Analysis of the Relationship Between the Exchange Rate Policy of the Russian Central Bank and the Interest Rates: Uncovered and covered Parity

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An important condition for the transition to the free float and inflation targeting regime is the ability of the Russian Central Bank to pursue an active independent policy of interest rate adjustment. The purpose of this investigation is to analyze the effect produced by the exchange rate policy of the Russian Central Bank on the money market and to assess the sensitivity of domestic interest rates to foreign rates through the covered and uncovered interest rate parities. Assessment of variations in the coefficients of the tested relationships at different stages of the Russian Central Bank's exchange rate policy will allow judging the success of the institutional development which prepares a gradual transition to free float and inflation targeting.

Key Words: exchange rate regimes, interest rate parity, non-deliverable forwards
JEL classification: F31, F33

1. Introduction

Problems of the relationship between the currency policy and the interest rates are important from the point of view of both the formation of the monetary policy and the decision making by financial market participants. In particular, when the Russian Central Bank (RCB) chooses an exchange rate regime, its effect on the independence of interest rates should be taken into account. For financial market participants the difference in cost between the funding in the domestic currency and the funding in the foreign currency is a possibility of covered or uncovered arbitrage. Analysis of this problem becomes particularly important and pressing when accelerated integration of the country into the international capital market takes place and large foreign borrowings are made.

The main concepts of the interrelationship between the exchange rate and the interest rates are formulated within the principle of interest rate parity, in which case not only the quantitative parameters but also the character of the relationships in question vary depending on the features of the economy and the policy pursued by the monetary authorities.

Our investigation of the effect that the exchange rate policy of the RCB produces on the interrelationship of the Russian and foreign interest rates follows two lines. First, based on the data on spot exchange rates, we test the hypothesis of uncovered interest rate parity. Second,

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using the data on the forward exchange rate and the arbitrage condition, we find the implied rate of interest and investigate its interrelationship with the observed Russian rate of interest.

Before turning to the analytical part of the investigation, we briefly recall the main stages of the RCB exchange rate policy and the trend for dollarization of liabilities by Russian banks and companies in the past years.

Stages of the exchange rate policy of the Russian Central Bank

Though the Russian Central Bank has been employing the controllable floating exchange rate since 1998, the conditions for pursuing the exchange rate policy were noticeably varying within this general regime. Approaches of the Russian Central Bank to the exchange rate policy were partly modified as well.

As was many times pointed out in the annually adopted "Guidelines of the Unified State Monetary Policy", the exchange rate policy of the Russian Central Bank takes into account, in addition to other aspects, its effect on the internal and external competitiveness of Russian goods. Until 2008, the Guidelines included quantitative estimates of the expected variation limits of the real effective ruble exchange rate. The Russian Central Bank interpreted these limits as desirable from the point of view of maintaining the price competitiveness while never entering into a commitment to exceed these limits. The exchange rate policy of the Russian Central Bank also assumes the smoothing of the sharp exchange rate fluctuations that are not brought about by fundamental factors. At the same time the possibilities of influencing the ruble exchange rate dynamics under strong balance of payments are objectively restricted: the Russian Central Bank is capable of doing this only to that extent to which it is not in conflict with the main goal of the monetary policy to decrease inflation.

In some studies (Vdovichenko, Voronina, 2004; Esanov, Merkl, Vinhas de Souza, 2005) it was revealed that the exchange rate is among the target indicators of the RCB monetary policy playing an important part in its formation. Explicit allowance for exchange rate fluctuations in the monetary policy rules is in principle typical of most "emerging markets". The recent investigation (Mohanty, Klau, 2004), where monetary policy reaction functions (i.e., Taylor rules) were constructed for 13 transition economies, revealed a significant reaction of the monetary policy to the changes in the real exchange rate in 11 of the said economies. By and large, a policy like this can be tentatively characterized as the "soft targeting of the exchange rate".

Over the period under investigation, 2001 to 2008, the RCB exchange rate policy can primarily be divided into two stages. Until February 2008, the operation reference was the US

dollar exchange rate; later, the cost of the two-currency basket (whose composition gradually varied in 2005–2007 and has remained unchanged since February 2007). In other words, the first stage featured the soft targeting of the dollar exchange rate and the second stage featured the soft targeting of the two-currency basket.

Figure 1 depicts the dynamics of the ruble exchange rate to the dollar and the two-currency basket.

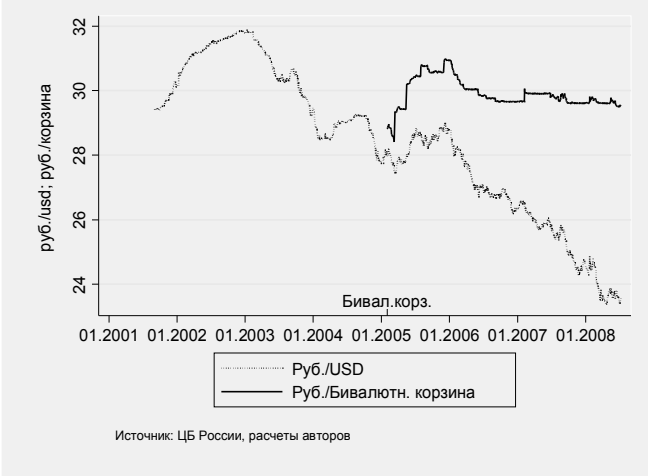

Fig. 1. **Dynamics of the ruble exchange rate to the dollar and the two-currency basket**

Notes:
руб --> rub
корзина --> basket
Бивал. корз. --> Two-curr. bask.

Source: RCB, calculated by authors

When the dollar exchange rate targeting is carried out, the ruble interest rates should appreciably depend on the dollar rates, which sets a limit to the RCB in pursuing an independent monetary policy. Note that this statement is completely valid only if there is free transboundary movement of capital, which levels profitability of domestic and foreign loans. Indeed, as follows from the known "trilemma", it is impossible to have free movement of capital and to manage the exchange rate and interest rates at the same time. With restrictions on the capital account, dependence of domestic interest rates on foreign ones decreases, which gives the RCB a free hand in pursuing the domestic monetary policy. In the middle of 2006, limitations on capital operations were lifted in our country. However, even before that the Russian financial markets were to a large extent integrated into the international ones.

After the transition to the two-currency basket targeting, the exchange rate of the ruble to the dollar or euro was largely governed by their cross rate. This makes the exchange rate of the

ruble less predictable because the dollar and the euro are in the free float regime. As is seen in Fig. 1, from the beginning of 2006 till July 2008 the dollar grew weak against the ruble, which corresponded to its weakening against the euro in the world market. Introduction of the two-currency basket targeting and establishment of a more flexible exchange rate of the ruble to the dollar should decrease the influence of the dollar interest rates on the Russian interest rates. Testing of this hypothesis and estimation of the change in this dependence will increase the possibility of the RCB pursuing an independent monetary policy.

