

“Clustering of Russian banks: business models of interaction of the banking sector and the real economy”

AUTHORS	Venera Vagizova Ksenia Lurie Ihor Ivasiv
ARTICLE INFO	Venera Vagizova, Ksenia Lurie and Ihor Ivasiv (2014). Clustering of Russian banks: business models of interaction of the banking sector and the real economy. <i>Problems and Perspectives in Management</i> , 12(1)
RELEASED ON	Thursday, 20 February 2014
JOURNAL	"Problems and Perspectives in Management"
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”



NUMBER OF REFERENCES

0



NUMBER OF FIGURES

0



NUMBER OF TABLES

0

© The author(s) 2026. This publication is an open access article.

Venera Vagizova (Russia), Ksenia Lurie (Russia), Ihor Ivasiv (Ukraine)

Clustering of Russian banks: business models of interaction of the banking sector and the real economy

Abstract

This paper concentrates on the clustering analysis of Russian credit institutions in order to determine business models of the existing banks activity and expose the possibilities of effective cooperation with the real sector of the economy of the country.

Keywords: bank, clustering analysis, *k*-means method, Kohonen neural network, business model, real sector of economy.

JEL Classification: G21.

Introduction

In theory the system of the interaction between the state and the real sector of the economy is developing through financial intermediaries, and in this particular case through the banking system. The real sector of the economy and households receive financial flows through credit institutions.

In practice the mechanism of resources reallocation will function in another way (Table 1). The developed financial market with its high institutional provision level manifests the asymmetry in interaction between the banking sector and the real sector of the economy. It occurs due to the discrepancies in different rates of profitability and riskiness of the sectors within the generation of the investment income.

Table 1. Main discrepancies of the interaction between the Russian banking sector and the real sector

Discrepancies	Banking sector of economy	Real sector of economy
Profitability	25%	10%
Risks	Moderate risk level – oriented activities	High risk level of a project insolvency
Time of investment income generation	Short-term money – oriented activities	Long-term projects, requirement for long-term money

The shortage of the “long-term money” in the economy to be provided and invested for a long time period is the main problem of the banking system under current conditions. The development of the Russian Federation Central Bank transactions such as the additional issue of long bonds and refinancing credit institutions under the lower interest rates is considered by the contemporary economic theory and practice to be the means of overcoming this shortage. There is a possibility of granting long-term financial resources to the real sector of the economy directly through banks by means of the indicated methods, in the opinion of the analysts basing on the experience of foreign central banks.

However, the events of 2008-2010 have manifested that the refinancing mechanism prove inefficient in the Russian realities. The required resources obtained by the credit institutions have marshaled them to financial markets but not to the real sector of the economy.

Long-term financial resources provision creates an obstacle in terms of a time lag in profit earning as well as results in high enough costs and risks of non-payment of the allocated resources. Attracting long-term resources involves higher costs on interest rates and insecurity of these resources preservation for the period specified in the contract.

There occurs the conflict of interests between the Central Bank and credit institutions, when one party upon providing financial resources plans to use them for the long-term support of the real sector, and the other party applies the obtained resources for its own benefit to make a profit within the short term.

The research of Russian credit institutions based on the clustering analysis of their business strategies fulfillment may seem quite relevant in this respect. The topical issue of the contemporary monetary theory and practice is the identification of bank groups with different business models as well as with their potential opportunities of long-term lending to the real sector of the economy on the background of banking sector stability maintenance as a whole.

The goal of the present study is (1) the research of courses of such asymmetry, one of which, in our opinion, could be the institutional misalignment in the banking system; and (2) the monetary resources effective management tools development to ensure the interaction between the banking sector and the real sector of the economy.

For the purposes of the asymmetry in the interaction between the banking sector and the real sector of the economy research it appears advisable to fulfill the clustering analysis of Russian credit institutions’ business strategies and to identify bank groups with

different business models as well as with their potential opportunities of long-term lending to the real sector of the economy on the background of banking sector stability maintenance as a whole.

The clustering analysis in terms of a *k*-means method and Kohonen neural networks has been selected as a research tool. The selection of the clustering analysis is substantiated by the necessity to identify internal resources for the interaction between the banking sector and the real sector of the economy.

1. Literature review

Banks' clustering for identification of the banks and the banking system stability is in the focus of the research and practical studies in this area, not considering the interaction with the real sector of the economy which, respectfully, the banking business should be focused on. Contemporary research is focused on the identification of the banking system stability factors in the financial markets and financial services industry.

