Economic Education and Research Consortium
Russian Economic Research Program

Working Paper No 99/08

Interest Rates and Domestic Borrowing Costs in the Medium-Term Perspective

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Program Area: Macro & Finance

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NON-TECHNICAL SUMMARY

World financial turmoil that began late in 1997 has increased significantly interest to analysis of underlying mechanics of securities markets performance. This issue is especially topical for Russia, where financial crisis turned to be quite deep and comprehensive. Evidently, one of the fundamental reasons of the crisis was globalization of financial markets that played positive role under some conditions, but served as a multiplier for negative trends in the changed environment.

The study was aimed at medium-term forecasting of domestic interest rates and creating tools to evaluate debt management strategies. Analysis of the GKO market showed that 2 periods can be singled out, separated by introduction of the "currency band" in mid-1995. Before its introduction GKO interest rates were closely correlated to the expected yield of investment to foreign currency. Later this correlation weakens, and GKO interest rate is instead closely related to the currency securities yields, adjusted for the expected exchange rate growth, in line with the parity ratio principle.

The basic model taken as a starting point suggests that GKO interest rate depends on three factors: lagged interest rate, international interest rate adjusted for currency expectations, and some base rate, reflecting both macroeconomic situation and inflationary expectations. Relative importance of these factors is interpreted as “market efficiency”, “market integration”, and “macroeconomic dependency”. Possibility of varying weights of these factors was also considered at the stage of model specification.

Taking into account interdependence of all variables, the model was constructed as a system of simultaneous equation. Monthly data on Russian interest rates and macroeconomic indicators for the period July 1995 – October 1997 were used to estimate relationship of GKO interest rate, interest rate for Russian currency securities, Central Bank refinancing rate, and expected exchange rate (characterized by futures quotes), as well as their dependence on real volume of domestic borrowings, international reserves, and announced inflation and exchange rate growth. The CBR rate was chosen as the base domestic interest rate, taking into account both its role as an indicator for financial markets, and its connection to the major macroeconomic parameters. Special dummy variables were introduced to account for risks, related to political uncertainty before presidential elections.

The model accuracy proved to be fairly high on historic data. The model parameters imply that "market integration" has increased significantly over the period (which corresponds to the growing involvement of non-residents to Russian securities markets). It was found that market integration growth accounts for 2/3 of the observed decline in the GKO interest rates from 1995 to 1997. This conclusion confirms the widespread view that the interest rates decrease was primarily explained by non-residents involvement to the market, and provides its quantitative estimation. The model provides also estimate for the “election effect”: start of the elections period in March resulted in the GKO yields hike by 63 percentage points, and peak of pre-election uncertainty in June was marked with additional growth of yields by 103 percentage points.

Ex post and *ex ante* simulation carried out for the first and the second half of 1998 revealed that the model fails to produce good description of interest rates performance in the period of world financial crisis. Model analysis evidences that primary source of model inadequacy is poor prediction of exchange rate expectations. In reality exchange expectations have hiked due to deteriorated trade balance projections after decline in the world market commodity prices. Another reason is changed attitudes of investors to emerging markets (including Russia) with the initiation of the world financial crisis. Growing cautiousness in this period contrasted capital inflow during the previous year. Finally, the situation at the new stage was modified entirely by lack of confidence to the money authorities policy, resulting in quite different interpretation of the announced macroeconomic targets.

The model provides thus fair description of the major interest rates in Russia before the world crisis, while their performance during the crisis period deserves further analysis.

One major recommendation that can be drawn from the model analysis is necessity for the Central Bank to be very cautious in reducing refinancing rate. It should be made only after relatively long period of declining GKO/OFZ interest rates. Another general conclusion is that authorities should consider as dangerous and intolerable situation when market expectations differ significantly from the announced targets.

I. INTRODUCTION

The financial turmoil in world and Russian financial markets at the end of 1997 and the beginning of 1998 has increased the demand for an explanation of changes in interest rates and for interest rate forecasts. Evidently, the fluctuations in interest rates have been closely connected with the increased integration of financial markets, which modified the domestic responses to internal problems. Moreover, we face the question of whether the high level of domestic interest rates prevailing in Russia in 1997 was justified by internal economic and political risks. Furthermore, we have to find short- and medium-term economic policy measures that can affect fluctuations in domestic interest rates despite a high degree of globalization. The model developed and estimated in this paper is intended to provide answers to those questions.

There is no extensive literature on the interest rate determination in today's Russia. One of a few is the working paper on GKO interest forecasting by P.Teplukhin and A.Warner. Their model was able to predict interest rates in 1995 for periods up to two quarters. It is unclear whether this model can be suitable for the purposes of medium-term forecasting. We are familiar also with several studies relating to the forecasting of T-bill rates in Russia, which have been or are carried out as Master's theses in the New Economic School and the Higher School of Economics. The authors are trying in particular to relate short-term interest rates to basic macroeconomic indicators such as inflation, money supply, GDP, budget deficit, domestic debt etc. They found a clear correlation between real T-bill rates and budget deficit levels. There is no evidence supporting strong influence of other factors on the level of interest rates.

The borrowing strategy in the framework of macroeconomic policy is discussed, among others, by A.Illarionov. He reviews fiscal and financial developments in Russia during the last five years and argues that the government has been involved too much into economic activity, and consequently borrowed excessively from domestic markets. So, according to A.Illarionov, the reduction of budget expenditure would be a necessary pre-condition for the elimination of the chain of crises in Russia.

There exists a bulk of publications on the forecasting of interest rates in other countries. Two broad categories of the literature concerning interest rate forecasting can be distinguished: methodologies of interest rate forecasting, and empirical studies.

The first category includes forecasting models based on the theoretical models mentioned above. The Fisher's equation states that the future nominal rate of interest is approximately equal to the sum of expected real interest rate and expected inflation. There exist quite many models allowing to forecast real interest rates and inflation. According to some authors (Kinal and Lahiri, 1988, etc.), the real interest rate performs a random walk. They explain this behavior by the efficiency of financial markets, which implies that the latter appropriately respond to any new information, such as unexpectedly poor inflation or balance of payments results. However, many analysts believe that interest rates can only be explained in the context of a fully fledged model. The elements of such kind of model should include, in particular the wealth effect, which tends to depress the real interest rate (Mundell, 1963), and the tax effect, which works in the opposite direction (Darby, 1975). It is not easy to forecast the future rate of inflation too. Most models (Fama, 1975, etc.) are based on the rational expectations approach, where the expected inflation is related to the past inflation and instrumental factors, e.g. money supply and output growth.

Another line of research has been devoted to the global explanation of domestic interest rates (Aliber, 1973; Browne, 1983). In the efficient world financial markets with perfect capital mobility domestic interest rates have to be equal to the sum of the comparable-risk world interest rate and the expected domestic currency depreciation.

There exist also the extensive literature on the modeling of T-bill auctions (Smith, 1966; Sivesind, 1978).

The second category of literature includes empirical studies of nominal and real interest rate developments in various countries; and applications of theoretical models to explain these developments. Three sources seem to be most relevant to our study. K.Gupta and B.Moazzami (1996) have studied the relationships between interest rates and budget deficits in advanced economies. In particular, the authors examine the role of inflation expectations and the Fisher hypothesis. They have found that cross-country generalizations can be misleading, and country-specific factors still play a decisive role in interest rate determination. S. van Wijnbergen (1983) has studied a number of issues relating to the interest rate management in developing countries and simulated his models for South Korea. He elaborated on the effects of interest rate changes on savings, growth and inflation and found support for his arguments in empirical data. Finally, G. del Castillo (1991) wrote an important paper on interest rate determination with an active crawling peg system. He showed that the presence of political

uncertainty contributes to the deviation of domestic interest rates from the interest rate parity based on the announced future exchange rates. This is, apparently, the case in Russia, so we will try to apply his results in our research.

2. THE DATA SET

All statistical information that we collected can be divided into 5 broad categories: macroeconomic, monetary, budgetary, Russian financial markets, International financial markets. In each category we tried to get daily or monthly data series from 1992 to 1997. However, as the Russian market for government securities has been well developed only from the middle 1994, we focus mainly on the data series from June 1994 to December 1997. Most of the statistical analysis was conducted on a monthly basis, so we had around 40 observations for each indicator.

We decided to use as announced inflation the inflation rates forecast in the Government-CBR's Declaration on Economic Policy in the context of IMF programs for 1995 – 1996, and given by the CBR's Guidelines of Monetary Policy for 1997 – 1998. While in 1995 the inflation rate was under-forecast by two-fold, in the following years the forecasts have been quite close to reality. As the announced exchange rate in 1995, we use the growth of the exchange rate to the upper end of the horizontal exchange rate band. For the following years, we apply the announcement about the stable real exchange rate within the exchange rate bands.

Technically, we apply, for a given year, the announced inflation forecasts and exchange rate growth rates only for the first seven months of the year, and use weighted average figures of current and next year forecasts for the rest of each year, where the weights have been taken according to the number of months remaining.

To estimate the expected exchange rate growth we use exchange rate futures rates at the largest stock exchanges for that type of contracts (Moscow Stock Exchange before 1997, and MICEX — in 1997). For each month, we apply weighted average quotations on contracts between five and seven months.

