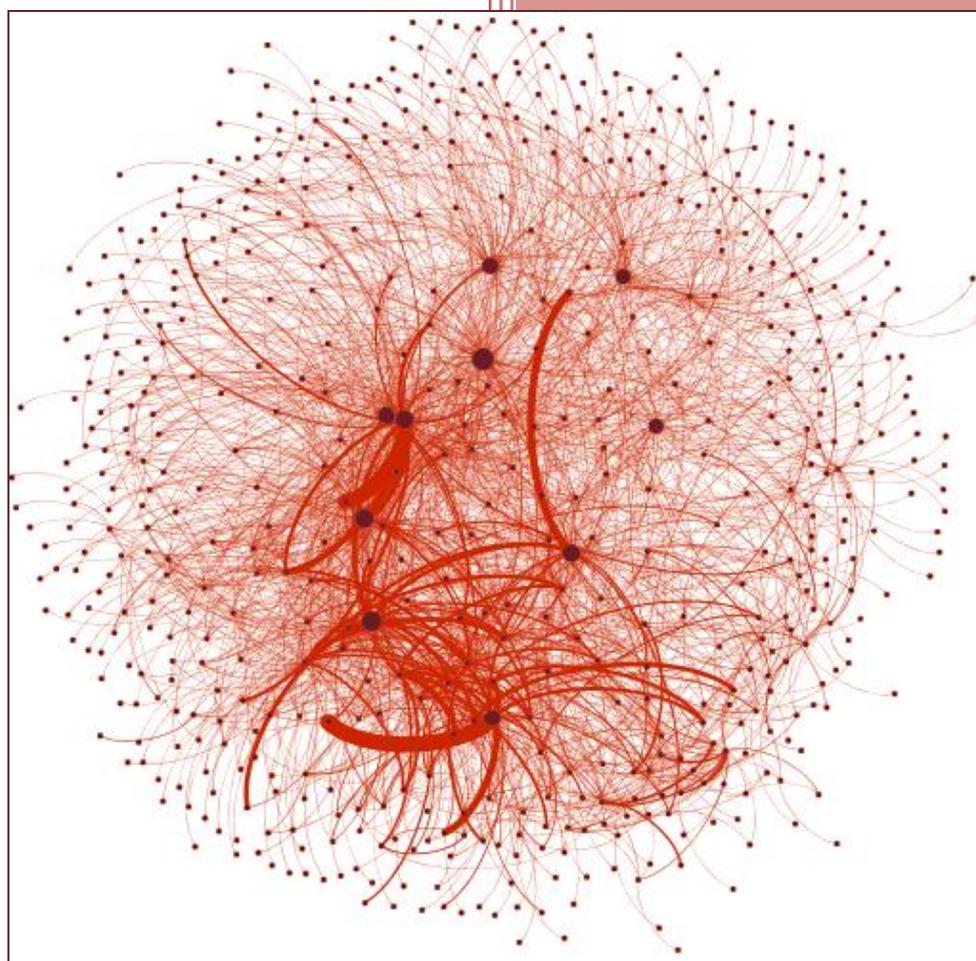


Quarter 1, 2013

# Money Market Review



The Central Bank of the  
Russian Federation (Bank  
of Russia)

This Review is prepared by the Bank of Russia Financial Stability Department jointly with the General Economic Department

Comments and proposals on the Review's structure and contents will be welcome at: [reports@cbr.ru](mailto:reports@cbr.ru).



*In using the materials of this publication, reference to the Central Bank of the Russian Federation is mandatory*

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## Purpose of the Money Market Review

In this Review, a money market means an interbank loan market (ILM), currency swap market (SWAP) and interdealer repo market. The focus is made on the repo market due to its intersectoral nature, with the Bank of Russia performing here the bulk of its operations to provide liquidity. The Bank of Russia is going to promote comprehensive development of the money market to:

- redistribute liquidity in a sustainable environment, i.e. with an acceptable volatility of short-term interest rates and smoothed change in the volume of transactions concluded on the market;
- provide equal access for market participants to liquidity sources;
- minimize counterparty default risk through quality management of security;
- achieve a balanced development of various market segments, in particular, a full-fledged segment beyond overnight maturity;
- create an environment for the market development with central counterparty participation.

### The importance of money market monitoring is determined by a number of factors:

- the money market plays a key role in the banking intermediation mechanism, which provides for constant transformation of short-term borrowings into long-term loans for the economy; its stable functioning enables banks to refinance their liabilities continuously and use their capital effectively for the purpose of financing the economy;
- the money market is the first to come under pressure in case of financial instability, with its parameters playing the role of early warning indicators;
- the money market is crucial for intragroup operations of financial groups and conglomerates to be scrutinized as part of consolidated supervision;
- the money market can concentrate the financial sector's systemic risks with regard to interdealer repos and swaps since its players include not only banks but also non-bank professional securities market participants;
- the money market trends allow to conclude on the current level of banking sector liquidity;
- potential disruption of the money market operation and the mass sale of assets used as collateral would push up the cost of market financing considerably and complicate the access of non-financial firms to it;
- the money market situation affects the central bank's ability to manage banking sector liquidity and short-term interest rates.

In view of the money market's importance for financial stability, the Bank of Russia Financial Stability Department (FSD) is launching a series of **regular quarterly reviews** of its situation and systemic risk levels.

**The ultimate purpose of this publication** is to contribute to financial stability by minimising systemic liquidity risk, which can be achieved by enhancing the money market transparency. A better awareness of the market structure and trends will allow participants to improve their understanding and assessment of own risks. Moreover, the Bank of Russia wants to communicate to market participants possible collective implications of individual investment decisions in the event of systemic effects which are not fully accounted for in the assessment of market risks.

**The Review, rather than being a Bank of Russia official publication**, is a research paper focused on analysis of market developments in the reporting period. The latest reported data are given as of the last business day of the quarter, while possible significant events after the reporting date are disregarded. The Review is available **in Russian and English** on the Bank of Russia website.

## Summary

### *Money market structure and Bank of Russia participation in the money market*

- The rouble money market constitutes an important source of liquidity for the financial sector, including the banking system. In 2013 Q1, the aggregate daily market turnover totalled 1.2 trillion roubles, of which swaps amounted to 0.68 trillion roubles, interbank loans – 0.32 trillion roubles, and repos – 0.25 trillion roubles.
- Money market trends in 2013 Q1 developed amid conditions when the aggregate influence of autonomous factors on the level of banking sector liquidity was close to neutral. At the same time, a decrease in large balances of credit institutions' correspondent accounts with the Bank of Russia, which accumulated as a result of large-scale federal budget spending in late 2012, caused structural liquidity deficit to contract by 0.6 trillion roubles on average for the quarter.
- Resident banks were key lenders and borrowers on the rouble money market. The share of resident banks in total lending grew from 85% in 2012 Q4 to 88% in 2013 Q1. At the same time, the banks' net position slightly decreased and amounted to about 230 billion roubles.
- Money market transactions were mostly short-term: overnight operations accounted for more than 80% of total transactions. Compared with the previous quarter, this share grew in all the segments of the money market.
- The share of equities in collateral on the interdealer repo market fell to 30% in 2013 Q1 from 34.8% in 2012 Q4. The main issuers of these equities were the largest Russian holding companies and businesses.
- The bulk of money market transactions were conducted via the Moscow Exchange (41.4%) and the Reuters Dealing system (45.85). Transactions on the interbank loan market were also carried out using the Delta system.
- Interdealer repo market discounts were generally at acceptable levels: 12-14% under transactions secured by equities and 8-12% under transactions secured by bonds. The market, however, saw a considerable share of deals with discounts of less than 2% (12% of total transactions). In the event of a crisis on the stock market, the value of the collateral for these transactions would fall below the size of obligations, increasing the probability of a default on these deals. At the same time, even despite sufficiently high discounts, market participants may face a shortage of funds in the event of margin calls.

### *Money market systemic risks*

- In 2013 Q1, the banking sector's collateral remained adequate for refinancing against market assets through Bank of Russia repos (an estimate of 4.1 trillion roubles as of March 1, 2013). The volume of market collateral used for refinancing did not exceed a half of the available volume in 2013 Q1.
- Under current (non-crisis) conditions, the risk of wide-scale defaults on the repo market somewhat decreased as against 2012 Q4. In general, the interdealer repo market is able to cope with a shock on the stock market (the assessment was made using the one-day stress test horizon, which accounts for about 90% of the interdealer repo market volume).
- In the event of a crisis period, the risk of wide-scale defaults will become substantial. Therefore, in the event of financial market deterioration, repo market participants will need to increase discounts on repo operations and reduce the acceptable market risk size.
- The stress test of the interbank loan market has showed that some banks are quite vulnerable to the complete closure of access to funding on the interbank loan market on the 30-day horizon. The value of potential outflows (over 400 billion roubles, taking into account

intragroup operations, and over 200 billion roubles with regard to banking groups) considerably exceeds the relevant figures obtained during stress tests for other segments of the money market, which evidences high importance of the interbank loan market in money market risk assessments.

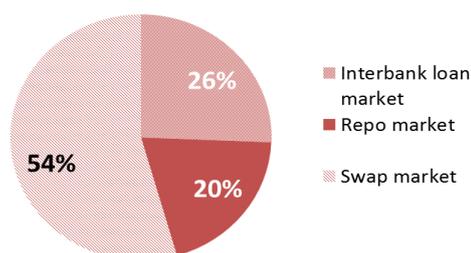
- The stress test of the swap market has showed that potential outflows on the swap market due to the rouble depreciation do not carry systemic risk. Even on the horizon of five business days, the size of outflows with regard to all banks (excluding banks, which registered an inflow) amounted to 91.5 billion roubles. It should be noted that the stress test studied the toughest scenario of the rouble's record depreciation in the period since 2007.

# 1. MONEY MARKET STRUCTURE AND BANK OF RUSSIA PARTICIPATION IN THE MONEY MARKET

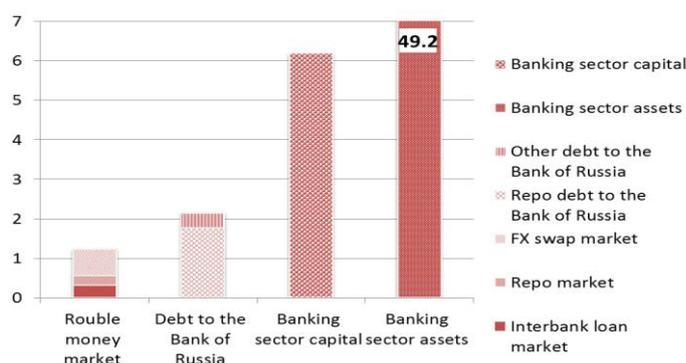
## 1.1. Money market structure and conditions: swaps, repos, interbank loans<sup>1</sup>

Money market participants<sup>2</sup> comprise banks, non-bank financial institutions, their customers, including non-residents. The Bank of Russia plays an essential role on the money market by using it for managing the banking sector liquidity. Since short-term transactions are most common on the market, it is the overnight and '1-week' transactions that will be focused upon hereafter. Consequently, unless otherwise specified, estimates are made on the basis of transactions with a maturity of up to seven days.

**Chart 1. Money market structure (quarterly average), %**

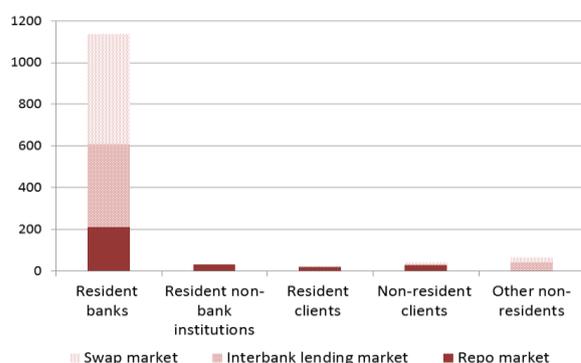


**Chart 2. Money market value as against banking sector characteristics, trillion roubles**

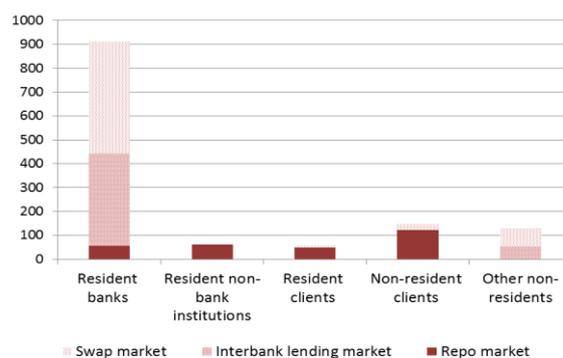


In 2013 Q1, the aggregate turnover and the structure of operations on the money market remained virtually unchanged. The aggregate daily turnover on the money market totalled 1.2 trillion roubles, of which swaps amounted to 0.68 trillion roubles (54%), repos – 0.25 trillion roubles (20%) and interbank loans – 0.32 trillion roubles (26%). The money market value underwent changes in comparison with the banking system characteristics as the banking sector assets and capital grew by about 20% whereas the debt value to the Bank of Russia, on the contrary, decreased. At the end of 2013 Q1, the volume of operations on the swap market grew considerably due to forthcoming tax payments. As of March 28, the swap market value reached 930 billion roubles.

**Chart 3. Creditors on the money market, billion roubles**



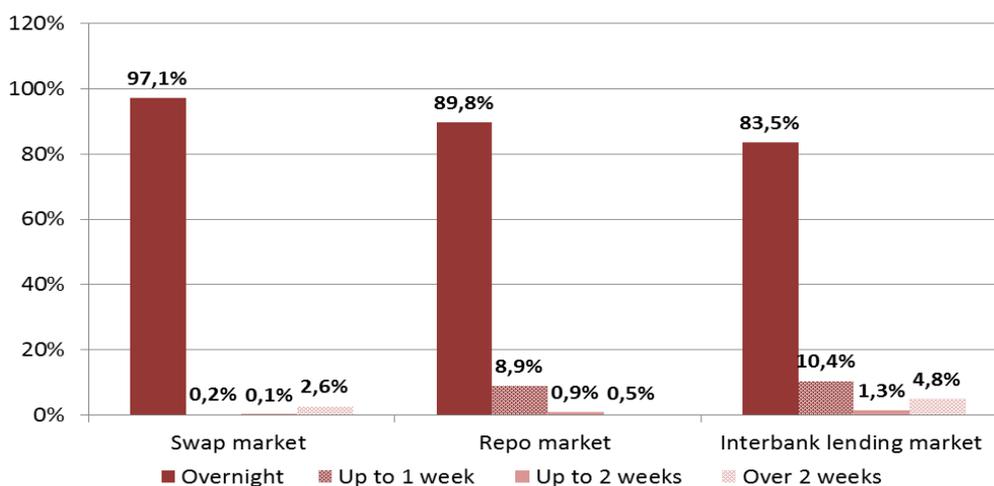
**Chart 4. Borrowers on the money market, billion roubles**



<sup>1</sup> This research is based on the data provided by the Moscow Exchange for repos and the data available in reporting form 0409701 "Statement on Foreign Exchange and Money Market Operations." For more details, see Section 5 "Data Sources and Description."

As in the previous quarter, the interbank loan market and swap market were mostly resident interbank markets, whereas bank loans to customers accounted for a major share of transactions on the repo market (Chart 3 and Chart 4). The share of resident banks in total lending grew from 85% in 2012 Q4 to 88% in 2013 Q1. At the same time, the banks' net position slightly decreased and amounted to around 230 billion roubles. The volumes of borrowings by non-resident clients also contracted, from 162 billion roubles to 147 billion roubles. Therefore, banks continued to play the main role on the money market. Apart from banks, an essential place was held by borrower clients, among whom there was a fairly large share of non-residents (37% of total transactions).

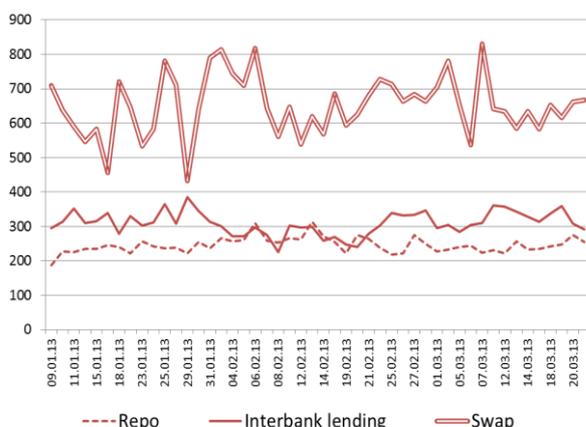
**Chart 5. Term structure of money market segments, %**



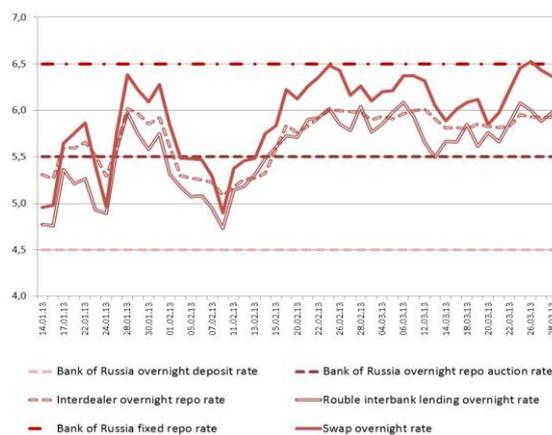
The maturity of money market transactions decreased in 2013 Q1 compared with 2012 Q4. The share of overnight operations grew in all the market segments: from 94.9% to 96.8% on the swap market, from 87.7% to 89.8% on the repo market and from 81.9% to 83.5% on the interbank loan market. Overall, money market transactions were mostly short-term.

During 2013 Q1, volumes and interest rates tended to grow on the money market (Chart 6 and Chart 7). It was the swap market that saw most of the growth in volumes. It should be noted that in spite of a higher demand for liquidity, the situation on the money markets remained stable in general: money market rates remained within the Bank of Russia interest rate band.

**Chart 6. Volumes of operations in money market segments, billion roubles**

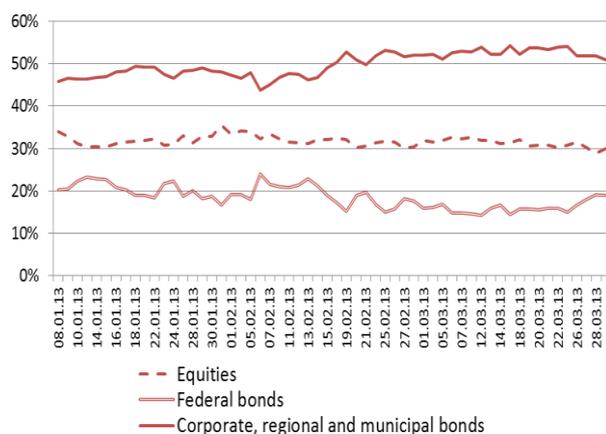


**Chart 7. Overnight money market rates, %**

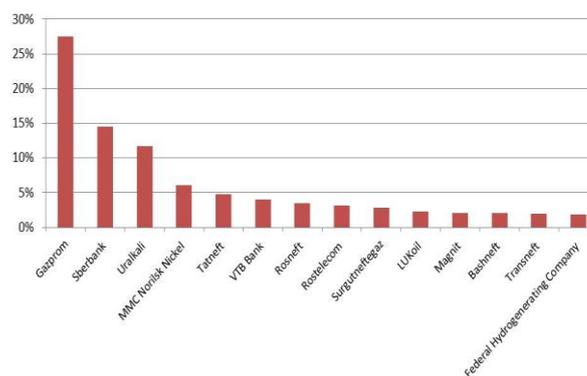


In 2013 Q1, corporate, regional and municipal bonds accounted for the largest share in collateral on the interdealer repo market (Chart 8). Equities accounted for about 30% after their share dropped by 4.8 percentage points from 2012 Q4. The principal issuers of equities used as collateral on the interdealer repo market were the largest Russian corporations – Gazprom, Sberbank, Norilsk Nickel and others. Among the twenty largest issuers, special mention should be made of Uralkali fertilizer producer with a market share of over 10% and Seligdar gold mining holding company. Repo operations with the Bank of Russia, on the contrary, saw the use of federal bonds as the main collateral. Transactions secured by these assets accounted for about 58% of banks’ debt to the regulator. The share of equities was quite small as they accounted for about 1.3% of the value of open positions.

**Chart 8. Share of collateral on the interdealer repo market, %**

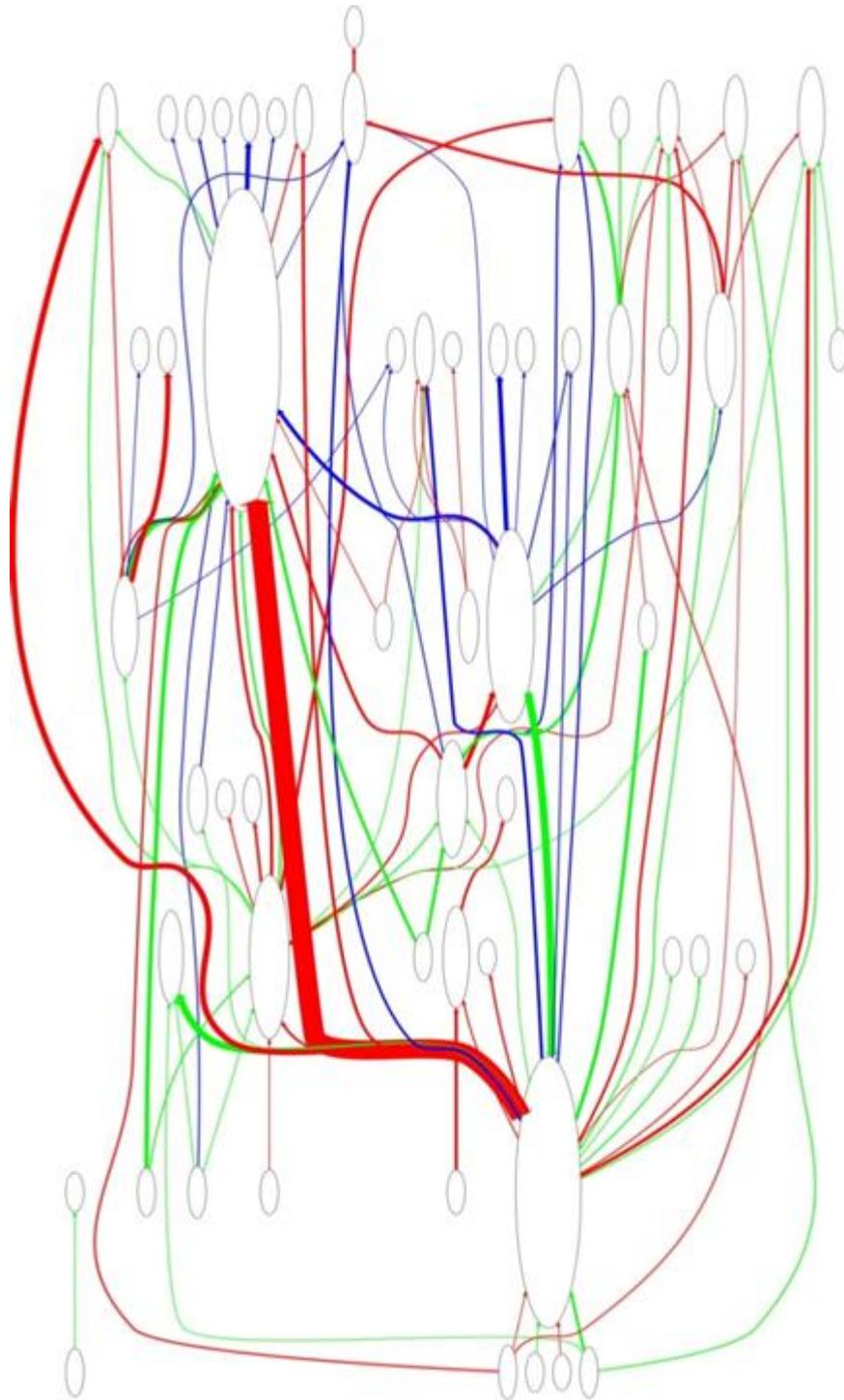


**Chart 9. Major issuers of equity collateral on the interdealer repo market, %**



As in the previous quarter, a fairly large number of active participants operated on the money market in 2013 Q1 (Chart 10). At the same time, the money market was heterogeneous, including, above all, several large participants with a high volume of transactions and a considerable number of small participants (for more detail, see Section 4.3 “Money market network analysis”). The money market also saw a substantial volume of intermediation transactions both within a single market segment (e.g., swap) and between different segments. The intermediation chain length (the number of participants between the source and recipient of liquidity) was insignificant, i.e. the market showed no ‘intermediation’ nature in general. In addition, it should be noted that a substantial share of transactions on the money market was prolonged during the quarter.

