrial production series is more adequate: the official data, on the one hand, are published on a monthly basis, and on the other hand, are rather accurate and not subject to revision.

As to one more "real" variable, namely, the rate of unemployment, is concerned, there are two arguments against it. First, it is also quarterly based (monthly data are published, but they have rather conditional status and as a rule are prone to major adjustments). Secondly, relative importance of unemployment figures remains low. In Russia this indicator is not of wide use (in contrast to, let's say, Europe or USA). Economic agents and the Government do watch over its dynamics, but not as steadfastly, as in the case of GDP, industrial production, inflation or international reserves. Nevertheless we did try to incorporate unemployment in our models. Moreover, on the final stage of our project we also estimated an equation which included output of

five basic sectors of the economy[4] as an indicator of economic activity. This aggregate provides more comprehensive image of the economy than industrial production does. Its advantage over GDP is availability of monthly series: prime figures are rather accurate and not subject to major alteration.

We did not include international reserves in the set of target variables either. First, the level of reserves was crucially low in 1999 only. By the end of 2000 reserves amounted to USD 28 billion. This volume exceeded pre-crisis level 1.5 times and allowed 3-month import coverage. Thus, even if accumulation of reserves was among the Central bank goals, then only over a short period of time. After 2000 dynamics of this aggregate did not pose a problem. And in 1999-2000 regulation of international reserves more likely was the minor question for the Central Bank. The later was focused on exchange rate dynamics and inflation, and always tried to smooth drops on foreign exchange market even at the expense of reserves.

4. MONETARY POLICY RULE ESTIMATIONS

4.1. Data description

We estimated models on the 2000-2003 period characterised both the stability of monetary policy targets and instruments, and the availability of the necessary data. To rise predictability of our model required by experts, we proceeded to yearly growth data rather than monthly growths used before. Unfortunately, well-known low power of unit root tests for small samples do not give us possibility to explore this problem accurately, so we decided to suppose the stationarity of our growth rates data a priori.

Measurement of each variable was adjusted to the growth rate with respect to the same month of the previous year[5]. In order to construct series for targets (π^*, y^*), corresponding official statements of monetary authorities were elicited from the yearly Main Monetary Policy Guidelines, which are prepared and published by the Bank of Russia. Monthly data were obtained by linear interpolation. As far as industrial production, output of five basic sectors, unemployment and real exchange rate targets are concerned, they were evaluated by HP-filter.

Data on gold and foreign currency reserves are the official data of the Central bank. Following recommendations of experts, we adjusted initial series having excluded the influence of fluctuation in US$/Euro exchange rate.

To construct intervention series, dynamics of gross international reserves was corrected for external debt payments. Two facilities employed by the Central Bank to sterilise excess liquidity are reverse REPO and deposit operations. Amount of funds placed by commercial banks on the Bank of Russia

[4] Industry, agriculture, construction, transportation and retail trade.

[5] See specification of variables at Annex 1.

accounts was used as a proxy for sterilisation. Participation of the budget in sterilisation process was approximated by the dynamics of general government's deposits place with the Central Bank, official data on which were published in Analytical Accounts of Monetary Authorities.

4.2. The estimation results

Monetary policy rule estimated by GMM. The first stage of our research consists in the monetary policy rule estimation by the commonly used in these sorts of investigations, especially in the forward-looking form of the rule, Generalised Method of Moments (GMM) (see, among others, Clarida, Gali and Gertler, 1998 and 2000, Cuche, 2000 etc.).

First, this method is useful for estimation of forward-looking reaction functions where the right hand side contains expected values for economic activity variable, inflation or exchange rate, which are not directly observable. Second, it helps to eliminate a potential simultaneity bias: the instrument changes in respond to anticipated inflation, real variable and exchange rate variations but, in turn, may affect these variables.

Proceeding GMM, we need to choose vector of instrument variables, which should be known at the moment of making decision with respect to b_t. Initially, for this purpose we used just lags of correspondent targets and instrument variables, further the set of instruments was largely extended. We tried to incorporate into the model as instruments such indicators as world oil prices, Russian oil export, capital flows (net export of goods and services) as a share of GDP, reserves accumulation as a share of GDP, variety of real and nominal energy prices (mostly on electricity and natural gas), world and domestic interest rates, as well as uncovered interest rate parity calculated by different methods. After that, our model was examined for overidentification and validity of instruments.

Validity of instruments. Results of GMM estimation are considered adequate if the overidentification hypothesis fails and instruments are exogenous. The latter is a precondition for consistency of estimations.

In the theory, there are weak, strong and super exogeneity. A variable z_t in a model is defined to be *weakly* exogenous for estimating a set of parameters λ if inference on λ conditional on z_t involves no loss of information. Heuristically, given that the joint density of random variables (y_t, z_t) always can be written as the products of y_t conditional on z_t times the marginal of z_t, the weak exogeneity of z_t entails that the precise specification of the latter density is irrelevant to the analysis, and, in particular that all the parameters which appear in this marginal density are nuisance parameters.

If in addition to being weakly exogenous, z_t in not caused in the sense of Granger by any of the endogenous variables in the system, then z_t is defined to be *strongly* exogenous. If all the parameters λ of the conditional model are invariant to any change in the marginal density of z_t, and z_t is weakly exogenous for λ, then z_t is said to be *super* exogenous (Ericsson, Irons 1994, pp.40-41).

For instruments to be valid only weak exogeneity is required.