For the currency-denominated securities (Minfin bonds) interest rates were extrapolated to reflect their higher maturity. Adjusted interest rates corresponding to 6 months maturity were constructed.

All interest rates were expressed in annual terms.

Indicator	Description	Objective
	Macroeconomic indicators	
Nominal and real GDP	Monthly Goskomstat (GKS) series	Basis for comparative ratio analysis
Consumer price indices (CPI)	Monthly CPI (GKS)	Constructing real values of financial indicators
	Monetary indicators	
Money base M2 (= NDA+NIR = cash + res)	Monthly CBR data	Analyzing impact of money supply
Refinancing rate	CBR data	Baseline domestic interest rate
	Budget	
Budget deficit	Ministry of Finance (MoF) and Economic Expert Group (EEG) monthly data	Analyzing government borrowing requirements
Borrowing from domestic markets	Monthly data of MoF and EEG on issuance of GKO/OFZ, and receipts to the federal budget from their placement.	Analyzing possible impact of borrowings on interest rates
Net borrowing	Monthly data of MoF and on GKO/OFZ re-payment and federal budget net financing	Analyzing possible impact of net financing on interest rates
	Russian financial markets	
Exchange rate (spot and futures)	Spot (MICEX) and future (MCSE) daily and average monthly rates	Analyzing exchange rate expectations to compare yields for securities in foreign and national currencies
Interbank credit rate	Monthly average MIBOR rates on 30 days and overnight interbank loans (CBR data)	Capturing the liquidity constraints of the banking sector for the analysis of GKO market
GKO-OFZ rates	Daily and average monthly GKO and OFZ rates (MICEX and MoF data) for all types of securities with volumes of trade; primary and secondary markets	Constructing interest rates model
	International financial markets	
Russian foreign currency instruments	Daily data (MoF and Eurobrokers) on yields for Russian Eurobonds (from November 1996) and MinFin bonds (from June 1994)	Analyzing interest parity condition
US T-bills	Average monthly yields for US 6 months T-bills	Calculating and analysing spreads for Russian currency securities

3. DATA ANALYSIS

As the project's main concern is the explanation of interest rate developments for domestic government securities, a significant amount of time are devoted to the analysis of interest rate movements from 1994 to 1997.

3.1. SPECIFICATION

The Market. It is possible to use either primary or secondary auction data on GKO yields. We have chosen primary auction data as the major indicator on the basis of two considerations:

- the Ministry of Finance is interested primarily in primary auction rates as the latter determine its borrowing costs rather than secondary market developments;
- primary and secondary market rates are highly correlated over the entire period under consideration except for November and December 1995; we analyze on a later stage both the primary auction premia over the secondary auction rates, and the outliers of 1995 in order to complete the description.

Maturity. Taking into account that at an early stage of the development of GKO market the Ministry of Finance has been issuing mainly very short-term instruments (3 to 6 months), while later the maturity structure has been shifting towards 6 months and 1 – 3 years securities, we have chosen yields on 6-month papers as a benchmark. In those cases where there were no 6-month papers issued, we have built yield curves and then adjusted yields available for GKOs with other maturities. An alternative would be to use secondary auction data on the papers maturing in 6 months.

The Period. As data for most indicators is available from June 1994, we concentrated on the analysis of GKO interest rates from June 1994 to December 1997. Earlier period is of less interest, as the government securities markets were not mature enough.

Effective and real values. As the tax treatment of various Russian financial instruments varies, we have considered after-tax yields of all instruments including GKOs. The tax on GKO yields obtained by residents was introduced only in 1997. In addition, for a comparative analysis we use the CPI-deflated and dollar-equivalent values of nominal interest rates.

The development of the major macroeconomic indicators is presented in the graphs below.

3.2. Preliminary Data Analysis

Our analysis confirmed that there is a close link between GKO yields in the primary and secondary markets. This correlation over the period from January 1995 until September 1997 for the yields for GKOs with 6-month maturity turned to be 0.95. The regression of the secondary yield (YS) on the primary one (YP) was significant with adjusted $R^2 = 0.91$, and had the form: YS = 7.3% + 0.882 YP. On average, the secondary yields were lower than the primary ones by 6.5 percentage points.

There was only one period when these yields differed significantly: in November and December of 1995 when interest rates in the secondary market went up, while those in the primary market remained unchanged.

Yields for GKOs depend significantly (especially before 1997) on their maturity, and yield/maturity relationship for different months are relatively well described with logarithmic curves.

The development of the yields over time was quite similar for 3-month and 6-month securities both in the primary and in the secondary mar-

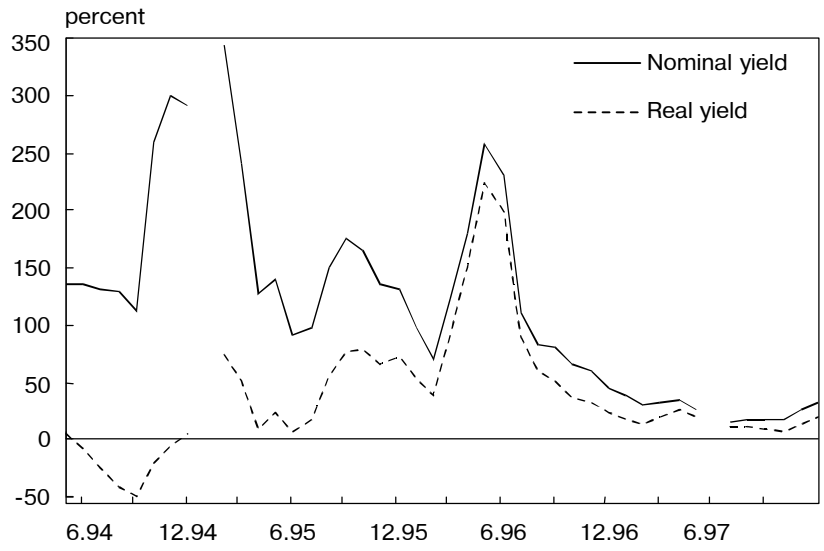

Fig. 1. Nominal and Real 6-mnth GKO Yield (Primary).

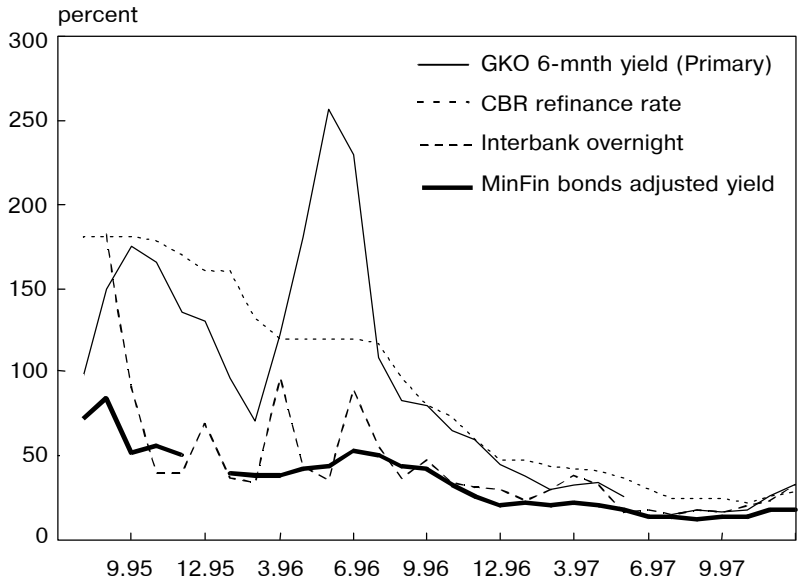

Fig. 2. Major Interest Rates in 1995 – 1997.

kets. This suggests that our analysis should be invariant with respect to the choice of a particular indicator of the interest rate.

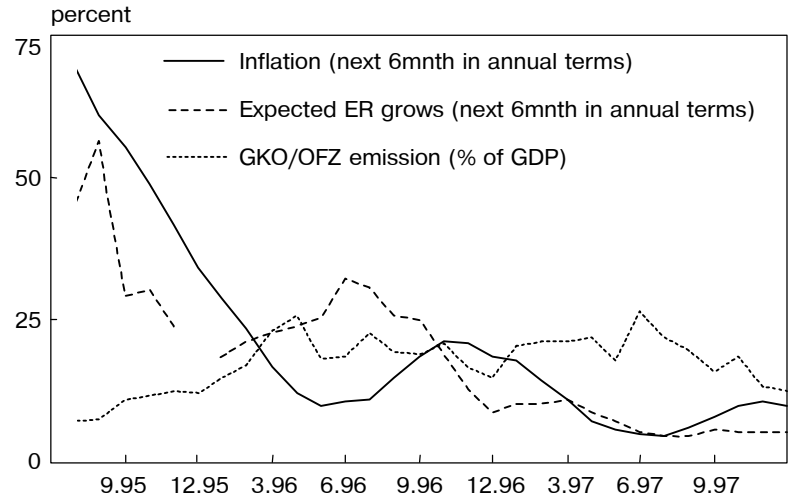

Fig. 3. Major Macroeconomic Indicators in 1995 – 1997.