2. Testing of the uncovered interest rate parity hypothesis

In the first part of the analysis we test the principle of uncovered interest rate parity for validity. The principle implies that the investor chooses between the investment of a unit fund into the domestic currency or the foreign currency. In the former case the investment profit per unit time is governed by the domestic interest rate i while in the latter case the expected profit depends on the foreign interest rate i^* and the expected change in the exchange rate. It is hypothesized that a higher interest rate attracts investors, the demand for currency increases, and its exchange rate goes up. In prospect, however, the exchange rate is governed by fundamental factors; therefore, investors should expect weakness in the currency which compensates for higher interest rates. The choice of a lot of investors should result in an equilibrium state, when the profits of different currency investments coincide,

$$1 + i_t = (1 + i_t^*)\frac{E_t(S_{t+1})}{S_t}$$

where $E_t(S_{t+1})$ is the exchange rate expected at the moment of time t as it is at the next moment of time $t+1$ and S_t is the spot exchange rate at the moment of time t.

In the economic literature it was traditionally believed that fulfillment of the uncovered parity condition indicates the efficiency of the currency market. However, numerous empirical studies carried out for the main world currencies with the floating exchange rate (Fama, 1994) show that uncovered parity does not hold (Froot, Thaler, 1990). In the recent work (Brunnermeier et al., 2008) it is also found that currencies of countries with a higher interest rate do not grow weak against currencies with a lower interest rate as uncovered currency parity requires but rather grow strong.

This empirical fact for the main currency pairs with the floating exchange rate is not thought of as being evidence for inefficiency of the currency market. In many publications it is pointed out that factors which are not involved in the tested expression for uncovered interest

rate parity, such as the risk premium (Engel, 1996), nonlinearity of data-generating processes (Sarno et al., 2006)), and transaction costs, appreciably affect the exchange rate dynamics and can be rationally taken into account by investors. It follows that the interest rate differential between the countries alone cannot account for the dynamics of their exchange rate, and yet the fact that in most investigations the correlation between the interest rate differential and the change in the exchange rate has a negative sign is still the major puzzle of international finance (Obstfeld and Rogoff, 2001).

At the same time some researchers consider that uncovered interest rate parity holds over particular periods for the world's main currencies and for some currencies of the developing countries. With the EU countries (before introduction of euro) taken as an example, it was found in the work (Flood, Rose, 1994) that the hypothesis partially holds for countries with the fixed exchange rate. In the investigation (Frankel, Poonawala, 2006) it is shown that interest rate parity better holds for a sample of developing countries than for developed countries. Considering that there are a lot of various risk premiums for developing countries both in the money market and the foreign currency market, fulfillment of the uncovered parity condition for these countries does not indicate higher efficiency of their currency markets. In the work (Frankel, Poonawala, 2006) fulfillment of the uncovered parity condition is attributed to a more predictable currency policy in the developing countries. Most central banks of these countries de jure declare the floating exchange rate and de facto pursue the currency targeting policy. This phenomenon has long been noticed (Calvo and Reinhart, 2002) and is given the name "fear of floating".

Thus, the test of the hypothesis for validity may simultaneously be a test of the exchange rate policy for predictability. In this connection it is interesting to trace how the transition from the ruble's peg to the dollar to the two-currency basket targeting has affected fulfillment of the uncovered parity condition in Russia.

Data used

As an indicator characterizing Russian interest rates, we use the daily values of MosIBOR (Moscow Inter-Bank Offered Rate) for the periods of one and three months. These rates are calculated by the National Currency Association and serve as an indicative rate in the Moscow interbank market. A measure of foreign rates is LIBOR (London Inter-Bank Offered Rate) for deposits in US dollars for the similar periods. The rate of exchange of the ruble to the dollar is characterized by the official exchange rate of the Russian Central Bank.

The calculation of uncovered parity on the basis of the *daily* data faces the problem of overlapping observations (Hansen and Hodrick, 1980). This is because the monthly profitability

of the long position in the foreign currency is calculated every day. To avoid the problem, it is convenient to use *monthly* data. Based on the daily observations, we calculated the monthly average for each series used and obtained 82 monthly observations for the period from September 2001 to July 2008.

Two variables are mainly studied within our analysis:

1) Spread between the Russian one-month (three-month) MosIBOR interest rate and the dollar LIBOR rate for the similar period;
2) Actual percentage change in the exchange rate of the ruble to the dollar

$$\Delta S = (S_t - S_{t-1}) / S_{t-1} * 100 \quad ,$$

where a period of one month or three months is taken for the unit time. This indicator is equal to the profitability of the operation of buying the dollar and selling it in one month (three months), i.e., the profitability of the long uncovered dollar position.

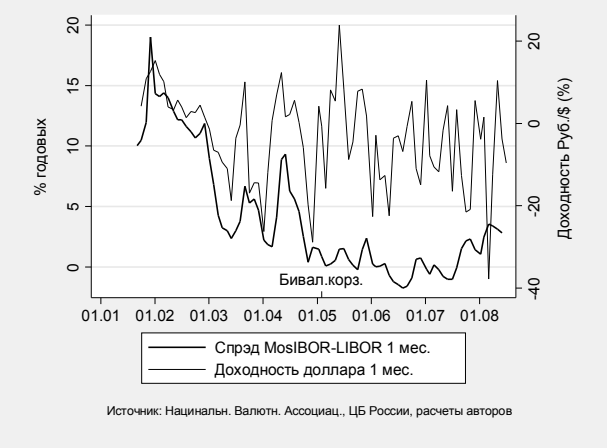

Fig. 2. **Dynamics of the one-month MosIBOR-LIBOR spread and the dollar buying profitability in one month**

Notes:
% годовых --> annual interest rate
Доходность --> Profitability
Руб --> Rub
Спрэд … --> MosIBOR–LIBOR spread, 1 month
Доходность доллара… --> Dollar profitability, 1 month

Source: National Currency Assoc., RCB, calculated by authors

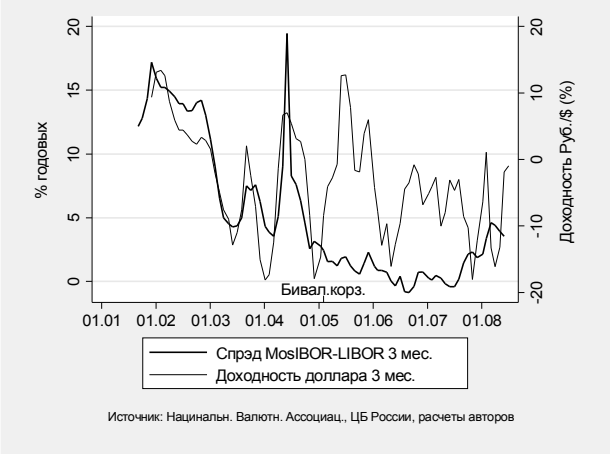

Fig. 3. **Dynamics of the three-month MosIBOR-LIBOR spread and the dollar buying profitability in three months**