The paper [10] using the *k*-means method for clustering of 35 largest Austrian banks within the period 1995 to 2000 so as to identify strategic groups of credit institutions is the most close in its meaning to our study. The author has chosen the input parameters of the consolidated index of disposable funds, loans, interbank loans and deposits, deposits and profits, and operational losses. The results of the analysis offer five banks clusters, only three among them could be considered as strategic bank groups with regard to the homogeneity of the clusters. The remaining two clusters manifest indexes volatility. This paper discusses strategic groups of credit institutions and the possibility of their existence, but does not take into account the interaction with the population and the real economy.

Paper [8] divides 48 Polish banks into 5 identified strategic groups such as universal banks, corporate banks, retail banks, mortgage banks, regional banks and banks providing automobile loans. The observation sums up the results of the years within the period from 1999 to 2005. Clustering is based on regression analysis. Besides, the authors record banks migration. In this direction Russian scientist's research was also conducted. Author [3] analyzes the data of Russian banks in the period from 1997 to 1998 by functional focus of these banks. These developments have served as the basis of our work. The difference is that the goal of clustering is not the definition of the functions of credit institutions in the banking system, but the study of problems in the interaction of the banking and real sectors of the economy. As well as identifying the internal capacity

of the Russian banks in long-term crediting of the real sector of the economy.

The clustering analysis in paper [7] identifies 5 business models of credit institutions in Australia, which correspond to certain factors determining the financial stability of credit institutions included in the group. Identified groups characterize only the financial stability of the banking system itself, but does not take into account the interaction with the population and the real economy.

Russian scientists are also studying the financial stability of credit institutions. Thus, publications [5, 6] divide credit institutions into large, medium and small size ones, as well as offer the fulfillment of clustering analysis in compliance with CAMELFS indexes of bank activity inside these groups. The group of large size banks comprises 11 business models (4 of which describe 95.1% of the made observations). The group of medium size banks comprises 13 business models (4 groups describe 96% of the made observations). And at last the group of small size banks comprises 28 business models (6 groups describe 90% of the made observations).

The clustering analysis is also used by rating agencies, both domestic (such as Expert RA) and foreign ones, to determine the financial stability of the credit institutions. However, the issues of interaction of banking and real sectors of the economy are also not taken into account, making the study one-sided.

Thus, a feature of the banking sector studies using cluster analysis lies in the variety of approaches and methods for assessing and forming groups of banks. There is no single approach to clustering of the banking system on various grounds. In our work, the Russian banking system clustering is performed by self-organizing neural networks of Kohonen. To compare the results with other types of cluster analysis, the cluster analysis by K-Means, which is present in majority of such studies, is also performed. The main object of study is the liquidity of credit institutions and the business models of interaction between banking and real sectors of the economy. That is, an attempt to combine the analysis of stability of the bank in terms of liquidity risk management and its interaction with the real sector of the economy and the population, is made.

2. Research methodology

The paper pays particular attention to the liquidity management method since a bank is an institution focused on the monetary and loan market. The liquidity of credit institutions is the most important index reflecting bank activities. Therefore, we have

attempted to give comprehensive assessment of this index to improve our understanding of the possibilities for bank's interaction with the population and the real sector of the economy.

The reliability of the study is supported by the fact that the indexes calculation has been carried out basing on the current data of the Russian credit institutions disclosing their statements on the site of the Bank of Russia.

Clustering analysis is currently one of the most popular and advanced mathematical grouping methods both in economics and other existing sciences.

Clustering method enables data classification by various properties. Thus, if there is no possibility to logically divide the available data into different groups and the data base is too large, the mathematical clustering method will allow solving the task by means of the developed algorithms. There are a lot of clustering analysis methods; some of them allow to process only small amount of data (e.g. tree-like clustering), some methods are intended for classifying large data bases (e.g. a *k*-means method). Each method works by a unique algorithm; therefore, there appears a problem of choosing the best method for solving topical tasks. Moreover, the uniqueness of the algorithms causes different results of clustering within different solution methods. We have chosen a *k*-means method and Kohonen neural networks for clustering analysis of Russian banks determining the credit institutions activity strategies with regard to the liquidity.