**Chart10. Money market participant positions**

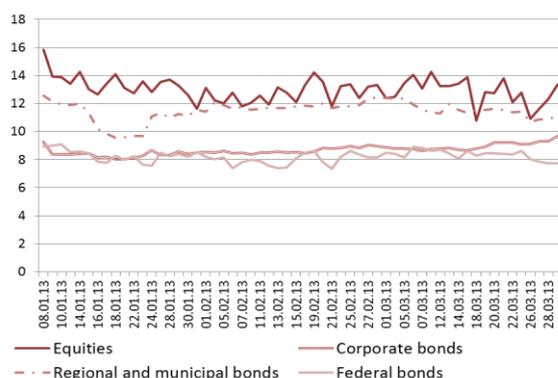


*Note. The Chart shows a directed graph illustrating cash flows on the money market. The pointed arrows (graphs) correspond to liquidity providing transactions, while tops represent market participants. The directed graph shows cash flows beyond 2 billion roubles. The arrow thickness corresponds to the participant's accumulated position towards a specific counterparty, the font size – the participant's volume of transactions on the money market. Red colour – transactions on the swap market, blue colour – transactions on the repo market, green colour – transactions on the interbank loan market.*

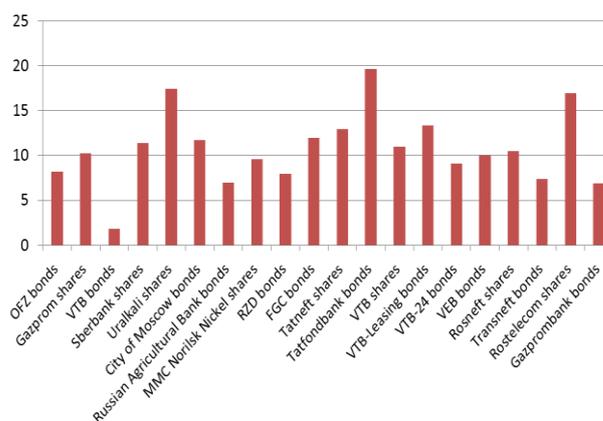
## 1.2. Analysis of discounts on the interdealer repo market

In 2013 Q1, discounts on the interdealer repo market stayed at acceptable levels in general (Chart 11). Compared with the daily fall of 1-5% in the value of the bulk of bonds during the 2008 crisis, bond discounts on the repo market average 8-12%. Discounts on equities relative to the decrease in their value during the crisis stayed at lower levels: equities saw a daily fall of 10-20% in their value during the 2008 crisis whereas the average discount on equities on the interdealer repo market equals 12-14%. Among the most wide-spread collaterals on the interdealer repo market in 2013 Q1, only VTB bonds demonstrated fairly low discounts (Chart 12). This was due to the implementation of a large non-market transaction where VTB bonds were used as collateral.

**Chart 11. Discounts by type of collateral, %**

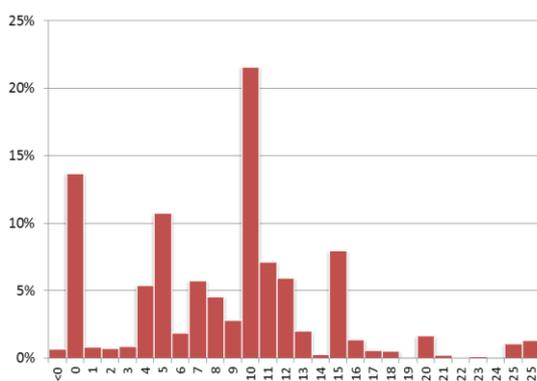


**Chart 12. Discounts on major assets used in collateral, %**

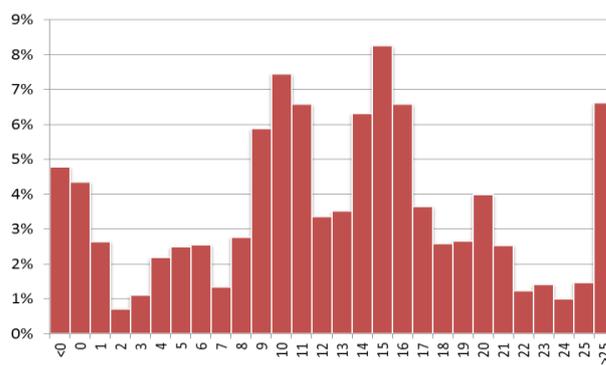


Discounts differ significantly in specific transactions. For example, discounts in slightly less than 15% of bond-secured transactions assume values close to zero (Chart 13). Therefore, in the event of a shock on the stock market, the value of collateral under these transactions would fall below the size of obligations, increasing the probability of a default. With regard to equities, this figure is lower; however, the share of transactions with discounts of less than 2% is also considerable (Chart 14).

**Chart 13. Discount distribution in bond-secured transactions, %**



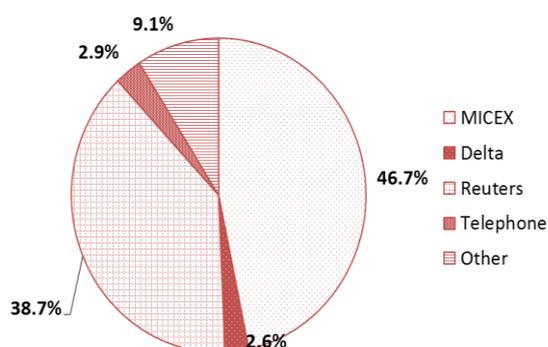
**Chart 14. Discount distribution in equity-secured transactions, %**



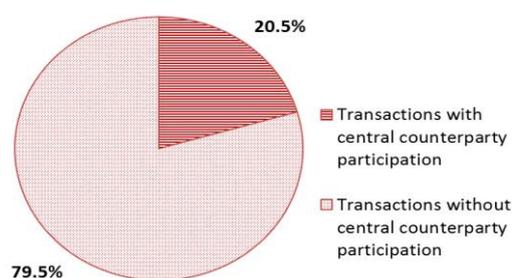
### 1.3. Trading and information systems on the money market

The bulk of transactions on the money market are conducted in the market's over-the-counter segment (Chart 15). Interdealer repos are virtually fully<sup>2</sup> concentrated on the Moscow Exchange where over 94% of these transactions are concluded. Inside the exchange, the bulk of interdealer repos are conducted in the Main Market sector: these transactions account for about 99% of all exchange-traded interdealer repos. Repos with the central counterparty are less developed on the Moscow Exchange as this segment accounts for slightly over 1% of interdealer repo transactions. Overall, however, operations with the central counterparty hold a significant share on the money market: slightly less than a quarter of transactions (Chart 16) are conducted with the participation of the central counterparty (this share is mainly attributable to operations on the swap market).

**Chart 15. Share of trading systems on the money market, %**



**Chart 16. Central counterparty participation in money market operations, %**

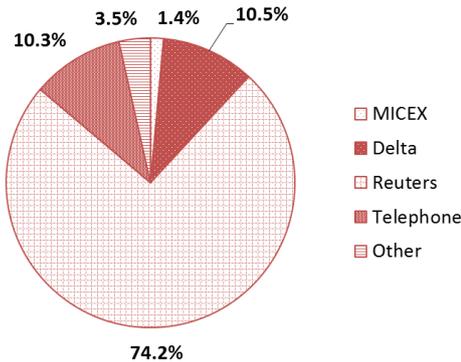


Most of operations on the interbank loan market (over 70%) are conducted via the Reuters Dealing trading platform (Chart 17). Electronic interbank trading floors are represented by the St. Petersburg Currency Exchange trading system and the Delta trading platform that accounts for about 10% of all operations. Despite the low volumes of exchange-traded transactions on the interbank loan market, these platforms, particularly the Delta platform, were used by quite a large number of banks. The data available in reporting form 0409701 "Statement on Foreign Exchange and Money Market Operations" show that over 70 banks, including both small regional banks and banks on the list of the country's top thirty credit institutions, conducted transactions in the Delta system.

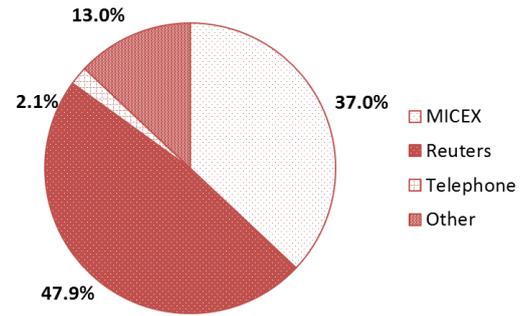
On the swap market, dominant positions were held by the Moscow Exchange and the Reuters Dealing system (Chart 18), which accounted for 37% and 47.9% of all transactions, respectively. Some operations (about 2.2%) were also conducted via foreign brokers.

<sup>2</sup> The analysis in this section is based exclusively on the data available in reporting form 0409701 "Statement on Foreign Exchange and Money Market Operations." The data provided as per this form are given in Section 5 "Data Sources and Description."

**Chart 17. Share of trading systems on the interbank loan market, %**



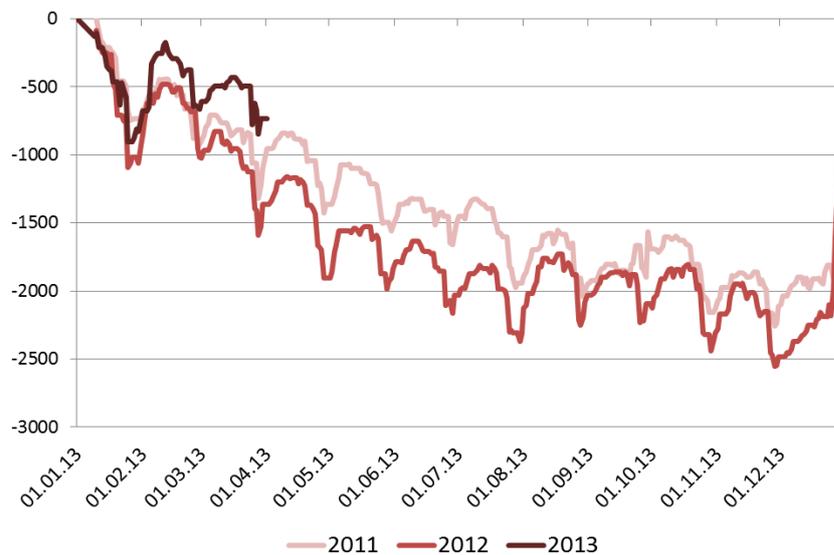
**Chart 18. Share of trading systems on the swap market, %**



### 1.4. Banking sector liquidity and Bank of Russia participation in the money market

In 2013 Q1, the situation on the money market developed amid conditions when the aggregate influence of autonomous factors on the level of banking sector liquidity was close to neutral. Considerable flows of budget funds and changes in money supply traditionally registered at the start of a calendar year had a decisive impact on banking sector liquidity in the period under review.

**Chart 19. Changes in balances of the general government's accounts with the Bank of Russia on accrual basis since start of year, billion roubles (the marks show influence on liquidity)**



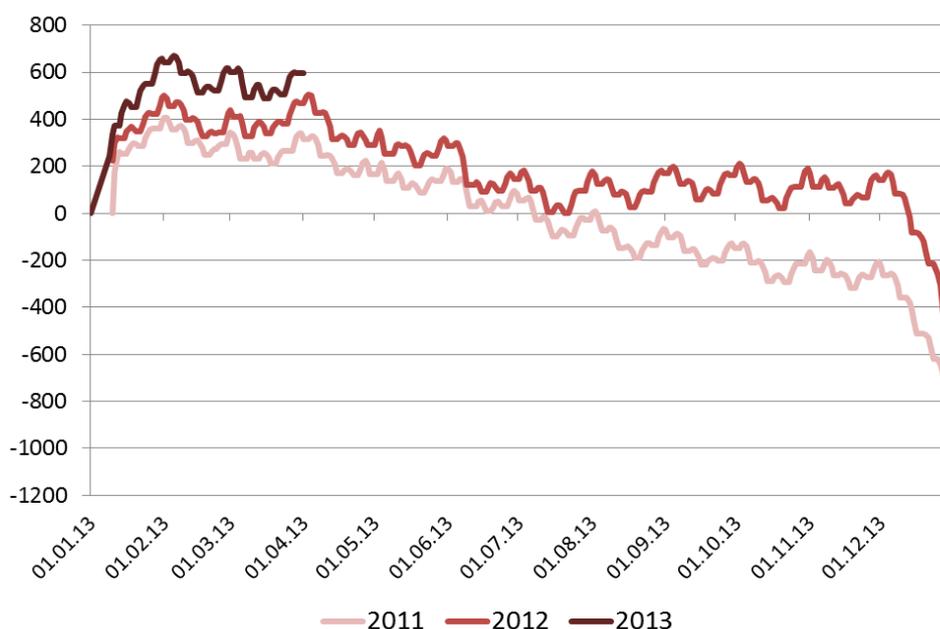
The key factor of liquidity outflow from the banking sector in 2013 Q1 was the budget channel, which absorbed 679.9 billion roubles, including 502.8 billion roubles as the amount by which the general government's revenues exceeded its expenditures (1,322.6 billion roubles and 728.1 billion roubles, respectively, in 2012 Q1). In the period under review, the banking sector redeemed substantial amounts of funds deposited by the Federal Treasury, which was an additional factor of liquidity outflow. Amid declining volumes and maturities of such deposit placements, these

redemptions caused an outflow of 353.8 billion roubles from the banking sector (527.8 billion roubles in 2012 Q1).

Credit institutions continued to demonstrate quite moderate demand for OFZ bonds at auctions held by the Finance Ministry of Russia, which in conjunction with substantial redemptions of the domestic state debt increased banking sector liquidity by 176.8 billion roubles (in 2012 Q1, liquidity outflow from the banking sector was 66.7 billion roubles due to the effect of this factor).

Budget funds outflow from the banking sector in the period under review was largely compensated by the fall in the demand for cash. The most substantial change in money supply was observed in January due to the effect of seasonal factors. Overall, the fall in money supply increased banking sector liquidity by 595.8 billion roubles in 2013 Q1.

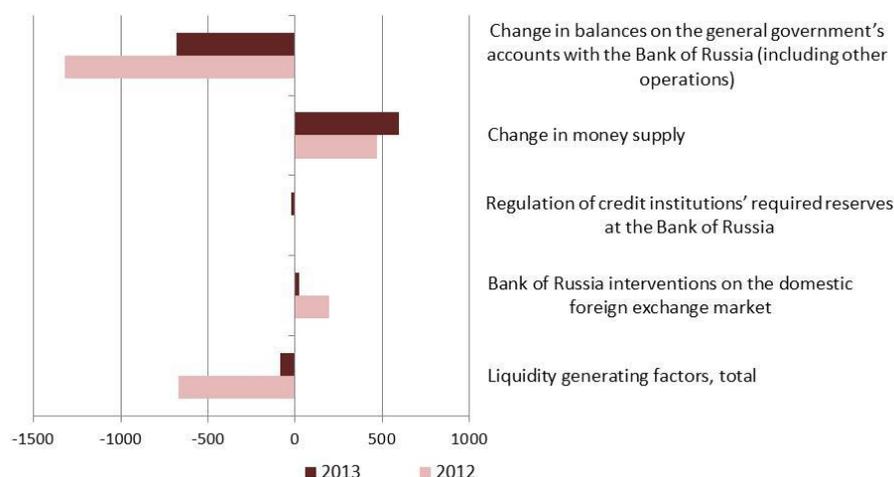
**Chart 20. Change in money supply on accrual basis since start of year, billion roubles  
(the marks show influence on liquidity)**



Amid the increased exchange rate flexibility, the impact of Bank of Russia foreign exchange interventions on banking sector liquidity remained insignificant. In 2013 Q1, Bank of Russia transactions on the domestic foreign exchange market resulted in the increase of banking sector liquidity by 24.5 billion roubles.

As the above autonomous factors had their impact on banking sector liquidity, the Bank of Russia net credit to credit institutions increased by 83.5 billion roubles in 2013 Q1 to 1.1 trillion roubles.

**Chart 21. Liquidity generating factors in 2012 Q1 and 2013 Q1, billion roubles (the marks show influence on liquidity)**



A seasonal fall in credit institutions' balances on correspondent and deposits accounts with the Bank of Russia at the start of the calendar year, which decreased by 500.1 billion roubles and 182.8 billion roubles, respectively, in 2013 Q1, was a major factor that helped reduce their debt on Bank of Russia refinancing operations.

Repo operations with the Bank of Russia remained the principal mechanism of credit institutions' refinancing. At the same time, considerable changes were registered in the structure of debt on these transactions: the average volume of auction-based one-day operations declined to 97.2 billion roubles as against 330.6 billion roubles in 2012 Q4 while liabilities with one-week maturity remained unchanged at 1.1 trillion roubles.

As structural liquidity deficit was observed to decline in 2013 Q1, there was also a decrease in the debt on Bank of Russia loans secured by credit institutions' non-market assets or guarantees: the average level of this debt fell by 247.8 billion roubles in the first quarter compared with the previous quarter to 464.3 billion roubles.

## 2. MONEY MARKET SYSTEMIC RISKS

### 2.1. Issuing activity on the stock market

A capacious securities market is a necessary condition for the development of the repo market, a money market segment. New securities issues enlarge the list and volume of instruments which can be used as collateral under transactions. Amid bank higher demand for refinancing, an enlarged securities market may help resolve the problem of potential shortage of marketable collateral to secure Bank of Russia refinancing. The issuing activity on the debt market is most important for supplying adequate collateral for refinancing, as bonds traditionally dominate Russian bank portfolios and presently feature substantially low discounts in Bank of Russia repos.

Table 1 contains data on Russian stock market issues. According to FSD estimates, in 2013 Q1, the issue of OFZs, municipal and corporate bonds (net of Eurobonds) amounted to about 0.6 trillion roubles, with a total of 85 new debt issues placed on the market. Overall issuing activity on the Russian market was low in 2013 Q1 as against 2012 Q4 due to smaller issues of OFZs and municipal bonds. The volume of Russian Eurobond issues remained at a fairly high level in 2013 Q1.

**Table 1. Stock market issuing activity in 2013 Q1, billion roubles**

Type of securities	Issuing volume par value	Number of issues (auctions)
OFZs	188	3 new issues (18 auctions within 7 issues)
Municipal bonds	-	-
Corporate bonds	436	82 issues
<b>Russian market total</b>	<b>624</b>	<b>85 issues</b>
Eurobonds	533	44 issues
<b>Total</b>	<b>1157</b>	<b>129 issues</b>

Sources: RUSBONDS, Finance Ministry, FSD estimates.

In 2013 Q1, the total par value of bonds included in the list of securities accepted for exchange-traded repo transactions differed insignificantly from the overall volume of bonds excluded from the list. This was largely explained by the fact that the Finance Ministry redeemed three bond issues worth 0.3 trillion roubles in January-March 2013, which caused a relatively large “outflow” of securities from the repo list. This outflow, however, was compensated by the active inclusion of new corporate bond issues in the repo list (overall, over 40 bond issues were added to the list in 2013 Q1).

New securities issues are actively used on the interdealer repo market. Sixty of the 85 securities issues were used as collateral for interdealer repo transactions over the last two weeks in 2013 Q1.<sup>3</sup> About 550 different securities issues were involved in repo transactions over the period under review. According to FSD estimates, the volume of transactions with the new securities issues accounted for 17% of the total volume of all transactions over the period.

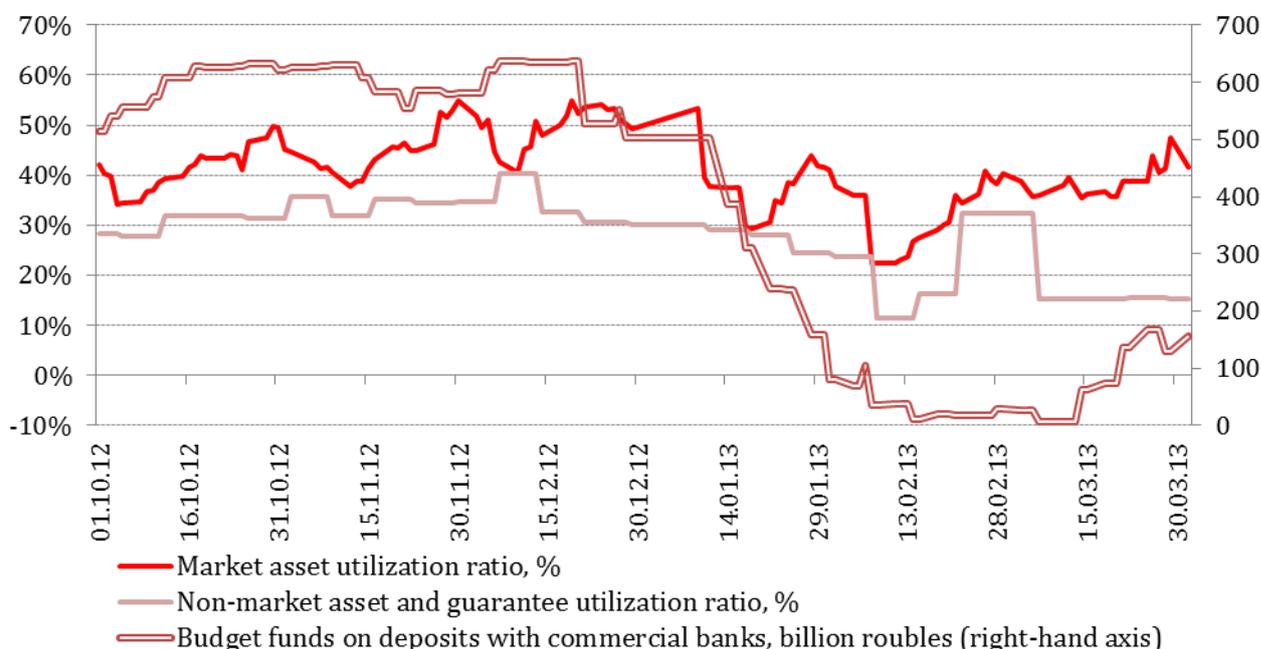
### 2.2. Bank collateral adequacy

The Bank of Russia pays special attention to a regular assessment of the refinancing potential due to a steadily high volume of credit institutions’ debt to it. To this end, the Bank of Russia uses so-called ‘collateral utilization ratios’ – the ratio of credit institution debt to the Bank of Russia by a

<sup>3</sup> The FSD selected the last two weeks of 2013 Q1 as an estimation period. The idea was, on the one hand, to make estimates for a period when most securities under review were already issued, and, on the other hand, to have a long enough period for estimation. This approach provides most representative estimates.

certain refinancing instrument to total collateral held by the credit institutions, which can be used for refinancing with the use of this instrument. At present, the FSD estimates two types of the utilization ratio: the market asset utilization ratio (used for refinancing through Bank of Russia repos)<sup>4</sup> and the non-market asset and guarantee utilization ratio (used for refinancing through Bank of Russia secured loans)<sup>5</sup>.