Notes:
% годовых --> annual interest rate
Доходность --> Profitability
Руб --> Rub
Спрэд … --> MosIBOR–LIBOR spread, 3 months
Доходность доллара… --> Dollar profitability, 3 months

Source: National Currency Assoc., RCB, calculated by authors

Figure 2 depicts the dynamics of the spread between the Russian one-month MosIBOR interest rate and the one-month dollar LIBOR rate, and the historical profitability of the uncovered dollar long position over a period of one month. Figure 3 shows the similar dynamics for the three-month rates and profitability. It is evident from the graphical analysis that the dynamics of the variables under study over the dollar targeting period differs from the dynamics over the two-currency basket targeting period. First, at the basket targeting stage the MosIBOR–LIBOR spread grew narrower[4]; second, the dollar buying profitability increased after the introduction of the basket; and third, at the dollar targeting stage the interest rate spread and the dollar profitability look more correlated than at the two-currency basket targeting stage. We will test the latter statement using the econometric analysis.

We focus attention primarily on parity to the dollar, which is explained by the fact that the operations in this currency in the Russian market greatly exceed in amount the operations in euros. According to the RCB data, in January 2008 the dollar spot transactions amounted to a

[4] Note that the narrowing of the MosIBOR–LIBOR spread is to a large extent related to a decrease in the inflation rate in Russia over the period under discussion and a decrease in the Russian credit risk due to an increase in the RCB foreign exchange reserves.

total of $562 million while the euro transactions in the dollar terms amounted to $24 million. The amount of forward dollar transactions was $184 million, and forward euro transactions in the dollar terms amounted to $8 million. Dollars also dominated in the structure of borrowings. At the beginning of 2006 their share in the structure of foreign currency liabilities of the banking system (without participation in capital) was 91.4% against 7.5% of euro liabilities. By the end of the period under consideration the share of euro liabilities increased, and yet it was almost six times as small as the share of dollar liabilities.

A rather narrow euro market negatively affected its pricing before the introduction of the two-currency basket. Using the formula for calculation of the sliding average standard deviation on the 15-day interval, we calculated the volatility of the daily dollar and euro profitability relative to the ruble. It is evident from Fig. 4 that the volatility of the euro exchange rate to the ruble was much higher than the volatility of the dollar exchange rate to the ruble before the two-currency basket targeting began. After the exchange rate of the euro to the ruble became dependent on the world exchange rate of the euro to the dollar, the euro/ruble pair pricing became less dependent on the inefficiency of this exchange market segment caused by a low volume of euro trading in the Russian exchange marked. It follows that one of the successes of introducing the two-currency basket targeting was that the volatility of the exchange rate of the ruble to the euro decreased and was correlated with the volatility of the exchange rate of the ruble to the dollar.

After the transition to the two-currency basket targeting it can be assumed that percentage parity began holding for the basket containing the dollar and the euro and that the exchange rate policy of the RCB turned out to be predictable relative to the basket. Let us test this hypothesis.

We took into account that the composition of the two-currency basket changed several times. At each moment the value of the basket was calculated using the current weights of the dollar and the euro and the synthetic foreign interest rate was constructed by aggregating the dollar and euro interest rates.

The results of the Dickey–Fuller stationarity tests of the data series obtained are presented in Table 1. They indicate that the cointegration order of the series under study is I(1) and we may use the Johansen test for the investigation of their cointegration rank, as presented in Table 2.

Table 1

Augmented Dickey–Fuller test
Null hypothesis: variables contain a unit root

Variable	ADF test	Variable	ADF test
Percentage spread MosIBOR–Synthetic rate based on euro and dollar LIBOR			

Spread, one-month	-2.394	Δ Spread, one-month	-4.962***
Spread, three-month	-2.067	Δ Spread, three-month	-5.401***
Profitability of the two-currency basket in relation to the ruble			
Dollar profitability, one-month	-3.548**	Δ Dollar profitability, one-month	-9.235***
Dollar profitability, three-month	-2.782	Δ Dollar profitability, three-month	-5.404***

Notes.
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*
The sample includes 39 observations (February 2005–June 2008).

Table 2

Johansen test for cointegration

		One-month profitability i_{trace}	Three-month profitability i_{trace}
(Basket profitability MosIBOR–Synthetic Rate spread)	Rank=0	20.8517***	22.723***
	Rank=1	8.893	5.654

Notes. The AIC, SBIC, FPE, and HQIC tests for determination of the number of vector autoregression lags indicate two lags.
The specification involves an unbounded constant and a linear trend in the levels, which implies stationarity of cointegration equations around the constant average.

In both cases the hypothesis that the cointegration rank is 0 is rejected at the 1% level while the hypothesis that the cointegration rank is 1 cannot be rejected. Thus, it follows that the data series under study are connected by a long-run equilibrium relationship and we can test its strength and statistical significance.

Table 3

Sensitivity of the two-currency basket profitability to the synthetic interest rate spread

Periods of exchange rate policy	One-month investment horizon			Three-month investment horizon		
	Adaptation rates	*Adaptation rates*	*Interrelation-ship between levels* ,	*Adaptation rates*	*Adaptation rates*	*Interrelation-ship between levels* ,
Two-currency basket targeting 01.02.2005–01.07.2008	-0.129*** (0.062)	-0.022*** (0.007)	14.993*** (4.769)	-0.301*** (0.072)	-0.016 (0.018)	1.019 (1.431)

Notes.
Values in parentheses correspond to the standard errors
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*
Positive sign indicates a negative interrelationship.

It is evident from Table 3 that the signs of the coefficients and for both investment horizons point to the fact that the uncovered parity hypothesis does not hold for the two-currency basket. The negative sign of the coefficient suggests that the negative deviation of the interest rate spread from the equilibrium with the two-currency basket profitability entails an increase in the deviation from the equilibrium.

The positive sign of the coefficient points to the negative long-run interrelationship between the two-currency basket profitability relative to the ruble and the synthetic interest rate spread. In the case of the one-month investment horizon, this interrelationship is significant both economically and statistically.