The *k*-means method is the most popular clustering method which assumes the data division into a predetermined number of classes. Vector partition of the array in the process of clustering into the required number of groups occurs depending on the identified center of the defined cluster and the proximity of the set index from the center (Euclidean distance). The program divides the clusters by the maximal external variability and the minimal internal variability. The program recalculates the mass centre for the cluster at every iteration and forms a new grouping. The algorithm tends to minimize the total squared error of the cluster points from the cluster's center [11]:

$$V = \sum_{i=1}^k \sum_{x_j \in S_i} (x_j - \mu_i)^2, \tag{1}$$

where *k* is the number of clusters, *S_i* are the clusters obtained, *i* = 1, 2, ..., *k* and μ_i is the center of vector's mass; $x_j \in S_i$.

The neural network simulation is a relatively new method of data clustering in the contemporary science. Artificial neural networks are based on the human biological neural networks operation transforming the received information and communicating it to human consciousness. The simplest operation of a neural network involves three types of neurons such as input neurons, hidden neurons and an output neuron. Kohonen's neural networks are also widely used in research studies. A variation of Kohonen's Self Organizing Map (SOM) has been used for Kohonen neural networks. This method is based on non-linear programming able of mass data processing and network self-learning (Table 2). Kohonen's Self Organizing Maps differ fundamentally from any types of clustering since they are capable of unsupervised learning. Supervised learning assumes the existence of two data types (input data and output data), and the task of the network is to create the reflection of one data type onto the other. In case of the unsupervised learning the network will operate only with input data independently determining the structure of the output parameters. The self-learning permits to apply other data arrays to the trained network. For example, the data of the other countries could be applied to the trained network of the Russian banks. Thus, the present method makes it possible to increase the research area to banking systems of other countries. Kohonen's network is designed to identify clusters in data and to learn to understand the very structure of the input parameters. The Kohonen's network algorithm is similar to the *k*-means method and involves a method of successive iterations, however, Kohonen's model compresses the multidimensional input data space into the two-dimensional output space, while the vectors which are close to one another at the input will be close to one another in the topology map (Table 2).

Vectors of the input signals are processed one by one, and the nearest code vector ("Winner-take-all") $W_{j(x)}$ is found for each of them. Thereupon all code vectors W_l for which η_{jl} ($0 \leq \eta_j \leq 1$) are calculated by the formula [11]:

$$W_l^{new} = W_l^{old} (1 - \eta_{j(x)l} \theta) + x \eta_{j(x)l} \theta, \tag{2}$$

where, $\theta \in (0,1)$ is a learning step. The neighbors of the winning code vector (as per priori specified proximity table) are transferred to the same side with the same vector, in proportion to the proximity degree.

Table 2. Main differences of the chosen clustering analysis methods

	<i>k</i> -means method (<i>k</i> -means)	Kohonen's neural network
Maximum amount of data array	No	No
Number of clusters	To be known in advance	To be known in advance

Table 2 (cont.). Main differences of the chosen clustering analysis methods

	<i>k</i> -means method (<i>k</i> -means)	Kohonen's neural network
Algorithm	There occurs the vector partition of the array into the required number of groups depending on the identified center of the defined cluster and the proximity of the set parameters from the center (Euclidean distance).	The algorithm is similar to the <i>k</i> -means method but Kohonen's model compresses the multidimensional input data space into the two-dimensional output space, when the vectors which are close to one another at the input will be close to one another in the topology map.
Learning	No	Unsupervised learning

The specified systems allow solving the tasks of data classification which can serve as a basis for further research of the chosen array.

3. Scope of research

Software product StatSoft 8.0 and analytical information on the official website of the Bank of Russia for 836 Russian credit institutions as of January 01, 2012 have been used for the research fulfillment. The banking system and statements allow to analyze banks every quarterly date. The initial sampling has been fulfilled basing on the multiple value of the banks quantity index. Further analysis is planned basing on the number of the dates.

The following values characterizing the banking system liquidity have been chosen for clustering analysis indexes:

- ◆ Equity capital level.
- ◆ Raised funds (deposits): accounts (up to 180 days, up to one year, up to 3 years, more than 3 years).
- ◆ Loans: overdraft (up to 180 days, up to one year, up to 3 years, over 3 years).
- ◆ Interbank credits (interbank loans): issued and obtained.

Such parameters have been chosen as they reflect the level of the interaction between the bank and the real sector of the economy.