4. GENERAL TRENDS IN FINANCIAL MARKET INDICATORS

The period from June 1994 to May 1998 was characterized by a high degree of volatility in interest rates. Especially, this relates to the period until July 1996. After that, we have observed a steadily decreasing trend in interest rates, except for the recent developments connected to the world financial crisis. We were able to distinguish 8 periods within the entire time interval where various economic and political factors have determined the specific trends in interest rates on government securities. The development of the macroeconomic indicators as well as major underlying characteristics of the government economic policy and regulations are presented below for each of the periods.

1. June 1994 – September 1994: Negative Real Interest Rates. Yields for GKO are slightly declining, while inflation rate is growing. This makes real interest rates more and more negative (–235% in September). Throughout the period borrowings are relatively high, and money supply is growing. The exchange rate lags behind the inflation until July, but then demand for dollars starts to increase. The CBR sells its reserves to restrain the exchange rate, the latter increases nevertheless in September.

2. October 1994 – May 1995: "Black Tuesday" effect. The collapse of the exchange rate market in October was followed by a hike of interest rates in the government securities market up to 300%. From that on we observe only positive real interest rates in the market, which can make us consider the "black Tuesday" as a necessary correction to market interest rates. It should be mentioned that the growth of interbank rates was by far less marked.

The Government and the CBR (acting under the new Law on the Central Bank prohibiting a direct monetary financing of the deficit) responded with tight control over the fiscal and monetary policy, including cutting down money supply and the volume of borrowings. As a result, the inflation and the exchange rate growth have been slowing down, and the nominal interest rates returned to their pre-crisis level by April (though with positive real level).

3. June 1995 – October 1995: "Exchange Rate Corridor". The stabilization of the foreign currency rate was consolidated by the Central Bank with the introduction of a managed exchange rate regime, i.e. the "corridor" with relatively narrow announced band of variation. Actual

exchange rate throughout the period was significantly lower than in April and May.

A new hikes of interest rates in the interbank and GKO (up to 150 – 180%) markets occurred in August-September. The evident reason for the former was a banking crisis caused by a risky policy of a number of medium-level banks that have not managed to adjust to a new low-inflation economy. The inter-bank market has collapsed (which was reflected in a jump in inter-bank rates), and then the securities market also proved to be involved in the interest rates growth. As a result, GKO interest rates have returned back to the level of the beginning of 1995, and started to come down only when the liquidity in the inter-bank market has been restored.

It look reasonable to suggest, that the crisis in the interbank market was an immediate cause for the drop in the demand for GKO, as banks were left without much money to invest in government securities.

4. November 1995 – December 1995: Peak in the Secondary Market. The last two months of 1995 were the only ones when primary and secondary GKO rates showed different development. While primary GKO rates stayed relatively low (130%), secondary market rates fluctuated at much higher levels (200%). Other macroeconomic indicators were remaining stable, which made us to look for non-economic explanations.

One can suggest that the GKO price drop in the secondary market was caused by political factors: uncertainty on the eve of the parliament elections. While the Government and the Central Bank kept the primary market under control to maintain a tight budget and monetary policy, the secondary market fluctuated under the pressure of political considerations. As the election period ended, secondary market rates came down to the level of the primary market.

5. January 1996 – March 1996: Early Stabilization. As the monetary policy was tighter than ever supported by a type of "crawling peg" system, inflation continued to slow down and have come to a level of 1% per month by the middle of 1996. Correspondingly, before the political pressures started to play a decisive role in financial decisions, interest rates have decreased to 70% in February 1996. This reduction in interest rates have been supported by a major increase in portfolio capital inflow into GKO market, so that the demand for Russian government securities increased substantially. The share of non-residents in the GKO market (though mostly in the form of various "shadow" schemes) has reached 15 – 20% by May 1995. However, political con-

siderations related to the Presidential elections have started to play an increasing role in the market and by March 1996 interest rate increased again to 110%.

6. April 1996 – June 1996: The Price of the Presidential Elections. Growing since March, GKO yields peaked in May, reaching 258%. One reason was relatively high volume of net borrowings in March – May, used to settle wage and pension arrears, promised by the President. But uncertainty on the outcome of the forthcoming Presidential elections undoubtedly was more important. It has been used by major players in the GKO market to increase the yields and get outstanding profits. Mostly, this related to non-resident investment banks and hedge funds that invested a lot in GKOs in the middle of 1996 on the basis of the forecast that Yeltsin will win anyway, and money will return. At the same time, Russian investors have put their money mostly into hard-currency form which was reflected in a huge residential capital outflow. As Yeltsin finally won and economic fundamentals remained positive (including low inflation), this speculative market situation has ended right after elections, and interest rates have returned back to the previous magnitudes.

7. July 1996 – October 1997: Financial Stabilization Reached. Interest rates were affected by two kinds of factors at this stage. First, steady improvement of macroeconomic indicators resulted in lower inflation and exchange rate expectations. Second, the government security market has been gradually integrated into the international financial markets. This showed up in more easy access to the GKO markets for non-residents, who held approximately 1/4 of the GKO in 1996. An important event was granting Russia international credit rating in October 1996 and the first issues of Russian Eurobonds in late 1996 and early 1997.

As a result, GKO interest rates have come down very quickly from 105% in summer 1996 to 25% in May 1997. From May to October 1997, interest rates have decreased further to the level of 16 – 17%. Those developments have been supported by very favorable conditions in the world financial markets where investors expected the continuation of squeezing the spreads between developed and emerging market instruments.

8. November 1997 – May 1998: External Shocks and Russian Financial Crisis. Following the crisis in South East Asian financial markets, all major world financial markets became more volatile, and investors have started to look for safer investment opportunities. That has already caused a substantial increase of the spreads between the de-

veloped and emerging market instruments, and Russia has appeared to be one of the victims. Interest rates increased again by up to 10 percentage points to 25 – 30%.

The wave of Asian financial crisis of the Fall 1997 has caused an instability in all emerging financial markets, particularly large in Russia. Negative trends developed in both corporate and government security markets. Already in the first days of crisis, the interest rates — both external and internal — increased by 3 – 5 percentage points, while stock indices returned to the spring 1997 levels. The growth in domestic rates has been suppressed by two factors. Firstly and most importantly, by the CBR interventions aimed to support the government security market as well as the exchange rate market. Secondly, by the restrictions on capital flows which have still been in place in 1997.

Despite measures taken by the CBR to reduce liquidity (via the increase in reserve requirements on hard-currency deposits and the attraction of excess liquidity to interest-bearing deposits), and to increase the trust in the exchange rate policy (via the announcement of a medium-term strategy), the credibility crisis was not stopped, and hard-currency reserves of the CBR were rapidly falling. As a result, GKO/OFZ rates substantially exceeded the refinancing rate. The CBR was pushed to support the Ruble by a significant increase in interest rates.

The refinancing rate was increased to 28%, and the yields on government securities stabilized at the level of 25 – 30%. The unstable equilibrium was supported by various forms of external borrowing. Nevertheless a speculative attack on the Ruble took place at the end of January 1998. Interest rates jumped well above the refinancing rate to the level of 35 – 40%. The CBR was again forced to rely on a further increase in its refinancing rate (up to 42%), to avoid a substantial capital flight from the Russian market. After a short-lasted jump to 45 – 50%, the yields fell to 35 – 40%, then to 30 – 35%, and finally to 24 – 28%. That gave the CBR grounds to reduce the refinancing rate step by step to the level of 30%. The reduction of GKO/OFZ rates was accelerated by an inflow of non-resident capital supported by the abolishment of any restrictions on the repatriation of profits from January 1, 1998. Further reduction of interest rates was stopped by the Government reshuffle. As a result of political uncertainty, the rates slowly increased reaching 30% by the beginning of May 1998. In the middle of May, the abundance of negative news (both “Asian” and domestic) led to a new credibility crisis and a new speculative attack on the Ruble. GKO/OFZ rates again jumped above 40%. To defend the Ruble and stabilize financial markets, the CBR increased the refinancing rate to 50%, and the yields stabilized at a level of around 45 – 50%.

5. DISCUSSION OF THE MODEL APPROPRIATENESS

5.1. Major Factors under Interest Rate Trends

Following the descriptive analysis, we have been able to identify major factors under the general trends of interest rates on Russian government securities observed from June 1994 to December 1997. Those include: exchange rate developments and policy, political risks, the state of the Russian banking sector, the degree of integration into the world market, and the evaluation of government securities by the world financial market.

5.2. Relevance of the Model

The basic model that was taken as a starting point of our analysis can be described by the following system of equations (del Castillo (1991), Juttner (1990)):

$$i_t = \psi\,\theta\,(i_t^* + \delta_t^e) + \psi\,(1-\theta)\,i_{t-1} + (1-\psi)\,(r_t + \pi_t^e) \quad (1)$$

$$\delta_t^e = \delta[CA_t,\ IR_t,\ M_t,\ \pi_t^e,\ \delta_t^a,\ X_t] \quad (2)$$

$$r_t = r[M_t/P_t,\ BD_t,\ T_t,\ Y_t] \quad (3)$$

$$\pi_t^e = \pi[M_t,\ W_t,\ \pi_{t-1},\ \pi_t^a,\ \delta_t^e,\ Z_t], \quad (4)$$

where i_t is the nominal interest rate, i_i^* — the dollar interest rate, δ_t^e — expected depreciation of the domestic currency, r_t — long-term real interest rate, reflecting macroeconomic environment, π_t^e — expected inflation, CA_t — current account balance, IR_t — official international reserves, BD_t — budget deficit, M_t — money supply growth, π_t^a — expected inflation rate announced by the Government, δ_t^a — announced exchange rate depreciation, P_t — price level, T_t — composite effective tax rate, W_t — wage growth, X_t, Y_t, Z_t — other factors, ψ — a parameter reflecting the degree of integration of the domestic economy into the world economy, θ — a parameter reflecting the degree of financial markets efficiency.