One way to examine the adequacy of the model is to follow Davidson, MacKinnon (1993, 235-236) and test joint null hypothesis for correct specification of the model and validity of instruments. The test statistic (equalled to the number of observations multiplied by uncentered R^2 of the original model's residuals regression on the set of instruments) should be less than $\chi^2_{(l-k)}$, where l is the number of instruments while k is the number of explanatory variables of the original model. However, if the null hypothesis is rejected, it gives us no information whether non-overidentification or exogeneity were failed.

That is the reason why investigation of two problems, i.e. the right specification and exogeneity of instruments, taken separately is more convenient. To test overidentification we used the standard *J*-statistic, generated by EViews. After that, all instrument variables in the specification were checked for weak exogeneity by commonly used *Wu-Hausman* test (Ericsson, Irons 1994, 103-104). Thus, each suspicious variable is regressed on all the instruments of the model. Then the estimated error term from this regression is put into the original model as an independent variable and its significance is tested by *t*-statistic. If this term is insignificant, the null hypothesis of weak exogeneity for the given instrument is not rejected.

The third crucial condition that ought to be met to obtain consistent estimates is non-autocorrelated residuals. This property is very important in the case of models similar to what we use, i.e. models that include lagged depended variable in the right-hand side of the equation. The simplest test that a good model should pass is adequate value of Durbin-Watson statistic.

Estimation results. On the first stage monetary policy rules in its standard form (with various interest rates as instruments) were built. We used two alternative interest rates: interbank market interest rate on one-day credit and the Bank of Russia interest rate on overnight deposit. We also tried to make use of longer-term deposit rates but failed to obtain reasonably good equations. Indeed, the share of overnight deposits very rarely dropped below 40 per cent and in some periods reached 70 per cent of total amount of funds placed by commercial banks on deposit with the Central Bank. We did not consider other interest rates managed by the Bank of Russia due to the lack or low intensity of corresponding activities. As far as interbank market is concerned, it is also dominated by one-day operations (these accounted for 75-95 per cent of total turnover of the rouble sector of the market). The reason for this is twofold. First of all, interbank market is intrinsically short-term. Mutual distrust among banks conserved in post crisis period also adds to this fact.

Our preliminary results testified that over the most of post crisis period interest rate policy of the Bank of Russia had been rather adaptive. Coefficients under inflation, GDP and exchange rate had correct sign, however was much less than 1 in absolute value. Positive signs in the case of the first two target variables mean that the Central Bank tightened monetary policy by adjusting interest rates upward, when faced acceleration of consumer price growth and economic activity. Negative sign in the case of the third target variable indicates that the Bank of Russia raised interest rates, having stimulating outflow of rouble funds from money market to foreign exchange market, growth of demand for dollars and subsequent slow down of rouble appreciation. Lagged variable of interest rate had positive sign and was less than 1 in absolute value, which is in accordance with the theory.

It means that the Central Bank adjusted interest rate gradually to minimise negative effect of abrupt changes in its policy on money market and the economy as a whole. On the second stage, we failed to obtain satisfactory model specification when turned to data in new format (i.e. growth rates with respect to the same month of the previous year). This fact may be considered as an argument in favour of miner importance of interest rates as monetary policy instruments.

Alternative model specification that used yearly instead of monthly growth rates of the variables did not provide satisfactory monetary policy rule for interest rate as an instrument. The best equation (see Attachment 2, Table 2.8) possesses bad statistics: it has low explanatory power (R^2) and insignificant coefficient under target inflation. Moreover, value of J-statistic does not allow accepting the hypothesis of non-overidentification, which questions the consistency of estimated results. Besides, coefficients are of wrong sign. Thus, acceleration of inflation correlates with interest rate reduction, which also could be seen as an evidence of non-conventional and rather adaptive interest rate policy of the Bank of Russia in the post crisis period. At the same time coefficient under lagged interest rate is positive and quite large, which indicates interest rate smoothing applied by the Central Bank to avoid negative effect of sudden changes on money market and the economy. All in all these results once again support the idea that interest rate policy was not of prime priority for the Bank of Russia in 2000-2003.

Then we explored high-powered money in place of an instrument. The Bank of Russia influences inflation through the regulation of money supply. The latter depends upon dynamics of the base money – aggregate that is most controllable by the Central Bank

Now we will discuss problem of selecting target variable used as a proxy for the level of economic activity. Initially we employed two alternative indicators, i. e. GDP and industrial production. Attempts to incorporate the latter aggregate into monetary policy rule did not provide satisfactory outcome – both in the case of MPR that used interest rates in place of instrument and MPR that utilised base money. For this reason we focused on GDP series.

Estimated monetary policy rule with real GDP growth variable had clear economic interpretation, but failed to meet all required econometric properties. For instance, one of the models (see Annex 2, Table 2.1) suffered marked residual autocorrelation. This weakness could be eliminated only through inclusion of non-exogenous variables into the set of instruments[6].

Further we estimated models incorporated alternative proxies for economic growth, i.e. unemployment dynamics and output of five basic sectors. The former indicator failed to produce reasonable outcome: its coefficient had wrong sign incompatible with economic theory. Thus growth of unemployment usually associated with lower economic activity and in this case it makes sense to loose monetary policy to stimulate the economy. It means that in the equation with base money as an instrument coefficient under unemployment (or, to be more exact, gap between its actual value and the target represented by HP trend) ought to be positive, while our estimations

[6] According to Wu-Hausman tests.

produced negative sign. One of possible explanation to this fact is unorthodox relationship between unemployment and output dynamics in post crisis period: two indices moved concurrently in the same direction.