All specified indexes have been calculated with reference to the currency of the bank total balance

so as to exclude the scale effect at clustering by the *k*-means method (Table 3).

Table 3. Designation of analyzed indexes

Index	Designation
Equity capital / Balance	ECB
Deposits:	
Customers accounts / Balance	CAB
Deposits up to 180 days / Balance	D180B
Deposits up to 1 year / Balance	D1B
Deposits up to 3 years / Balance	D3B
Deposits over 3 years / Balance	Do3B
Loans:	
Overdraft / Balance	LOB
Loans up to 180 days / Balance	L180B
Loans up to 1 year / Balance	L1B
Loans up to 3 years / Balance	L3B
Loans over 3 years / Balance	Lo3B
Interbank loans:	
Issued interbank loans / Balance	IILB
Obtained interbank loans / Balance	OILB

Interbank loans differ fundamentally from the other indexes by the resources circulation environment (Figure 1). Whereas the deposits and loans circulate within the real sector of the economy, the population and the banking system, the interbank loan forms a process within the banking system itself, as in this case the resources exchange is carried out solely among the banks. Consequently, both the issued and the obtained interbank loans shall be identified.

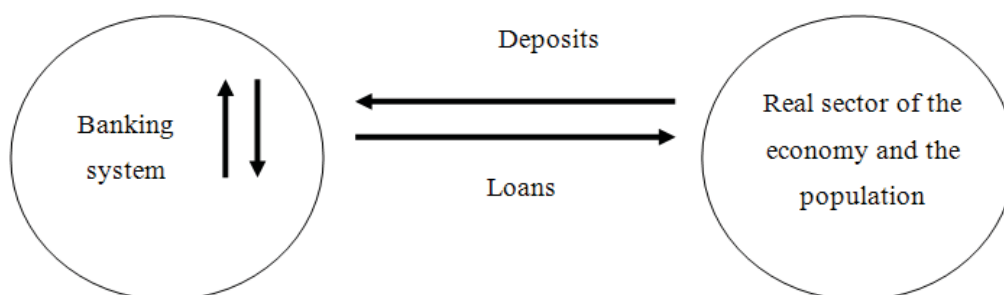


Fig. 1. Credit institutions resources distribution chain

The results of the dispersion analysis have manifested a significant impact of the analyzed variables on the clustering results. Thus, the segments differ by the selected variables.

This is confirmed by the fact that at the probability level of 95%, *F*-statistics of the selected parameters is higher than the critical *F* value 2.62 (Table 4).

Table 4. Analyzed indexes' importance factors

Index	F-test	Index	F-test
ECB	656.45	LOB	9.18
CAB	742.58	L180B	20.75
D180B	16.51	L1B	83.99
D1B	48.04	L3B	115.68
D3B	132.09	Lo3B	33.70
Do3B	12.87	IIBL	71.64
-	-	OIBL	2.85

The clustering analysis by the *k*-means method required the application of the factor analysis to meet the requirements of uniformity and completeness of the available data. The factor analysis resulted in the identification of 13 factors, of which 8 factors explain 78.54% of the dispersion at the significance level of 0.95 (Table 5). The identified

factors (Table 3) allow to reduce the correlation dependence among the initial parameters and to eliminate excess variables from further calculations. The most important parameters among the factors have been defined in the matrix of factor loadings. The mark of 0.5 on the Chaddock scale has been chosen as a significance test.

Table 5. Factor loadings matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8
ECB		-0,61332						
CAB								
D180B					0.659291			
D1B							0.54635	
D3B		0.511251						
Do3B				0.511538				-0.55343
LOB								
L180B	0.661641							
L1B	0.678683							
L3B			-0.74069					
Lo3B						0.802672		
IIBL		-0.72935						
OIBL				-0.77067				

For better understanding of the identified factors we give their description with reference to liquid resources types used in credit institutions (Appendix). Every

factor has an individual value, and at the same time the identified factors can be divided into two big groups such as bank assets sources and loans (Table 6).

Table 6. Factors breakdown by type of activity and credit institution groups

Sources of bank assets	Bank loans
Factor 2: Equity capital, medium-term deposits and interbank loans	Factor 1: Short-term and medium-term loans
Factor 4: Long-term deposits and interbank loans	Factor 3: Long-term loans
Factor 5: Short-terms deposits (up to 6 months)	Factor 6: Overdraft loans
Factor 7: Short-terms deposits (up to 1 year)	
Factor 8: Long-term deposits	

The obtained factors are used as key parameters for banks clustering by the *k*-means method in the research.