These results confirm our conclusions given in the main body of our investigation that uncovered interest rate parity relative to the dollar/ruble exchange rate does not hold, and indicate that the RCB exchange rate policy became less predictable after the introduction of the two-currency basket.

These facts suggest that it is expedient to use the dollar segment of the Russian exchange market as the most liquid one when the efficiency of the RCB exchange rate policy and its impact on the domestic interest rates are studied.

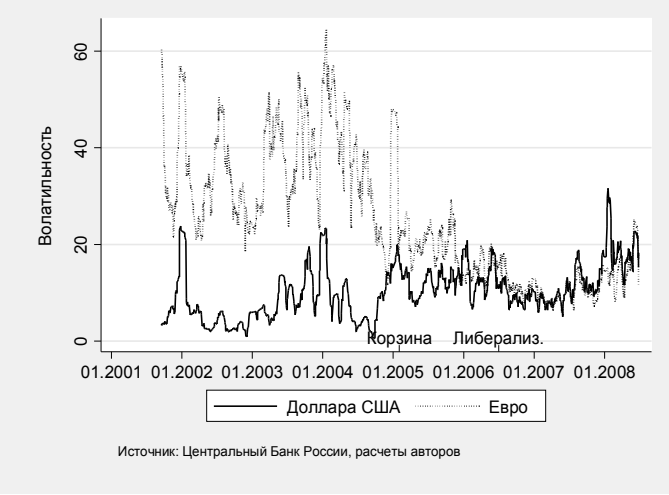

Fig. 4. **Volatility of the daily profitability of the dollar and euro exchange rates to the ruble calculated by the sliding average method**

Notes:
Волатильность --> Volatility
Корзина --> Basket
Либерализ. --> Liberaliz.
Доллара США --> US dollar
Евро --> Euro

Source: RCB, calculated by authors

Cointegration analysis

We break our sample into two subsamples. The period from September 2001 to February 2005 is the dollar targeting period, and the period from February 2005 to July 2008 is characterized by introduction of the two-currency basket targeting. The purpose of his breaking is to test the hypothesis that changes in the exchange rate policy resulted in qualitative shifts in the dynamics of deviations from interest rate parity.

The first step of our investigation is the test of the series under consideration for stationarity using the augmented Dickey–Fuller test in the specification with a trend. It is evident from Table 4 that for the levels of our data series the null hypothesis of unit root cannot be rejected at the 1% level whereas for the first differences of the variables in question the null hypothesis is rejected. This indicates that the cointegration order of the series in question is I(1), and we can use the Johansen test to investigate their cointegration rank.

Table 4

Augmented Dickey–Fuller test
Null hypothesis: variables contain a unit root

Variable	ADF test	Variable	ADF test
MosIBOR–LIBOR interest rate spread			
Spread, one-month.	-1.961	Δ Spread, one-month	-8.048***
Spread, three-month	-2.582	Δ Spread, three-month	-9.749***
Profitability of the dollar in relation to the ruble			
Dollar profitability, one-month.	-4.036**	Δ Dollar profitability, one-month.	-4.738***
Dollar profitability, three-month	-3.166	Δ Dollar profitability, three-month	-6.875***

Notes.
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*
The sample includes 77 observations

As the data under investigation are nonstationary, some investigations on New Zealand [see Munro (2005)], Denmark, and Germany [see Johansen and Juselius (1992); Juselius (1995)] were carried out using the cointegration analysis for examining the uncovered interest rate parity. It allows testing the hypothesis of existence of a long-run equilibrium relationship between the variables under investigation and the rate of return to it after a short-run deviation from the equilibrium.

Table 5

Johansen test for cointegration

		One-month profitability λ_{trace}	Three-month profitability λ_{trace}
(Dollar profitability, MosIBOR–LIBOR spread)	Rank=0	36.783***	26.568***
	Rank=1	4.618	5.567

Notes.
The AIC, SBIC, FPE, and HQIC tests for determination of the number of vector autoregression lags indicate two lags.
The specification involves an unbounded constant and a linear trend in the levels, which implies stationarity of cointegration equations around the constant average.

In Table 5 we present the Johansen test statistics for the one-month and three-month investment horizons. In both cases the hypothesis of cointegration rank 0 is rejected at the 1% level whereas the hypothesis of cointegration rank 1 cannot be rejected. It follows that the data series under investigation are connected by a long-run equilibrium relationship and we can test its strength and statistical significance.

The two-variable model to be tested can be represented by the specification

$$\begin{pmatrix}\Delta y_{1,t}\\ \Delta y_{2,t}\end{pmatrix} = \begin{pmatrix}\alpha_1\\ \alpha_2\end{pmatrix}(1 \quad \beta)\begin{pmatrix}y_{1,t-1}\\ y_{2,t-1}\end{pmatrix} + \begin{pmatrix}\phi_{11} & \phi_{12}\\ \phi_{21} & \phi_{22}\end{pmatrix}\begin{pmatrix}\Delta y_{1,t-1}\\ \Delta y_{2,t-1}\end{pmatrix} + \begin{pmatrix}\varepsilon_1\\ \varepsilon_2\end{pmatrix} \qquad (1)$$

where the vector $\mathbf{y}_t = (y_{1,t} \quad y_{2,t})'$ is the interest rate spread and the profitability of the buying of dollars with a one-month or three-month horizon.

The coefficients α in system (1) are interpreted as the rate of adaptation of one of the series under investigation to the long-run equilibrium between them, and the coefficient β is interpreted as the interrelationship between the levels of the variables under investigation in their equilibrium state.[5] The results of estimation for the one- and three-month data are presented in Table 6.

[5] One of the long-run coefficients is normalized to unity.

Table 6

Sensitivity of the dollar profitability to the interest rate spread

Periods of exchange rate policy	One-month investment horizon			Three-month investment horizon		
	Adaptation rates	*Adaptation rates*	*Interrelation-ship between levels,*	*Adaptation rates*	*Adaptation rates*	*Interrelation-ship between levels ,*
1) US dollar targeting 01.09.2001-01.02.2005	-0.605*** (0.232)	0.146*** (0.047)	-1.477*** (3.298)	-0.279*** (0.086)	0.231*** (0.063)	-1.302*** (0.270)
2) Two-currency basket targeting 01.02.2005- 01.07.2008	-1.005*** (0.212)	0.024* (0.013)	-0.567 (1.477)	-0.386*** (0.103)	0.000 (0.014)	-2.210 (1.617)

Notes.
Values in parentheses correspond to the standard errors
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*