**Chart 22. Utilization ratios and budget funds on bank deposits in 2012 Q4 and 2013 Q1**



Growth in utilization ratios suggests that a share of the collateral, which is not involved in refinancing operations, in the total volume of available collateral is shrinking. A high utilization ratio is indicative of the limited volume of freely available collateral in the banking sector. Some participants may find it difficult to obtain liquidity from Bank of Russia refinancing operations with a banking sector utilization ratio being far less than unity due to uneven distribution of the collateral.

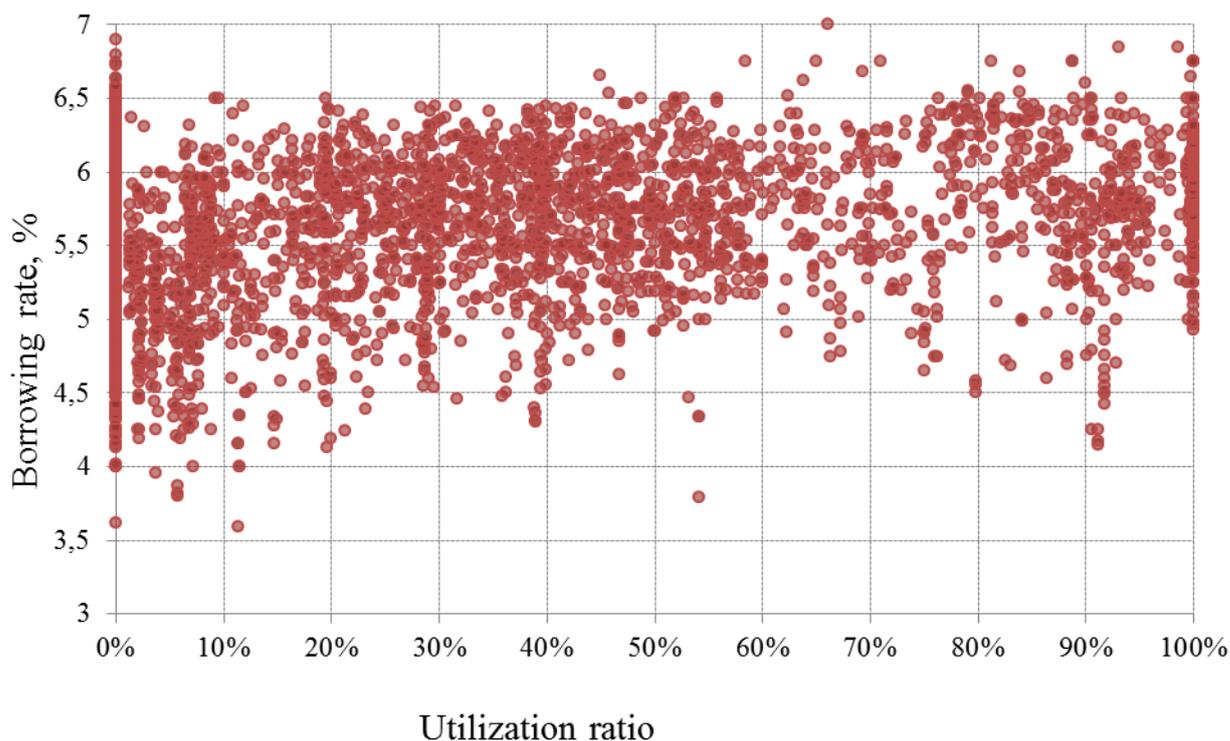
In 2013 Q1, Bank of Russia repos remained the principal instrument of credit institution refinancing: bank debt by this instrument varied between 0.8 trillion roubles and 1.8 trillion roubles, while the market asset utilization ratio - between 25% and 45% (Chart 22). The non-market asset and guarantee utilization ratio remained less than the market asset utilization ratio throughout the entire 2013 Q1 and stood at 10%-30% for most of the quarter.

Theoretically, a growth in utilization ratios may cause a rise in money market rates because credit institutions may show increased demand for liquidity on the interbank market once they have used up their possibilities of raising funds from the Bank of Russia against market assets. In practice, however, the dependence of borrowing rates for some banks on the interbank market on the level of the market asset utilization ratio is not so obvious (Chart 23). It can be stated that this dependence is non-linear in nature and/or is largely shaped by other factors determining money market trends.

<sup>4</sup> Market asset utilization ratio was calculated by using bank reports, based on the value of the securities owned by the banks participating in Bank of Russia repos.

<sup>5</sup> Non-market asset and guarantee utilization ratio was calculated on the basis of a regular poll of the largest credit institutions. Therefore, the value of this ratio is an approximate estimate of the use of collateral in the banking sector as a whole.

**Chart 23. Rates on unsecured rouble borrowings for major banks and the utilization ratio level in 2012 Q4 and 2013 Q1**



In response to increased demand for refinancing, the Bank of Russia extended its list of securities eligible to serve as collateral for repos by including resident stocks in 2012 Q2. At present, however, there is hardly any room left for further extending the repo list with issued securities. It already includes about three fourths of the bond issues traded on the Moscow Exchange and virtually three fourths of the portfolio of securities held by banks (by volume based on the current market value). Excluded securities largely represent non-resident bonds and resident stocks (Table 2).

**Table 2. Russian bank securities portfolio, %**

		Portfolio of	Share of total portfolio	
			01.12.2012	01.03.2013
Included into repo list	Bonds	Ministry of Finance	33.2%	30.2%
		banks	10.5%	11.7%
		Russian regions and municipalities	3.3%	3.8%
		other residents	18.4%	20.5%
		non-residents	4.3%	3.5%
	Stocks	residents	5.0%	4.9%
		non-residents	0.0%	0.0%
TOTAL included into repo list		75.1%	74.7%	
Excluded from repo list	Bonds	banks	1.4%	1.2%
		Russian regions and municipalities	0.1%	0.1%
		other residents	4.1%	5.3%
		non-residents	10.9%	11.1%
	Stocks	residents	7.6%	6.5%
		non-residents	1.2%	1.2%
	TOTAL, excluded from repo list		24.9%	25.3%
Total		100.0%	100.0%	

Note: calculated on the basis of the custodian accounting data available in reporting Form 0409711 "Statement on Securities".

According to estimates based on the March 2013 data, the value of marketable collateral held by credit institutions (adjusted by Bank of Russia repo discounts) expanded from 2012 Q4 due to increased volume of debt securities included into the repo list (their value was estimated at 3.8 trillion roubles in December 2012). The potential for refinancing against non-market assets under “soft” collateral stood at 1.1 trillion roubles in 2013 Q1.

**Table 3. Bank collateral as of March 2013, trillion roubles**

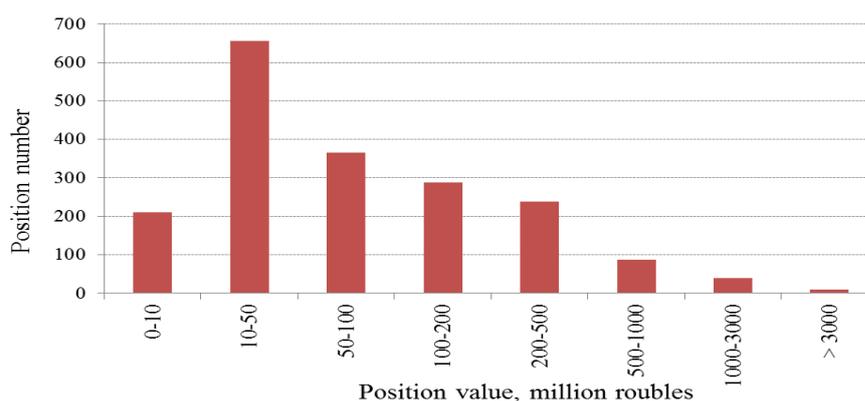
Collateral	Outstanding volume	On bank balance sheet	On bank balance sheet (conservative estimate)
<b>Debt securities</b>	7.4	3.9	3.7
<b>Equity securities</b>	4.0	0.2	0.2
<b>Total</b>	11.4	4.1	3.9

*Note. The data were calculated taking account of Bank of Russia repo discounts; outstanding debt securities include no Russian Eurobonds; conservative estimate recognises that some collateral is held by banks which are not engaged in Bank of Russia repos.*

### 2.3. Potential “hot sale” effect on the bond market

The long-term growth of secured lending volumes intensifies the so-called problem of “hot sales.” In the event of a borrower’s default on repo obligations, the securities under a repo transaction remain in the creditor’s ownership. The creditor may be forced to sell these securities to compensate for the shortfall of funds due from the borrower. The sale of a substantial volume of securities may trigger undesirable consequences both for the seller (because he may face a sharp depreciation of the securities as they are sold) and for the market as a whole (because this may aggravate the situation in some market segments and devalue securities portfolios for their holders). The scope of this problem is largely dependent on the repo market structure: the volume of transactions, borrowers’ sustainability, characteristics of the securities used as collateral in repo transactions, etc.

**Chart 24. Distribution of the volumes of borrowers’ positions on the interdealer repo market by bond issue as of end of 2013 Q1, million roubles**



The interdealer repo market structure observed at the end of 2013Q1 (in the segment where bonds are used as collateral) makes the “hot sale” effect scenario on the bond market hardly probable. This is attributed to the following factors:

First, 87% of market participants’ positions are secured by bonds that are included in the Bank of Russia repo list. This means that transaction participants, which are credit institutions, are able in most cases to obtain liquidity from Bank of Russia refinancing operations against the pledge of securities. This factor will also help a creditor other than a credit institution obtain emergency

liquidity on the interdealer repo market from a counterparty being a credit institution by offering advantageous arbitrage transaction terms.

The second factor is closely linked with the first one: most of bonds used in interdealer repo transactions have fairly high credit ratings. There will be no difficulty in selling even a relatively large amount of these bonds (as regards the ratio of bond selling and issuing volumes) on the market with moderate discounts compared with the prevailing market price or the current price of similar bonds.

Aside from this, the current interdealer repo market structure is highly diversified by borrower and securities used as collateral. The volume of positions held by most borrowers on certain issues of securities used as collateral does not exceed 100 million roubles (Chart 24) and is not substantial for the “hot sale” scenario to materialise.

The analysis of bond trading on the Moscow Exchange in 2012 shows that the instances, which can be potentially regarded as “hot sales” (the availability of any substantial trading volumes accompanied by a significant fall in bond prices) are singular in nature<sup>6</sup>. In most such cases that were revealed the bond price recovered to the previous level on the following trading day.

Therefore, defaults by some borrowers on interdealer repo transactions do not create at present do not significantly increase the likelihood of the “hot sale” scenario on the bond market.

## 2.4. Interdealer repo market stress testing

### *Moderate shock scenario*

Stress testing was based on data available for March 29, 2013. The algorithm of shock computation for bonds was changed in the methodology employed for stress testing (for details, see the section “Methodology of Interdealer Repo Market Stress Testing”).

Systemic risk (risk of mass defaults) was slightly lower in 2013 Q1 (Table 4). In particular, collateral deficit decreased from 10.7 billion roubles to 5.7 billion roubles. At the same time, the value of defaulted transactions slightly increased, from 112 billion roubles to 123.8 billion roubles. The absolute values were not so high, suggesting that the interdealer repo market would be able to go through a single-day shock on the stock market.

**Table 4. Comparative results of interdealer repo market stress tests**

Parameter	2012 Q1	2012 Q3	2012 Q4	2013 Q1	2013 Q1
	Methodology 1	Methodology 2: moderate shock		Methodology 3: moderate shock	
Market value, billion roubles	519.1	427.5	508.8	492.7	492.7
Number of transactions, units	8106	7510	7805	8148	8148
Accountable value of transactions, billion roubles	361.5	426.2	451.4	390.3	482.9
Accountable number of transactions, units	6561	7479	7476	7342	7816
Value of defaulted transactions, billion roubles	114	96.1	112	72.0	123.8
Number of defaulted transactions, units	3898	3436	3543	3307	3415
Collateral deficit, billion roubles	8.2	6.1	10.7	4.2	5.7

<sup>6</sup> In 2012, less than 15 instances of the fall of bond exchange prices by over 10% were registered (in the main trading mode and/or in the negotiated deals mode) by the close of a trading day with the trade volume exceeding 1 million roubles.

Transactions secured by equities and federal bonds were found to be most vulnerable to stock market shocks (Table 5) due to a high share of securities lending in repos with stocks and a considerable cluster of transactions with bonds with low discounts and long duration.

**Table 5. Results of interdealer repo market stress tests by collateral**

Type of collateral	Market value, billion roubles	Value of defaulted transactions, billion roubles	Share of defaulted transactions, %	Collateral deficit value, billion roubles
Government bonds	93.2	28.7	30.7%	0.93
Corporate, regional and municipal bonds	251	58.4	23.3%	1.72
Stocks	138.6	36.7	28.5%	3.02

Repo transactions in which non-resident customers acted as borrowers (Table 6) were the least risky while transactions in which resident customers and financial firms acted as borrowers posed the highest risk. Moderate risks in transactions with non-resident customers could be explained by higher requirements set by the market participants' risk management systems to non-residents. A similar situation was observed in 2012 Q3. A sharp growth in risks under transactions with non-residents in the fourth quarter of 2012 could be explained by a large volume of operations with a discount of -50% (in these transactions the value of collateral was half the value of obligations) between a large Russian bank and its offshore subsidiary.

**Table 6. Results of interdealer repo market stress tests by borrower**

Type of collateral	Market value, billion roubles	Value of defaulted transactions, billion roubles	Share of defaulted transactions, %	Collateral deficit value, billion roubles
Banks	106.0	29.0	27.3%	1.69
Non-bank institutions	71.1	27.5	38.7%	1.03
Resident customers	120.4	48.5	40.3%	2.04
Non-resident customers	178.5	18.7	10.5%	0.91

Banks and non-bank institutions were stable on the repo market: only one company showed a 3% increase in the ratio of its collateral deficit to capital (to reach 10.5%). A similar situation was observed in 2012 Q3 and Q4.

Similar to results obtained in the previous quarters, the market remains vulnerable to the severe shock scenario<sup>7</sup>: potentially defaulted transactions accounted for less than half of total transactions (223.2 billion roubles), collateral deficit – 16.5 billion roubles. Thus, in the event of a crisis the current interdealer repo market discounts would be inadequate. If market participants simultaneously revise discounts upwards, this may have a negative pro-cyclical effect in a crisis situation.

### ***Methodology of interdealer repo market stress testing***

Stress testing of the interdealer repo market is aimed at assessing the impact of potential stock market shocks (collapsing prices) on the interdealer repo market. Stress tests address the following questions:

- Will a stock market shock trigger mass defaults on the interdealer repo market (a domino effect)?
- What participants, groups of participants are most vulnerable to shocks?

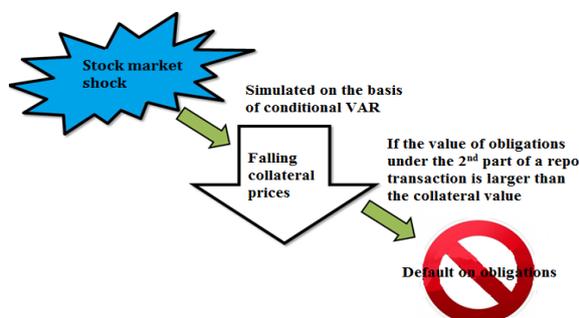
<sup>7</sup> Steady (for a month or longer) and substantial (by 30% and more) fall of stock prices, substantially increased (doubled and more) market volatility, manifestation of recessionary trends in the global economy, including crisis situations in specific developed or major developing countries, drastic fall of key world indices.

- What market segments (repos with stock, government bonds, corporate bonds, etc.) are most vulnerable to shocks?
- Are the current interdealer repo discounts adequate?

### Algorithm of stress testing

- Stock market shock;
- Falling collateral prices;
- Higher probability of defaults on the 2<sup>nd</sup> part of repos;
- Assessing possible implications of stock market shock for the repo market.

Chart 25. Repo market stress testing scheme



### Stress tests consider two stock market shock scenarios:

- 1) Moderate shock. This scenario simulates a stock market shock under the current (non-crisis) conditions. The size of the shock is assumed with regard to a potential drop in the securities value at the crisis onset. The key purpose of running this scenario is to assess the interdealer repo market resilience to a stock market shock in the current market conditions.
- 2) Severe shock. This scenario simulates a stock market shock during a potential crisis. The size of the shock is assumed with regard to a potential drop in the securities value at the crisis height. The key purpose of running this scenario is to determine whether there would be a need to change repo parameters in the event of a crisis.

A crisis fall in the securities value is assessed for each asset separately. Stress tests assess the size of a moderate shock while the size of a severe shock is assumed to equal the size of the latter increased by 5%. The algorithms of calculating a crisis fall in prices differ for stocks, government bonds (OFZs), corporate, regional and municipal bonds.

Stocks were initially grouped on the basis of a daily price fall during the 2008 crisis to assess a crisis plunge in prices. The first group was formed to comprise the stocks that were least of all affected by the crisis (mainly blue chips) while the second group included second-tier stocks and so on. Crisis falls in the prices of various stocks within one group were averaged to obtain assessments for each particular group. Stocks that were not traded during the 2008 crisis or were illiquid at that time were assigned to a specific group depending on their liquidity.

Under the new methodology of stress testing, a fall in the value of bonds is simulated on the basis of changes in the yield curve (previously, VaR assessments of separate bond issues and bond issue groups were used for this purpose). A stress scenario of yield changes has been developed on the basis of the 2008 crisis data, taking account of different terms to maturity and the credit quality of securities (the ratings of issues and/or issuers were used as the indicators of credit quality). Overall, a stress test scenario has become more conservative.

Stress tests analysed each open position (transaction) on the interdealer repo market (Bank of Russia operations were not taken into account). A transaction under analysis in stress testing is considered to be potentially defaulted if the collateral value calculated with due regard to the crisis price fall is found to be smaller than the value of repo obligations. For potentially defaulted transactions, collateral deficit is calculated as the difference between the value of obligations under a repo transactions and the collateral value adjusted for the crisis price fall. Subsequently, stress test results are aggregated by different parameters.

The data are aggregated, among other things, at the level of certain participants. For each particular participant, the following ratios are taken into account to determine the impact of stock market shock on the repo market:

- The value of potentially defaulted transactions / the value of all transactions,
- The value of collateral deficit / the value of all transactions;
- The value of collateral deficit / shareholder equity.

## 2.5. Interbank loan market stress testing

Stress testing was based on data available for March 29, 2013 and simulated complete closure of access to funding on the interbank loan market (for details, see the section: “Methodology of Interbank Loan Market Stress Testing”), while assessments of potential outflows used the difference between the value of loans raised and extended by banks on the 30-day horizon.

Stress tests were made both for separate banks and bank groups<sup>8</sup>. The largest banks and bank groups by outflows are given in Table 7.

**Table 7. Major banks and bank groups by outflows caused by the closure of access to funding on the interbank loan market on the 30-day horizon**

Place	Bank name	Outflow value, billion roubles	Place	Banking group name	Outflow value, billion roubles
1	Bank 1	184.59	1	Banking group 1	129.49
2	Bank 2	47.58	2	Banking group 2	28.28
3	Bank 3	30.90	3	Banking group 3	24.09
4	Bank 4	28.67	4	Banking group 4	20.29
5	Bank 5	23.74	5	Banking group 5	19.35

Outflows for banks, which saw the value of loans obtained for a maturity of up to 30 days exceed the value of loans extended for the same maturity, totalled 714.31 billion roubles (taking into account intra-group operations). This figure for banking groups is considerably lower: 346.92 billion roubles, which reflects both offsets by certain banks within one banking group of their opposite positions and failure to take account of the positions of banks that are not included in any of the segregated banking groups (overall, 55 banking groups were segregated).

Considering that the interbank loan market is the market of unsecured lending, the closure of access for net borrower banks to funding on the market means a massive outflow of funds and a potential threat to their liquid position. Importantly, over a half of potential outflows assessed on the 30-day horizon are related to overnight positions (448.22 billion roubles and 201.82 billion roubles for particular banks and banking groups, respectively). This means that in the event of a shock on the interbank loan market, many banks may face substantial outflows already in the first days of the stressed market. Moreover, as some banks have maturity mismatches for loans obtained and loans extended, overnight-horizon outflows exceed outflows on the 30-day horizon.

Stress tests on the interbank loan market address the following two questions:

- 1) What impact will the closure of access to interbank loan market funding have on the banking sector liquidity?

<sup>8</sup> Bank groups were segregated on the basis of publicly available information on affiliated organisations.

- 2) What banks are most vulnerable to the risk of the closure of access to the interbank loan market funding and require increased attention?

Both information on positions in different money market segments and information on the liquidity cushion (cash, funds on correspondent accounts with the Bank of Russia exceeding the required reserve levels, potential refinancing at the Bank of Russia against various types of collateral, other highly liquid assets).

A comparison of potential outflows on the interbank loan market on the 30-day horizon with potential Bank of Russia refinancing against market assets has showed that eight out of 55 banking groups lack sufficient amounts of market assets (taking discounts into account) to cover potential outflows on the interbank loan market on the 30-day horizon, while the value of uncovered outflows totals 105 billion roubles. At the same time, considering the potential of using Bank of Russia refinancing instruments against the collateral of non-market assets and guarantees, the presumed shock on the interbank loan market may be compensated by the Bank of Russia support while the banking sector will not experience a shortfall of liquidity for short-term liability funding.

### ***Methodology of interbank loan market stress testing***

Interbank loan market stress tests feature a method of assessing the vulnerability of market participants' positions to the full closure of access to interbank loan market funding on the 30-day horizon. It is assumed that banks would be unable to refinance their obligations (prolong their loans) on the interbank lending market during one month. Therefore, the size of outflows for each particular bank is assessed as the difference between the value of loans extended and the value of loans obtained on the interbank loan market with a maturity of not more than 30 days.