The initial parameter values have been used as input data at clustering by the Kohonen's self-organizing neural network method.

4. Description of results

The two most popular and advanced clustering methods, such as the *k*-means method and

Kohonen neural networks, have been used to meet the set challenge.

We have identified the maximum value of 150 different bank clusters by means of the neural network simulating (Figure 2). This number has been obtained by detecting the amount of groups having no zero clusters. Clustering has indicated both individuality and high degree of influence rendered by each identified bank group on the money flow market despite the universality of banking activity.

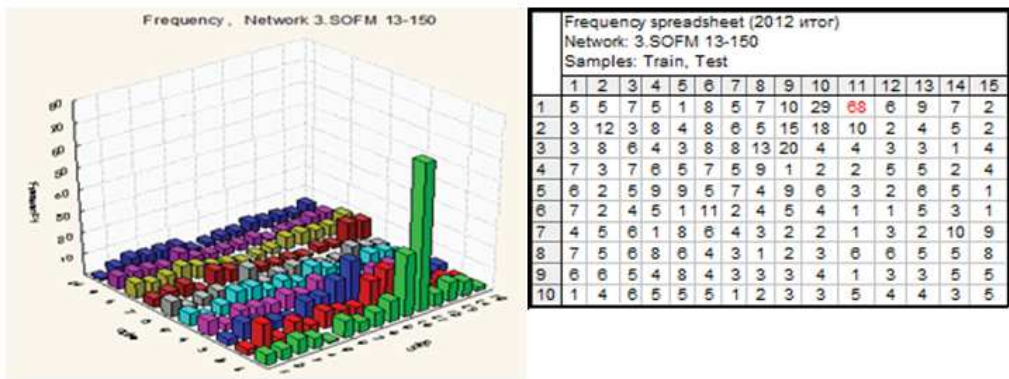


Fig. 2. Clustering into 150 groups by Kohonen’s neural networks

The network error at a given number of groups comprises 0.019, i.e. it is in maximal proximity to the final set point of 0.02 (table value of minimum allowable error). The analysis of the network construction error has been carried out for iden-

tification of the optimal clusters number. The network error increases evenly as the number of the identified classes reduces, and an abrupt jump in the error value from 0.0498 to 0.0708 occurs between class10 and class 20 (Figure 3).

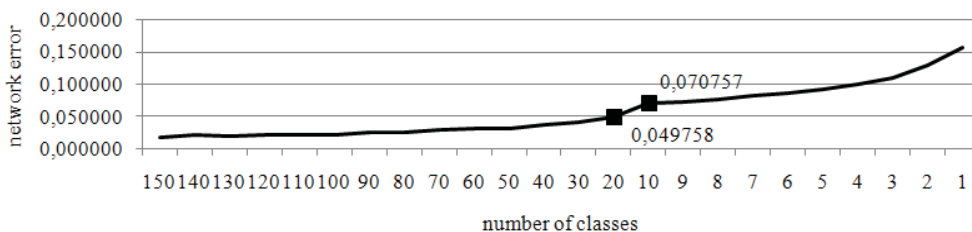


Fig. 3. Dependence of the Kohonen network error change on the number of identified classes (from 150 to 1)

It appeared that the maximum discontinuity is observed in the values of classes 11 and 10 during

the step-by-step analysis of the network errors in the given class interval (Figure 4).

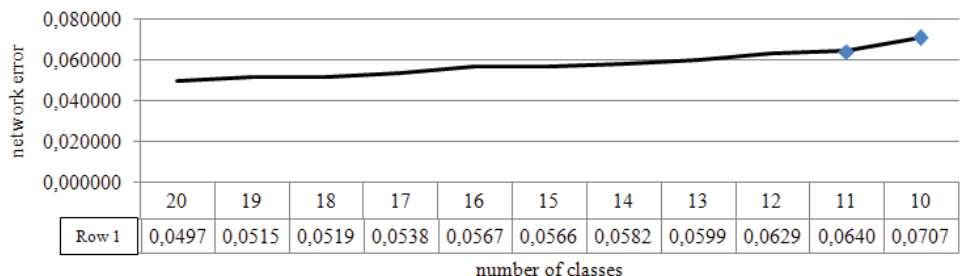


Fig. 4. Dependence of the Kohonen network error change on the number of identified classes (from 20 to 10)

Main statistical factors of clustering into 11 groups by Kohonen neural networks are shown in Table 7.