It is evident from the table that at the dollar targeting stage there existed a long-run cointegration relationship between the interest rate spread and the dollar buying profitability across both the one-month and three-month horizons because the interest rate spread–profitability interrelationship coefficients β are significant at the 1% level and have expected signs.[6] This indicates that the relationship between the interest rate spread and the realized change in the exchange rate of the ruble to the dollar agreed with the uncovered parity hypothesis: an increase in the average differential of the Russian interest rates relative to the dollar rates was associated with the depreciation of the ruble. After the introduction of the two-currency basket targeting we cannot reject the hypothesis that the coefficient β is insignificant; accordingly, we do not observe an interrelationship between the interest rate spread and the realized exchange rate of the ruble to the dollar at this stage of the exchange rate policy.[7]

At both stages of the exchange rate targeting the foreign LIBOR rate is exogenous, but in the case of dollar targeting the exchange rate of the dollar is more predictable than in the case of two-currency basket targeting. Hence it follows that at the given exchange rate expectation in the period until February 2005 the domestic MosIBOR interest rate should to a larger extent be governed by uncovered interest rate parity. This result agrees with the results of the investigations mentioned above (Flood, Rose, 1994; Frankel, Poonawala, 2006), according to which the uncovered parity hypothesis holds at a more predictable exchange policy. Fulfillment

[6] The negative sign in the cointegration expression indicates positive interrelation between the variables of interest.
[7] It is worth mentioning that the estimation of the cointegration equation by the Johansen method is sensitive to the size of the sample because critical values of test statistics are only asymptotically valid. Johansen proposes the correction by Bartlett's method but at the same time points out that the size of the sample affects the estimate of the adaptation coefficient α and does not affect the long-run elasticity coefficient β, which is of major interest for us from the point of view of the uncovered parity hypothesis.

of the uncovered parity condition at this stage does not point to higher efficiency of the exchange market but rather indicates that at a predictable exchange rate and an exogenous foreign interest rate the domestic interest rate changes in accordance with the parity.

On transition to the two-currency basket targeting the exchange rate of the ruble to the dollar becomes less predictable, and the domestic MosIBOR interest rate will, accordingly, also depend on the currency exchange risk premium. This premium is unobservable and does not enter into our equation under test. Since the currency exchange premium changes over time, uncovered parity does not hold at a more flexible exchange rate, which is confirmed by our results.

The adaptation rate coefficients γ_1 and γ_2 indicate the following. Since the coefficient γ_1 is negative, the dollar profitability rapidly returns to equilibrium if there occurred its positive deviation from the equilibrium relationship with the interest rate spread. The positive value of γ_2 indicates that if there occurs negative deviation of the interest rate spread from the equilibrium with the dollar profitability, it also returns to equilibrium. The statistically significant positive value of the coefficient γ_2 obtained for the dollar targeting stage points to the fact the in this period the interest rate spread returned to the long-run equilibrium with the exchange rate. The statistically insignificant coefficient γ_2 at the two-currency basket targeting stage indicates that the spread and thus the domestic MosIBOR rate do not react to deviations from uncovered parity.

From the point of view of monetary authorities, our results are interesting by their demonstrating that after the introduction of the two-currency basket targeting the direct dependence of the domestic Russian interest rates on the foreign ones decreased. This indicates that the RCB exchange rate policy became less predictable at this stage and that the domestic interest rate became less dependent on the foreign one, which better favors the independent domestic monetary policy.

Form the point of view of exchange market participants, the nonfulfillment of the interest rate parity condition indicates that the value of the foreign and domestic funding is not leveled off in accordance with the parity. Considering the distinct trend for the strengthening of the ruble in 2006–2008 readily seen in Fig. 1, which was due to the favorable balance of trade and the fall in the dollar exchange rate to the main world currencies, and the fact that domestic interest rates are not adapted in accordance with uncovered parity, it can be concluded that the ruble has become the so-called investment currency. A number of currencies for which uncovered interest

rate parity stopped holding over the period of the steady dollar exchange rate weakening until September 2008 are given in the work (Brunnermeier et al., 2008). This worldwide trend partially explains the increasing dollarization of liabilities by the Russian private sector which occurred against the background of positive spread between the Russian and dollar interest rates and a stable trend for the strengthening of the ruble against the dollar.

3. Liberalization of the capital account and covered interest rate parity

Covered interest rate parity

The principle of covered interest rate parity is referred to the situation where the investor has a possibility of buying a forward contract and thus to determine beforehand the rate at which he can execute reverse conversion of the funds allocated in a foreign currency. In this case parity takes the form

$$1 + i_t = (1 + i_t^*)\frac{F_{t,t+1}}{S_t} \quad ,$$

where $F_{t,t+1}$ is the forward rate for the time t at the time t+1.

If the covered parity principle did not hold, it would mean that the investor could get arbitrage without any risk. The empirical test proves that if there are no obstacles for capital movement, differences in the taxation regime, and credit risks, this principle holds, as a rule (Isard, 2006). Deviations from the covered interest rate occur when there are constraints on the flow of capital and transactions costs (Frankel and Levich, 1977). The degree of deviation from covered parity for a given country allows judging the degree of liberalization of its currency circulation and integration into the world capital market. Many researchers (Vieira, 2003) use the analysis of the fulfillment of the covered parity condition for assessing the actual existence of constraints on movement of capital.

It is noteworthy that one of the latest important stages of the exchange control in Russia was introduction of capital account liberalization in the middle of 2006. Using the measure of deviation from covered parity we can trace how the degree of Russia's integration into the world capital market was changing at different stages of the RCB exchange rate policy. Before we turn to the testing of the hypothesis, it is necessary to make clear the mechanism of forward contracts and the calculation of the implied interest rate reflecting the cost of covered foreign borrowing.

Imputed interest rates calculated on the basis of non-deliverable forwards

Non-deliverable forwards (NDFs) are an offshore instrument created for investors working in countries with constraints on the flow of capital and interested in hedging currency risks. The mechanism of this kind of contract has been detailed in the work (Debelle et al., 2006). The main feature of this forward is that it is quoted by foreign banks and all payments are effected in a foreign currency. This market is well developed for Asian currencies (Chinese yuan, Indian rupee, Korean won, Philippine peso, Indonesian rupiah, new Taiwanese dollar) and Latin American currencies.[8]

In March 2006 the Russian National Currency Association[9] polled 20 large Russian banks. According to the results of the poll, NDF forwards constituted 48.9% of all derivative contracts on currency made by the banks with nonresidents. Contracts for a period shorter than six months made up 85%; among them, contracts for a period from three to six months comprised 24.7% of the total amount. It is interesting that the share of the banks' own speculative positions in NDF forwards amounted to 72.6% while the share of contracts where the banks participated as intermediaries for customers was 27.4%. This indicates that though NDF forwards were invented by foreign banks for foreign investors as a hedging instrument, Russian banks extensively use this instrument for covered arbitrage of exchange.