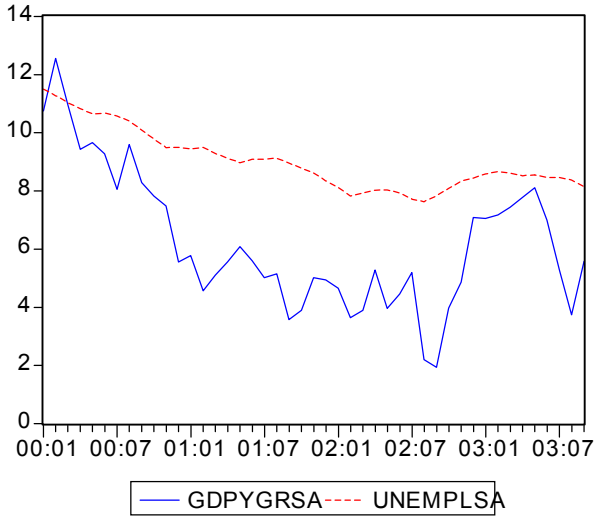

Fig. 4. GDP growth (GDPYGRSA) and unemployment (UNEMPLSA) dynamics in 2000-2003

Attempts to use explicit indicator, i.e. growth of employed workers instead of the level of unemployment were not successful either. This variable was either insignificant (see Annex 2, Table 2.11) or of incorrect (positive) sign, which made relationship meaningless from economic point of view.

Output of five basic sectors proved to be more appropriate indicator of economic activity. Like in the previous instances we used gap between actual and trend values with the latter obtained through HP filter. We managed to get reasonably good model that both satisfied econometric requirements and had clear economic meaning. Iterative procedure allowed us to select valid instruments with the absence of residual autocorrelation and overidentification problem, satisfying weak exogeneity. After all we construct monetary policy rule where base money dynamics depends upon divergence of inflation, output of five basic sectors and average monthly real exchange rate from their target (or trend) values in the same period (see Annex 2, Table 2.10). Model of this type is defined as "forward-looking" as long as the Central Bank does not have data describing stance of the markets and the economy at the time of decision making.

Further exercises allowed us to extend 'planning horizon' while preserving economic meaning and good econometric properties of the model (see Annex 2, Table 2.2). In the equation three-month ahead values of target variables are taken into account. Thus, we can conclude that the Bank of Russia did applied "forward-looking" approach but with rather short 'planning horizon' not exceeding one quarter. Meanwhile, some of inflation models describing post crisis period (see, for example, Voronina and Vdovichenko, 2001, as well as authors covering related issues on http://www.eeg.ru) reveal that growth of money supply affect inflation dynamics with up to nine-month lag. Having said this we point out that it makes sense for the Bank of Russia to further

extend 'planning horizon'. This recommendation is based upon our findings and should be seen as a policy advice following from the project.

On the basis of results, one can conclude that base money management seems to have a more pronounced stabilising profile in comparison with interest rates running. Coefficients under target variables significantly differ from 0. Negative signs are in line with the theory and mean that acceleration of inflation and positive divergence of economic activity from the target made the Central Bank tighten monetary policy and slacken growth of money supply. Positive sign under real exchange rate also has clear economic meaning. To contain pace of the rouble appreciation the Bank of Russia allows monetary policy softening. Growth of money supply and spare rouble funds stimulate higher demand for foreign currency. As a result nominal depreciation of the rouble goes faster, while real appreciation decelerates.

In the beginning, we obtained "illogical" coefficient of lagged base money variable. Its was rather small in absolute value (not in exceed of 0.1) but negative in sign. In practice it meant that the Central Bank does not smooth base money dynamics, but adjusted it abruptly with subsequent reverse correction. Use of new data format allowed us to avoid this defect. In the new model the coefficient is "correct" both in terms of its sign (positive) and absolute value. The range of values (0.4-0.8) gives reasons to believe that the Bank of Russia really smoothed the base money dynamic on average.

Monetary policy rule estimated by OLS. On the second stage we employed the other commonly used approach to estimate the monetary policy rule, namely OLS (see, among others, Cuche, 2000, Aron and Muellbauer, 2000). One of the advantages associated with this method is the opportunity of getting around the endogeneity problem. It evaluates monetary policy rule using forecasted values for target variables instead of the facts.

On the basis of results obtained by Vdovichenko, Voronina (2001) and Dynnikova (2002) researches, we constructed models for inflation, GDP and real exchange rate (see Annex 2, Tables 2.4., 2.5., 2.6.). Yearly inflation positively depends upon inflation expectations, base money dynamics and growth of administered prices. GDP growth reduces inflation through increase in money demand. Main explanatory variables entering GDP model are constant term (trend) and lagged GDP growth. One more variable that have strong effect on GDP dynamics is the price of oil. As far as real exchange rate model is concerned, we based on Dynnikova (2002) who evaluates equilibrium medium-term real exchange rate depending upon oil prices, real energy prices and net capital outflow as a share of GDP. The latter variable leads to depreciation of rouble, while the others strengthen it.

In our best equation describing behaviour of the central Bank (see Annex 2, Table 2.3.) we manage to obtain correct signs for all coefficients: negative for inflation and GDP gaps and positive for exchange rate gap. Unfortunately, we failed to work out the significance of the inflation target. This fact is considered to be the main drawback of the model. This situation may be the consequence of wrong specification of initial models for inflation, GDP and real exchange rate. At the same time it may be regarded as a general weakness of this method, as it implicitly presupposes that the central

bank makes monetary policy decisions having based upon the same models as the authors. Evidently, this assumption may be far from the reality.