Table 7. Statistical data of 11 clusters of Kohonen neural network calculations

	Minimum (Train)	Maximum (Train)	Mean (Train)	Standard deviation (Train)	Minimum (Test)	Maximum (Test)	Mean (Test)	Standard deviation (Test)	Minimum (Overall)	Maximum (Overall)	Mean (Overall)	Standard deviation (Overall)
Equity capital	0.0	136384.4	6599.9	13657.5	0.0	97190.1	6431.4	11490.1	0.0	136384.4	6566.6	13251.6
Deposits accounts	0.0	158161.5	17638.7	22325.5	0.0	142761.7	17436.4	22567.3	0.0	158161.5	17598.8	22360.0
Deposits up to 180 days	0.0	220863.6	21292.2	23108.1	0.0	120081.5	21017.8	21497.1	0.0	220863.6	21238.0	22786.9
Deposits up to 1 year	0.0	274925.2	12267.7	21507.5	0.0	79073.7	12009.4	16164.4	0.0	274925.2	12216.7	20554.7
Deposits up to 3 years	0.00	49992.78	900.94	2565.83	0.00	17839.09	1170.59	2862.10	0.00	49992.78	954.16	2627.35

Table 7 (cont.). Statistical data of 11 clusters of Kohonen neural network calculations

	Minimum (Train)	Maximum (Train)	Mean (Train)	Standard deviation (Train)	Minimum (Test)	Maximum (Test)	Mean (Test)	Standard deviation (Test)	Minimum (Overall)	Maximum (Overall)	Mean (Overall)	Standard deviation (Overall)
Deposits over 3 years	0.0	346704.0	15579.4	35339.0	0.0	178547.0	15074.6	25880.6	0.0	346704.0	15479.7	33669.9
Loans up to 180 days	0.0	216073.0	6495.1	19826.0	0.0	122918.7	4917.6	15873.9	0.0	216073.0	6183.7	19112.4
Loans up to 1 year	0.0	158161.5	17638.7	22325.5	0.0	142761.7	17436.4	22567.3	0.0	158161.5	17598.8	22360.0
Loans up to 3 years	0.0	220863.6	21292.2	23108.1	0.0	120081.5	21017.8	21497.1	0.0	220863.6	21238.0	22786.9
Loans over 3 years	0.0	274925.2	12267.7	21507.5	0.0	79073.7	12009.4	16164.4	0.0	274925.2	12216.7	20554.7
Loans Overdraft	0.00	49992.78	900.94	2565.83	0.00	17839.09	1170.59	2862.10	0.00	49992.78	954.16	2627.35
Issued interbank loans	0.0	346704.0	15579.4	35339.0	0.0	178547.0	15074.6	25880.6	0.0	346704.0	15479.7	33669.9
Obtained interbank loans	0.0	216073.0	6495.1	19826.0	0.0	122918.7	4917.6	15873.9	0.0	216073.0	6183.7	19112.4

Mean values in the groups have appeared different (Table 8). This fact confirms the validity of the when constructing 11 clusters by the *k*-means method identified clusters existence assumption.

Table 8. Mean values of clusters identified by *k*-means method

Variable	Cluster										
	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11
Factor 1	0.067	0.049	0.048	0.055	0.030	0.053	0.038	0.005	0.069	0.053	0.088
Factor 2	-0.066	-0.023	-0.001	-0.088	-0.005	-0.045	-0.033	-0.002	0.019	-0.015	-0.156
Factor 3	0.020	0.024	-0.006	0.004	-0.006	-0.046	-0.053	-0.001	-0.013	0.009	0.011
Factor 4	0.023	-0.018	0.009	-0.027	0.002	0.023	-0.069	0.000	0.013	0.002	0.034
Factor 5	-0.009	-0.035	-0.004	0.083	-0.003	-0.015	-0.011	0.000	-0.011	-0.007	0.021
Factor 6	0.008	0.019	-0.010	-0.038	-0.003	0.001	0.015	0.000	-0.024	-0.004	0.005
Factor 7	0.028	-0.028	-0.005	-0.017	0.001	0.011	0.007	0.001	-0.019	0.025	0.040
Factor 8	0.037	-0.004	0.037	0.018	0.013	0.007	0.010	0.002	0.065	0.011	0.052

Factors analysis of variance for clustering by *k*-means method see in Table 9.