NDF forward quotations[10] and LIBOR rates allow calculating the implied interest rate for the Russian market

$$i^{implied}_{\ t} = \frac{NDF^{T}_{\ t}}{S_t}(1 + i^{*}_{t}) - 1 \qquad (2)$$

where $NDF^{T}_{\ t}$ is the quotation of the forward contract at the time t for a period T, i is the LIBOR interest rate for the same period as the forward, and S is the spot exchange rate at the time t. The implied rate characterizes profitability of investment in foreign currency with simultaneous purchase of a forward contract. Then the test of fulfillment of the covered parity condition means a comparison of the implied and domestic interest rate values.

Dynamics and volatility of interest rates

We can graphically depict the observed three-month LIBOR and MosIBOR interest rates and also the implied interest rate[11] calculated by formula (2) using three-month forwards.

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[8] See Ma, Ho, McCauley. (2004) и Fernandez (2003, 2006)
[9] See Piskulov (2006)
[10] We use quotations for three-month and one-month forwards on the exchange rate of the ruble to the dollar.
[11] This rate is the cost in rubles of covered borrowing on the international capital market.

It is evident from the plot in Fig. 5 that implied and observed Russian interest rates are strongly correlated and the MosIBOR rate is on the average higher, which indicates that foreign borrowing at the LIBOR rate with conversion to rubles with simultaneously opening a forward contract to buy currency at the expiry date of debt contracts is cheaper than domestic borrowing in rubles.

This differential was particularly large at the dollar targeting stage up until 2005. This fact can probably be explained in part by the risk premium which Russian borrowers pay when borrowing sums in dollars and which we ignored in formula (2) when calculating the implied rate. The purpose of our investigation is to analyze how the RCB exchange rate policy affected the interrelationship of the interest rates in question.

Another interesting observation allowed by Fig. 5 is that after introduction of the two-currency basket in February 2005 the implied interest rate became more volatile and began fluctuating around the observed MosIBOR rate. It points to increasing insecurity of currency arbitrage because of a less predictable dollar exchange rate.

Apart from the analysis of the dynamics of changes in levels of interest rates with respect to each other, it is interesting to examine how their volatility was changing over various periods of time. This can be traced in the plots of the dynamics of daily interest rate changes in Figs. 6 and 7. The most interesting inference from this graphical analysis is that introduction of the two-currency basket in 2005 coincides in time with an appreciable decrease in volatility of the domestic Russian MosIBOR rate and an increase in volatility of the implied rate calculated by formula (2).

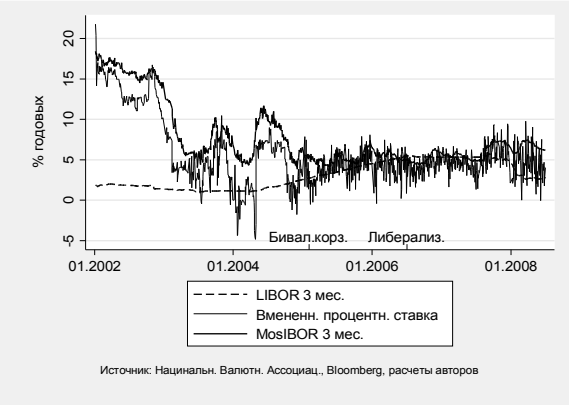

Fig. 5. **Dynamics of the implied interest rate according to covered arbitrage and observed three-month interest rates**

Notes:
% годовых --> annual interest rate
Бивал. корз. --> Two-curr. bask.
Либерализ. --> Liberaliz.
LIBOR 3 мес. --> LIBOR, 3 months
Вменен. процент. ставка --> Implied interest rate
MosIBOR 3 мес. --> MosIBOR, 3 months

Source: National Currency Assoc., Bloomberg, calculated by authors

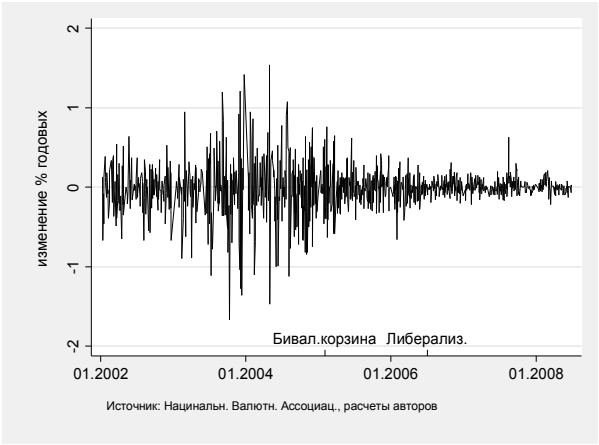

Fig. 6. **Daily change in the three-month MosIBOR interest rate**

Notes:
изменение % годовых --> change in annual interest rate
Бивал. корз. --> Two-curr. bask.
Либерализ. --> Liberaliz.

Source: National Currency Assoc., calculated by authors

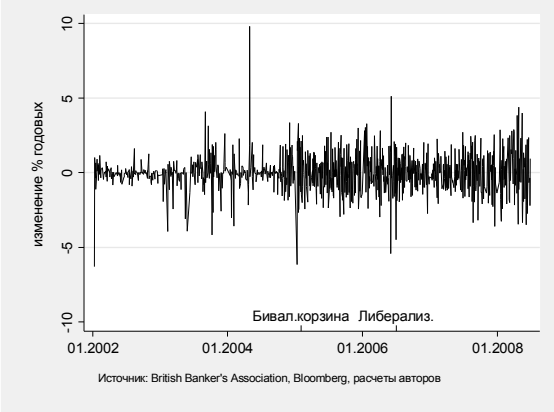

Fig. 7. **Daily change in the three-month implied interest rate**

Notes:
изменение % годовых --> change in annual interest rate
Бивал. корзина --> Two-curr. basket
Либерализ. --> Liberaliz.

Source: National Currency Assoc., Bloomberg, calculated by authors

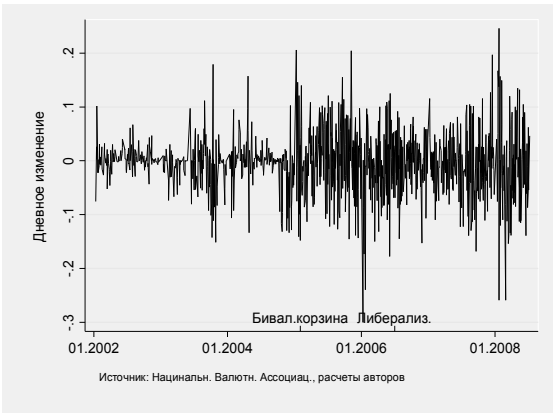

Fig. 8. **Daily change in the exchange rate of the ruble to the dollar**

Notes:
Дневное изменение --> Daily change
Бивал. корзина --> Two-curr. basket
Либерализ. --> Liberaliz.