Anyway, results of the second stage are also fairly interesting, as far as they confirm once again that the Central bank regulated base money dynamics being guided by actual and target values of GDP, real exchange rate and inflation. One more interesting findings is planning horizon extended in this case to 6 months, while GMM estimations gave forward-looking monetary policy rule with only 3 month outlook. This fact gives basis for further research as they confirm our supposition that Bank of Russia controls real exchange rate, output and, probably, inflation dynamics.

Monetary policy rule as a system of interventions and sterilisations. In the third part of our project we built up monetary policy rule as a system of simultaneous equations for intervention and sterilisation operations of the Bank of Russia. By doing this we formalise the situation when the Central Bank manages base money dynamics with the use of the two above named instruments. In our work we followed standard Two-Stage Least Square methodology which is commonly used for estimation of simultaneous equations on small samples.

In its final specification the model uses the same set of instruments as the initial model, estimated by GMM (see Annex 2, Table's 2.1. instruments list), and produces correct signs for all the coefficients (see Annex 2, Table 2.7.).

Intervention series was obtained from data describing the dynamics of international reserves. Monthly changes in the latter were corrected for both external debt payments and US$/Euro fluctuations and related to the base money aggregate. According to the model interventions of the Central Bank on foreign exchange market in 2000-2003 were determined exclusively by real exchange rate dynamics. If rouble appreciated too rapidly, the Bank of Russia showed increased demand for foreign currency, accumulated reserves and strengthening of the rouble slowed down. Our attempts to add inflation and/or output gaps into the first equation were not successful. Thus we can conclude that neither the threat of inflation nor the trends of economic activity affected the behaviour of the Central Bank on currency market.

Intensity of sterilisation activity on the contrast depended upon developments in the real (GDP) and monetary (inflation) sectors of the economy. Increasing volume of sterilisation correlated with rising inflation gap deposits' balance. On the other hand, lesser sterilisation was associated with fading economic activity. Finally, sterilisation was proportional to interventions.

These results allows us to suggest that the main focus of the monetary policy over the most of post crisis period used to be exchange rate policy, while inflation fighting was of secondary importance.

Thus, the last stage of the research confirmed our previous findings. First, the target variables of the Bank of Russia are inflation, output and real exchange rate, and the latter target dominates the other two. Second, behaviour of the Central Bank was aimed at inflation reducing, promoting economic growth and softening sharp fluctuations of the real exchange rate.

5. CONCLUSION

On the first stage of the project we estimated monetary policy rules with the use of Generalised Method of Moments and both interest rates and monetary base in place of instruments. Obtained results demonstrate that interest rate policy of the Bank of Russia has been rather adaptive in post crisis period, while management of base money dynamics possessed pronounced stabilising pattern. These findings are in accordance with our knowledge and understanding of monetary policy as well as official statements of the Central Bank itself.

Further our analysis revealed that despite officially declared priority of anti-inflation policy major efforts of the Bank of Russia were turned to the regulation of the exchange rate. There are some reasons to suggest that the Central Bank intervened in the exchange market with the aim to affect not only the smoothness of the exchange rate but also its equilibrium level

These conclusions are proved by the estimation results obtained though the application of three different methods. It is also should be noted, that construction of monetary policy rule in the form of a system of two simultaneous equations (for intervention and sterilisation) does not have analogue in the literature and offers the ground for further investigation.

As a direction of the further research it is possible to offer discussion of the following problems: What parameters of the reaction function of the central bank should be? What can be these values, taking into account specific situation found in the case of Russia? Do empirical results obtained by the authors of this paper correspond to optimum values?

APPENDICES

A1. description of Variables

Variable	Description	Source
1. baseygr(hp)	Yearly growth of five base sectors (industry, agriculture, construction, transportation and retail trade) output (smoothed by HP-filter)	GKS
2. bmygr	Yearly growth of base money (to the same month of the previous year)	CBR
3. brentygr	Yearly growth of world oil price (Brent) (to the same month of the previous year)	WB
4. cpitwygr	Yearly growth of target inflation (to the same month of the previous year), monthly interpolated from the year figures, published in the "Main Objectives of Monetary Policy" of the Bank of Russia, corrected by the statements of official authorities within the year	CBR, the authors' calculations
5. cpitygr	Yearly growth of target inflation (to the same month of the previous year), monthly interpolated from the year figures, published in the "Main Objectives of Monetary Policy" of the Bank of Russia	CBR, the authors' calculations
6. cpiygr	Yearly growth of consumer price index (to the same month of the previous year)	GKS
7. cpiygrf	Forecast of consumer price index growth (to the same month of the previous year), according to the model described in Table 2.4, Appendix 2.	The authors' calculations
8. dres_gdp	CBR reserves growth, as a share of GDP	CBR, the authors' calculations
9. elygr	Power industry producer price index (to the same month of the previous year)	GKS
10. emplygrsahp	Yearly growth of employment, seasonally adjusted (smoothed by HP-filter)	GKS, the authors' calculations
11. eraygr	Average US dollar exchange rate growth to the same month of the previous year	CBR
12. euraygr	Average euro exchange rate growth to the same month of the previous year	CBR
13. gap_base	Difference of baseygr and baseygrhp	The authors' calculations
14. gap_cpi	Difference of cpiygr and cpitygr	The authors' calculations
15. gap_cpiw	Difference of cpiygr and cpitwygr	The authors' calculations