Table 9. Factors analysis of variance for clustering by *k*-means method

Variable	Between	df	Within	df	F	Signif.
	SS		SS			p
Factor 1	0.477313	10	0.109757	825	358.7787	0.0000
Factor 2	0.821892	10	0.238664	825	284.1066	0.0000
Factor 3	0.206719	10	0.216196	825	78.8837	0.0000
Factor 4	0.204741	10	0.108033	825	156.3515	0.0000
Factor 5	0.093620	10	0.117015	825	66.0057	0.0000
Factor 6	0.057426	10	0.055466	825	85.4152	0.0000
Factor 7	0.176608	10	0.108069	825	134.8226	0.0000
Factor 8	0.252934	10	0.131758	825	158.3744	0.0000

Thus, it has been discovered that the most adequate bank clustering based on the *k*-means method and Kohonen neural networks can be traced by division of the banks array into 11 groups. The results of clustering by means of two methods showed the commensurate results, but Kohonen's neural networks have been selected as the main method, which will subsequently enable the available data prediction.

Four business models of credit institutions have been identified despite the universality of banks.

Here is the description of an average representative of the cluster included in the business model.

1. Business model (clusters 1, 2 and 11): an average representative of this group is characterized as the largest bank in the country which has high

banks). The banks of this group are motivated to interact with the real sector of the economy.

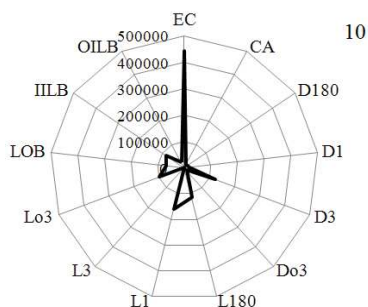


Fig. 8. Mean values of resources allocation in cluster 10

The cluster includes 54 small credit institutions such as LLC “Commercial Bank “Alzhan”, CJSC “AKB “Vladicombank”, LLC “Commercial Bank “Gefest”, CJSC “AKB “Petersburg City Bank”, LLC “Commercial Bank “Doris”, LLC “Commercial Bank “Makha-chkala City Bank”, JSC “Commercial Bank “Renta-Bank”, JSC “AKB “Severo-Vostochniy Alyans”, JSC “Ukhtabank”, LLC “Commercial Bank “Eco-Invest”.

Conclusion

At this phase of the work the clustering method has allowed to identify the business models of the credit institutions in the formed groups, to consider the interconnection of the banks in every cluster with the real sector of the economy and suggest possible development ways of this interaction. The hypothesis of the institutional misalignment in the Russian banking system has been confirmed, and we have traced the interaction problem sources between the

banking sector and the real sector of the economy during the analysis of the bank business models existing at present.

We plan the further development of effective monetary resources management tools for the insurance of the interaction between the banking sector and the real sector of the economy.

The research work is to be continued in the framework of the developments made by M.Y. Ibragimov and R.M. Ibragimov in respect of the heavy tails theory. It seems possible to apply the theory of heavy tails to the banking sector as alternative stress testing of the identified groups of the credit institutions for their resistance to crisis developments. This will permit to develop an econometric approach to the effective management of the liquidity of the economy as a whole, to consider the monitoring of the banking system not as a separate component that takes into account the issues of the state of the banking sector separately from the other sectors of the economy, but to carry out a comprehensive analysis of the interconnected economic systems. While the current monitoring scheme of the banking system is aimed at processing the available data and short-term forecasting of the banking system condition, the studies will permit to monitor the state and the interaction between the banking sector and the real sector of the economy for the future.

The effective level of the liquidity of the credit institutions in the clusters is to be determined for the efficient interaction with the real sector of the economy and ensuring the banking system stability.