Our preliminary analysis described in the previous section provides a good argument that this model is in fact relevant in the explanation of interest rate developments in the Russian government security markets.

The Role of the integration into the world financial markets. The model assumes that the more integrated the domestic economy is, and the more efficient the financial markets are, the more rapidly will the interest rate adjust to the interest parity condition (first brackets). If the economy is relatively closed (ψ close to zero) and markets are not efficient enough (θ close to zero), the model predicts that the nominal interest rate would follow the Fisher equation (second brackets).

We have found that before 1996 when the degree of integration of Russian financial markets into the world market was low (as measured by the participation of non-resident investors in government security markets), the correlation between GKO yields and exchange rate adjusted yields on MinFin bonds was close to zero (−0.09), while in 1996 and 1997 when the share of non-residents in GKO market fluctuated from 15 to 35 percent, the correlation was strong (0.80). In the period from October 1996 (when the Russian credit rating was announced and the first Eurobonds were placed) until December 1997 the correlation was almost perfect (0.98).

The role of exchange rate expectations. The effect of exchange rate expectations on interest rate developments has been itself a function of the exchange rate policy conducted by the Central Bank. Before the middle of 1995 when the first exchange rate band was announced, the floating exchange rate played an almost deterministic role in interest rate expectations as speculations in the exchange rate market served as the only serious alternative for the government security market. The expectations of the exchange rate growth[1] are substantially correlated with corresponding GKO yields from May 1994 until May 1995 (0.57). This suggests both a direct effect of the exchange rate expectations (when currency is an alternative to GKO for investors), and an indirect effect via inflationary expectations. Our model implies that the exchange rate expectations are reflected in inflationary expectations that in turn affect nominal interest rates.

After the announcement of the exchange rate band, the direct effect has gradually disappeared, and from 1996 the exchange rate expecta-

[1] We used the adaptive form of expectations rather than the exchange rate futures as the data on the latter are still not complete.

tions affect interest rates via the interest rate parity as the weight of the latter increased significantly from the beginning of 1996. This conclusion is supported both by the insignificant correlation between the exchange rate expectations from June 1995 to September 1997 (−0.07), and by the high correlation between GKO and MinFin bond yields.

5.3. Interpretation of the Interest Rates Development in Terms of the Model

The considerations about the role of integration and exchange rate expectations suggest that the model of interest rate determination (1) – (4) is indeed relevant and reasonable. On the one hand, it provides qualitative explanation of interest rate fluctuations over the entire period and over the two major sub-periods divided by a structural break in the middle of 1995.

Before June 1995, under unstable exchange rate expectations, bigger weight can be attributed in the model to the influence of internal factors. The latter is reflected by the second and the third part of Equation (1), and Equation (4), where inflationary expectations are a function of exchange rate expectations.

After June 1995, especially from the beginning of 1996, the model places most of the weight on external factors reflected in world interest rates adjusted with stable exchange expectations. This relationship is built into the model as the first part of Equation (1), and Equation (2), where exchange rate expectations are related to the announced exchange rate regime.

Our analysis shows that the model should incorporate the estimation of political risks that played a decisive role in the determination of interest rates during election campaigns. Our model will include this risks as the variable Y(t) in Equation (3). Political risks raise a risk premium that should be incorporated into the real interest rate, and may as well affect the risk premium included into the dollar interest rate i_t^*.

6. THE MODEL SPECIFICATION

We have given up estimation of inflation expectations and real interest rates, which appear in the initial model. It was decided to replace the term ($r_t + \pi_t^e$) with the nominal rate R_t, taking as R_t some interest rate, depending on "domestic" macroeconomic variables (like inflation, money supply, budget deficit, etc).

One of the key issues was the choice of a particular rate for use as an indicator R_t. Several options were tried: the Central Bank refinancing rate RCBR, the interbank overnight rate RIB, and average deposit rate RDEP. Each of them has its own salient features, affecting its possible role in the model. The RCBR depends to some extent on both macroeconomic variables and other interest rates, but it is essentially a variable controlled by the monetary authorities. In this case R_t may be considered as an exogenous variable, set outside the model. Such version of the model is important from the viewpoint of possible implications of the Central Bank policy. A recent situation when this issue was of crucial interest is the period of the financial markets turmoil, when the CBR had to manipulate the refinancing rate, exchange rates and the GKO interest rates.

The major features of the interest rates under consideration are as follows:

The Central Bank refinancing rate

- controlled by the CBR, so it can be used as a policy instrument;
- relatively stable most of the time as compared to other rates; but it can experience significant abrupt changes;
- specific relationship with GKO/OFZ rate (say, RCBR cannot be sustainably kept at a lower level than the GKO/OFZ rate), putting limitations on its use as a policy instrument.

Interbank overnight rate

- high volatility;
- dependence on the major macroeconomic factors: short-term money demand and supply, state of the banking sector, etc;
- only implicit interdependence with the GKO/OFZ rate;

- "objective" nature, as it is defined on the highly competitive market.

Deposit rate

- medium-size stability;
- linked to such macroeconomic factors as demand for money and supply of savings;
- a high correlation with GKO/OFZ rates, as the government security market is one of the main directions of investment.

The initial presentation of the model (1) – (4) incorporates the product of the key parameters, θ and ψ. But the model can be modified to "untie" this product making its construction easier. The first equation of the model was subsequently represented as:

$$i_t = \varphi_1 (i_t^* + \delta_t^e) + \varphi_2 i_{t-1} + \varphi_3 R_t$$

Parameters φ_1 to φ_3 characterize respectively the impact of "international" interest rates, inertia in interest rates formation, and domestic macroeconomic situation. In fact, if we suppose that $\varphi_1 + \varphi_2 + \varphi_3 = 1$, this is equivalent to the initial equation, with $\theta = \varphi_1/(\varphi_1 + \varphi_2)$, and $\psi = \varphi_1 + \varphi_2$. Having estimated parameters $\varphi_1 - \varphi_3$, we can thus obtain the measures of "market efficiency" and "market integration". Moreover, parameters $\varphi_1 - \varphi_3$ have by themselves even better interpretation than ψ and θ, as contribution of each of the three components is characterized with its own parameter.

Whatever is the choice of the interest rate R_t, it is essential to take into account its bilateral link to the GKO rate i_t. To reflect this, a system of simultaneous equations was estimated that included four endogenous variables:

i_t — GKO/OFZ auction interest rate,

i_t^* — interest rates on Minfin bonds (denominated in USD), adjusted to the 6-month maturity,

δ_t^e — expectations of the USD exchange rate in 6 month (translated into annual exchange rate growth),

R_t — one of the domestic interest rates.

The choice of i_t^* changes somewhat the underlying interpretation of the model. The first component in the Equation (1) in the modified version is not just "international interest rate", but rather "interest rate of Russian securities in international markets". It incorporates thus both international interest rates (T_t) and international estimates of specific risks s_t associated to Russian securities.

The equations have been constructed in the following form:

$$i_t = \varphi_1 (i_t^* + \delta_t^e) + \varphi_2 i_{t-1} + (1 - \varphi_1 - \varphi_2) R_t + c_{13}D1 + c_{14}D2 + + c_{15}D3,$$

$$R_t = r[R_{t-1}, i_t (i_{t-1}), \pi_t^a, \delta_t^a, MS_t, B_t],$$

$$i_t^* = T_t + s[i_{t-1}^*, R_t, \pi_t^a, \delta_t^a, IR_t],$$

$$\delta_t^e = \delta[MS_t, \pi_t^a, \delta_t^a, \delta_{t-1}^e, IR_t],$$

where D1, D2, D3 are dummies, allowing for the effect of the Presidential elections: D1 = 1 in the first months of the pre-elections period (March – April 1996) and 0 otherwise, D2 = 1 in the point of maximum political risk in June 1996, D3 = 1 in July 1996, when the rates returned to their normal levels (the necessity to incorporate the latter variable is caused by the use of lagged variable i_{t-1} in the first equation),

MS_t — some indicator of money supply. Several variables were tried as such indicator: real M2 value (M2 deflated by CPI); money supply growth rates (average for the last 3 or 6 months), without lag or lagged for 1 to 3 months; real money base; money base growth rate (averaged and lagged in the same way as M2),

B_t — some indicator of actual or potential scale of domestic borrowings. Again several variables were tried for this role, including: Federal budget deficit, real volume of GKO/OFZ placement; real receipts from placing GKO/OFZ; real net financing via GKO/OFZ market (in all cases "real" meant "deflated by CPI" or "expressed in % of GDP");

T_t — interest rate for the US 6-month treasury bills,

IR_t — gross international reserves of Russia (in USD billion),

r, s, δ — linear functions characterizing correspondingly dependence of the "domestic" interest rate R_t, spread, and expected exchange rate growth on the factors defining them.