Variable	Description	Source
16. gap_cpiw_f	Difference of cpiygrf and cpitwygr	The authors' calculations
17. gap_emply	Difference of emplygrsa and emplygrsahp	The authors' calculations
18. gap_gdp	Difference of gdpygr and gdptygr	The authors' calculations
19. gap_gdp_f	Difference of gdpygrf and gdptygr	The authors' calculations
20. gap_gdpa	Difference of gdpygra and gdptygr	The authors' calculations
21. gap_ind	Difference of indygr and indygrhp	The authors' calculations
22. gap_inda	Difference of indygra and indygrahp	The authors' calculations
23. gap_rera	Difference of reraygr and reraygrhp	The authors' calculations
24. gap_rera_f	Difference of rerafygr and reraygrhp	The authors' calculations
25. gap_rercpi	Difference of rercpiygr and rercpiygrhp	The authors' calculations
26. gap_rere	Difference of rereygr and rereygrhp	The authors' calculations
27. gap_rereff	Difference of rereffygr and rereffygrhp	The authors' calculations
28. gazygr	Natural gas price index (to the same month of the previous year)	GKS
29. gdptygr	Yearly growth of GDP (to the same month of the previous year), monthly interpolated from the year figures, published in the "Main Objectives of Monetary Policy" of the Bank of Russia	CBR, the authors' calculations
30. gdptygra	Average yearly growth of GDP (to the same month of the previous year), monthly interpolated from the year figures, published in the "Main Objectives of Monetary Policy" of the Bank of Russia	CBR, the authors' calculations
31. gdpygr	Real GDP growth to the same month of the previous year	GKS
32. gdpygra	Average yearly real GDP growth	GKS
33. gdpygrf	Forecast of GDP growth (to the same month of the previous year), according to the model described in Table 2.5, Appendix 2.	The authors' calculations
34. indygr	Real industry production growth to the same month of the previous year	GKS
35. indygra	Average yearly real industry production growth	GKS

Variable	Description	Source
36. indygr(a)hp	(Average) real industry production growth to the same month of the previous year, smoothed by HP-filter	GKS, The authors' calculations
37. intervnet_bm_y	Yearly volume of interventions calculated as CBR international reserves growth corrected by external debt payments, as a share of base money	CBR, the authors' calculations
38. intervnet_bm_m	Monthly volume of interventions calculated as CBR international reserves growth corrected by external debt payments, as a share of base money	CBR, the authors' calculations
39. irup_lcb7	Uncovered interest rate parity between 7-day CBR deposit rates and 7-day LIBOR rates, including exchange rate growth	IMF (IFS), CBR, the authors' calculations
40. irup_lm30	Uncovered interest rate parity between 30-day Moscow Interbank Offered Rates (MIBOR) and 30-day LIBOR rates, including exchange rate growth	IMF (IFS), CBR, the authors' calculations
41. irup_lm7	Uncovered interest rate parity between 7-day Moscow Interbank Offered Rates (MIBOR) and 7-day LIBOR rates, including exchange rate growth	IMF (IFS), CBR, the authors' calculations
42. libor30	30-day LIBOR	IMF (IFS)
43. libor7	7-day LIBOR	IMF (IFS)
44. mbky	1-day Moscow InterBank Actual Credit Rate	CBR
45. nx1_gdpsm	Nat export of goods and services as a share of GDP, interpolated on monthly data	CBR the authors' calculations
46. overnighty	Average 1-day CBR deposit rate	CBR
47. relppiygr	Power industry producer price index deflated by PPI (to the same month of the previous year)	GKS, the authors' calculations
48. relpyygr	Power industry producer price index as a share of GDP deflator (to the same month of the previous year)	GKS, the authors' calculations
49. rerafygr	Forecast of real exchange rate growth (to the same month of the previous year), according to the model described in Table 2.6, Appendix 2.	The authors' calculations
50. reraygr(hp)	Real US dollar exchange rate growth, calculated on the base of CPI and average exchange rates (smoothed by HP-filter)	CBR, the authors' calculations

Variable	Description	Source
51. rercpiygr(hp)	Real US dollar exchange rate growth, calculated on the base of CPI, average exchange rates (smoothed by HP-filter) (the difference from the previous variable is the method of US inflation calculation)	CBR, GKS, IMF (IFS), the authors' calculations
52. rereffygr(hp)	Real effective exchange rate, to the same month of the previous year (smoothed by HP-filter)	IMF (IFS) the authors' calculations
53. rereygr(hp)	Real US dollar exchange rate growth, calculated on the base of CPI, end-of-period exchange rates (smoothed by HP-filter)	CBR, the authors' calculations
54. rgazppiygr	Natural gas price index deflated by PPI (to the same month of the previous year)	GKS, the authors' calculations
55. rgazpyygr	Natural gas price index as a share of GDP deflator (to the same month of the previous year)	GKS, the authors' calculations
56. stercb_bm_y	Growth of commercial banks deposits in CBR and CBR REPO operations, yearly, as a share of base money	CBR, the authors' calculations
57. stercb_bm_m	Growth of commercial banks deposits in CBR and CBR REPO operations, monthly, as a share of base money	CBR, the authors' calculations
58. stergovcb_bm_y	Growth of commercial banks and government deposits in CBR and CBR REPO operations, yearly, as a share of base money	CBR, the authors' calculations
59. stergovcb_bm_m	Growth of commercial banks and government deposits in CBR and CBR REPO operations, monthly, as a share of base money	CBR, the authors' calculations
60. tomnexty	Tomnext CBR rate	CBR
61. weeky	One-week deposits CBR rate	CBR