References

1. Aleksashin, P.G., F.T. Aleskerov, V.Y. Belousova, Y.S. Popova, V.M. Solodkov (2012). Dynamic analysis of business models of Russian banks within the period of 2006-2009, Preprint WP7/2012/03, National Research University “Higher School of Economics”, Moscow: Publ. House of Higher School of Economics.
2. Alekserov, F.T., V.M. Solodkov, D.S. Chelonokova (2006). Dynamic analysis of behavior patterns of commercial banks in Russia, *HSE Trade Magazine*, 1, pp. 48-62.
3. Artificial intelligence portal. Kohonen neural network. Available at www.aiportal.ru.
4. Bobyshev, A.A. (2001). Typical strategy and financial intermediation: 7. Working Paper BSP/01/047, Moscow School of Economics.
5. Debok, G., T. Kohonen (2001). *Financial analysis by means of Self Organizing Maps* / translated from the English, Moscow: Alpina.
6. Hastie, T. (1984). Principal Curves and Surfaces, Ph.D. Dissertation, Stanford Linear Accelerator Center, Stanford University, Stanford, California, US.
7. Ferstl, R., D. Seres (2014). Clustering Austrian banks’ business models and peer groups in the European Banking Sector, *Financial Stability Report*, 24, pp. 79-95.
8. Grzegorz Halaj, Dawid Z. Ochowski (2009). Strategic groups and banks’ performance, *Financial Theory and Practice*, 33 (2), pp. 153-186.
9. Ibragimov, M., R. Ibragimov, J. Walden (2013). *Heavy-tailed distributions and robustness in economics and finance*.
10. Koller, Wolfgang. Strategic Groups in Austrian Banking 1995-2000.
11. Kohonen, T. (1989/1997/2001). *Self-Organizing Maps*, Berlin – New York, Springer-Verlag.
12. Official website of the Central Bank of Russia. Information disclosure by credit institutions. Available at www.cbr.ru.

13. Osovsky, S. (2002). *Neural networks to process information*, translated from the Polish by I.D. Rudinsky, Moscow: Finance and statistics.
14. Statistics electronic manual StatSoft. Available at <http://www.statsoft.ru>.
15. Wasserman, F. (1992). *Neural Computing. Theory and Practice*, Moscow, Mir.
16. Yin, H. (2007). Learning Nonlinear Principal Manifolds by Self-Organising Maps, In: Gorban A.N. et al. (eds.), LNCSE 58, Springer.

Appendix

Table 1A. Characteristics of the factors identified upon studying the credit institutions indexes by means of the factor analysis

Factor	Description
Factor 1: Long-term and medium-term lending	The greatest influence is rendered by the following indexes: loans for a period from 180 days to 3 years (short designation (0.66) and medium-term (0.68) loans). This factor indicates the bank activity in the part of short and medium-term loans. That is, the allocation of the available resources on short- and medium-term basis in the real sector of the economy and population.
Factor 2: Equity capital, medium-term deposits and inter-bank loans	The greatest impact has the following indexes: equity (-0.61), deposits from 1 year to 3 years (medium-term resource attraction) (0.51) and interbank loans (-0.73). The bank equity represents the resources of the bank which may also be involved in the turnover and generate profits. In our opinion, this type of resources is to be reasonably referred to the long-term bank resources. Short terms are mostly used as part of the interbank lending; therefore, these resources are referred to the short-term ones.
Factor 3: Long-term lending	The greatest impact has the following indexes: loans over 3 years (long-term loans) (-0.74). This factor indicates the bank activity in the part of the resources allocation on the short-term basis.
Factor 4: Long-term deposits and interbank loans	The greatest impact has the following values: deposits over 3 years (long-term resource attraction) (0.51), interbank loans (-0.77). This factor combines the long-term resource attraction and interbank loans.
Factor 5: Short-term deposits	The greatest impact has the following indexes: deposits up to 180 days (short-term resource attraction) (0.66). This factor indicates the preference on the part of the bank clients to invest for short periods up to six months.
Factor 6: Overdraft lending	The greatest impact has the following indexes: overdraft loans (short-term loans) (0.80). This factor indicates the bank activity in the part of granting short-term loans with a lack of funds on a client's account. Overdraft loan is granted to clients on a contract basis, providing the ability to quickly obtain a loan onto the account; the repayment of the loan shall be effected by the incoming funds.
Factor 7: Short-term deposits	The greatest impact has the following indexes: deposits from 180 days to 1 year (short-term resource attraction) (0.55). This factor indicates the preference on the part of the bank clients to invest for short periods up to a year.
Factor 8: Long-term deposits	The greatest impact has the following indexes: deposits over 3 years (long-term resource attraction) (0.55). The factor indicates the preference on the part of the bank clients to invest for long periods; the client's loyalty to the bank could also be proved.