One of the hypotheses was that the measures of market "integration", "inertia", and "macroeconomic dependency" are changing with time. To test it, in addition to the models where coefficients $c_{11} - c_{13}$ were constant, models with variable coefficients of the form: a + b*t, a + b*log(t), a + b/t.

The observations comprised 28 months (July 1995 to October 1997). The choice of the initial point is explained by the structural break revealed in the previous analysis since the introduction of the exchange rate corridor, while the end point was chosen basing on the stationarity analysis. Augmented Dickey – Fuller unit root test initially implemented for the period July 1995 – December 1997 failed to reject null hypothesis of non-stationarity for the series i_t^*. Applied for the truncated period July 1995 – October 1997, this test made possible to reject non-stationarity for all endogenous variables. The necessity to cut the last two months of 1997 looks natural as they date to the period of world financial crisis.

Table 1.
Augmented Dickey – Fuller Test.

	ADF Test	**Critical value**	**Significance level, %**
$\mathbf{i_t}$	4.41	4.32	1
$\mathbf{RCBR_t}$	2.44	1.95	5
$\mathbf{i_t^*}$	4.37	4.34	1
$\mathbf{\delta_t^e}$	2.05	1.95	5

The system was estimated by the two-stage least squares procedure.

The following model specification proved to be the best:

$$i_t = c_{11}\ln(t)\,(i_t^* + \delta_t^e) + c_{12}\, i_{t-1} + (1 - c_{11}\ln(t) - c_{12})\, RCBR_t + \\ + c_{13}\, D1 + c_{14}\, D2 + c_{15}\, D3, \quad (5)$$

$$RCBR_t = c_{21}RCBR_{t-1} + c_{22}\, i_t + c_{23}\, \pi_t^a + c_{24}\, \delta_t^a + c_{25}\, borr_t, \quad (6)$$

$$i_t^* = T_t + c_{31}\, i_{t-1}^* + c_{32}\, RCBR_t\,, \quad (7)$$

$$\delta_t^e = c_{41}\, \delta_{t-1}^e + c_{42}\, \pi_t^a + c_{43}\, IR_t, \quad (8)$$

where "borr" denotes GKO/OFZ placement at constant prices (i.e. deflated by CPI), while IR and RCBR, as mentioned above, are the international reserves and CBR refinancing rate correspondingly.

This system meets rank conditions of identification.

Significant serial correlation was revealed for the i_t^* variable. To deal with it the moving average technique was used, which eliminated autocorrelation.

7. THE MODEL ESTIMATION

The output for each equation estimation is presented below.

Equation 1.

$$i_t = \underset{(t = 2.5)}{0.0689 \ln(t) (i_t^* + \delta_t^e)} + \underset{(t = 10.5)}{0.789 i_{t-1}} +$$

$$+ (1 - 0.0689 \ln(t) - 0.789) RCBR_t + \underset{(t = 5.3)}{0.627 D1} + \underset{(t = 6.4)}{1.026 D2} - \underset{(t = 4.8)}{0.838 D3}$$

$R^2_{adj} = 0.957$, $F = 127.9$, $s = 0.145$, $DW = 1.56$, Durbin $h = 1.16$.

Residual Tests. Normality of residuals *is rejected at 5% level* (Jarque – Bera test = 9.16).

The hypothesis of no serial correlation *is not rejected* by either Ljung – Box or Breush – Godfrey tests:

Lag	Autocor.	Partial autocor.	Q-Stat.	Prob.
1	0.157	0.157	0.667	0.41
2	−0.254	−0.286	2.496	0.29
3	−0.109	−0.015	2.852	0.42
4	0.019	−0.032	2.864	0.58
5	−0.125	−0.177	3.380	0.64
6	−0.223	−0.198	5.102	0.53
7	−0.044	−0.066	5.173	0.64
8	0.085	−0.047	5.454	0.71
9	0.166	0.105	6.594	0.68
10	0.141	0.097	7.481	0.68
11	−0.108	−0.153	8.040	0.71
12	−0.091	−0.025	8.473	0.75

Lag	LM-stat.	Prob.
1	0.95	0.33
2	3.23	0.20
3	3.35	0.34
4	3.78	0.44
5	6.14	0.29

White's Test *does not reject* homoskedasticity ($N^{*}_{obs}\, R^2 = 13.8$, Prob.= 0.39).

Equation 2.

$$RCBR_t = \underset{(t = 18.4)}{0.874\ RCBR_{t-1}} + \underset{(t = 6.4)}{0.130\ i_t} + \underset{(t = 3.2)}{0.358\ \pi^a_t} - \underset{(t = -3.8)}{2.286\ \delta^a_t} + \underset{(t = 2.9)}{7.759 \cdot 10^{-6}\ borr_t}$$

$R^2_{adj} = 0.995$, F = 1208.3, s = 0.040, DW = 2.31, Durbin h = −0.80.

Residual Tests. Normality of residuals *is not rejected* (Jarque–Bera test = 0.71).

The hypothesis of no serial correlation *is not rejected* by either Ljung–Box or Breush–Godfrey tests:

Lag	Autocor.	Partial autocor.	Q-Stat	Prob
1	−0.099	−0.099	0.278	0.60
2	−0.205	−0.217	1.508	0.47
3	0.295	0.264	4.186	0.24
4	−0.075	−0.077	4.365	0.36
5	−0.427	−0.374	10.518	0.06
6	0.082	−0.089	10.760	0.10
7	0.011	−0.093	10.764	0.15
8	−0.181	−0.009	12.065	0.15
9	−0.077	−0.226	12.313	0.20
10	0.043	−0.219	12.398	0.26
11	0.140	0.153	13.346	0.27
12	−0.152	−0.203	14.552	0.27

Lag	LM-stat.	Prob.
1	0.25	0.62
2	1.59	0.45
3	3.31	0.35
4	3.51	0.48
5	7.51	0.19

White's Test *does not reject* homoskedasticity ($N^{*}_{obs}\, R^2 = 12.6$, Prob.= 0.25).

Equation 3.

$$i^{*}_{t} = T_t + 0.225\, i^{*}_{t-1} + 0.0535\, RCBR_t\,,$$

$$(t = 6.9) \qquad (t = 14.1)$$

MA(1) = 0.338,

$R^2_{adj} = 0.968$, F = 415.3, s = 0.007, DW = 2.06, Durbin h = −0.15.

Residual Tests. Normality of residuals *is not rejected* (Jarque − Bera test = 0.61).

The hypothesis of no serial correlation *is not rejected* by either Ljung − Box or Breush − Godfrey tests:

Lag	Autocor.	Partial autocor.	Q-Stat	Prob
1	−0.029	−0.029	0.027	0.99
2	−0.101	−0.101	0.354	0.55
3	−0.116	−0.124	0.805	0.67
4	−0.234	−0.260	2.720	0.44
5	−0.036	−0.100	2.768	0.60
6	−0.035	−0.134	2.814	0.73
7	0.109	0.011	3.288	0.77
8	−0.068	−0.182	3.480	0.84
9	0.124	0.072	4.159	0.84
10	0.021	−0.032	4.180	0.90
11	−0.053	−0.031	4.320	0.93
12	−0.013	−0.055	4.328	0.96

Lag	LM-stat.	Prob.
1	0.22	0.64
2	0.37	0.83
3	2.40	0.49
4	2.91	0.57
5	3.69	0.59

White's Test *does not reject* homoskedasticity ($N^{*}_{obs}\, R^2 = 4.93$, Prob. = 0.29).

Equation 4.

$$\delta^{e}_{t} = 1.189\ \delta^{e}_{t-1} + 0.568\ \pi^{a}_{t} - 0.00467\ IR_{t},$$

$$(t = 4.6) \qquad (t = 9.2) \qquad (t = -3.3)$$

$R^2_{adj} = 0.870$, F = 87.6, s = 0.047, DW = 1.80.

Residual Tests. Normality of residuals *is not rejected* (Jarque–Bera test = 0.61).

The hypothesis of no serial correlation *is not rejected* by either Ljung–Box or Breush–Godfrey tests:

Lag	Autocor.	Partial autocor.	Q-Stat.	Prob.
1	0.058	0.058	0.102	0.75
2	0.211	0.208	1.495	0.47
3	−0.063	−0.089	1.625	0.65
4	0.036	0.001	1.670	0.80
5	−0.301	−0.287	4.905	0.43
6	−0.196	−0.199	6.337	0.39
7	−0.196	−0.075	7.841	0.35
8	−0.152	−0.122	8.790	0.36
9	−0.161	−0.131	9.918	0.36
10	0.006	−0.038	9.919	0.45
11	0.015	−0.070	9.930	0.54
12	−0.027	−0.179	9.967	0.62

Lag	LM-stat.	Prob.
1	0.09	0.76
2	1.35	0.51
3	1.51	0.68
4	1.52	0.82
5	3.81	0.58

White's Test *does not reject* homoskedasticity ($N^{*}_{obs} R^2 = 10.22$, Prob. = 0.12).

Terms constant, increasing or decreasing with time were tried for coefficients $\varphi_1 - \varphi_3$. The best estimates were obtained when we used increasing (with diminishing rate) "market integration degree" φ_1, constant "degree of inertia" φ_2, and correspondingly decreasing "macroeconomic dependence" φ_3. Calculated figures of these parameters as well as that for the parameters θ, ψ from the initial model (1) – (4) are presented below for the whole period under consideration.