Data on aggregate and spent volumes of each type of the collateral provided by banks on a weekly basis were used to analyse the adequacy of the potential of Bank of Russia refinancing against various types of collateral.

## **2.6. Swap market stress tests**

Stress testing was based on data available as of March 29, 2013. A historical data approach was used to assess a foreign currency shock (for details, see the section: "Methodology of Swap Market Stress Testing") while additional rouble liquidity that banks have to use on the swap market to maintain their current foreign exchange position was selected for a possible assessment of the impact of a foreign currency shock on the banks' liquid position.

As a result, the stress test calculated the aggregate value of required additional liquidity<sup>9</sup> for both time horizon scenarios, which is given in Table 8.

**Table 8. Results of swap market stress testing by time horizon**

Stress test time horizon	Rouble depreciation, %	Value of required additional liquidity for banks, billion roubles	Value of required additional liquidity for banking groups, billion roubles
1 business day	3.67%	36.7	18.2
5 business days	9.14%	91.5	45.4

<sup>9</sup> This indicator was calculated for all banks as the sum of non-negative values of additional liquidity contributions.

Table 9 shows banks and banking groups, which account for the bulk of required additional contributions (the data are given for the 1-day stress test scenario).

**Table 9. Major banks and banking groups by outflows requiring additional rouble liquidity under swap market transactions**

Place	Bank	Value of required additional liquidity for banks, billion roubles	Place	Banking group	Value of required additional liquidity for banking groups, billion roubles
1	Bank 1	7.22	1	Banking group 1	7.27
2	Bank 2	4.39	2	Banking group 2	2.07
3	Bank 3	3.11	3	Banking group 3	1.64
4	Bank 4	2.08	4	Banking group 4	1.50
5	Bank 5	2.02	5	Banking group 5	1.32

For banks involved in a regular poll of the largest credit institutions, a comparison was made between required additional liquidity contributions on the swap market due to the rouble depreciation and the potentially unused volume of Bank of Russia refinancing. Only one bank held unused market assets as of late March, which were not sufficient to cover outflows caused by a shock on the swap market. Moreover, as the poll data showed, this bank's unused potential for refinancing against other types of collateral (non-market assets, guarantees) was equal to zero. Therefore, the bank would most likely have to use alternative sources of funding (funds on its correspondent account with the Bank of Russia, extra loans on the interbank loan market, etc.) to cover potential outflows related to the need to make additional contributions on the swap market.

Overall, stress testing shows that the banking sector is fairly resilient to the risk of a foreign currency shock while outflows linked with the need to make additional liquidity contributions under swap market transactions do not carry a systemic risk.

### ***Methodology of swap market stress testing***

Swap market stress tests feature a method of assessing market participants' vulnerability to an unlikely and exceptional but plausible change in the value of the bi-currency basket. Swap market stress testing is aimed at assessing the impact of the rouble devaluation on the financial position of certain banks and the resilience of the banking system as a whole<sup>10</sup>. The size of a shock is selected to quantitatively assess an extreme but possible risk. Swap market stress testing involves a scenario analysis to assess the financial sector's sensitivity to simulated shocks. Thus, a stress test is a prospective analysis tool in the sense that it aims to assess the effects of possible events whose probability is not exactly known.

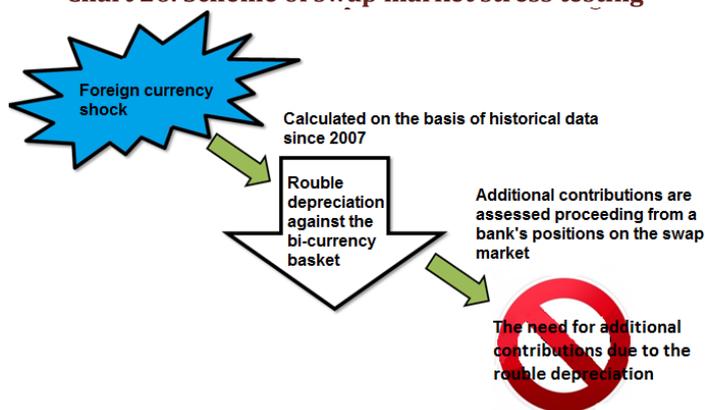
Swap market stress testing is an aggregated stress test to calculate the shock implications for each market participant and eventually aggregate the results for assessing the total impact of the financial turmoil on the sector as a whole.

<sup>10</sup> The scenario of the rouble devaluation is considered as a stressed scenario, which means that in the event of this scenario, banks' aggregate losses (considering losses from revaluation of outstanding loans in foreign currency) would exceed aggregate losses in the case of the rouble appreciation.

### Algorithm of stress testing

- Foreign exchange market shock;
- Falling rouble value against the bi-currency basket;
- Banks that are foreign currency net borrowers have to hold more roubles on the swap market to maintain their positions;
- Assessing a possible impact of the foreign currency shock on banks' liquidity

Chart 26. Scheme of swap market stress testing



### Stress test specifications

- 1) A sharp devaluation of the rouble against the bi-currency basket is assumed as a market shock. The model of simulating the impact of the rouble devaluation on banks' financial position was based on the assumption that the euro-dollar rate would remain unchanged.
- 2) Two stress test scenarios were studied: with the time horizons of 1 business day and 5 business days. In both cases, a historical data approach was used to determine the stress test's main parameter (the percentage devaluation of the rouble against the bi-currency basket). Over the period since 2007, the rouble's record falls against the bi-currency basket were found on the horizons of 1 business day and 5 business days.
- 3) A key stress test pre-condition is that the banks' need for foreign exchange is invariable on the entire stress test horizon. In other words, all the transactions opened as of March 29, 2013 are prolonged with the size of the transaction's foreign currency part left unchanged.
- 4) The stress test was conducted for both banks and banking groups. The latter scenario helped assess banking groups' potential outflows with account taken of existing relationships between financial institutions.
- 5) For banks involved in weekly polls of treasury departments conducted by the FSD, an assessment was made of liquidity adequacy (market collateral and other types of collateral) to cover outflows linked with the impact of a foreign currency shock on their swap market positions.
- 6) The following types of swap operations were selected for stress tests on March 29, 2013 from among all transactions concluded for an overnight term: the rouble (the US dollar)<sup>11</sup>; the rouble (the euro); the US dollar (the rouble); the euro (the rouble).

<sup>11</sup> The brackets indicate the collateral currency.

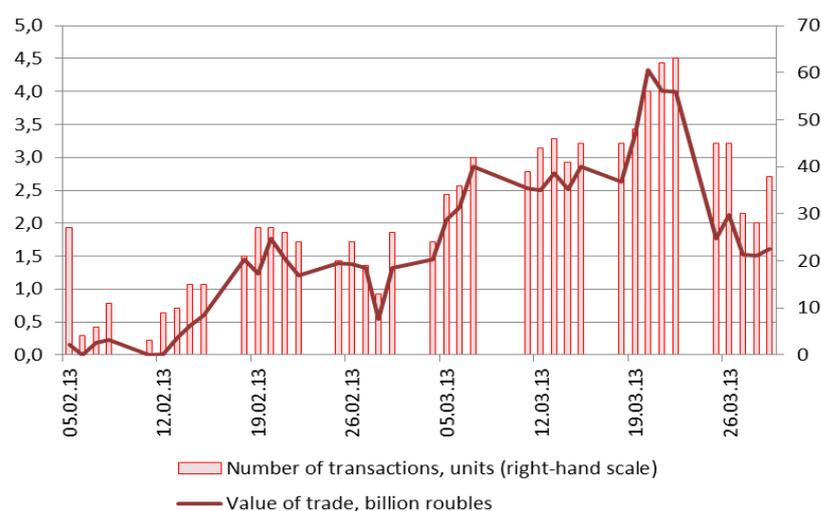
### 3. MONEY MARKET INFRASTRUCTURE DEVELOPMENT

#### 3.1. The launch of the project of interdealer repos with the central counterparty

In 2013 Q1, the National Clearing Centre (NCC), which is part of the Moscow Exchange Group, started to perform the functions of the central counterparty on the interdealer repo market. Until recently, the NCC was responsible for clearing on the foreign exchange market (from 2007), the stock market (from 2011) and the futures market (from 2012), and also acted as the central counterparty on the foreign exchange market. The project of the central counterparty on the interdealer repo market is intended to reduce the risk of defaults by counterparties on the money market and, consequently, ease access to the market and lower risk premium.

In 2013 Q1, the aggregate turnover of the central counterparty's trade on the interdealer repo market totalled 63.6 billion roubles. Daily trade turnovers varied between 1.5 billion roubles and 1.7 billion roubles and tended to grow (Chart 27). Trade dynamics demonstrate clearly expressed cyclical nature. Specifically, at the end of each month, when credit institutions show stronger demand for liquidity to make tax payments for their clients, trade turnovers decrease in the wake of the liquidity deficit. Despite the cyclical nature of trades, it is highly probable that the trend of growing trade volumes will continue.

**Chart 27. Trade volumes on the interdealer repo market with the NCC participation, billion roubles**



The low share of interdealer operations currently handled by the central counterparty can be explained by the conservative restrictions set by the NCC's risk management system. The targets of trade with the central counterparty are limited to Russian government bonds. The list of instruments eligible for trade comprises 33 OFZ bond issues. Discounts on these bonds are close to the market level. On the one hand, operations through the NCC look attractive because they offset the risks of defaults by counterparties. This may be advantageous for professional securities market participants other than banks, and also for medium-sized and small credit institutions, which may carry higher risk premiums. The choice of OFZs as the basic asset is obvious because of their reliability, which allows the NCC to perform its functions continuously. On the other hand, however, the main interest of small market participants is concentrated beyond the government bond market. The prevailing borrowers on the market – investment companies and their customers – prefer to pledge corporate bonds and stocks. OFZ bonds have low yields and are preferred by large banks, which hold them to diversify their portfolios and manage their current liquidity. As a result, turnover in the overnight segment with the NCC participation does not exceed 4% of the turnover of interdealer repos with OFZs and accounts for about 1% of open positions on the market of interdealer repos with OFZs.

The NCC trading site has a solid potential for growth linked with various strategies of market participants conducting transactions with the central counterparty. It is the place for operation of the largest liquidity suppliers that are on the list of the top thirty banks by assets. At the same time, non-bank dealers and brokers both integrated into banking groups and conducting operations on their own raise money through the NCC. The central counterparty market looks to be moderately concentrated. The NCC's three largest counterparties account for 38% of the aggregate trade turnover and the five largest counterparties account for 53%. Overall, 63 participants concluded transactions on the NCC trading floor in 2013 Q1.

## 4. MODELS OF MONEY MARKET ANALYSIS

### 4.1. Money market liquidity transmission (involving the Bank of Russia)

This section presents the results of analysis of the liquidity transmission mechanism<sup>12</sup> on the money market (in repo, interbank loan, and swap segments) based on transaction data from January 10 to April 1, 2012, which included 57 trading days. The analysis focuses on short-term transactions with a maturity of 1 to 7 days, which account for a substantial share of the money market volume and constitute the principal tool designed to provide liquidity to the banking sector.

In 2013 Q1, the daily value of open positions on the money market with a maturity of up to seven days (net of reverse repos, T+N futures and other transactions without rouble-denominated instruments) slightly increased from the fourth quarter of 2012 and averaged 3,645.6 billion roubles (a growth of 2.8% over the quarter)<sup>13</sup>. The share of transactions in the repo segment fell by 6.8 percentage points to 43.2% but remained the largest on the money market - the daily value of opened positions averaged 1,573.7 billion roubles, of which 1,203.7 billion roubles (33.0% of the total money market value) were Bank of Russia repos. The remaining part represented by the interdealer repo market amounted to 370.0 billion roubles (10.1% of the money market). The role of the other money market segments increased: the share of swap transactions grew by an average of 4.9 percentage points over the quarter to 39.3% or 1,431.5 billion roubles in absolute values while the share of interbank loan operations rose by 1.9% to 17.6% or 640.4 billion roubles. The repo market volume includes transactions on all types of collateral (bonds, stocks, and depository receipts). Only rouble transactions are recognized in transactions in the interbank loan and swap segments.

The term structure of the market underwent changes in 2013 Q1, (see Table 9). The average daily value of overnight transactions on the repo market decreased from 555.8 billion roubles in 2012 Q4 to 356.5 billion roubles in 2013 Q1 while the swap market expanded from 772.7 billion roubles to 973.7 billion roubles and the interbank loan market – from 382.0 billion roubles to 445.9 billion roubles. A substantial part of transactions (36.1% of the money market) was concluded on the repo market in the '1-week' segment. Overnight transactions continued to prevail in the swap and interbank loan markets (23.7% and 11.7% of the money market, respectively).

Table 10 shows the distribution of monthly average-weighted interest rates by term of transactions and money market segment (repos, interbank loans and swaps). The rates on 1-week repos, most of which are transactions with the Bank of Russia, are lower on average than the rates on other types of transactions.

**Table 10. Average-weighted interest rates (%) and monthly average daily value of open positions on transactions (billion roubles) by money market segment**

Period	overnight			2-6 days			'1-week'		
	repos	Interbank loans	swaps	repos	interbank loans	swaps	repos	interbank loans	swaps
<b>2012-13</b>									
<b>October</b>	<b>5.88%</b> 468.9	<b>5.88%</b> 367.3	<b>6.29%</b> 730.2	<b>6.35%</b> 14.7	<b>6.00%</b> 9.9	<b>6.19%</b> 71.0	<b>5.58%</b> 1 136.5	<b>5.99%</b> 164.0	<b>6.09%</b> 27.9
<b>November</b>	<b>5.89%</b>	<b>5.92%</b>	<b>6.34%</b>	<b>6.49%</b>	<b>6.03%</b>	<b>6.33%</b>	<b>5.60%</b>	<b>6.14%</b>	<b>6.58%</b>

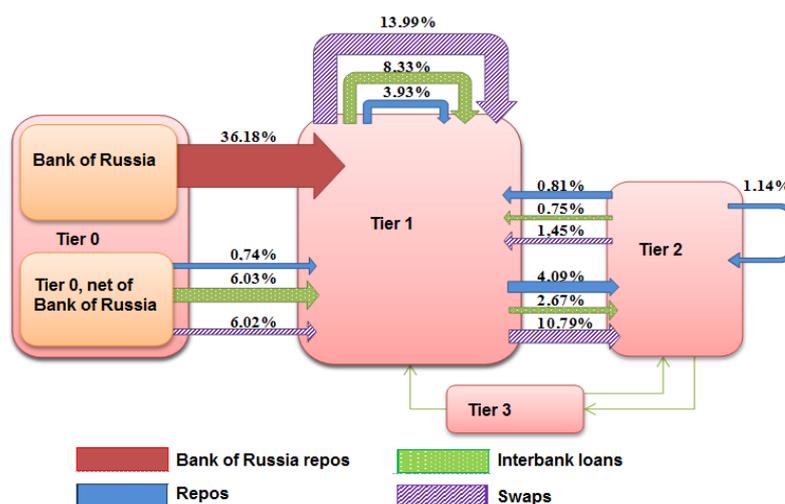
<sup>12</sup> See Conceptual Framework for Liquidity Transmission Analysis in the Interdealer Repo Market Report for 2012 Q1, p. 26. For a detailed description of the analytical system and its indicators please see Моисеев С.Р., Пангина И.В., Сосярко В.В. Анализ трансмиссии ликвидности на рынке междилерского РЕПО // Деньги и кредит, 2012, №7, с. 65-71.

<sup>13</sup> Including debts to the Bank of Russia.

	525.2	390.8	750.1	15.6	15.5	%	1 231.8	151.0	25.1
							157.9		
<b>December</b>	<b>5.83%</b>	<b>6.14%</b>	<b>6.46%</b>	<b>6.57%</b>	<b>6.23%</b>	<b>6.52</b>	<b>5.61%</b>	<b>6.14%</b>	<b>6.47%</b>
	720.8	391.1	861.2	14.1	24.8	%	1 255.3	158.5	48.7
							191.8		
<b>January</b>	<b>5.74%</b>	<b>5.22%</b>	<b>5.61%</b>	<b>6.03%</b>	<b>5.36%</b>	<b>5.98</b>	<b>5.57%</b>	<b>5.79%</b>	<b>5.69%</b>
	337.1	496.0	896.5	16.5	16.9	%	1 234.1	203.3	24.2
							128.7		
<b>February</b>	<b>5.80%</b>	<b>5.44%</b>	<b>5.82%</b>	<b>6.03%</b>	<b>5.44%</b>	<b>5.89</b>	<b>5.61%</b>	<b>5.84%</b>	<b>5.95%</b>
	348.4	415.1	848.7	14.0	14.0	%	1 054.8	197.0	46.9
							90.7		
<b>March</b>	<b>5.97%</b>	<b>5.77%</b>	<b>6.23%</b>	<b>6.07%</b>	<b>5.85%</b>	<b>6.35</b>	<b>5.59%</b>	<b>5.89%</b>	<b>6.22%</b>
	380.1	436.7	1160.4	14.9	22.0	%	1 311.1	132.7	49.0
							59.0		

The breakdown of the money market into tiers, which are determined by their proximity to primary liquidity sources, showed that tier-1 participants prevailed in 2013 Q1. The share of the transactions concluded in the repo segment between tier 0 (including the Bank of Russia and other principal creditors) and tier 1, including banks actively leveraging Bank of Russia refinancing facilities, fell from 43.35% to 36.18% in terms of value. Trading sessions on the swap market were arranged through the Moscow Exchange as the market's principal counterparty, which gave rise to a high volume of swaps in tier 1. Overall distribution of rouble liquidity flows among the tiers is presented in Chart 28, showing shares of tier-to-tier transactions in the total money market. In 2013 Q1, tier-1 participants accumulated 78.3% of total market liquid assets, transferring a portion of funds to other market participants. Tier-2 participants did the same and accounted for 19.7% of the money market. High intermediation ratio for tier 2 demonstrates a high liquidity retention rate, thereby only 0.7% of market liquidity reached tier 3. The structure of deals remained the same as in 2012 Q4, while the rouble liquidity flow from tier 1 to tier 2 slightly increased.

**Chart 28. Liquidity distribution on the money market with a maturity of up to seven days in 2013 Q1**



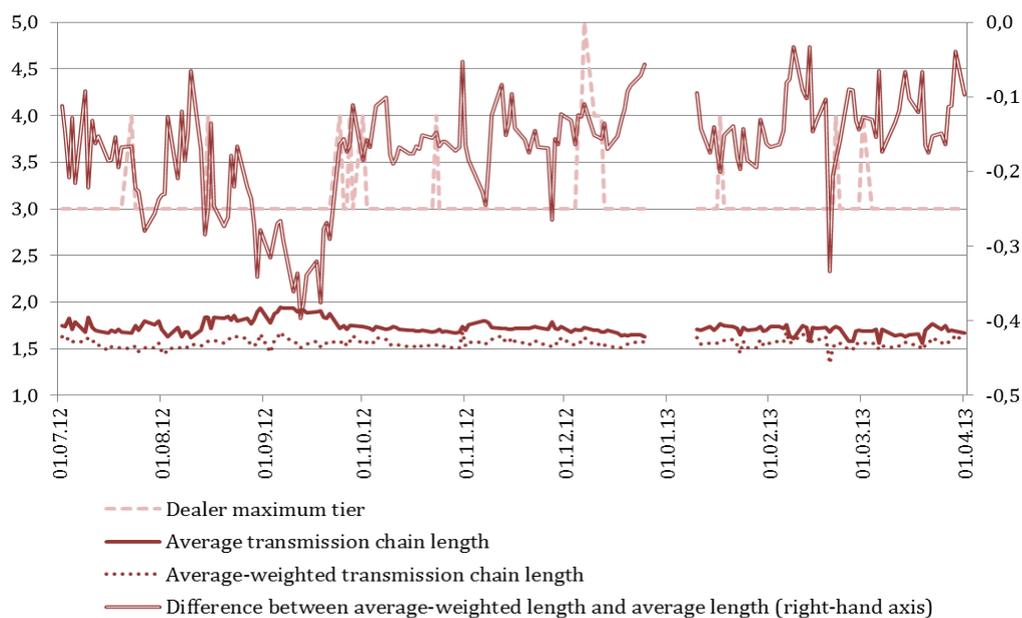
Note. The Chart shows a directed graph illustrating cash flows on the money market with a maturity of up to seven days. The pointed arrows (graphs) correspond to rouble liquidity providing transactions, while the blocks represent tiers of market participants. The percentage values demonstrate a share of these cash flows in the total volume of open positions on the money market, amounting to 3,324.7 billion roubles daily. The directed graph presents only cash flows exceeding this sum by 1%. The closed arrows mean that deals are closed between counterparties of the same tier.

The average daily number of dealers on the money market stood at 858 in 2013 Q1, which corresponded to the level of the previous quarter. Around 20 money market participants became primary creditors and went over to tier 1. The average number of tier 0 participants reached 444 (including more than 380 banks) while this number fell to 188 (163 banks) for tier 1 and 201 (80 banks) for tier 2 and increased to 22 (9 banks) for tier 3.

The average maximum length of transmission chain fell slightly to 3.05 in 2013 Q1 (-3.0% as against 2012 Q4). In most of the trading days, the maximum length of the transmission chain measured three cash transmissions when liquid assets were provided from tier 0 to 3, which was indicative of normal market conditions. During 3 of 57 days, liquidity was provided consecutively from tier 0 to 4 or 5.

In 2013 Q1, the *average-weighted length* of the transmission chain (the number of consecutive liquidity providing transactions, taking account of transaction value) was below the *average length* of the chain (the number of consecutive liquidity providing transactions, taking account of transaction volume, Chart 29) due to a large share of transaction values at lower tiers (between tier 0 and 1 in this particular case). The average-weighted length of the transmission chain remained unchanged during the quarter at 1.56. The difference between the average-weighted and average length of the transmission chain varied near the level of - 0.1. Generally, the market structure looked more stable in 2013 Q1 than in the previous quarter and the problem of current liquidity was less expressed.