Source: National Currency Assoc., calculated by authors

This fact indicates that the exchange rate policy of the RCB was successful in what concerns stabilization of the domestic monetary market and decrease in uncertainty of its participants about future interest rates. Increase in volatility of the implied rate is governed by its currency component because after introduction of basket targeting the uncertainty about the future exchange rate increased in the exchange market.

The analysis of volatility of interest rates over different periods of the exchange rate policy is more formally represented in Table 7, which gives the descriptive statistics of changes in interest rates.

Table 7

Descriptive statistics of changes in interest rates*

Periods of exchange rate policy	MosIBOR for three months	Three-month implied rate
1) Dollar targeting 01.09.2001–01.02.2005, 643 observations	-0.015 (0.447)	-0.017 (1.171)
2) Two-currency basket targeting (currency constraints) 01.02.2005–01.07.2006, 336 observations	-0.000 (0.210)	-0.005 (1.429)
3) Two-currency basket targeting (currency liberalization) 01.07.2006–30.06.2008, 466 observations	0.002 (0.099)	0.007 (1.402)

* *The table lists the averages and their standard deviations*

It is evident from the table that the standard deviation of changes in MosIBOR rates was steadily decreasing while the standard deviation of changes in implied rates was increasing. In the next part of our investigation we proceed to the regressive analysis of these interrelations.

Cointegration analysis of interest rates

Unlike the case in uncovered parity, where changes in the spot exchange rate have to be calculated *ex post*, in covered parity there is no problem of overlapping observations to hamper its testing, and thus we can use daily data. This allows us to perform cointegration for three stages of the exchange rate policy using three subsamples: dollar targeting, two-currency basket targeting, and capital account liberalization.

The first step of our investigation is the augmented Dickey–Fuller test of the series in question for stationarity. It is evident from Table 8 that for the levels of our data series the null hypothesis of unit root cannot be rejected at the 1% level while for the changes in interest rates the null hypothesis is rejected. This indicates that the cointegration order of the series under investigation is I(1), and we can use the Johansen test to investigate their cointegration rank.

Table 8

Augmented Dickey–Fuller test
Null hypothesis: variables contain a unit root

Variable	ADF test	Variable	ADF test
One-month rates			
LIBOR, 1 month	-0.513	Δ LIBOR, 1 month	-41.429***
MosIBOR, 1 month	-2.305	Δ MosIBOR, 1 month	-41.866***
One-month implied rate	-3.075 **	Δ One-month implied rate	-45.337***
Three-month rates			
LIBOR, 3 months	-0.467	Δ LIBOR, 3 months	-41.315***
MosIBOR, 3 months	-2.012	Δ MosIBOR, 3 months	-50.098***
Three-month implied rate	-2.986	Δ Three-month implied rate	-44.894***

Notes.
*** indicates statistical significance at the 5% level*
**** indicates statistical significance at the 1% level*
The sample includes 1445 observations

In Table 9 we present Johansen test statistics values for MosIBOR rates and the implied rate calculated in terms of covered parity. The hypothesis that cointegration rank = 0 is rejected at the 1% level while the hypothesis that cointegration rank = 1 cannot be rejected. It follows that the data series under investigation are connected by a long-run equilibrium relationship and we can test its strength and statistical significance.

Table 9

Johansen test for cointegration

		One-month rates i_{trace}	Three-month rates i_{trace}
MosIBOR, Implied rate	Rank=0	240.159***	105.958***
	Rank=1	5.602	3.322

Notes.
The AIC, SBIC, FPE, and HQIC tests for determination of the number of vector autoregression lags indicate three lags.
The specification involves an unbounded constant and a linear trend in the levels, which implies stationarity of cointegration equations around the constant average.

We break our data into three periods. The period from September 2001 to February 2005 is the dollar targeting period; the period from February 2005 to July 2006 is characterized by introduction of two-currency basket targeting; the period from July 2006 to June 2008 is characterized by additional steps to lift constraints on capital operations.

The model to be tested is represented by relation (1) used in the first part of our investigation on uncovered parity. The vector $y_t = (i_t \quad i^{implied}_t)'$ consists of two variables: i, the observed MosIBOR rate, and $i^{implied}_t$, the implied interest rate obtained using NDF forwards.

We may concentrate only on the first equation of the system and represent it in the form

$$\Delta i_t = \alpha(c + i_{t-1} - \beta i^{implied}_{t-1}) + \phi \Delta i^{implied}_t + \varepsilon_t \qquad (3)$$

The coefficient α measures the *rate of adaptation* of the short-run deviation of the Russian rate i to the long-run equilibrium. The coefficient β measures the long-run *interrelationship between the levels of* i and $i^{implied}_t$. Estimates of α and β are presented in Table 10.

As is evident from Table 10, the coefficient of the long-run relationship between the domestic MosIBOR rates and the implied rates is statistically significant for all stages of the exchange rate policy, which points to the long-term fulfillment of the covered parity condition. Interestingly, the value of the coefficient was increasing at various stages of the exchange rate policy with a particularly dramatic increase after liberalization of currency circulation. This indicates greater integration of the Russian monetary market into the international capital market and shows that the cost of foreign covered borrowing is in the long-run equilibrium relationship with the cost of domestic borrowing and that judging by the estimates of the coefficient β, covered interest rate parity held in Russia over the time interval under investigation. As judged from the increase in the coefficient β, integration of the Russian monetary market into the international one was increasing with increasing liberalization of capital account.

Table 10

Sensitivity of the Russian MosIBOR interest rate to the implied interest rate

	Three-month rates		One-month rates	
Periods of exchange rate policy	*Adaptation rate coefficient*, α	*Coefficient of interrelationship between rate levels,* β	*Adaptation rate coefficient*, α	*Coefficient of interrelationship between rate levels,* β
1) US dollar targeting, 01.09.2001–1.02.2005	-0.036*** (0.011)	-0.851*** (0.033)	-0.002 (0.008)	-0.844*** (0.037)
2) Basket targeting (currency constraints) 01.02.2005–01.07.2006	-0.010 (0.006)	-1,301*** (0.123)	-0.006** (0.003)	-1.121*** (0.085)
3) Basket targeting (currency liberalization) 01.07.2006–	-0.005** (0.002)	-1.511*** (0.098)	-0.000 (0.001)	-1.533*** (0.100)

30.06.2008				

Notes.
Values in parentheses correspond to standard errors
*** indicates statistical significance at 5% level*
**** indicates statistical significance at 1% level*