The calculated parameters imply that the degree of market inertia was constant at the level of 79%. A high level of market inertia could have been expected, given a relatively small volatility of interest rates in the period under consideration (correlation of the current to previous interest rate made up 0.87). The "market integration" was increasing from 0 to 23% in October 1997, while macroeconomic dependency was declining from 21% in July 1995 to 0 in April 1997, and became even negative by October 1997. The latter fact from our viewpoint does not deserve special discussion, as the parameter's magnitude doesn't differ significantly from zero. Increasing degree of market integration corresponds to a growing involvement of non-residents in Russian securities markets. During 1997, the share of GKO/OFZ holdings by non-residents increased from 17 to 28%.

In terms of the initial model, the "market integration" degree θ is growing from 0 to 23%, while the "market efficiency" is increasing from 79 to 100% plus.

Table 2.

Estimated Parameters of the Interest Rate Performance.

	φ_1	φ_2	φ_3	θ, %	ψ, %
Jul-95	0.000	0.789	0.211	0	79
Aug-95	0.048	0.789	0.163	6	84
Sep-95	0.076	0.789	0.136	9	86
Oct-95	0.096	0.789	0.116	11	88
Nov-95	0.111	0.789	0.100	12	90
Dec-95	0.124	0.789	0.088	14	91
Jan-96	0.134	0.789	0.077	15	92
Feb-96	0.143	0.789	0.068	15	93
Mar-96	0.151	0.789	0.060	16	94
Apr-96	0.159	0.789	0.053	17	95
May-96	0.165	0.789	0.046	17	95
Jun-96	0.171	0.789	0.040	18	96
Jul-96	0.177	0.789	0.034	18	97
Aug-96	0.182	0.789	0.029	19	97
Sep-96	0.187	0.789	0.025	19	98
Oct-96	0.191	0.789	0.020	20	98
Nov-96	0.195	0.789	0.016	20	98
Dec-96	0.199	0.789	0.012	20	99
Jan-97	0.203	0.789	0.008	20	99
Feb-97	0.207	0.789	0.005	21	100
Mar-97	0.210	0.789	0.001	21	100
Apr-97	0.213	0.789	−0.002	21	100
May-97	0.216	0.789	−0.005	22	100
Jun-97	0.219	0.789	−0.008	22	101
Jul-97	0.222	0.789	−0.011	22	101
Aug-97	0.225	0.789	−0.013	22	101
Sep-97	0.227	0.789	−0.016	22	102
Oct-97	0.230	0.789	−0.018	23	102

8. THE MODEL'S SIMULATION

To check roughly the quality of the model a dynamic simulation was implemented.

The first step was historical simulation for the period July 1995 – October 1997.

Observed and fitted endogenous variables are presented at the Fig.4 – 7. Their comparison demonstrates relatively good match in the recent period.

The accuracy of the simulation can be characterized with the figures in Table 3.

Our model enables an evaluation of the impact of the market integration with the world financial markets. This was carried out by comparing the results of the above *ex post* simulation with similar results under an assumption of constant coefficients $\varphi_1 - \varphi_3$. It was found that in the latter case the GKO interest rate would decrease from 165.8% in October 1995 to 117.2% in October 1997. Under changing coefficients the October 1997 simulated rate amounts to 17.0%, while the observed rate was 17.5%. This can have an interpretation that with a constant market integration the interest rate decline would have been only 33% of its actual fall. The remaining 67% of the interest rate decrease should be

Fig. 4. Observed and Fitted GKO Interest Rate.

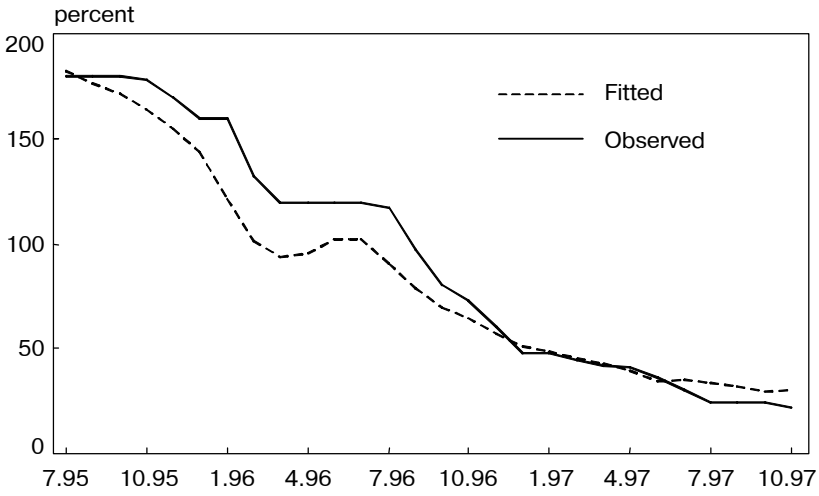

Fig. 5. Observed and Fitted GBR Refinancing Rate.

attributed then to a change in the market integration. This conclusion confirms thus the widespread view that the reason for interest rates decrease was, first of all, participation of non-residents in the market, and we give it a quantitative estimation.

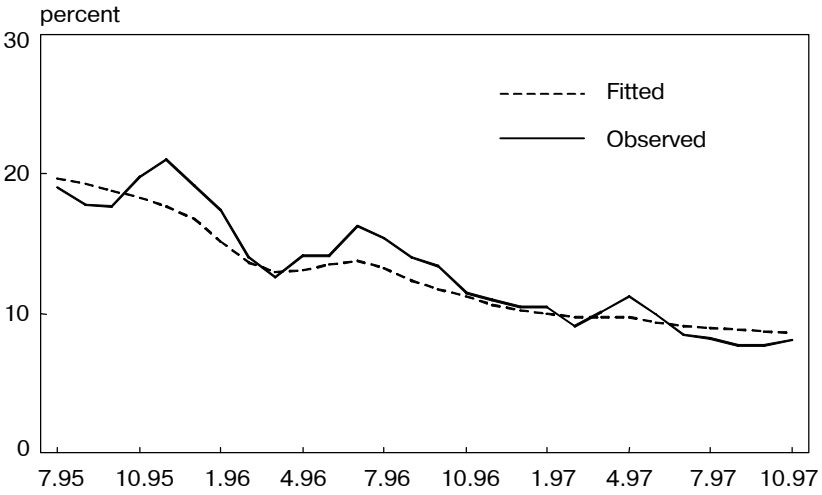

Fig. 6. Observed and Fitted MinFin Bonds Interest Rate.

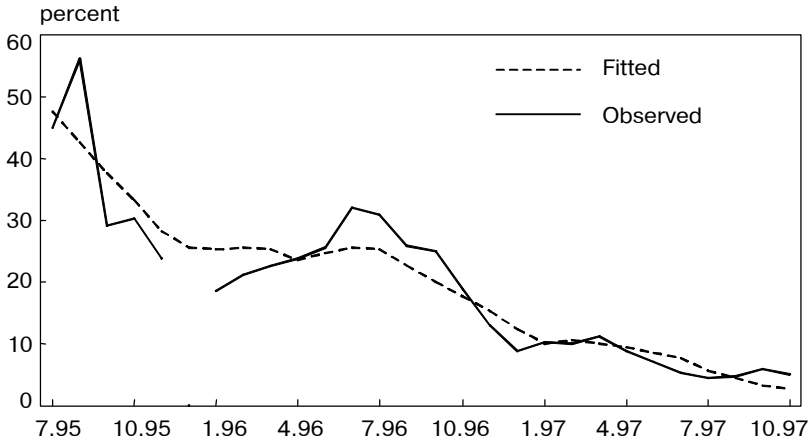

Fig. 7. Observed and Fitted Expected ER Growth (next 6 mnth in annual terms).

The conclusion from the model that may seem unexpected is that since mid-1997 the "domestic" interest rate, reflecting macroeconomic situation, did not affect the GKO rates directly, as φ_3 fell to zero. In terms of economic theory this result implies that Russia became by this time a "small open economy". Analysis of the GKO market at the micro-level supports the viewpoint that non-residents were dominating this market. Though they hold under 30% of the securities, non-residents managed to manipulate the whole market, by "signaling" the intention to leave it. According to the model, macroeconomic conditions still influenced the

Table 3.
Summary Statistics for Historical Simulation (July 1995 – October 1997).

	GKO Rate (i_t, %)	CBR Rate (RCBR, %)	Currency Securities Rate (i^*_t, %)	Exchange Rate Expectations (δ^e_t, %)
RMS error	18.0	15.4	1.4	4.4
RMS % error	18.8	17.6	9.4	23.5
Simulation error	−2.9	−8.5	−0.5	0.0
Simulation % error	4.1	−2.6	−2.6	2.9
Theil U	8.1	7.4	5.1	9.6

GKO rates in 1997, but only through the currency rate i* and the exchange rate expectations δ^{e}_{t-1}.