**Chart 29. Transmission chain length on the money market with a maturity of up to seven days in 2012 Q4 and 2013 Q1**



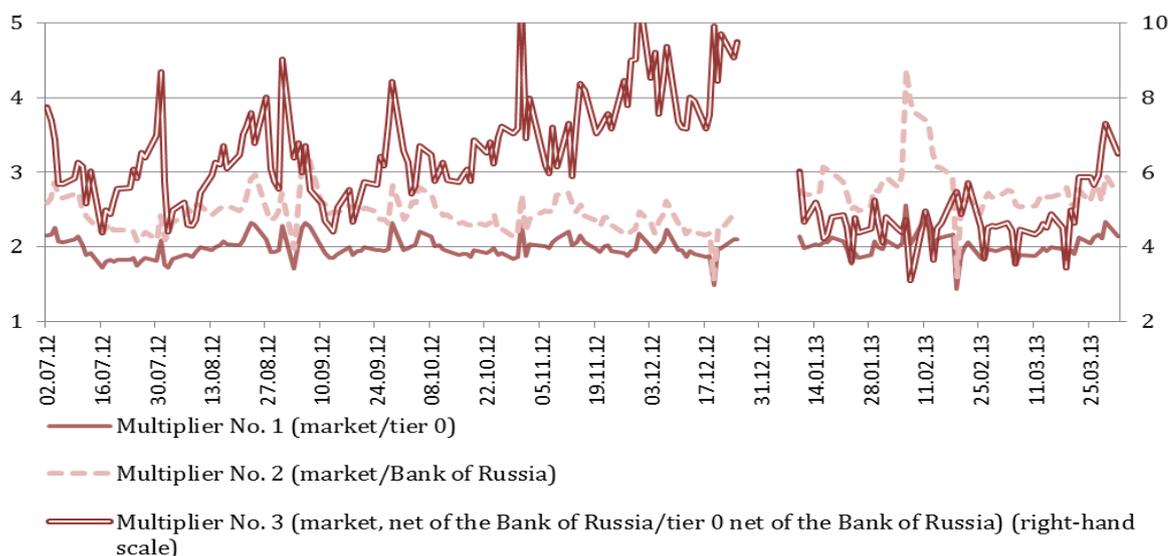
Average-weighted interest rates in the segment with a maturity of up to seven days at each liquidity distribution tier show the average rate, weighted by transaction value, this tier uses to borrow liquid funds. Generally, in 2013 Q1, the money market rates (Table 11) were lower in all segments than in the previous quarter due to the seasonal fall in banks' demand for liquidity. Interest rates fluctuations at tier 3 are due to a small number of transactions at this tier, especially in July and September.

**Table 11. Average-weighted borrowing rates by tier for transactions with a maturity of up to seven days, %**

Period	tier 1			tier 2			tier 3 and beyond		
	repos	interbank loans	swaps	repos	interbank loans	swaps	repos	interbank loans	swaps
2012-13									
<b>October</b>	5.62%	5.85%	6.25%	6.01%	6.28%	6.32%	6.00%	6.09%	6.52%
<b>November</b>	5.61%	5.90%	6.31%	6.22%	6.40%	6.35%	5.91%	6.02%	6.40%
<b>December</b>	5.62%	6.06%	6.44%	6.25%	6.50%	6.56%	5.65%	6.34%	6.63%
<b>January</b>	5.58%	5.37%	5.56%	5.86%	5.68%	5.68%	5.52%	5.72%	5.88%
<b>February</b>	5.61%	5.55%	5.77%	5.90%	5.98%	5.89%	5.76%	5.88%	5.99%
<b>March</b>	5.61%	5.80%	6.19%	6.14%	6.22%	6.29%	5.76%	6.73%	6.38%

Late in October-December 2012, higher volumes of Bank of Russia repos resulted in a gradual convergence of the values of *multiplier No. 1* (ratio of total market value to tier 0 transaction value) and *multiplier No. 2* (ratio of total market value to funds provided by the Bank of Russia). Widening of the gap between these multipliers shows that the Bank of Russia decreased its share at tier 0 (especially in early February 2013), although retaining the status of the principal primary creditor during this period. Market *multiplier No. 3* (ratio of total market value, net of the Bank of Russia, to tier 0 value, net of the Bank of Russia) stayed at a low level in January-February 2013 but grew in March 2013, which indicates higher activities of money market participants, net of Bank of Russia operations

**Chart 30. Money market multipliers**



In the second half of 2012 and in 2013 Q1, the intermediation ratio (net liquidity borrowing to total volume of transactions concluded at the tier, Table 12) for tier-1 participants saw a decrease. This testifies to the fact that the share of funds transferred by tier 1 to other money market participants (net of intra-tier transactions) increased from the previous quarter. As opposed to tier 1, tier 2 participants accumulated most of the borrowed funds in 2013 Q1. The intermediation ratio for tier 2 increased from 0.58 in January to 0.63 in March 2013.

**Table 12. Average-weighted intermediation ratio for tier 1 and tier 2**

<b>Period</b>	<b>tier 1</b>	<b>tier 2</b>
<b>2012-13</b>		
<b>October</b>	0.38	0.59
<b>November</b>	0.36	0.57
<b>December</b>	0.36	0.65
<b>January</b>	0.34	0.58
<b>February</b>	0.34	0.61
<b>March</b>	0.35	0.63

### *Money market liquidity transmission analysis*

Analysis of the money market transmission liquidity mechanism applies in full the interdealer repo market liquidity analysis method<sup>14</sup> to all segments of the money market.

The money market liquidity transmission analysis is based on data on transactions closed in three segments, namely repos, interbank loans, and swaps. Data on repos are compiled on the basis of trading information provided by Moscow Exchange Group. Data on interbank loan and swap transactions are available in Form No. 0409701 "Statement on Foreign-exchange and Money Market Operations" reported by credit institutions.

The ultimate objective of transmission analysis is to identify rouble liquidity flows between different groups of market participants, as well as conditions for liquidity distribution between these groups. The borrower and the creditor for each transaction are identified through the rouble borrowing principle. For example, for swaps the buyer is considered as borrower, while the seller of roubles as creditor.

Similar to the previously used repo market liquidity transmission analysis, the new money market analysis tool relies upon the concept of market tiers. The entire money market is viewed as a multitier system which describes the sequence of liquidity distribution between the groups of market participants. A money market tier describes a liquidity pool running through a group of participants. Tiers are sequentially aligned subject to participant proximity to the Bank of Russia refinancing system and other sources of liquidity (primary creditors).

The compiled data are used to calculate liquidity transmission tiers by using the following algorithm. At the initial stage, coefficient  $k_0$  is determined for each participant, which is equal to the ratio of participant's rouble borrowings to placements. The Bank of Russia and other market creditors with a low value,  $\leq 0.05$ , of coefficient  $k_0$  pertain to tier 0.

Market participant membership in consecutive tiers is determined iteratively. Coefficient  $k_1$  is used to calculate each consecutive tier, which is equal to the ratio of a given participant's borrowings from the preceding (already identified) tiers (first step – borrowing volumes from tier 0, second step – total borrowings from tiers 0 and 1, etc.) to the participant's total borrowings from all market participants. Given that coefficient  $k_1$  for a participant is higher than 10%, the participant is assigned a number of tier being equal to the current iteration step. For example, if a participant has borrowed from tiers 0 and 1 more than 10% of its borrowings, this algorithm will define him as

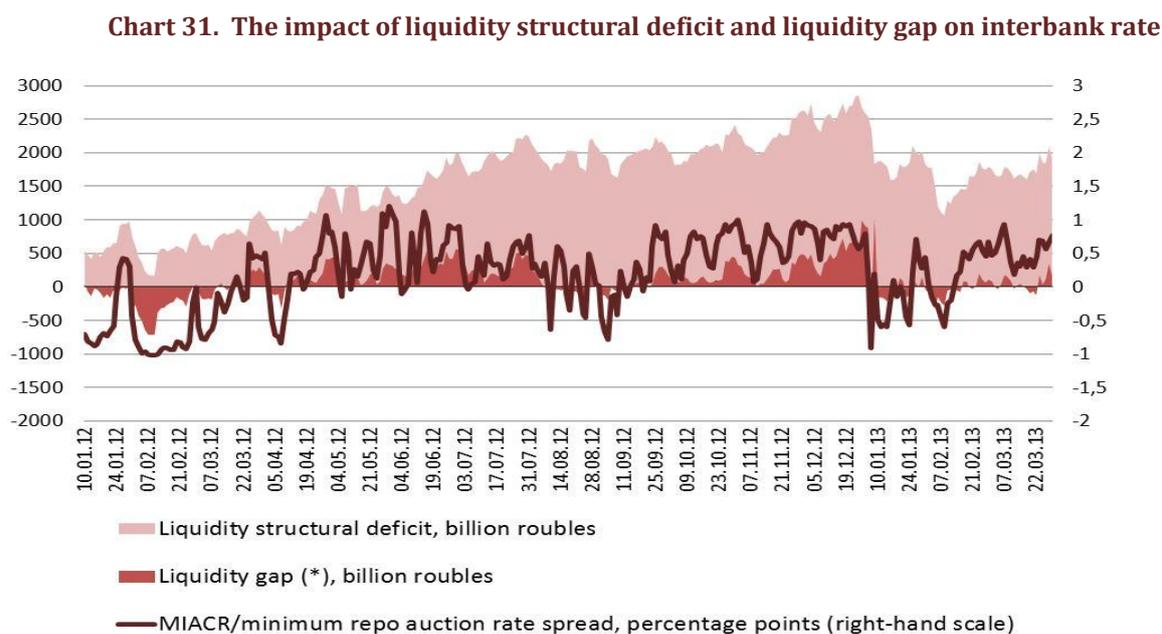
<sup>14</sup> See Conceptual Framework for Liquidity Transmission Analysis in the Interdealer Repo Market Report for 2012 Q1, p. 26. For a detailed description of the analytical system and its indicators please see Моисеев С.Р., Пангина И.В., Сосюрко В.В. Анализ трансмиссии ликвидности на рынке междилерского РЕПО // «Деньги и кредит», 2012. - №7 – p. 65-71.

tier-2 participant. The coefficients are used to ensure that small transactions with participants from the preceding tiers have no effect on assigning a tier number to a given market participant.

Iterations are basically intended to ensure that every consecutive tier include borrowers who closed transactions with creditors of the preceding tiers. Thus, a tree of relationships among market participants in different tiers can be developed.

## 4.2. Interbank loan market interest rate behaviour

Short-term interest rates on the interbank loan market fell by 41 basis points from the previous quarter to average 5.72% p.a. in 2013 Q1. Interbank loan rate volatility, measured by the mean-square deviation, remained substantial and stood at 43 basis points in 2013 Q1.



\*) The banking sector liquidity gap is determined as the difference between liquidity supply and demand on a specific day (for details refer to “On Determining Limits on Bank of Russia Market Operations on Liquidity Providing/Absorbing” in Section “Monetary Policy” posted on the Bank of Russia website<sup>15</sup>).

The contraction in liquidity structural deficit<sup>16</sup> (Chart 31), which averaged 0.6 trillion roubles in 2013 Q1, was the principal factor that contributed to the decrease in the average interbank loan rate during this period as compared with the previous quarter. This was mainly due to the reduction of large balances accumulated by credit institutions on their correspondent accounts with the Bank of Russia by the start of the period under review as a result of large-scale budget expenditures at the end of 2012.

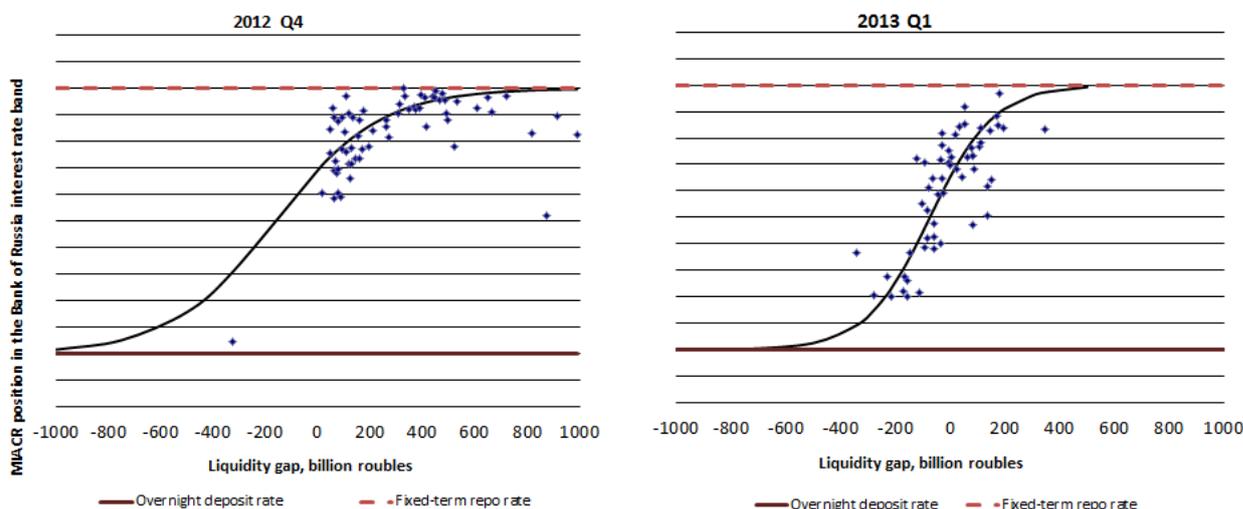
The interbank loan rate also declined due to changes in the structure of debts on Bank of Russia repos. As credit institutions showed growing demand for liquidity at 1-week repo auctions, maximum amounts stipulated under these operations were systematically used up. As a result, the liquidity gap in the period between weekly operations contracted significantly from 2012 Q4 to 10.3 billion roubles on average for the quarter as against 291 billion roubles in the previous period, which eased current liquidity pressure on the interbank loan rate. In particular, the interbank loan

<sup>15</sup> Monetary policy. – Access mode: <http://cbr.ru/dkp/>, free. Screen title.

<sup>16</sup> For the definition of liquidity structural deficit, see the section: “Short-Term Interbank Loan Rate Analysis.”

rate stayed in the lower part of the interest rate band on Bank of Russia liquidity providing/absorbing operations during most of the period under review due to current liquidity surplus that emerged in the first half of the quarter amid prevailing overnight liquidity absorbing operations and absent demand for Bank of Russia refinancing instruments.

**Chart 32. The impact of liquidity gap on the interbank loan rate in the Bank of Russia interest rate band**



According to available data<sup>17</sup>, the impact, which the external factors (the exchange rate, interest rates on external markets) had on the short-term interbank loan rate in Russia in 2013 Q1, amid substantial exchange rate volatility and insignificant Bank of Russia interventions on the domestic foreign currency market, remained close to zero and was virtually unchanged throughout the period under review (Chart 33).

The impact of other factors on the spread between the interbank loan rate and the Bank of Russia repo auction rate for loans with 1-day and 1-week maturity remained relatively stable in 2013 Q1 and therefore exerted no significant influence on the interbank loan rate dynamics.

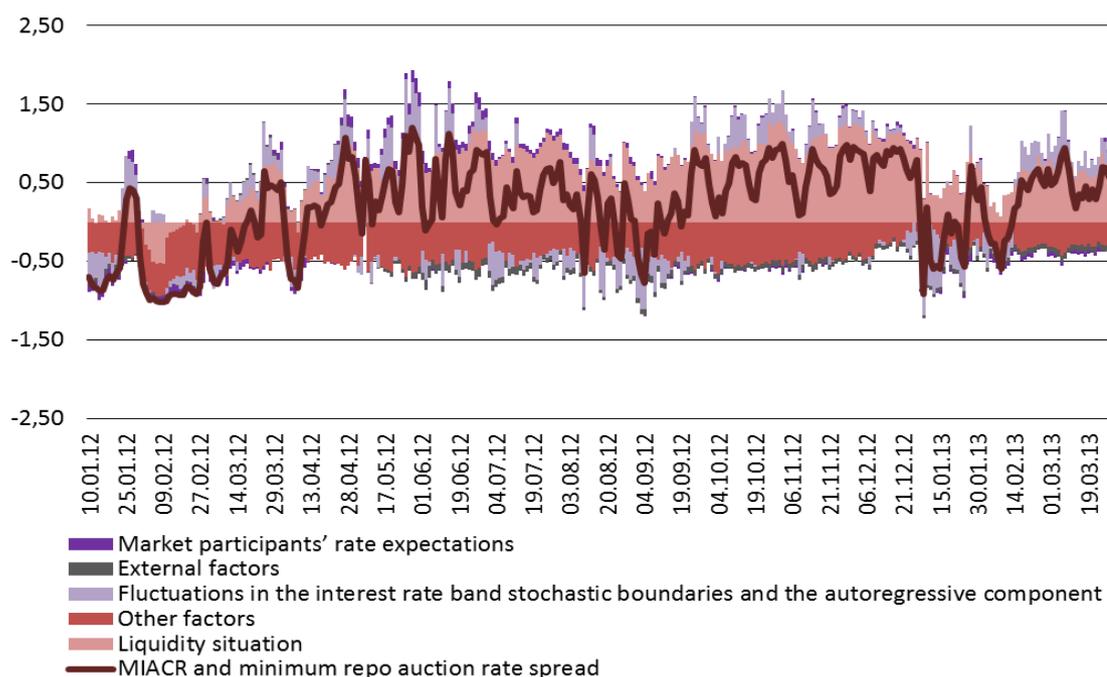
For the purposes of financial stability, it is important to identify certain shocks, which cause considerable fluctuations of the short-term money market rate. To this end, the interbank loan rate was analysed in terms of its sensitivity to fluctuations in the money market main indicators in 2013 Q1.<sup>18</sup>

The data available for 2013 Q1 were used to determine the average values and the average root-mean-square deviations of regression factors included in the model. The value of the money market rate, which is derived from the model and represents an averaged set of regression factors, normally equals with high accuracy the actual average value of the interbank loan rate for the period under review (in the case of 2013, Q1, 5.74% and 5.72%, respectively).

<sup>17</sup> The estimates of the impact of various factors on the money market rates were obtained through a stochastic model that describes the position of the short-term interbank loan rate in the Bank of Russia interest rate band (see the section: "Analysis of the Short-Term Interbank Loan Rate Behaviour").

<sup>18</sup> Based on the available stochastic model that describes the position of the short-term interbank loan rate in the Bank of Russia interest rate band (see the section: "Analysis of the Short-Term Interbank Loan Rate Behaviour").

**Chart 33. Contribution by various factors to the spread between the interbank loan rate and the minimum short-term repo auction rate, percentage points**



In the period under review, the interbank loan rate showed the highest sensitivity to changes in the size of the liquidity gap. The level of liquidity structural deficit was relatively stable in 2013 Q1 and exerted no significant influence on the interbank loan rate. The market interest rate sensitivity to changes in other explanatory variables in comparison with the current liquidity indicators generally remained inconsiderable throughout the period under review.

### ***Analysis of short-term interbank loan rate behaviour***

In order to analyse the current money market situation, it is important to identify factors that have a considerable impact on the short-term interbank loan rate. Its volatility is limited by such natural constraints as the interest rates on standing facility operations conducted by a central bank (in the case of the Bank of Russia – overnight deposit rates and interest rates on fixed-term liquidity provision operations). In its turn, the position of the interbank loan rate in the central bank's interest rate band is determined by a whole number of factors, the most important of which is the liquidity situation.

In the event of liquidity structural surplus, the banking sector mostly demonstrates demand for Bank of Russia absorption instruments, which (in the absence of market liquidity absorption instruments) moves the interbank loan rate down to the lower boundary of the interest rate band. In the event of liquidity structural deficit, on the contrary, the banking sector will mostly show demand for liquidity provision instruments, which will cause the interbank loan rate to grow.

It is also important to differentiate between the liquidity current and structural deficit/surplus. Current liquidity deficit means that the level of the demand for liquidity on a specific day exceeds the level of its supply created under the impact of autonomous factors, i.e. the liquidity level that would have been present in the banking system in a conventional situation of the central bank's absence from the market on that particular day (the resulting gap between liquidity demand and supply is covered by the central bank's liquidity provision operations). For the purposes of analysing the impact of the liquidity level on the interbank loan rate, *liquidity structural*

*deficit/surplus* means the difference between the Bank of Russia's claims to credit institutions<sup>19</sup> and credit institutions' surplus reserves at the Bank of Russia (which equal the amount of credit institutions' balances on their deposit accounts with the Bank of Russia and credit institutions' investments in Bank of Russia bonds (OBRs)). This indicator measures the aggregate liquidity gap, which is covered, among other things, by the central bank's previously held operations).

It is also important to analyse the impact of external factors (both the exchange rate dynamics and short-term interest rates on external markets) on the interbank loan rate in Russia. As is known, external rates exert the largest influence on domestic rates when fixed exchange-rate regimes are used. In the current situation in Russia, which is characterised by the volatile exchange rate and the absence of a clearly marked trend in the exchange rate dynamics, the influence of external factors on the domestic interbank loan rate is quite moderate.

For the purpose of assessing the impact of various factors on the interbank loan rate, the following model formula<sup>20</sup> can be used:

$$\frac{r(t) - \rho_1(t)}{\rho_2(t) - \rho_1(t)} = \varphi \left( \sum_{j=1}^n \beta_j X_{t,j} \right) + u_t,$$

where:

- $r(t)$  - interbank loan rate;
- $r_1(t)$ ,  $r_2(t)$  - correspondingly, the lower and upper boundary of the band of interest rates on central bank liquidity provision and absorption operations;
- The processes  $(\rho_i(t))_{t \geq 0}$ ,  $i = 1, 2$  are the Hull-White processes and are defined by stochastic differential equations

$$d\rho_i(t) = \alpha_i(r_i(t) - \rho_i(t))dt + \gamma_i dB_i(t), \quad i = 1, 2,$$

where  $(B_i(t))_{t \geq 0}$  - standard Brownian motion,  $\alpha_i \geq 0$ ,  $\gamma_i \geq 0$ ,  $i = 1, 2$ . The processes  $(\rho_i(t))_{t \geq 0}$ ,  $i = 1, 2$  и  $\{u_t\}_{t \in Z_+}$  are presumed independent in totality.

- $\{u_t\}_{t \in Z_+}$  - AR-ARCH(p,q) - process;
- $\{X_{t,j}\}_{t \in Z_+, j=1, \dots, n}$  - a set of factors influencing the money market rate position in the central bank interest rate band;
- $\varphi(\cdot)$  - arbitrary monotone non-decreasing function, including  $\exists \lim_{x \rightarrow -\infty} \varphi(x) = 0$ ,  $\lim_{x \rightarrow +\infty} \varphi(x) = 1$ .

The economic sense of the model under review is that it describes the interbank loan rate position in the stochastic band generated by the processes  $(\rho_i(t))_{t \geq 0}$ ,  $i = 1, 2$ , ranging around the natural boundaries of the interest rate corridor  $(r_i(t))_{t \geq 0}$ ,  $i = 1, 2$ . The assessment of the parameters  $\{\alpha_i, \gamma_i\}_{i=1,2}$  helps evaluate both the rigidity of the interest rate band boundaries and the velocity of the money market rate response to their change.

The interbank loan rate position in the stochastic corridor is described by the non-linear dependence on the analysed multitude of regressors  $\{X_{t,j}\}$ , with the nature of this dependence

<sup>19</sup> With regard to repos, Lombard loans, overnight loans, swap operations and loans secured by non-market assets and guarantees.

<sup>20</sup> For a detailed description, please see: Смирнов. В.Д. Моделирование динамики краткосрочных процентных ставок денежного рынка // Деньги и кредит, 2013. – №1. – с. 50-59.

being conditioned by central bank standing facility rates that play the role of natural constraints for interbank loan rate fluctuations.

This model also allows for measuring the short-term interbank loan rate sensitivity to changes in certain factors that exert substantial influence on its position in the interest rate band of Bank of Russia fixed-term liquidity provision/absorption operations.

To this end, the data for 2013 Q1 were used to determine the average values and the average root-mean-square deviations of regression factors included in the model. The value of the interbank loan market rate, which is derived from the model and represents an averaged set of regression factors, normally equals with high accuracy the actual average value of the interbank loan rate for the period under review (in the case of 2013, Q1, 5.74% and 5.72%, respectively).