Interrelationship between volatilities of Russian and implied interest rates

An important empirical fact to be seen in the graphical part of our investigation is the decrease in volatility of the observed Russian MosIBOR rate and the increase in the implied interest rate calculated from covered arbitrage. With the multivariational ARCH (1) model, we can estimate cross-volatility of the interest rates under investigation. To this end, we use the ARCH (1) specification for two variables which can be written as

$$\begin{matrix} y_{1,t} \\ y_{2,t} \end{matrix} = \begin{pmatrix} \delta_{01} \\ \delta_{02} \end{pmatrix} + \begin{pmatrix} \delta_{11} & \delta_{12} \\ \delta_{21} & \delta_{22} \end{pmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-1} \end{pmatrix} + \boldsymbol{\varepsilon}_t \qquad (4)$$

where the error vector $\boldsymbol{\varepsilon}_t = (\varepsilon_{1,t} \quad \varepsilon_{2,t})'$ follows the autocorrelated process: $\boldsymbol{\varepsilon}_t : N(0, \boldsymbol{\Sigma}_t)$

$$\boldsymbol{\Sigma}_t = C_0' C_0 + \begin{pmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{pmatrix}' \begin{pmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon_{2,t-1}^2 \end{pmatrix} \begin{pmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{pmatrix} \qquad (5)$$

The values of the matrix parameters alpha will yield the estimates of conditional volatility for each of the investigated variables and the value of conditional correlation between them. A similar approach was used by Hamao et al. (1990) and Park (2001) to analyze volatility interrelationship between exchange and stock markets and by Saleem and Vaihekoski (2008) to analyze volatility interrelationship of the Russian and world stock markets.

In Table 11 we present estimates of the coefficients alpha for the variables of interest $\mathbf{y}_t = (i_t \quad i^{implied}{}_t)'$.

As is evident from the table, the cross-correlation coefficient for three-month rates is significant at the first stage of the exchange rate policy and insignificant at its third stage (rows 1 and 3). This indicates that during dollar targeting there was both a long-run relationship between the levels of the interest rates and a significant interrelationship between their volatilities. After liberalization of the capital account the interrelationship between the volatilities of the three-month MosIBOR and implied rates lessened.

As is evident from the second part of the table, the one-month rates show the opposite dependence. The cross-correlation coefficient is insignificant at the first stage of the exchange rate policy and significant at its third stage (rows 1 and 3). This indicates that after

liberalization of the capital account the interrelationship between the volatilities of the one-month MosIBOR and implied rates enhanced.

Table 11

Interrelationship between volatilities of the Russian MosIBOR interest rate and the implied interest rate

	Three-month rates				One-month rates			
Periods of exchange rate policy								
1) US dollar targeting 01.09.2001–01.02.2005	0.000 (0.000)	-0.049* (0.028)	-0.579*** (0.142)	0.502*** (0.081)	0.239 (0.270)	0.005 (0.013)	-0.419 (0.310)	0.805*** (0.069)
2) Basket targeting (currency constraints) 01.02.2005–01.07.2006	0.492*** (0.160)	-0.004 (0.015)	0.357 (0.463)	0.058 (0.108)	0.399* (0.225)	0.003 (0.005)	0.608 (1.284)	0.061 (0.107)
3) Basket targeting (currency liberalization) 01.07.2006–30.06.2008	0.000 (4.388)	-0.001 (0.009)	0.100 (0.819)	0.329*** (0.081)	0.633*** (0.147)	0.013*** (0,002)	2.305 (1.613)	-0.134 (0.084)

Notes.
Values in parentheses correspond to standard errors
** *indicates statistical significance at the 5% level*
*** *indicates statistical significance at the 1% level*

The absence of clear-cut interrelationship between volatilities for different investment horizons is probably due to the fact that volatility of the implied rate is largely governed by its currency component. After liberalization of the capital account in June 2006 volatility of the ruble exchange rate to the dollar was much higher than at the dollar targeting stage until February 2005 (it is evident from Fig. 8). Hence it follows that after liberalization of the capital account (row 3 in Table 11) the exchange rate volatility passed on to the volatility of domestic MosIBOR interest rates through covered parity in one-month horizons whereas in three-month horizons nothing of the kind was observed.

4. Discussion of results

Our investigation indicates that over the investigated period of time from late 2001 to mid-2008 the RCB policy generally favored heading toward the stated goal of gradually increasing flexibility of pricing.

The test of the uncovered interest rate parity hypothesis at the dollar targeting stage up until February 2005 shows that the interest rate spread and the domestic MosIBOR rate moved in correlation with the expected change in the rate of exchange of the ruble to the dollar. At the stage of introducing the two-currency basket targeting uncovered parity stopped holding. These results agree with the results of investigations on other countries which reveal that uncovered

parity holds for currencies with easily identified trends and does not hold for currencies with a more flexible rate.

The next important stage of currency exchange regulation was liberalization of the capital account in June 2006. Our results show that this measure enhanced the interrelationship of Russian interest rates and implied interest rates calculated through non-deliverable forwards. This indicates greater integration of the Russian capital market into the world one.

At this stage the exchange rate was highly predictable. A more stable exchange rate, as shown in a number of investigations, favors an increase in foreign trade activity and investments and thus favors the long-term economic growth. For example, in the works (Aghion et al., 2006; Husain et al., 2005) it is shown that in countries with a low level of financial development volatility of the real exchange rate decreases the long-term rate of growth. These works indicate that for countries with *underdeveloped institutes* the exchange rate targeting policy is more comprehensible for the private sector, disciplines the central bank, and favors higher macroeconomic stabilization as compared with countries that do not pursue a clear monetary policy.

At the same time, according to the "trilemma", the ability of the central bank to regulate interest rates decreases. This regulation was important, in particular, in the past years due to arising signs of "overheating" of Russian economy. In addition, it was empirically shown in the investigation (Edwards, Levy Yeyati, 2003) that in countries with a less flexible exchange rate policy the consequences of outside shocks were manifested more distinctly. Some researchers (Carare and Stone, 2006; Eichengreen, 2002)) point out that many countries go over from exchange rate targeting to inflation targeting as the financial sector keeps developing, which allows them to carry out an independent domestic monetary policy.

To sum up, the conclusion can be drawn that in order to overcome the constraints imposed by the "trilemma" and to decrease currency arbitrage, the RCB should strive to carry out a less predictable exchange rate policy. The Russian Central Bank has set this medium-term objective which is associated with moving over toward inflation targeting. Prerequisites and consequences of introducing inflation targeting in Russia are considered in particular in the work (Ulyukaev, Zamulin, Kulikov, 2006).

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Submitted January 3, 2009