A2. Results of estimations

The estimated model:

$$b_t = (1 - \rho)\,\alpha + (1 - \rho)\beta(\pi_{t,k} - \pi^*_{t,k}) + (1 - \rho)\gamma(y_{t,q} - y^*_{t,q}) + (1 - \rho)\delta(rer_{t,l} - rer^*_{t,l}) + \rho b_{t-1} + \xi_t$$

Table 2.1. The initial monetary policy rule model estimated by GMM (with autocorrelated residuals)

Dependent Variable: BMYGR

Method: Generalized Method of Moments

Sample: 2000:01 2003:09

Included observations: 45

No prewhitening

Bandwidth: Fixed (3)

Kernel: Bartlett

Convergence achieved after: 18 weight matricies, 19 total coef iterations

BMYGR=(1-C(5))xC(1)+(1-C(5))xC(2)x(GAP_CPIW)+(1-C(5))xC(3)
x(GAP_GDP)+(1-C(5))xC(4)x(GAP_RERA)+C(5)xBMYGR(-1)

Instrument list: CPIYGR(-5) OVERNIGHTY(-1) GDPYGR(-3) GDPYGR(-4)
GDPYGR(-5) GDPYGR(-6) BRENTYGR(-1) BRENTYGR(-2)
BRENTYGR(-5) BMYGR(-5) BMYGR(-7) IRUP_LCB7(-4)
RELPYYGR(-2) RGAZPYYGR(-5) ELYGR(-3) REREFFYGR(-6)

	Coefficient	Std. Error	t-Statistic	Prob.
C(5)	0.458976	0.063120	7.271506	0.0000
C(1)	45.95675	0.960852	47.82914	0.0000
C(2)	-1.566979	0.320562	-4.888222	0.0000
C(3)	-2.233727	0.566408	-3.943671	0.0003
C(4)	2.100170	0.107264	19.57951	0.0000
R-squared	0.838240	Mean dependent var		45.73333
Adjusted R-squared	0.822064	S.D. dependent var		11.28427
S.E. of regression	4.759987	Sum squared resid		906.2991
Durbin-Watson stat	0.792902	J-statistic		0.096664

The degree of freedom is: 16 instruments – 5 coefficients = 11.

Table 2.2. The best monetary policy rule model estimated by GMM in forward-looking form

Dependent Variable: BMYGR

Method: Generalized Method of Moments

Sample(adjusted): 2000:01 2003:06

Included observations: 42 after adjusting endpoints

No prewhitening

Bandwidth: Fixed (3)

Kernel: Bartlett

Convergence achieved after: 38 weight matricies, 39 total coef iterations

BMYGR=(1-C(5))xC(1)+(1-C(5))xC(2)x(GAP_CPIW(3))+(1-C(5))xC(3)
x(GAP_BASE(0))+(1-C(5))xC(4)x(GAP_RERA(3))+C(5)xBMYGR(-1)

Instrument list: BMYGR(-5) M2YGR(-6) BMYGR(-7) OVERNIGHTY(-1)
TOMNEXTY(-2) IRUP_LCB7(-3) IRUP_LCB7(-4) IRUP_LCB7(-5)
CPIYGR(-5) GAP_BASE(-2) BASEYGR(-3) BASEYGR(-4)
BASEYGR(-5) BASEYGR(-6) BRENTYGR(-4) BRENTYGR(-5)
BRENTYGR(-6) BRENTYGR(-7) RELPYYGR(-1) RELPYYGR(-3)
RGAZPYYGR(-6) ELYGR(-3) REREFFYGR(-6) REREFFYGR(-7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(5)	0.807441	0.015211	53.08311	0.0000
C(1)	42.62679	0.614515	69.36654	0.0000
C(2)	-1.019127	0.162907	-6.255868	0.0000
C(3)	-0.739653	0.147551	-5.012857	0.0000
C(4)	1.781515	0.137690	12.93863	0.0000
R-squared	0.898730	Mean dependent var		45.95429
Adjusted R-squared	0.887782	S.D. dependent var		11.65762
S.E. of regression	3.905189	Sum squared resid		564.2686
Durbin-Watson stat	2.226740	J-statistic		0.222027

Table 2.3. The best monetary policy rule model estimated by OLS

Dependent Variable: BMYGR

Method: Least Squares

Sample(adjusted): 2000:01 2003:02

Included observations: 38 after adjusting endpoints

Convergence achieved after 5 iterations

BMYGR=(1-C(5))xC(1)+(1-C(5))xC(2)x(GAP_CPIW_F(6))+(1-C(5))xC(3)
x(GAP_GDP_F(6))+(1-C(5))xC(4)x(GAP_RERA_F(6))+C(5) xBMYGR(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(5)	0.727594	0.093000	7.823557	0.0000
C(1)	51.78477	3.583921	14.44919	0.0000
C(2)	-1.126403	1.061339	-1.061304	0.2963
C(3)	-4.077513	1.631285	-2.499571	0.0176
C(4)	2.288381	0.494372	4.628864	0.0001
R-squared	0.906834	Mean dependent var		46.95342
Adjusted R-squared	0.895542	S.D. dependent var		11.78864
S.E. of regression	3.810089	Akaike info criterion		5.635261
Sum squared resid	479.0536	Schwarz criterion		5.850733
Log likelihood	-102.0700	Durbin-Watson stat		2.219783