The model helps analyse the interbank loan rate sensitivity to shocks typical of the period under review (within this research, they were presumed to equal one average root-mean square deviation), for each regressor separately and on the assumption that other explanatory variables take on average quarterly values. As the model represents non-linear relationships, it is important to note that the range of interbank loan rate fluctuations, which is defined by a change in the level of some regressors, depends not only on the quantitative characteristics of explanatory variables in the analysed period but also on the rate position in the interest rate band. In other words, in the event that the interbank loan rate stays in the middle of the Bank of Russia interest rate band, its sensitivity to shocks would be the highest. As the interbank loan rate moves close to one of the band boundaries (for example, due to the changed liquidity situation), it will see a change in its sensitivity to the altered level of explanatory variables.

### **4.3. Money market network analysis**

The money market structure exerts considerable influence on the probability and the scope of a domino effect and, therefore, it is highly important to understand the nature of relationships between financial institutions to maintain financial stability. Network analysis helps determine a system of relationships between money market participants, the volumes and directions of cash flows, which makes it possible to quantitatively assess current systemic risk and its dynamics, reveal the sources of market fluctuations, identify the channels of a possible crisis spread on the money market. Finally, information on the money market structure helps measure interest rate controllability and the efficiency of the Bank of Russia monetary policy.

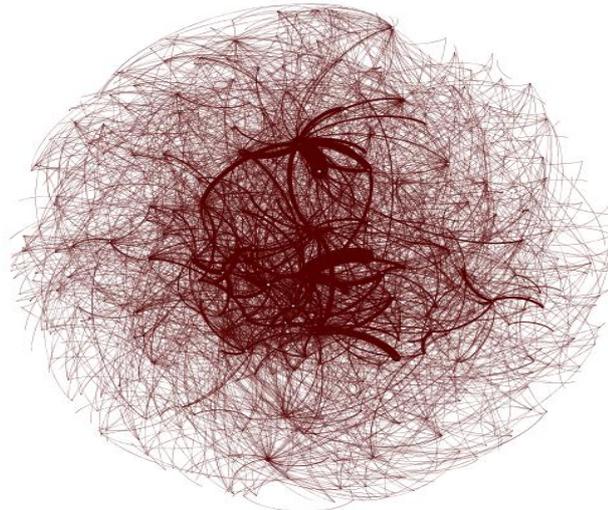
This section analyses the main network indicators of the rouble money market<sup>21</sup>. The money market is presented in the form of a graph in the following way: market participants are located at the vertices while the edges are directed from creditors to borrowers, with each edge showing a corresponding amount in roubles (on all transactions) called the edge weight, which the creditor (the primary vertex) lent to the borrower (the final vertex) in the stated period<sup>22</sup>. As of April 1, 2013, the money market graph had 804 vertices and 2,554 edges integrated into one connected component.

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<sup>21</sup> Excluding operations with the Bank of Russia.

<sup>22</sup> A money market graph as of certain date XX.YY.20ZZ means a graph that shows all transactions with maturity dates no later than five business days after the selected date XX.YY.20ZZ.

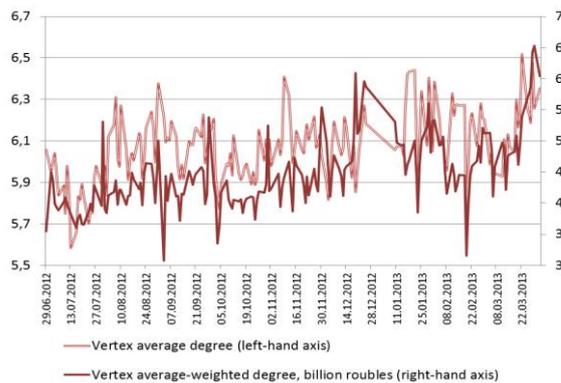
**Chart 34. Money market network as of the end of 2013 Q1**



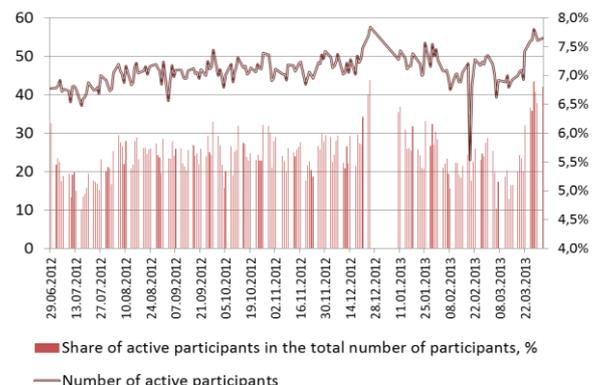
The rouble money market is characterised by *low density*, which shows it as a sparse (far from a complete<sup>23</sup>) graph. An average market participant's behaviour can be characterised as showing a low level of activity: on average, each participant has a small number of counterparties and conducts a small volume of operations, which is demonstrated by *the average and average-weighted degree indicators* (Chart 35): as of April 1, 2013, *the average degree* constituted 6.4 counterparties while *the weighted-average degree* (a position on the counterparty) totalled 6.0 billion roubles. The indicators are stable through time - their root-mean-square deviation does not exceed 2.7% and 10.8%, respectively.

While most market participants show low activity, there are some market players that demonstrate increased activity. Therefore, the money market graph represents a heterogeneous structure. Considering cross connections between counterparties, the number of borrowers for creditors varies to a lesser extent (this variation constitutes 6.7 participants) than the number of creditors for borrowers (12.3 participants), which suggests that there are market participants who have difficulty in finding creditors for a requested amount. Similarly, variation of the value of loans extended by creditors makes up 21.3% of the average size while variation of the value of funds raised by borrowers equals 22.4%.

**Chart 35. Activity indicators**



**Chart 36. The number of active participants<sup>24</sup>**

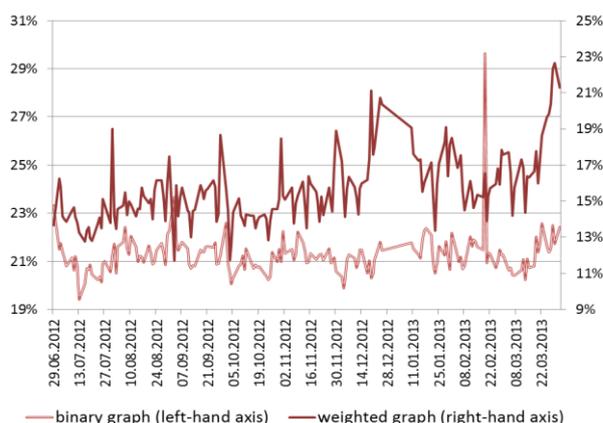


<sup>23</sup> A graph is called complete if there is connectivity between any of its two vertices.

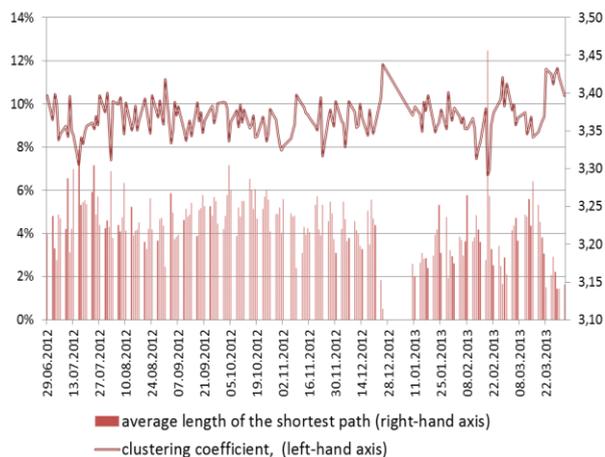
<sup>24</sup> For the definition of the number of active participants, see the section: "Method of Money Market Network Analysis." A sharp fall in the number of active participants on February 19, 2013 was due to a 57% fall in the total number of participants as compared with the previous day.

In our estimates, there were 55 *active players* on the money market as of April 1, 2013 or 6.8% of the total number of market participants (this indicator is shown in Chart 36). With a small number of *active participants*, the money market is far from an *absolutely centric network* (i.e. there is no player on the market that sees the entire volume of money market operations running through it). As of the end of 2013 Q1, *the proximity to the absolutely centric market measured 20.7% for the binary graph (excluding the weights) and 16% for the weighted graph (including the weights)* (Chart 37).

**Chart 37. Proximity to absolutely centric market**



**Chart 38. “Small world” indicators**



Research results show that most actual networks in world practice, including the Russian money market graph, display the efficiency characteristic: with a small number of connections, the average distance between the network’s two vertices is also quite small. In other words, the networks correspond to *the small-world phenomenon*, under which a considerable number of vertices are not connected with each other but most connections can be established through a small number of intermediaries (or through a short distance)<sup>25</sup>. The small-world’s drawback is that it may spread quickly through the system in case of its emergence. The existence of dense subgroups (an additional sign of a “small world” under the Watts-Strogatz model<sup>26</sup>) numerous increases the network participants’ damage from a potential shock. The Russian money market does not meet this characteristic. As of April 1, 2013, the shortest path between two vertices had an average length of 3.2 edges, while the clustering coefficient characterising the graph density equalled 10% (Chart 38). For the sake of comparison, the average distances between two vertices on the interbank markets in the Czech Republic<sup>27</sup> and Austria<sup>28</sup> are 2.6 and 2.3 edges, respectively, while their clustering coefficients are, correspondingly, 37% and 12%.

The Russian money market network meets three characteristics typical of scale-free networks. First, the network contains a small number of active market participants (i.e. participants with a large number of counterparties) and a big number of low-activity participants (with a small number of counterparties). Secondly, with the increased activity of a participant in the surveyed market, a shock that the participant could bring into the system would not increase considerably, if

<sup>25</sup> The small-world example can be found in the human community where “all people of the Earth know each other through six handshakes.”

<sup>26</sup> Watts D.J., Strogatz S.H. Collective dynamic of small-world networks//Nature, 1998. Vol. – 393. – pp. 409-410.

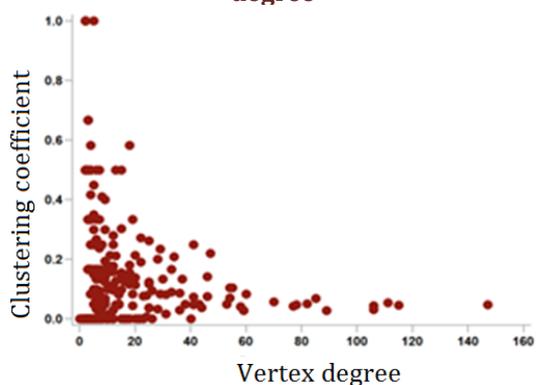
<sup>27</sup> Hausenblas V., Kubicova I., Lesanovska J. Contagion Risk in the Czeck Financial System: A Network Analysis and Simulation Approach//Czech National Bank Working Paper Series, 2012. – Vol. 2012/14.

<sup>28</sup> Boss M., Elsinger H., Thurner S., Summer M. Network Topology of the interbank market//Quantative finance,2004. – Vol.4. – pp. 677-684.

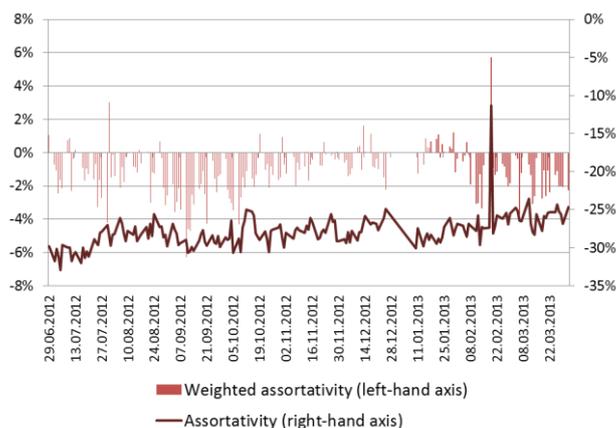
it ran through the system, which means that the money market has a potentially low contagion effect. In other words, a rise in *the degree of vertex* inside the graph (the number of the participant's counterparties) will come with a fall in the vertex *clustering coefficient* (Chart 39). Thirdly, the money market network is characterised by *disassortative mixing*, which is defined as the desire of big participants (with a large number of counterparties) to conduct transactions with low-activity borrowers (with a small number of connections with counterparties), and vice versa. This can be evidenced by a substantial negative *assortativity coefficient*, which equalled  $-24.7\%$  as of April 1, 2013 (Chart 40). No similar *disassortative mixing* was observed in the case when activity was measured by the volume of transactions (*the assortativity coefficient* was close to 0).

At the same time, the distribution of degrees in the Russian money market network does not correspond to the exponential law and, therefore, the network is not scale-free as compared to the Czech and Austrian interbank market networks. As opposed to them, the Russian money market features large contrast between the activity of leading participants and the passivity of the other players because vertex degrees reflect a larger extent of decreasing exponential distribution (Chart 41).

**Chart 39. Vertex clustering coefficient and vertex degree**



**Chart 40. Assortativity coefficients**



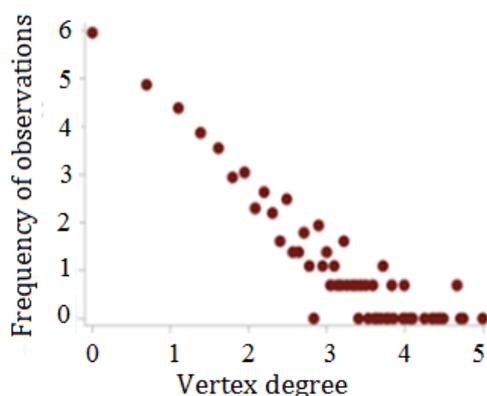
The above-mentioned facts testify to the money market hierarchical structure where players are weakly protected from destabilisation of the market's central participants. In order to identify them, we should select a group of key players who form the so-called *core* and a group of the other, secondary participants referred to the so-called *periphery*. In an *ideal market model*, the core comprises market participants that perform the role of both active creditors and active borrowers. At the same time, *periphery* participants do not conduct transactions between each other directly but perform them through *the core* participants. Therefore, the *core* members are systemically important market participants in as many as three areas: as potential shock sources, potential shock transmitters and potential defaulters. A multitude of players is divided into *the core* and *the periphery* in the money market actual graph proceeding from the *graph's proximity to the ideal market graph*.

As of the end of 2013 Q1, 10 players comprised the money market *core* and 794 players – the market *periphery*, with the degree of proximity to the ideal market equalling 18.3%. The core and *periphery* main characteristics are given in Table 13.

Thus, the Russian money market can be referred with some conventionalities to small-world networks and is characterised by the reduced potential contagion effect. A sudden shock in the money market network reaches a market participant after passing through 2-3 intermediaries on average. The market has a clearly-expressed hierarchical structure where main liquidity flows run through only 6.8% of active market participants while all of the ten core participants are referred to systemically important players. The network subgraph, which comprises only active participants,

has the properties similar to the properties of the entire network (this subgraph is also referred to the small world with the reduced contagion effect). In the next issues of Money Market Reviews, we intend to study in detail the core of the money market and its systemically important participants.

**Chart 41. Cumulative degree distribution function (logarithmic scale)<sup>29</sup>**



**Table 13. Core/periphery comparison**

Indicator	Core	Periphery	Graph
Number of participants	10	704	804
Average vertex degree (number of counterparties)	8.4	5.2	6.4
Average-weighted vertex degree (billion roubles)	16.6	4.3	6.0
Number of active participants	9.4	30	55
Graph density	46.7%	0.31%	0.4%
Average shortest path length	1.3	3,5	3.2
Graph clustering coefficient	60%	6.1%	10%

### **Method of money market network analysis**

#### **General information on the graph theory**

The graph theory studies objects called vertices or nodes and relations between objects called arcs or edges. A graph without positive numbers (weights) assigned to vertex edges is called a binary graph and a graph with positive numbers (weights) is called a weighted graph. A graph indicating a direction of flow between vertices is called a directed graph; otherwise it is called an undirected graph. Each weighted graph can be easily made binary by bringing the weights to zero and undirected by removing the edge directions. A minimum set of two vertices and one connection between them forms a simple graph. A full or complete graph is a graph where all the vertices are connected with each other.

#### **Money market report definitions**

*Absolutely centric market* – the market with its network represented in the form of a star graph (and, correspondingly, showing the maximum possible degree dispersion among all the graphs with the same number of vertices).

*Scale-free network* - a network whose vertex degree distribution follows the exponential law of distribution. These graphs have low clustering coefficients and a small number of high-degree vertices, which suggests that if a shock strikes a vertex, it is highly probable that this would not be a key vertex and, therefore, this would not cause a contagion effect.

*Outcome weighted degree variation* – the standard deviation of the volume of lending to money market participants from the average lending volume. It characterises the degree of market heterogeneity and is measured as percentage of the average size. The indicator’s high value may testify to the low degree of risk diversification by some money market participants.

<sup>29</sup> On the logarithmic scale, the degree distribution function corresponds to the straight line. In this Chart, the heavy lower part shows a shift of the distribution function density towards zero (i.e. exponential distribution).

*Income weighted degree variation* – the standard deviation of the share of borrowing by money market participants in the overall borrowing volume. It characterises the degree of market heterogeneity and is measured as percentage of the average size. The indicator's high value may testify to the existence of some banks with small volumes of borrowed funds.

*Income degree variation* – the standard deviation of the number of borrowers for creditors on the market. It characterises the degree of market heterogeneity and is measured as percentage of the average size. The indicator's high value may testify to the low degree of risk diversification by some money market participants.

*Outcome degree variation* - the standard deviation of the number of creditors for borrowers on the market. It characterises the degree of market heterogeneity and is measured as percentage of the average size. The indicator's high value may testify to the low degree of risk diversification by some money market participants.

*Weighted assortativity* – the correlation between the outgoing degrees of creditors and the incoming degrees of their borrowers. If the coefficient is positive, this means that active creditors (measured by the value of extended loans) are inclined to lend to active borrowers (measured by the value of borrowings) and, vice versa: inactive creditors are inclined to lend to inactive borrowers. If the assortativity coefficient is negative, this means that inactive creditors are inclined to establish relations with active borrowers and vice versa. If the coefficient is near zero, this means that there is no clearly-marked trend on the market.

*Weighted degree* – the volume of operations (both lending and borrowing) carried out by a market participant. It shows the degree of the market participant's activity measured by the volume of operations.

*Weighted proximity to the absolutely centric market* - variation of the market weighted undirected graph relative to variation of the star graph with the same number of vertices and the same density (the same weights are assigned to the star graph edges). This ratio is measured as percentage of the star graph variation. The indicator's high value shows the market proximity to the maximally centralised market when one participant plays the role of a key creditor and a key borrower while the other participants form the periphery and perform operations only through a key player rather than conducting operations with each other directly.

*Star graph* – a graph where all the vertices are not connected with each other, except for one vertex, which is connected with all the other vertices of the graph.

*Clustering coefficient of a graph vertex* – vertex neighbourhood density compared to the maximally possible vertex neighbourhood density in an undirected market graph. The indicator's high values testify to high risk concentration.

*Clustering coefficient of a graph* – the average clustering coefficient for all graph vertices; it characterises the degree of money market risk diversification. The indicator's high values testify to high risk concentration.

*Assortativity coefficient* – the correlation between the outgoing degrees of creditors and the incoming degrees of their borrowers. If the coefficient is positive, this means that active creditors (measured by the number of borrowers) are inclined to lend to active borrowers (measured by the number of creditors) and, vice versa, inactive creditors are inclined to lend to inactive borrowers. If the assortativity coefficient is negative, this means that inactive creditors are inclined to establish relations with active borrowers and vice versa. If the coefficient is near zero, this means that there is no clearly-marked trend on the market.

*Small world* – a network with a small average shortest path length.

*Vertex neighborhood* – a network subgraph containing all the vertices adjacent to the primary vertex and the corresponding edges.

*Edge density* – the number of edges in a money market undirected binary graph relative to the maximally possible number of edges in a complete graph; it assumes values from 0 to 1 and

characterises the degree of the money market integration (the closer this indicator is to 1, the more fragmented and the less centralised is the market).

*Complete graph* – a graph with the edge density equal to 1.

*Sparse graph* – a graph with low edge density

*Weighted-average degree* – the average value of the weighted degree for all vertices.

*Average geodesic path length* – the average (for all pairs of vertices in an undirected market graph) minimum number of edges that must be traversed to travel from one market participant to another, taking into account the direction of travel; it shows the average number of iterations required for a shock emerging in the system to reach a randomly selected money market participant. The indicator's high values are evidence of the market proximity to a small-world network.

*Average degree of a vertex* – the average degree of all vertices.

*Proximity to the absolutely centric market* - variation of the degree of the binary undirected market graph relative to variation of the star graph with the same number of vertices. This ratio is measured as percentage of the star graph variation. The indicator's high value shows the market proximity to the maximally centralised market when one participant plays the role of a key creditor and a key borrower while the other participants form the periphery and perform operations only through a key player rather than conducting operations with each other directly.

*Degree of a vertex* – the number of counterparties (both creditors and borrowers), which a corresponding money market participant has. It shows the degree of the market participant's activity measured by the number of counterparties.

*Number of active participants* – the average number of money market participants' counterparties weighted by the volume of operations; it characterises the number of participants that handle the bulk of transactions on the money market.

### ***Core/periphery model***

A key idea of the Core/Periphery<sup>30</sup> model is to segregate the core, which is represented by a small group of banks actively engaged in money market transactions both as creditors and borrowers. At the same time, the remaining banks that form the periphery are connected to each other only through the core members rather than directly. The core structure is determined, first of all, to identify some group of banks (the core), which by virtue of historical, institutional or other reasons actively interact with each other, forming some kind of a community on the interbank loan market. Secondly (and more importantly), this approach helps divide banks into systemically important and systemically unimportant organisations. Banks from the core are systemically important because they have a large number of relations on the market and, consequently, bear higher credit and liquidity risks compared with other market participants, on the one hand, and are also the sources of these risks, on the other hand. They also perform the function of intermediaries between periphery members unable to participate in transactions with each other directly, which determines the core members' special role as the potential transmitters of the contagion effect on the interbank loan market.

The core and the periphery are segregated, using the following principle:

- 1) as the first step, 200 participants are selected who can claim to belong to the core by their activity (the volume and value of transactions);
- 2) a subset of participants is selected (from 200) and an ideal market graph is built with these participants in the core;
- 3) the proximity of the ideal market graph to the actual graph is computed;

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<sup>30</sup> Borgatti S. P. and Everett M. G. Models of core/periphery structures // Social Networks, 2000. – No. 21. – pp. 375-395.

- 4) some other subset is selected;
- 5) and so forth.

This process takes place until proximity to the ideal market graph becomes minimal. As a measure of proximity, the Pearson correlation between the adjacency matrices of the actual and ideal market graph is used (undirected weighted graphs are considered).