The next step in our analysis is an *ex post* forecast for the period November 1997 – June 1998. The projected GKO interest rates (see Figs 8 – 11), amount to 11% in June. This complies entirely with the

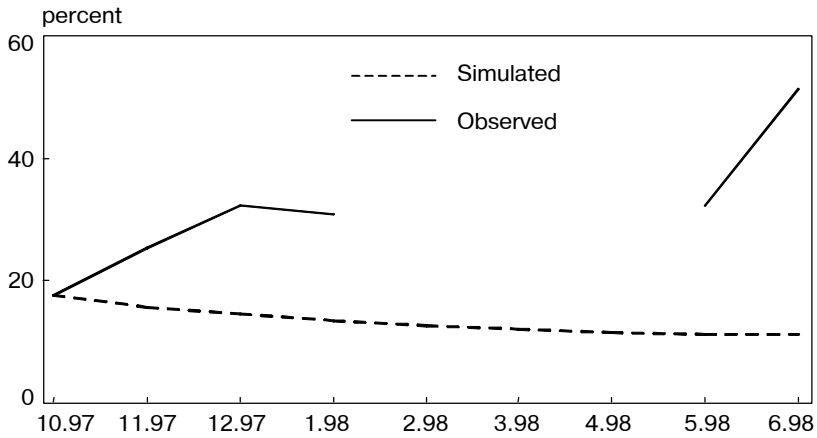

Fig. 8. Observed and Simulated *ex post* GKO Interest Rate.

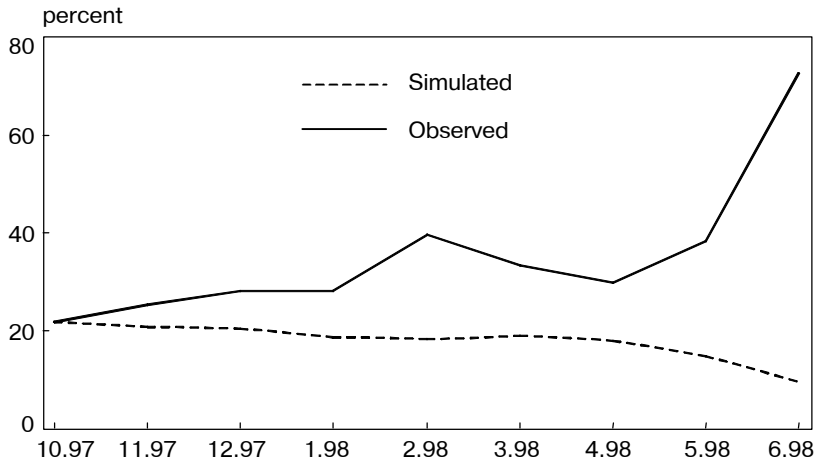

Fig. 9. Observed and Simulated *ex post* CBR Refinancing Rate.

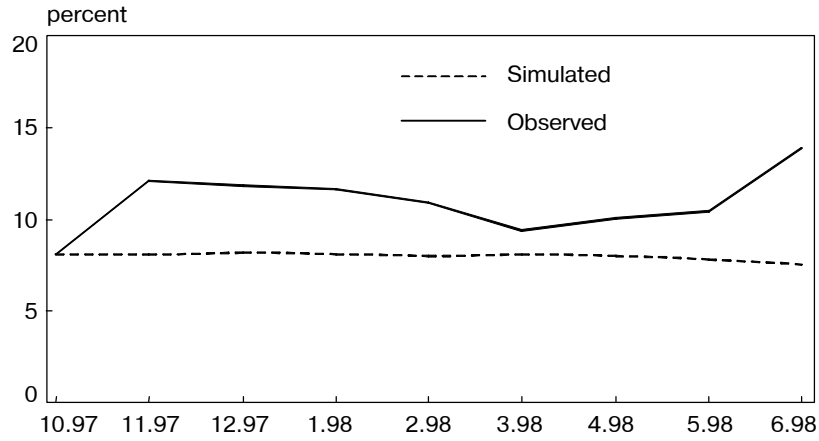

Fig. 10. Observed and Simulated *ex post* MinFin Bonds Interest Rate.

government forecast used in the Federal Budget for 1998, but evidently differs drastically from the actual rates in June, which made up 51% for the 6-months GKO.

We have to conclude thus that our model provides satisfactory description for the interest rates development before the financial crisis, but fails to explain market performance after crisis initiation.

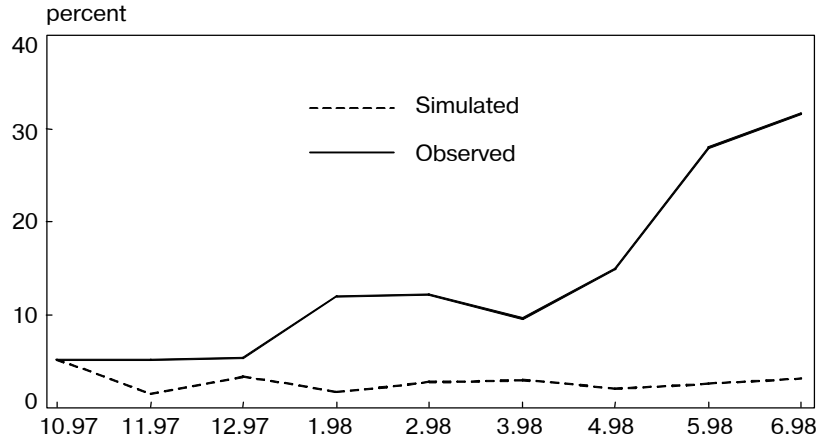

Fig. 11. Observed and Simulated *ex post* Expected ER Growth.

9. THE MODEL DISCUSSION AND INTERPRETATION

Our simultaneous equations account for the inter-relation among various internal and external interest rates. The refinancing rate (as a base domestic rate) fulfills the role of a connection between external and domestic yields on government securities. The external rate has two components: the base 6-month US Treasury rate and the spread reflecting a country risk. It is assumed that this spread is also included in the refinancing rate, which is endogenous in our model.

Most of the estimated coefficients have the right signs and do not require special discussion. The main exception is the negative sign of the coefficient for the officially expected exchange rate growth in the equation for the refinance rate. We can suggest the following explanation. Given low credibility of its announced policy, the Central Bank had to use higher refinancing rate to support any projected reduction of exchange rate devaluation. The Central Bank changes *ex ante* its refinance rate in accordance with announced exchange rate policy, while market rates develop mostly following market's own exchange rate expectations. If the latter differs substantially from the former, the Central Bank may be forced to change *ex post* its refinance rate in the opposite direction to affect the market sentiment and persuade the market that the CBR will stick to the announced policy. We found negative correlation between the refinance rate and the difference between the announced and the expected future exchange rates, while the refinance rate was positively correlated with both announced and expected rates separately.

The assumption that the sum of coefficients in the main interest rate equation is equal to one is justified by the significance of this equation, and by the fact that in most regression runs without this assumption, the unitary hypothesis could not be rejected. That implies that the external and internal factors in the equation are substitutes, while being correlated each with the other. The relative influence of two classes of factors changes over time in opposite directions: the role of the external rate has gone up implying a gradual increase in the degree of market "integration", while the role of the domestic rate ("macroeconomic dependence") has diminished. The degree of integration of the Russian market into the world financial system went up from "zero" in the middle in 1995 to around 23% at the end of 1997.

The "inertia" coefficient entered the model as a constant with a relatively high value of around 0.79, implying a constantly large inertia in interest rate changes.

Negative values of the coefficients for the refinancing rate from the second half of 1997 is the result of a negative influence of domestic factors on GKO/OFZ yields. The model indicates that the influence of the refinancing rate is channeled through the trust of investors. If investors believe that an increase in the refinancing rate was required and justified, the capital would flow into the market and GKO/OFZ rates would decrease. However, if investors think that a reduction in the refinancing rate was premature, this can cause an outflow of capital and an increase in GKO/OFZ rates.

It is crucial to discuss why the model fails to produce an accurate *ex post* forecast for the H1 1998 development. The major source of discrepancy was the projected magnitude of the expected exchange rate. Actual futures quotations envisaged in June a 32% devaluation on annualized basis (and even more — over 50% in the Chicago Stock Exchange), while the model predicts devaluation as low as 5.4% — quite close to the announced exchange rate devaluation (5%). This error is also responsible, to a great extent, for the forecast errors of other indicators.

The sharp rise of the expected exchange rate can be attributed to several factors, which are not reflected in the model. First, world prices for the major commodities exported by Russia dropped in the fourth quarter of 1997 and the first half of 1998. This persuaded most investors that the ruble became an overvalued currency, and hence its devaluation should be expected shortly. Our estimates suggest that the ruble was still somewhat undervalued at that time, if measured by the purchasing power parity level.

Second, the Asian financial crisis and subsequent devaluation of some currencies in Asia aroused investors' cautiousness towards all emerging markets, but especially the Russian one, due to slow pace of structural reforms and rapid growth of government short-term external debt. These sentiments were absent and did not influence capital inflows during the previous year. The major difference was a lower servicing load on both government and private debts in 1997, and this difference is not reflected in the model. Third, political instability hindered implementation of the reforms that could have stabilized the economy.

As a result, international reserves of the CBR were depleting rapidly, in spite of extensive new foreign borrowing. Reserves were also contracting in response to increasing inability of the Government to raise tax revenues and the evidence of continuing high capital flight.