Table 2.4. Inflation model, used for monetary policy rule estimations by OLS

Dependent Variable: CPIYGR

Method: Least Squares

Sample: 2000:01 2003:09

Included observations: 45

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPIYGR(-1)	0.770955	0.026061	29.58323	0.0000
BMYGR	0.030720	0.014807	2.074671	0.0443
ELYGR	0.096884	0.014953	6.479026	0.0000
GDPYGR	-0.075674	0.051517	-1.468923	0.1495
R-squared	0.967159	Mean dependent var		18.45333
Adjusted R-squared	0.964756	S.D. dependent var		3.803563
S.E. of regression	0.714063	Akaike info criterion		2.248995
Sum squared resid	20.90530	Schwarz criterion		2.409587
Log likelihood	-46.60239	Durbin-Watson stat		1.595102

Table 2.5. GDP model, used for monetary policy rule estimations by OLS

Dependent Variable: GDPYGR

Method: Least Squares

Sample: 2000:01 2003:09

Included observations: 45

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.139964	0.512299	4.177178	0.0001
GDPYGR(-1)	0.585190	0.087833	6.662556	0.0000
BRENTYGR	0.020368	0.004585	4.441955	0.0001
R-squared	0.823074	Mean dependent var		6.244889
Adjusted R-squared	0.814649	S.D. dependent var		2.320974
S.E. of regression	0.999234	Akaike info criterion		2.900685
Sum squared resid	41.93570	Schwarz criterion		3.021130
Log likelihood	-62.26542	F-statistic		97.69397
Durbin-Watson stat	1.881741	Prob(F-statistic)		0.000000

Table 2.6. Real exchange rate model, used for monetary policy rule estimations by OLS

Dependent Variable: RERA

Method: Least Squares

Sample(adjusted): 1999:01 2003:08

Included observations: 56 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39.23796	10.51942	3.730048	0.0005
BRENT	1.154923	0.112307	10.28366	0.0000
NX1_GDPSM	-1.085985	0.213191	-5.093960	0.0000
RELPY	0.800721	0.132420	6.046843	0.0000
R-squared	0.890919	Mean dependent var		102.1107
Adjusted R-squared	0.884625	S.D. dependent var		12.23791
S.E. of regression	4.156831	Akaike info criterion		5.756132
Sum squared resid	898.5205	Schwarz criterion		5.900800
Log likelihood	-157.1717	F-statistic		141.5694
Durbin-Watson stat	0.535379	Prob(F-statistic)		0.000000

Table 2.7. The best monetary policy rule model estimated as a system of equations (interventions and sterilizations)

System: SYS_GOVCB_BM_Y

Estimation Method: Two-Stage Least Squares

Sample: 2000:01 2003:09

Included observations: 45

Total system (balanced) observations 90

	Coefficient	Std. Error	t-Statistic	Prob.
C(3)	8.076631	2.703574	2.987391	0.0037
C(4)	1.249418	0.396138	3.153996	0.0022
C(5)	3.648572	0.616436	5.918816	0.0000
C(7)	0.148938	0.014205	10.48460	0.0000
Determinant residual covariance		665627.4		

Equation: INTERVNET_BM_Y=C(3)xGAP_RERA

Observations: 45

R-squared	-16.305109	Mean dependent var	121.3987
Adjusted R-squared	-16.305109	S.D. dependent var	27.70048
S.E. of regression	115.2323	Sum squared resid	584253.7
Durbin-Watson stat	0.017844		

Equation: STERGOVCB_BM_Y=C(4)xGAP_CPIW+C(5)xGAP_GDP

+C(7)xINTERVNET_BM_Y

Observations: 45

R-squared	0.779581	Mean dependent var	24.99667
Adjusted R-squared	0.769085	S.D. dependent var	15.50050
S.E. of regression	7.448553	Sum squared resid	2330.200
Durbin-Watson stat	0.551392		

The set of instruments for this model is the same as for the initial GMM equation (see Table 2.1.)

Table 2.8. The best monetary policy rule model estimated by GMM (with the interbank interest rate as the monetary policy instrument)

Dependent Variable: MBKY

Method: Generalized Method of Moments

Sample(adjusted): 2000:01 2003:09

Included observations: 45 after adjusting endpoints

No prewhitening

Bandwidth: Fixed (3)

Kernel: Bartlett

Convergence achieved after: 5 weight matricies, 6 total coef iterations

MBKY=(1-C(5))xC(1)+(1-C(5))xC(2)x(GAP_CPIW)+(1-C(5))xC(3)
x(GAP_GDP)+(1-C(5))xC(4)x(GAP_RERA)+C(5)xMBKY(-1)

Instrument list: RERAYGR(-1) RERAYGR(-4) BRENTYGR(-2) BMYGR(-3)
BMYGR(-4) BMYGR(-6) BMYGR(-7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(5)	0.704903	0.245991	2.865560	0.0066
C(1)	11.50868	2.879097	3.997321	0.0003
C(2)	-1.202203	0.750187	-1.602536	0.1169
C(3)	-2.593586	1.403586	-1.847828	0.0720
C(4)	0.812911	0.370247	2.195590	0.0340
R-squared	0.202982	Mean dependent var		7.564444
Adjusted R-squared	0.123281	S.D. dependent var		4.253189
S.E. of regression	3.982401	Sum squared resid		634.3807
Durbin-Watson stat	2.645352	J-statistic		0.016855

Table 2.9. The best monetary policy rule model estimated by GMM (with the base money as an instrument and GDP as a variable of economic activity), where the autocorrelation of residuals was corrected

Dependent Variable: BMYGR

Method: Generalized Method of Moments

Sample(adjusted): 2000:02 2003:09

Included observations: 44 after adjusting endpoints

No prewhitening

Bandwidth: Fixed (3)