#### 4.4. Network indicators of systemic importance of money market participants

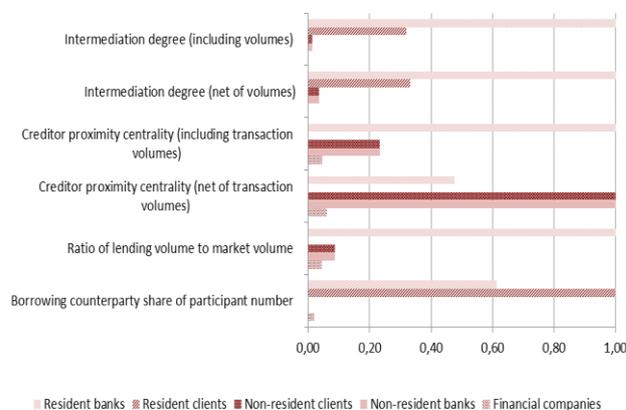
Money market stability depends largely on its key (systemically important) participants, whose actions may trigger a systemic risk on the money market. Such participants conduct large volumes of operations, have a wide range of counterparties, actively involve in intermediation operations, and exert substantial impact on the market.

To identify systemically important participants in assessing the above-mentioned characteristics, the Bank of Russia used both traditional indicators which show market participant activity (volume of operations, number of counterparties), and indicators calculated on the basis of network analysis (the method is described in the Money Market Review for 2012 Q4). The specified indicators were calculated individually for each participant. The results were further aggregated by groups of participants (for example, resident banks, non-resident customers, etc.). The aggregation process included several stages:

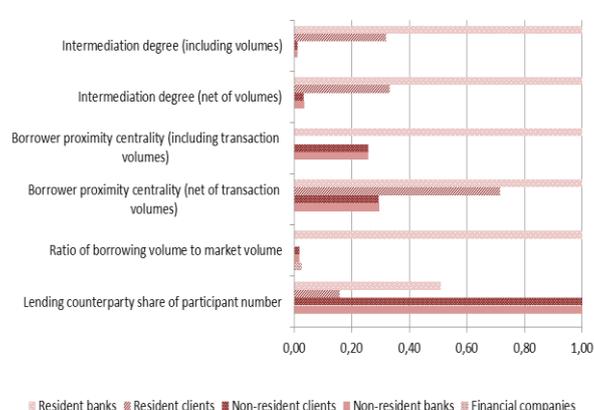
- ten participants with the highest values of a target indicator were selected for each type;
- the average value of a target indicator was calculated based on the selected ten participants;
- for comparative analysis, the estimates obtained in the previous clause (the average value of an indicator) were normalized (scaled [0;1]).

In 2013 Q1, banks were the principal participants determining the money market conditions (Chart 42). In addition, both resident and non-resident customers were relevant among creditors. Resident customers were characterised by a large number of borrowing counterparties, because some brokers and banks had subsidiaries which extended loans to the customers of these participants. Among borrowers, customers also played an essential role. One may assume that a big number of non-resident counterparties was determined by the borrowings of large Russian companies on the repo market through foreign firms. The influence of non-resident banks on the market increased considerably from the previous quarter; there was an especially big increase in the number of creditors of these banks. As in the previous quarter, financial companies played an insignificant role.

**Chart 42. Indicators of systemic importance of creditor groups**



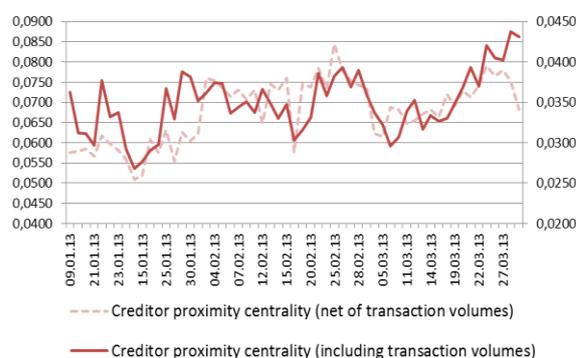
**Chart 43. Indicators of systemic importance of borrower groups**



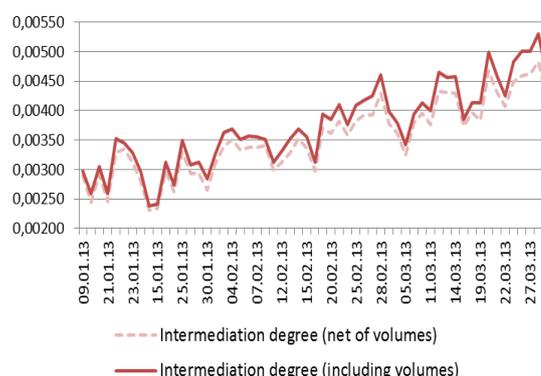
Market centrality<sup>31</sup> decreased as compared with 2012 Q4, reflecting weakening influence of major creditors on the market, which can be explained by the lower demand for liquidity. At the same time, market centrality during the quarter, on the contrary, showed some growth (Chart 44). The influence of intermediaries on the market was characterised by similar trends: market centrality decreased considerably from the previous quarter but showed some growth during the quarter (Chart 45).

Money market systemic risks decreased as compared to 2012 Q4 due to lower money market centrality and intermediation, i.e. market performance indices were getting less dependent upon actions of a few organisations. In general, the indices of centrality and intermediation remained at acceptable levels. Specifically, not particularly high market concentration levels and a moderate intermediation chain length testify to this.

**Chart 44. Money market centrality**

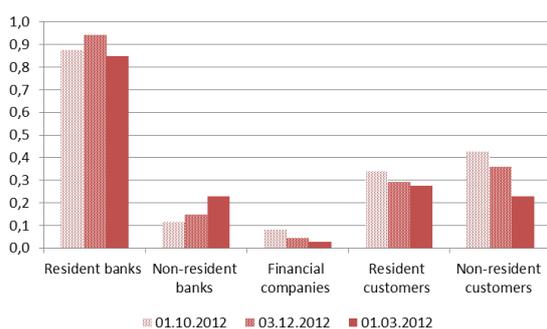


**Chart 45. Intermediation degree on the money market**

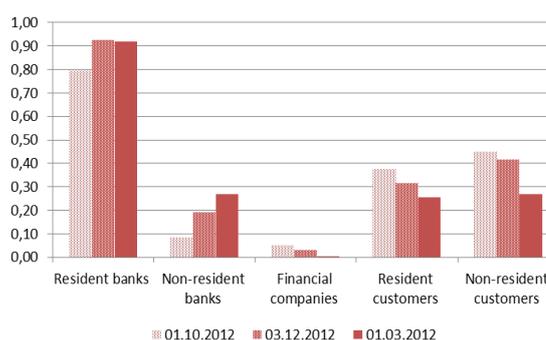


Customers and financial companies contributed most to weaken the influence of systemically important participants on the money market (Chart 46 and Chart 47), while the influence of non-resident banks increased.

**Chart 46. Systemic importance aggregate by creditor**



**Chart 47. Systemic importance aggregate by borrower**



Therefore, banks were the principal participants of the money market; however, their influence slightly decreased compared with the previous quarter.

<sup>31</sup> Market centrality is an indicator reflecting proximity to an ideal 'centralised' market in which liquidity is provided from a participant (centre) and then redistributed among other participants.

## 4.5. Systemic importance of interdealer repo market participants

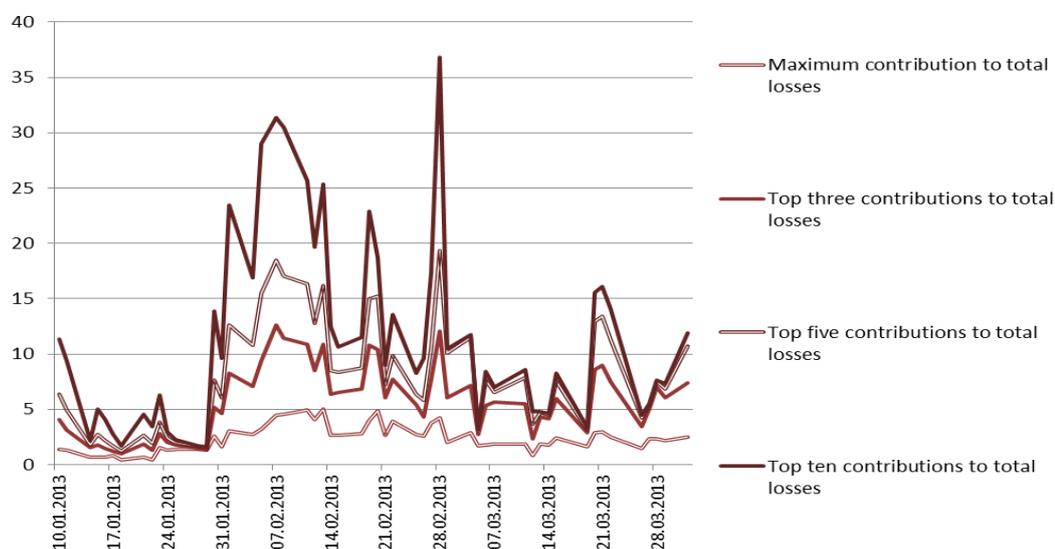
The Shapley Value method allows measuring a degree of systemic importance of each market participant for the financial sector and for groups of financial institutions holding similar portfolios of securities pledged in repo transactions. The Shapley Value directly assesses systemic liquidity risk and market risk via counterparty intra-market linkages as an amount in roubles that market players excluding direct counterparties are set to lose in case of each financial institution's default (see the section "Assessment Method of Systemic Importance of Interdealer Repo Market Participants").

Based on the obtained results, the maximum contribution to total losses of the financial system (including both banks and non-banks, excluding losses of direct counterparties) from the leading systemically important market participant did not exceed 5 billion roubles in 2013 Q1.

The average value of this indicator doubled in 2013 Q1 as compared with the previous quarter. The value of the "top three contributions to the total losses of the financial system" indicator was below 12.7 billion roubles, with the average value also showing a twofold increase. The value of the "top five contributions to the total losses of the financial system" did not exceed 19.3 billion roubles, with the average value showing a 34% increase. The value of the "top ten contributions to the total losses of the financial system" was below 36.8 billion roubles.

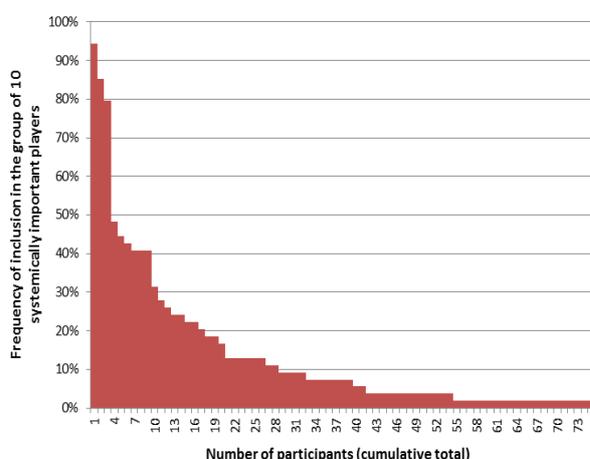
This indicator's average value grew by 64% in 2013 Q1 as compared with the previous quarter. The rise of this indicator, amid a considerable increase in the maximum contribution to the total losses (by two times), suggests increased risk concentration on the largest repo market player that contributes most to systemic risks.

**Chart 48. Shapley Value daily dynamics in 2013 Q1 (distribution of financial system potential losses as a result of a domino effect by individual scenarios, net of losses of immediate counterparties), billion roubles**

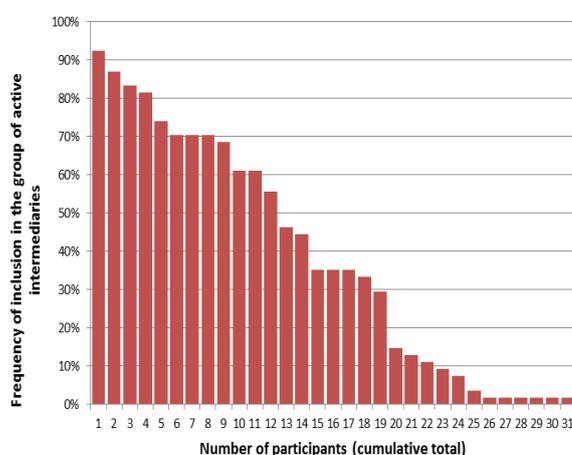


The analysis of distribution among the number of inclusions in the group of 10 systemically important participants (Chart 49) shows that in 2013 Q1 there were 3 participants who were included in this group with a frequency of over 80% and 22 participants who were also included in this group with a frequency of over 40%.

**Chart 49. Distribution of inclusions in the group of 10 systemically important participants with maximum contributions to total losses in 2013 Q1**



**Chart 50. Frequency of inclusion in the group of active intermediaries<sup>32</sup> for risk transfer on the repo market in 2013 Q1**



In order to find the reasons for sharp volatility of the Shapley Value during the surveyed period (Chart 48), we must examine the following indicator of the repo market participant's activity as an intermediary for systemic risk transfer: the volume of counterparties' losses as a result of a participant potential default, multiplied by the number of scenarios (excluding the individual scenario), in which the market participant declares a default (this indicator will be further called *the intermediary activity indicator*). The following two conditions must be met for this indicator to be greater than zero for a certain financial institution:

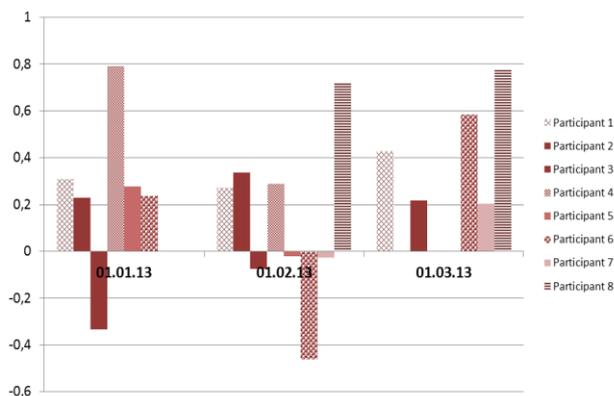
- 1) a financial institution must operate on the repo market both as a creditor and a borrower;
- 2) the N1 and equity levels must be small enough for a participant to be treated as a potential defaulter as a result of its counterparty's default.

Our estimate shows that in 2013 Q1 there were about 8 participants in the system (their composition insignificantly changes every day – Chart 50), which demonstrated a positive value of this indicator. An estimate of the correlation between the value of the top ten contributions to the total losses of the financial system and the activity indicator of 8 participants included in the group of active intermediaries with a frequency of over 70% (Chart 51) shows that in 2013 Q1 there were 2 repo market participants that played a key role in systemic risk transfer (Chart 52): in January 2013, 80% of changes in the value of the top ten contributions to the system's total losses were caused by changes in the activity of Participant 4, and in February and March 2013 over 78% of changes in this indicator were due to changes in the activity of Participant 8.

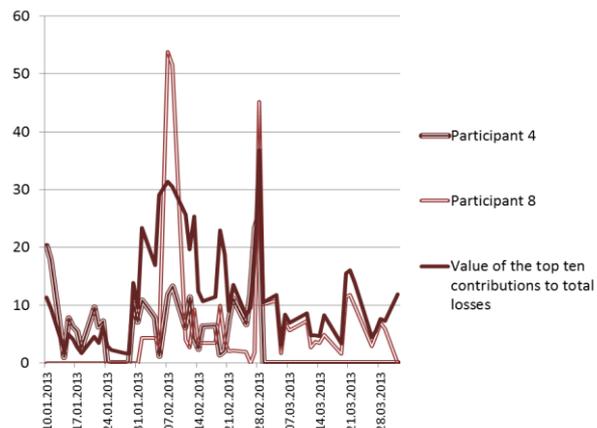
These figures testify to the fact that the dominant role (which is more significant than the power of the original shock) in the spread of a domino effect on the repo market is played by intermediaries for systemic risk transfer.

<sup>32</sup> The group of active intermediaries on the repo market comprises participants with positive intermediation activity indices.

**Chart 51. Correlation between the value of the top ten contributions to total losses and intermediary activity indicator of 8 participants included in the group of active intermediaries with a frequency of over 70%**

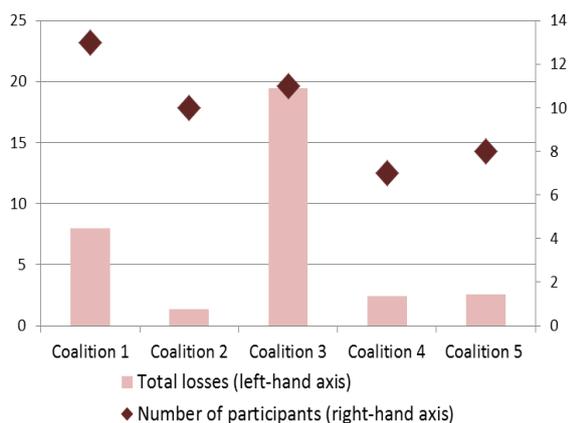


**Chart 52. Indicators of intermediary activity for risk transfer on the repo market in 2013 Q1**



The identification of the systemically important groups of financial institutions shows that co-existence of repo players with similar portfolios increases systemic risk. The analysis suggests that the system’s potential losses from the default of systemically important coalitions average 6.8 billion roubles while the biggest losses for the system (19.5 billion roubles) could potentially be caused by a coalition of 3 investment companies and 3 banks from the list of the top 30 banks compiled in accordance with the Bank of Russia methodology. In the event of a crisis, this coalition’s portfolio may lose 8.7% of its value.

**Chart 53. Distribution of losses across systemically important coalitions as of April 1, 2013 (billion roubles)**



**Table 14. Systemically important coalitions as of April 1, 2013**

Coalitions	Number of participants	Number of banks in the coalition from the top 30 list compiled under Bank of Russia methodology	Number of investment companies in the coalition	Expected portfolio devaluation in the event of a crisis
Coalition 1	13	3	5	-15%
Coalition 2	10	4	3	-10%
Coalition 3	11	3	3	-8.7%
Coalition 4	7	3	0	-6.4%
Coalition 5	8	4	0	-5%

### ***Method of assessing the systemic importance of interdealer repo market participants***

Starting from the first quarter of 2013, the FSD has switched to a modified Shapley Value estimation approach. The new approach will allow assessment of the systemic importance of financial institutions assuming the scenarios of individual defaults of financial institutions.

The first framework of this approach will help estimate potential losses of the financial sector for each financial institution, if the individual default scenario materialises (here and below, starting from February 2013, the losses of the Central Bank are fully excluded from the financial sector's losses). The individual default scenario means a default of an individual institution and the subsequent domino effect, caused by the counterparties' inability to meet their obligations<sup>33</sup>. The FSD estimates that the domino effect may take from one to five rounds.

The second framework will serve to estimate potential losses of the financial sector for each financial institution, if the individual default scenario materialises, less losses incurred by direct counterparties of the initial defaulter. In other words, the sought-for losses will be calculated as sector losses caused by the domino effect excluding losses incurred during the first round. An aggregate value for all the financial institutions will be the modified Shapley Value. This approach allows measuring the domino effect systemic risk caused by an individual financial institution's default (excluding its total liabilities) as aggregate losses of market participants with no relations to the original defaulter.

The third framework will allow estimation of potential losses of the sector caused by a default of a coalition of financial institutions. A coalition here means a group of market participants with similar portfolio compositions. This approach will classify each repo market participant into a group of financial institutions with similar portfolio structures. It should be noted that players may belong to several coalitions simultaneously. Portfolio value correlations are used as a measure of portfolio similarity.

Ultimately, the Shapley Value, estimated by any of the three methods, describes the degree of a financial institution's systemic importance for the overall sector. Under each of the three frameworks, the value is calculated for each institution, to be further used as a basis for ranking market participants. Systemic importance of a financial institution is a function of not only the number of its interconnections in the market (number of counterparties), and of the total value of its market position, but also of the overall structure of linkages in the market. Moreover, under the third framework, the financial institution's systemic significance will be considerably affected by the structure and volatility of its portfolio value, and by the number of players in its coalition.

#### **4.6. Domino effect assessment on the interbank loan market**

The Snow Vector method describes a degree of systemic importance of each participant on the interbank market as a sum of losses incurred by market participants in the event of a certain bank default. Thus, the Snow Vector provides the assessment of liquidity systemic risk and credit risk through the prism of intramarket relations among counterparties (see the section "Domino Effect Assessment Method on the Interbank Loan Market").

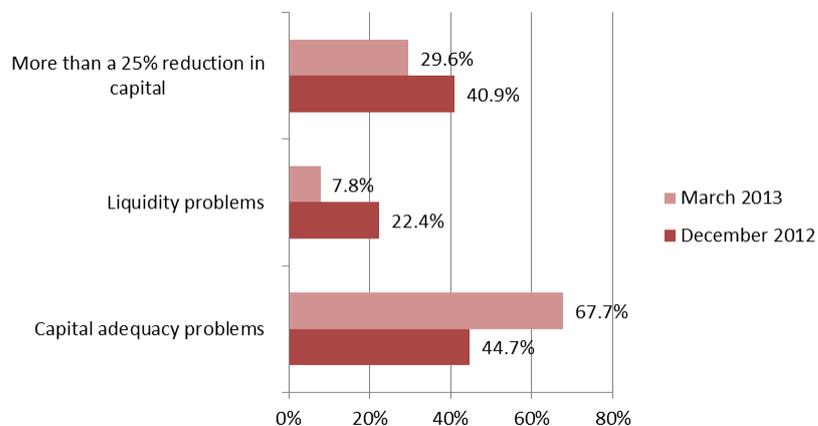
The analysis of liquidity systemic risk and banking sector credit risk allowed assessing banks' total losses as a result of individual bank defaults and the subsequent domino effect. Calculation of the Snow Vector as of the end of 2013 Q1 showed that the distribution of losses under individual scenarios saw some changes as compared with December 2012. Based on the obtained results, maximum contribution to banking sector total losses by a leading systemically important market participant was 168.9 billion roubles, or just a 1% increase from December 2012. The sum of

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<sup>33</sup> The methodology assumes the portfolio devaluation in accordance with the regulatory standards of Basel III, under which corporate bonds with ratings between BBB- and A+, and also the stocks of non-financial firms included in the country's main indexes have a discount of - 50%.

twenty maximum values of the 'system losses caused by bank default' indicator decreased by 14.6% amid a 5.3% increase in the sum of five maximum values of this indicator and a 6.7% rise in the sum of three values of this indicator. This testifies to an increased risk concentration on the interbank loan market.

**Chart 54. Potential default factors on the interbank loan market<sup>34</sup>**



Capital adequacy problems still remained the principal potential default factor in 2013 Q1 (Chart 54), with their significance growing by 23 percentage points. This fact can be explained by the lower average capital adequacy level in the banking sector, which fell from 13.6% as of December 1, 2012 to 13.4% as of March, 2013.

Among the 10 banks exerting the largest influence on the domino effect spread, 8 banks are referred to the group of the largest banks under the Bank of Russia methodology and the other 2 are the banks with foreign stakes.

Apart from this, 7 of the 10 banks exerting the largest influence on the domino effect spread had a large impact on the spread of systemic risk in December 2012 as well. These banks had their capital adequacy ratio below the banking sector's level as of March 1, 2013, although 3 of these banks saw some increase in this indicator as compared with December 2012.

This trend, along with a considerable reduction in the activity of those market participants who made substantial contribution to the multiplier effect in December 2012, caused a fall in the average multiplier effect in the system as of the end of 2013 Q1: the average multiplier<sup>35</sup> decreased by 16 times to a level of 1.1 as compared with the last month of 2012. Table 15 and Chart 55 contain comparative statistics by multiplier value.