One of the factors mentioned above is incorporated in the model: equation for currency expectations does include the level of international reserves. The actually observed decrease of international reserves in 1998 only insignificantly affects our projected interest rates. The reason is that the macro-economic situation was improving in the base period of the model estimation, but was deteriorating in the forecast period. In particular, international reserves and the government debt were in 1995 – 1997 less significant by far than in 1998.

Another point is that the situation at the new stage was characterized by lack of confidence to the monetary authorities policy, resulting in quite different interpretation of the announced macroeconomic targets. This changes entirely investors attitudes and behavior. Say, if investors believe the announced targets are reasonable, their expectations are positively correlated to them. In case of lack of confidence, this correlation is likely to be negative, as from the viewpoint of investors, say, unrealistic exchange rate targets make devaluation more probable. "Credibility crisis" was caused, on one hand, by inability of the Government to respond adequately to the challenge of the deteriorated financial conditions, and on the other hand, by lack of flexibility of the monetary authorities, which were reluctant to adjust their targets and policies with regard to the changed environment.

We believe that models of the type used in our study are able to provide reasonable description of the interest rates only when expectations do not differ much from the announced targets. Otherwise one should build model of different type, accounting for the effect of "objective" factors on investors' sentiments. The evident policy implications is that the authorities have to pay much more attention to the intended or unintended signals sent to investors, and make efforts to send only confident signals.

The major reasons for unsatisfactory *ex post* forecasts provided by the model were thus global changes of investment environment and failure to account for some important macroeconomic parameters in the equation for currency expectations.

10. INTEREST RATES AND DOMESTIC DEBT PROJECTION

Possible way of applying the interest rate model to evaluate fiscal policy scenarios is considered below. This model was incorporated to the broader framework to forecast domestic debt developments. At the same time it enabled *ex ante* projections of the interest rates.

10.1. DOMESTIC PUBLIC DEBT: OVERVIEW

At the end of 1997, Russia's total outstanding domestic public debt amounted to 606.9 trillion Rubles (USD 101.6 billion), or 22.7% of GDP. This public debt comprised domestic debt of the Government amounting to 556.0 trillion Rubles, debt of the sub-federal local governments of 37.7 trillion Rubles and 3.2 trillion Rubles owed by the State Pension Fund. Total Government domestic debt service payments increased from 1.1% of GDP in 1992 to 4.7% of GDP in 1996 and declined to 3.5% of GDP in 1997.

Domestic indebtedness of the Government consists of state treasury bills ("GKOs", from May 1993), Federal Loan Bonds ("OFZs", from June 1995), ruble-denominated saving bonds ("OGSZs", from September 1995) for retail investors with coupon yields tied to OFZ rates, internal Government hard-currency bonds ("OVVZs" known as "Taiga" bonds or "MinFins", from 1992) and securitized arrears on centralized credits to the agricultural sector and Northern regions of 1992 – 1995, as well as various smaller items.

Foreign investor access to the market for Russia's Government securities was significantly liberalized over the course of 1997, all restrictions on repatriation of profits from operations with GKOs and OFZs were eliminated as of 1 January 1998. The only remaining limitation on the access of foreign investors to the market is the requirement that non-residents trade in the securities through special "S" accounts with authorized banks. Currently, non-residents hold approximately 30% of all GKO/OFZ stock by face value.

Russia's Government domestic debt policies were significantly affected by developments associated with the financial crisis in Asia at the end of 1997. As difficulties intensified, GKO/OFZ yields rose appreciably, resulting in a projected increase in domestic debt service payments for 1998 of approximately 0.9% of GDP. In response, the Government curtailed new GKO/OFZ issuance to the rollover of existing obligations. At

that time the Government issued securities with shorter maturities, which caused the weighted average maturity to decrease from 9 months at 31 October 1997 to only 8 months at 1 January 1998. Early in 1998, the Government announced its intention to continue to limit GKO/OFZ issuance until interest rates and maturities available in the domestic debt market returned to normal levels.

10.2. Model for Domestic Debt Projection

The broad framework included in addition to the Equations (5) – (8) the following relationships:

a) Receipts N_t to the federal budget from the GKO/OFZ placement is calculated as sum of the necessary net financing F_t and required redemption R_t (which is defined by the earlier borrowings):

$$N_t = F_t + R_t,$$

b) Volume Z_t of the GKO/OFZ placement depends on the receipts N_t and GKO interest rate i_t:

$$Z_t = N_t^* \ (1 + i_t),$$

We identify here 6-months interest rates i_t estimated in the model with the average GKO/OFZ rates. The reason is that throughout 1997 rates for 6-months and 12-months securities were quite close, so no adjustment was required.

c) Borrowings at constant prices are evaluated assuming that actual inflation is the same as the announced one:

$$borr_t = Z_t / \pi_t^a .$$

Amount of borrowing was calculated then together with the interest rates from the enlarged system, including equations (5)–(8) and the relations presented in a)–c).

d) Redemption due at the moment $(t + \tau)$ in future was calculated as:

$$R_{t+\tau} = Z_t,$$

Here we simplified the task, assuming for simulation purposes that all government securities have standard maturity τ, and thus leaving apart their dispersion around this level.

e) GKO/OFZ outstanding debt D_t, defined as debt stock at the previous step plus the difference of the issued (Z_t) and redeemed (R_t) securities:

$$D_t = D_t + Z_t - R_t .$$

10.3. Assumptions and Projections

A dynamic simulation was carried out for the period July – December 1998.

We suggested that the formation of the government securities market in Russia is close to completion, therefore assumed that parameters φ_1 to φ_3 in the Equation (5) can be taken constant for the end 1997 and 1998, at their level of October 1997.

To check whether our model implies logical results, we have conducted a number of model experiments related to a forecast of interest rates in 1998 under a certain economic policy scenario. The forecast assumptions included:

- the announced inflation of 7% for 1998 and 5.5% in 1999,
- the announced policy of a stable real exchange rate,
- a stable 6-month US Treasury rate of 5.2% (as at the end of 1997) for the whole period,
- volumes of net supplies of GKO/OFZ paper as planned by the Federal budget. The latter were calculated basing on the projected budget revenues and expenditure, and other sources of financing,
- scheduled volumes of government securities redemption.

The assumed specific figures are presented in the Table 4.

The projected figures of the model variables are presented in the Table 5, while borrowings and domestic debt developments are given in the Table 6.

Thus estimated GKO/OFZ outstanding debt for the end 1998 amounted to 525.4 Ruble billion, and its expected growth in 1998 made up 20.5%, and the growth in H2 1998 was estimated at 13.1%.

Table 4.
The Major Characteristics of the Scenario for 2H1998 (Ruble Billion).

	Redemption	Net financing
Jul-98	38.24	0.65
Aug-98	27.37	1.46
Sep-98	35.11	0.89
Oct-98	29.45	0.58
Nov-98	30.27	0.77
Dec-98	18.35	0.50

Table 5.
Projected Values of the Model Endogenous Variables for the 1998.

	i_t, %	RCBR, %	i*, %	δ^e, %
Jul-98	42.7	71.9	13.1	2.4
Aug-98	35.3	66.7	11.6	0.9
Sep-98	30.0	62.8	11.0	3.5
Oct-98	25.7	57.1	10.6	2.9
Nov-98	22.2	51.8	10.2	2.4
Dec-98	19.4	44.0	9.7	2.1

Table 6.
Projected Value of the GKO/OFZ Placement and Their Outstanding Value (Ruble Billion).

	GKO/OFZ placement	GKO/OFZ outstanding debt
Jul-98	55.5	481.9
Aug-98	39.0	493.6
Sep-98	46.8	505.3
Oct-98	37.8	513.6
Nov-98	37.9	521.2
Dec-98	22.5	525.4

11. CONCLUSIONS AND POLICY RECOMMENDATIONS

The resulted forecast of GKO/OFZ rates seems to be reasonable from a qualitative point of view. The forecast that we obtained is very close to the Government's end-1998 target to reduce the average GKO/OFZ rate to 16%. Nevertheless, the events of the last months indicate that such forecast was over-optimistic.

The model implies that reductions of the refinancing rate had to be more gradual than those implemented by the Central Bank. The CBR has reduced the spread between the refinancing rate and the GKO rate to 5 percentage points by the middle of March 1998, while the model indicated that the spread had to be raised above 10% before the CBR could start to reduce it. As the Central Bank quickly reduced its refinancing rate, GKO/OFZ rates had to go up according to our model (as the weight coefficient is negative), which, in turn, was to push up the refinancing rate and gradually stabilize GKO/OFZ rates. This automatic stabilizing mechanism represents one of the main features of our model.

Thus, one of the first recommendations we can infer from our model is the necessity of a more careful approach to the reduction of the refinancing rate by the Central Bank. The reduction in the rate is well grounded only after a sufficiently long downward trend in GKO/OFZ yields, and — even better — after a substantial permanent reduction in the level of borrowing.

One can argue that the model involves an internal contradiction between the role of the refinancing rate as a policy instrument and its endogenuity. However, in our opinion, this seeming contradiction reflects a real world trade-off between using the refinancing rate as a leading signal and adjusting it to the market. The refinancing rate can be used as a market signal only if the Central Bank policy is highly credible. Otherwise, the Central Bank is bound to follow the market.

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