Kernel: Bartlett

Convergence achieved after: 26 weight matricies, 27 total coef iterations

BMYGR=(1-C(5))xC(1)+(1-C(5))xC(2)x(GAP_CPIW)+(1-C(5))xC(3)
x(GAP_GDP)+(1-C(5))xC(4)x(GAP_RERA)+C(5)xBMYGR(-1)

Instrument list: BMYGR(-5) M2YGR(-6) BMYGR(-7) OVERNIGHTY(-1)
TOMNEXTY(-2) IRUP_LCB7(-3) IRUP_LCB7(-4) IRUP_LCB7(-5)
CPIYGR(-5) GAP_GDP(-1) GAP_GDP(-2) GDPYGR(-3)
GDPYGR(-4) GDPYGR(-5) GDPYGR(-6) BRENTYGR(-1)
BRENTYGR(-2) BRENTYGR(-5) RELPYYGR(-1) RELPYYGR(-2)
RELPYYGR(-3) RGAZPYYGR(-6) ELYGR(-3) REREFFYGR(-6)

	Coefficient	Std. Error	t-Statistic	Prob.
C(5)	0.798841	0.035556	22.46685	0.0000
C(1)	49.48375	1.064883	46.46871	0.0000
C(2)	-0.991488	0.231047	-4.291290	0.0001
C(3)	-1.726486	0.564871	-3.056427	0.0040
C(4)	2.339575	0.190933	12.25339	0.0000
R-squared	0.890904	Mean dependent var		45.54250
Adjusted R-squared	0.879715	S.D. dependent var		11.34104
S.E. of regression	3.933312	Sum squared resid		603.3667
Durbin-Watson stat	1.383162	J-statistic		0.204692

Table 2.10. The best monetary policy rule model estimated by GMM (with base money as an instrument and base sectors output as a variable of economic activity), where autocorrelation of residuals is insignificant.

Dependent Variable: BMYGR

Method: Generalized Method of Moments

Sample: 2000:01 2003:09

Included observations: 45

No prewhitening

Bandwidth: Fixed (3)

Kernel: Bartlett

Convergence achieved after: 80 weight matricies, 81 total coef iterations

BMYGR=(1-C(5))xC(1)+(1-C(5))xC(2)x(GAP_CPIW)+(1-C(5))xC(3)
x(GAP_BASE)+(1-C(5))xC(4)x(GAP_RERA)+C(5)xBMYGR(-1)

Instrument list: BMYGR(-5) M2YGR(-6) BMYGR(-7) OVERNIGHTY(-1)
TOMNEXTY(-2) IRUP_LCB7(-3) IRUP_LCB7(-4) IRUP_LCB7(-5)
CPIYGR(-5) GAP_BASE(-2) BASEYGR(-3) BASEYGR(-4)
BASEYGR(-5) BASEYGR(-6) BRENTYGR(-4) BRENTYGR(-5)
BRENTYGR(-6) BRENTYGR(-7) RELPYYGR(-1) RELPYYGR(-3)
RGAZPYYGR(-6) ELYGR(-3) REREFFYGR(-6) REREFFYGR(-7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(5)	0.736060	0.018418	39.96367	0.0000
C(1)	42.07632	0.376917	111.6330	0.0000
C(2)	-0.397336	0.066695	-5.957464	0.0000
C(3)	-0.364798	0.100637	-3.624878	0.0008
C(4)	1.043832	0.047075	22.17359	0.0000
R-squared	0.882281	Mean dependent var		45.73333
Adjusted R-squared	0.870509	S.D. dependent var		11.28427
S.E. of regression	4.060625	Sum squared resid		659.5469
Durbin-Watson stat	1.731205	J-statistic		0.215019

Table 2.11. The best monetary policy rule model estimated by GMM (with base money as an instrument and growth of employment as an indicator of economic activity)

Dependent Variable: BMYGR

Method: Generalized Method of Moments

Sample: 2000:01 2003:09

Included observations: 45

No prewhitening

Bandwidth: Fixed (3)

Kernel: Bartlett

Convergence achieved after: 81 weight matricies, 82 total coef Iterations

BMYGR=(1-C(5))xC(1)+(1-C(5))xC(2)x(GAP_CPIW)+(1-C(5))xC(3)
x(GAP_EMPLY)+(1-C(5))xC(4)x(GAP_RERA)+C(5)xBMYGR(-1)

Instrument list: BMYGR(-5) M2YGR(-6) BMYGR(-7) OVERNIGHTY(-1)
TOMNEXTY(-2) IRUP_LCB7(-3) IRUP_LCB7(-4) IRUP_LCB7(-5)
CPIYGR(-5) BRENTYGR(-4) BRENTYGR(-5) BRENTYGR(-6)
BRENTYGR(-7) RELPYYGR(-1) RELPYYGR(-3) RGAZPYYGR(
-6) ELYGR(-3) REREFFYGR(-6) REREFFYGR(-7) GAP_EMPLY(
-2) GAP_EMPLY(-3) GAP_EMPLY(-7) BASEYGR(-3) BASEYGR(-4)

	Coefficient	Std. Error	t-Statistic	Prob.
C(5)	0.846111	0.030826	27.44800	0.0000
C(1)	40.88118	0.852743	47.94077	0.0000
C(2)	-1.240039	0.545766	-2.272106	0.0285
C(3)	-2.364778	1.449476	-1.631470	0.1106
C(4)	0.721611	0.264056	2.732798	0.0093
R-squared	0.883118	Mean dependent var		45.73333
Adjusted R-squared	0.871430	S.D. dependent var		11.28427
S.E. of regression	4.046162	Sum squared resid		654.8570
Durbin-Watson stat	2.039549	J-statistic		0.212076

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