The fall in the average multiplier in the system was accompanied by a decrease in the average number of rounds in individual scenarios: in 2013 Q1, this indicator fell by 20% to 1.43 rounds. At the same time, the maximum number of rounds was 4 under all scenarios, like in the previous quarter.

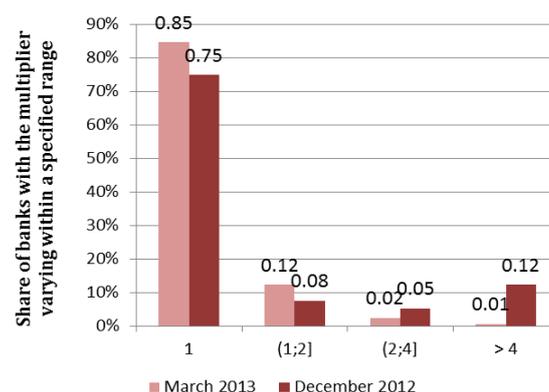
<sup>34</sup> The share of scenarios with realised default factor.

<sup>35</sup> Bank multiplier is referred to as the ratio of banking sector total losses as a result of a bank potential default to the bank debt value.

**Table 15. Comparative statistics by multiplier value in December 2012 and March 2013**

	December 2012	March 2013
<b>Average value</b>	17.70	1.10
<b>30% percentile</b>	1.00	1.00
<b>80% percentile</b>	1.63	1.00
<b>90% percentile</b>	7.82	1.05

**Chart 55. Distribution of multiplier values in December 2012 and March 2013**



Overall, the change in capital adequacy in the observed group of banks reduced their estimated influence on the domino effect spread and resulted, in particular, in a decrease in the sum of twenty maximum values of the ‘system losses caused by bank default’ indicator.

### ***Domino effect assessment method on the interbank loan market***

The Snow Vector method is aimed at examining credit shock spread channels on the interbank market (except for the interdealer repo market), identifying systemically important borrowers, most vulnerable market participants, as well as bank individual losses and banking sector total losses caused by a domino effect<sup>36</sup>.

The Snow Vector is defined as a method to analyse network relationships on the interbank loan market and describe adverse financial effect (a domino effect) in the event of default by one or more counterparties on their debt obligations. The vector is calculated through analyzing all possible combinations (scenarios) of credit shock spread. The number of scenarios corresponds to the number of participants on the interbank loan market.

A hypothesis has been made on that every interbank loan market participant may become a potential defaulter, i.e. a party in default. Credit risk losses which are equal to the amount of interbank liabilities (i.e. the value of all bilateral transactions which mature on a working day in question) are estimated for each of the defaulter’s counterparties by using simulation modelling. Once losses have been estimated, contracting banks are tested for being able to meet their obligations to other interbank market participants. The original counterparty default has the two-way impact on participant financial position: losses affecting capital adequacy, and liquidity lost as a result of payment schedule disruption.

To find out whether the original defaulter’s counterparty may subsequently default on its obligations, the Snow Vector employs a few formal criteria, namely lower actual required ratios: N1 capital adequacy, N2 bank instant liquidity, N3 bank current liquidity that are below specific thresholds (estimated as 1% percentiles of distribution of the respective values among all Russian banks), as well as capital reduction by more than one fourth. Should at least one of the criteria be met, a bank is to be regarded as potentially vulnerable to a domino effect and subsequently treated as a defaulter.

Thus, analysis of network relationships on the interbank loan market provides estimates of losses caused by default on all previously extended loans which mature within 5 working days. At the end of a working day, a list of counterparties in default and credit shock spread directions, bank individual losses and banking sector total losses caused by the original counterparty default are

<sup>36</sup> Моисеев С.Р., Снегова Е.А. Системная значимость участников денежного рынка // Банковское дело, 2012. - №3. - с. 24-29.

determined. These are calculated as total losses incurred at the stages of domino effect spread – banking sector subsequent losses are estimated at each stage and added to the previously obtained values. The algorithm has no limits as to the number of default spread rounds, which depends on the number financially unstable counterparties. More than one default rounds may occur within a day, because banks are linked in the overnight segment. A series of estimates based on Russian interbank loan data show that the entire banking sector can normally be affected by a domino effect within 1 to 4 rounds.

According to the Snow Vector, systemic importance of a bank as borrower is determined by several factors, namely the number of relationships on the market (number of lending counterparties); counterparty financial soundness; overall bank position on the interbank loan market; bank position with regard to its counterparties, i.e. risk concentration.

#### 4.7. Interest rate impulse transmission on the interbank market

In the interbank loan market segment, market participant overall connectedness<sup>37</sup> was assessed and interest rate impulse transmission between various groups of interbank loan market participants was analysed. The analysis of interest rate impulse transmission on the interbank loan market is based on the premise that the degree of market participants' connectedness determines the nature of impulse transmission. In particular, higher connectedness of market participants causes interest rate shock transmission to a greater number of participants and to a larger degree. Connected participants were identified and overall connectedness was assessed using the residual variance decomposition of the interest rate model in response to various shocks. The methodology of this approach and the description of the analysis data sample are given in the section "Method of Analysing Interest Rate Impulse Transmission on the Interbank Loan Market." Table 16 shows the results of revealing groups of banks<sup>38</sup> regarded as the most significant entities by the degree of their influence on the interest rate shock spread.

**Table 16. Groups of borrower banks on the interbank loan market assessed by the degree of spread of and vulnerability to interest rate shock, using connectedness indicators**

Bank grouping	Overall directed connectedness indicator		Overall connectedness net indicator	Market share*
	shock transmission	shock receipt		
	<b>by size of assets</b>			
<b>large</b>	1 733	1 792	- 59	0,36
<b>medium</b>	2 638	2 499	139	0,25
<b>small</b>	1 534	1 482	51	0,12
	<b>by type of ownership</b>			
<b>with government participation</b>	1 998	1 962	36	0,35
<b>private</b>	1 445	1 627	- 181	0,14
<b>with foreign participation</b>	2 461	2 185	276	0,24
	<b>by type of business model</b>			
<b>corporate</b>	2 502	2 442	60	0,33
<b>mixed</b>	2 253	2 276	- 23	0,28
<b>money market dealers</b>	1 150	1 055	94	0,12

\* The sum of shares makes up 73%, which corresponds to the share held in the borrowing segment of the interbank loan market by 28 banks included in the RUONIA calculation . The market share was determined by the value of operations in the rouble overnight segment in 2013 Q1.

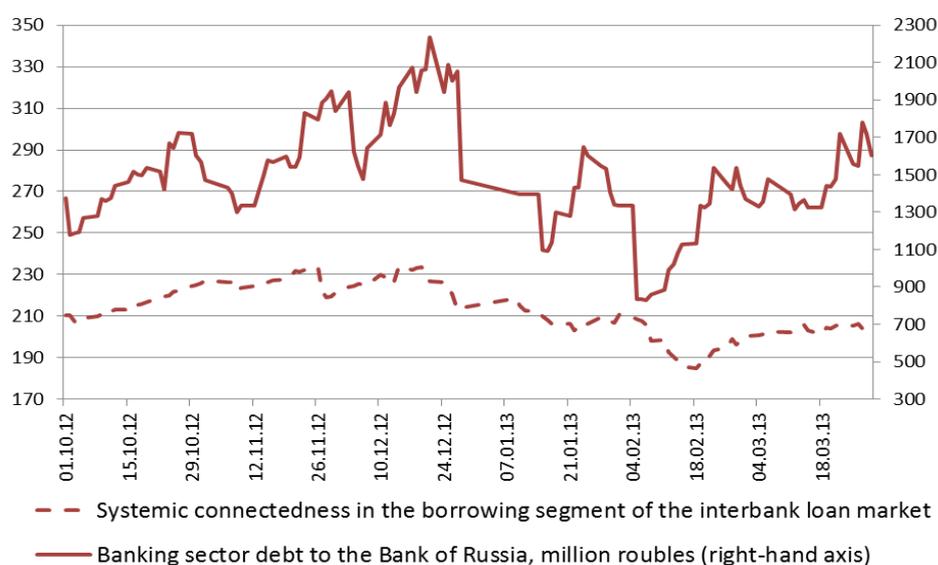
<sup>37</sup> Connectedness measures a degree of mutual dependence and mutual influence of interest rate volatility of certain interbank loan market participants.

<sup>38</sup> Classification criteria for these groups are given in the section "Method of Analysing Interest Rate Impulse Transmission on the Interbank Loan Market."

Bank groups were formed by three classification criteria: the size of assets, the type of a business model and the type of ownership. Banks from the group of the 30 largest banks defined in accordance with the Bank of Russia methodology were referred to the category of large and medium banks by the size of their assets. The category of small banks included banks mostly with foreign participation, which were actively involved in money market operations. In 2013 Q1, interest rate impulses spread from small and medium banks to large banks, from banks with foreign stakes to private banks and from money market dealers to banks with mixed business strategies.

For the purpose of analysing overall systemic risk on the interbank loan market, the indicator of systemic connectedness in the segment of short-term borrowings was calculated. The systemic connectedness indicator, and also the volume of banking sector debt to the Bank of Russia are given in Chart 56.

**Chart 56. Systemic connectedness in the borrowing segment and banking sector debt to the Bank of Russia**



A retrospective analysis of the systemic connectedness indicator shows that a change in the demand for liquidity is accompanied by a symmetric change in the systemic connectedness indicator.

As the demand for Bank of Russia refinancing increased in the second half of 2012, the systemic connectedness of interbank loan market participants in the borrowing segment was observed to grow. The outflow of Finance Ministry funds from January 2013 was compensated by repo operations with the Bank of Russia, which was also accompanied by increased participant connectedness, despite a downward (seasonal) correction in January 2013. As of April 1, 2013, the interest rate volatility of interbank loan market participants depended by an average of 7%<sup>39</sup> on the behaviour of any other participant, which is a relatively low value. In general, systemic connectedness of interbank loan market participants stayed at a low level in 2013 Q1. If liquidity shortage increases in 2013 Q2 and Q3, participant connectedness and, consequently, interest rate shock transmission will intensify.

<sup>39</sup> The estimate shows overall connectedness per participant.

### **Method of analysing interest rate impulse transmission on the interbank loan market**

The analysis is based on the method of decomposing variances of the interest rate model in response to various shocks. The method was offered in generalized form for linear and non-linear models by G. Koop, M.H. Pesaran and S. M. Potter in 1996.

The main advantage of the variance decomposition method is that the connectedness index helps assess both individual shocks transmitted from one analysed entity to another and aggregate shocks typical of a group of entities as a whole, for example, negative expectation shock. The method also assumes that an aggregate shock does not necessarily influence all entities at a time. The index is calculated on a certain time horizon, which helps identify an entity's delayed response to a past shock.

Another advantage of the generalised variance decomposition approach is that this method is invariant to the order of variables included in the vector autoregression (VAR) model, which simplifies assessments considerably in the absence of apriory information about model identification.

Variance decomposition of the interest rate model is based on the vector autoregression model with two variables on time horizon  $\tau$  :

$$\begin{aligned} x_t &= \alpha_1 + \beta_{11}x_{t-1} + \dots + \beta_{1\tau}x_{t-\tau} + \gamma_{10}y_t + \dots + \gamma_{10}y_{t-\tau} + \varepsilon_{1t} \\ y_t &= \alpha_2 + \beta_{21}y_{t-1} + \dots + \beta_{2\tau}y_{t-\tau} + \gamma_{20}x_t + \dots + \gamma_{20}x_{t-\tau} + \varepsilon_{2t} \end{aligned} \quad (1)$$

Each variable is described by the autoregressive component of the variable itself and the current and lagged values of the second variable. The influence of factors unaccounted-for in the model is expressed through the residual component  $\varepsilon_{it}$ ,  $i = \overline{1,2}$ . Moreover, the component  $\varepsilon_{1t}$ , which defines the level of  $x_t$  at the time point  $t$ , also exerts influence on the level of  $y_t$  through the lagged values  $x_{t-1}, \dots, x_{t-\tau}$ . This also holds true for the residuals  $\varepsilon_{2t}$  and the variable  $x_t$ . Considering the absence of autocorrelation for residuals, they should be expressed in the following way:

$$\varepsilon_{1t} = \varphi_{11}\varepsilon_{1t} + \varphi_{12}\varepsilon_{2t} + \dots + \varphi_{1\tau}\varepsilon_{1t-\tau} + \psi_{11}\varepsilon_{1t} + \psi_{12}\varepsilon_{2t} + \dots + \psi_{1\tau}\varepsilon_{2t-\tau} \quad (2)$$

(2)

Residual variance of the vector autoregression model with the lag  $\tau$  can be described in the following way:

$$\begin{aligned} \sigma_x^2(\tau) &= \sigma_x^2(\varphi_{1t}^2 + \varphi_{1t-1}^2 + \dots + \varphi_{1t-\tau}^2) + \sigma_y^2(\psi_{1t}^2 + \psi_{1t-1}^2 + \dots + \psi_{1t-\tau}^2) \\ \sigma_y^2(\tau) &= \sigma_x^2(\varphi_{2t}^2 + \varphi_{2t-1}^2 + \dots + \varphi_{2t-\tau}^2) + \sigma_y^2(\psi_{2t}^2 + \psi_{2t-1}^2 + \dots + \psi_{2t-\tau}^2) \end{aligned} \quad (3)$$

These equations can be used to express a share of the autoregression residual variance associated with the variable itself

$$\frac{\sigma_x^2(\varphi_{1t}^2 + \varphi_{1t-1}^2 + \dots + \varphi_{1t-\tau}^2)}{\sigma_x^2(\tau)} \quad \text{and} \quad \frac{\sigma_y^2(\psi_{1t}^2 + \psi_{1t-1}^2 + \dots + \psi_{1t-\tau}^2)}{\sigma_y^2(\tau)} \quad (4)$$

and with the other variable from the VAR model.

$$\frac{\sigma_y^2(\psi_{1t}^2 + \psi_{1t-1}^2 + \dots + \psi_{1t-\tau}^2)}{\sigma_x^2(\tau)} \quad \text{and} \quad \frac{\sigma_x^2(\varphi_{2t}^2 + \varphi_{2t-1}^2 + \dots + \varphi_{2t-\tau}^2)}{\sigma_y^2(\tau)} \quad (5)$$

If, for example,  $\varepsilon_{2t}$  does not contribute to describing the variance of variable  $x_t$  on some time horizon  $\tau$ , then  $x_t$  can be considered to be exogenous. In the opposite case, if the variance of the residual  $\varepsilon_{2t}$  fully describes the variance of variable  $x_t$ , this variable can be considered to be fully endogenous.

If the analysis applies to more than two variables, VAR models can be constructed for all possible pairs to measure a variance share of each variable described by the residual variance of each of the

other variables included in the analysis. The variance shares defined by the formulas (5) can be used to determine a connectedness matrix:

$$D_{n \times n} = \begin{pmatrix} d_{11} & d_{12} & \dots & d_{1n} \\ d_{21} & d_{22} & \dots & d_{2n} \\ \dots & \dots & \dots & \dots \\ d_{n1} & d_{n2} & \dots & d_{nn} \end{pmatrix} \quad (6)$$

Connectedness matrix elements  $d_{ij}$  (where  $i \neq j$ ) show the variance share of variable  $i$  that can be explained by the residual variance of variable  $j$ , i.e. the larger connectedness matrix element  $d_{ij}$ , the greater influence of variable  $j$  on variable  $i$ .

Diagonal elements  $d_{ii}$  calculated under the formulas (4) show "own connectedness," i.e. the variable variance share associated with the variable itself.

Connectedness matrix elements can be used to calculate overall directed connectedness indicators  $C_i$ :

$$C_{i \leftarrow \bullet} = \sum_{\substack{j=1 \\ j \neq i}}^N d_{ij} \quad (7)$$

which show the sum of variance shares of variable  $i$ , which emerges from shocks emanating from other variables of the system; and from  $j$

$$C_{\bullet, j} = \sum_{\substack{i=1 \\ j \neq i}}^N d_{ij} \quad (8)$$

the sum of variance shares of all variables, except for  $j$ , which are influenced by variable  $j$ .

Considering a high possible autocorrelation between the indicators and the absence of normalisation, the overall directed connectedness indicators  $C_{i \leftarrow \bullet}$  and  $C_{\bullet, j}$ , calculated as the sum of variance shares, may considerably exceed 100%.

In order to calculate the indicators of interest rate shock transmission of variable  $i$ , we need to determine the net indicator of overall connectedness:

$$C_i = C_{i \leftarrow \bullet} - C_{\bullet, i} \quad (9)$$

and systemic connectedness

$$C = \frac{1}{N} \sum_{\substack{i,j=1 \\ j \neq i}}^N d_{ij} \quad (10)$$

The net indicator of overall connectedness may serve as a good indicator of shock transmission by participant  $i$ , because it is assessed as the difference between the influence exerted by  $i$  on other market participants and the influence exerted by other market players on  $i$ .

The greater the positive value of overall connectedness net indicator  $C_i$ , the larger influence participant  $i$  has on shock transmission. The increase in the negative value of overall connectedness net indicator  $C_i$  signifies the greater vulnerability and exposure of participant  $i$  to shock.

The systemic connectedness indicator helps consolidate information on separate interconnections in the system into a general index. The systemic connectedness indicator reflects a share of residual covariance summarised across all variables and expressed as a percentage of overall residual variance of the shock transmission model. The larger the systemic connectedness index, the greater the shock spread across the market.

#### *Original data characteristics and time series construction for analysis*

The data available in Form No. 0409701 "Statement on Foreign-exchange and Money Market Operations," characterising particular transactions and indicating transaction counterparties, the

currency, interest rates, loan maturities, etc. were used to analyse the interbank loan market. The data sample is limited to the period from September 12, 2011 to April 2013, excluding the periods of January 1-9, March 3 and 7 and June 11, 2012 because the MIACR rate was not determined on certain days and most banks did not participate in interbank lending on the eve of public holidays.

The data on overnight rouble transactions, excluding transactions with the Bank of Russia, were selected from the database. During the entire observation period, the overnight segment accounted for 17.7% and the rouble turnover made up over 96.1% of the aggregate interbank market turnover.

Interconnections and interest rate shock transmission between interbank loan market participants were examined in the borrowing segment. If several transactions were concluded between two counterparties during one day, the borrowing rate and the placement rate were determined using the formula of a weighted average based on the transaction value.

Considering that one of the goals of the analysis is to identify interbank loan market participants exerting material influence on the spread of interest rate shock, which is related, in particular, to the extent of participants' activity, the sample covered 28 banks included in the RUONIA<sup>40</sup> indicative rate calculation, excluding ZAO Credit Agricole, owing to its low activity in 2012-2013. For the purposes of the analysis, banks were divided into groups depending on the type of ownership, the size of assets and the type of their business model. Assessments were subsequently made for groups defined on the basis of one criterion.

By the type of their ownership, banks were divided into banks with government participation (9 banks), banks with foreign participation (12 banks) and private banks (7 banks).

By the size of their assets, the first group included banks with assets of over 1 trillion roubles (8 banks), the second group comprised banks with assets from 150 billion roubles to 1 trillion roubles (12 banks) and third group covered banks with assets of less than 150 billion roubles (8 banks).

The business model was determined in accordance with the structure of borrowings and placements. Banks attracting mostly corporate deposits (over 35% of raised funds) and extending loans to corporate entities and individual entrepreneurs (over 40% of placements) were referred to the group of corporate institutions (13 banks). Money market dealers (6 banks) were identified by the share of interbank loans in placements or borrowings exceeding 60%. The remaining 9 banks were characterised by the mixed strategy of raising and borrowings funds. Along with a substantial share of funds raised from corporate entities or placed with these organisations, the share of individuals' funds (both raised and placed) was also considerable and stood at over 20%.

Missing values were interpolated with the substitution of the sum of the MIACR rate as of the date with missing values and the moving average quarterly rate deviation.

### ***Results of analysing directed connectedness and overall connectedness indicators***

The choice of the half-yearly time interval was prompted by the need to have a sufficient number of the degrees of freedom for assessing the VAR model of interest rate shock transmission.

The time horizon  $\tau$  was chosen to equal 10, which corresponds to 10 trading days. This horizon allows taking possible fluctuations inside the model into account. The inclusion of a large number of lag variables turned out to be inexpedient due to their low information content.

In order to exclude false correlation between the rates of particular interbank loan market participants, the RUONIA factor was added to the VAR model as an exogenous variable.

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<sup>40</sup> RUONIA member banks. - Access mode: <http://www.ruonia.ru/banks.html>, free. Screen title.

## 5. DATA SOURCES AND DESCRIPTION

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### *Operations covered in this review*

This review covered transactions whose economic sense consisted in rouble liquidity provision by one market participant to another. No restrictions for counterparties were introduced, i.e. the review took into account both transactions with the participation of banks as one party (or both parties) to the transaction and transactions without their participation (for example, interdealer repos between financial organisations and their clients). Therefore, the transactions covered by the review could involve banks (both resident and non-resident institutions), non-bank financial organisations (only residents) and clients (both corporate entities and private individuals, residents and non-residents) Central Bank (Bank of Russia) operations were examined separately. Transactions where counterparties were organisations integrated into one group or holding were excluded from the analysis (unless specified otherwise). The analysis covered swaps (concluded on institutions' own behalf or on behalf of their clients), interdealer repos (concluded on institutions' own behalf or on behalf of their clients), interbank loan operations (both interbank loans and interbank deposits). Unless specified otherwise, the review took into account the transactions concluded with a term of up to seven days inclusive. Unless specified otherwise, the review calculations were based on the value of transactions concluded as of the review's date.

### *Review information base*

The information base for swaps and interbank loan operations was reporting form 0409701 "Statement on Foreign Exchange and Money Market Operations," and for repo operations – the daily data provided by the Moscow Exchange and the results of trading under repo operations with the central counterparty.

The indicators related to Bank of Russia operations were calculated on the basis of the Bank of Russia's internal information.

Reporting form 0409701 "Statement on Foreign Exchange and Money Market Operations" includes information on interbank lending transactions (deposit transactions), with a value of over 1 million roubles and repo transactions. The reports are provided on a daily basis by credit institutions that are the largest participants of the foreign exchange and money markets (over 150 organisations).

More detailed information on reporting form 0409701 "Statement on Foreign Exchange and Money Market Operations" is given in Bank of Russia Instruction No. 2332-U of November 12, 2009 "On the List, Forms and Procedure for Credit Institutions to Compile and Present Reporting Forms to the Central Bank of the Russian Federation."

The daily data on the repo market, which the Bank of Russia obtains from the Moscow Exchange, contains information on all repos concluded in the Main Market segment of the stock market.

### *Information base coverage*

The review used the data on more than 90% of transactions concluded on the interdealer repo market. The analysis took into account only exchange-traded repo transactions. According to the V Survey of the Russian Repo Market prepared by the National Securities Market Association (NSMA), a self-regulatory organisation, exchange-traded repos accounted for 94% of total trade (by the turnover volume). With regard to exchange-traded operations, the review covered over 98% of these transactions: as of March 29, 2013, the value of such transactions concluded on the interdealer repo market and covered by the review totalled 278 billion roubles while the value of transactions not covered by the review and concluded in the Standard sector and the sector of repos with the central counterparty reached 2 billion roubles and 1.5 billion roubles, respectively.