Inna Kondius
PhD in Economics, Associate Professor,
Myroslava Kupyra
Postgraduate, Assistant,
Chair of Finance,
Lutsk National Technical University

METHODS OF COMPETITIVENESS ASSESSMENT OF UKRAINIAN FINANCIAL MARKET

Experts of the World Economic Forum proved low level of not only the reliability of the banking sector of Ukraine, but also its long-term integral part, as it is noted in the Global Competitiveness Report of Ukraine. The above-mentioned report is a portrait of the state of the economic and business environment of the country and demonstrates its ability to achieve a sustainable level of prosperity and growth. In 2017 under the Global Competitiveness Index Ukraine got 85th place among 138 countries, which participated in the evaluation, received 4.0 points out of 7 possible [1], which is in 1 point of relatively similar values lower than in 2014 and in 6 points lower than in the previous year, when the value of the analyzed index was 79th among 139 countries [2].

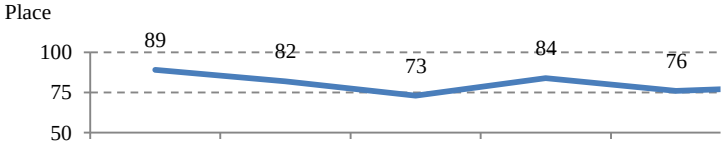

Fig. 1 - Dynamics of Ukraine's position alteration under the Global Competitiveness Index ranking

The state economy shows a significant gap in accordance with the world average index and much more gap in terms of the innovative economies indexes. Thus, one of the most crucial conditions for improving the competitiveness of the national economy is a reforming of the financial and banking sector, whereas an indicator of the financial market development is one of the lowest indexes. The last one is rather low and our country has only 130th place in 2017, which is in 17 points lower than in the previous year.

The index of reliability and confidence of banks is of a particular

interest. According with it, Ukraine has 137th place in the ranking (2.1 points), which is in 17 points lower than in 2016. There were quite low indexes in the ease of access to credit, availability of financial services, access to financial services, venture capital availability (Fig. 2), this specifies the low prospects of Ukrainian banking system, and competitiveness.

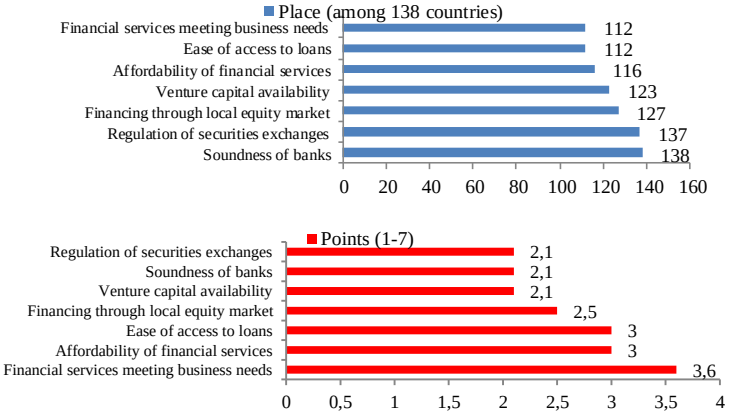

Fig. 2 - Ukraine Rating in 2017 under the index of "Financial Market Development" GCI

The financial and economic crisis has shown the importance of well-developed and well-functioning financial sector in the economy. Developed financial sector, foremost, directs resources for the implementation of the most profitable business or investment projects. So, effective financial sector gives a possibility to allocate resources, which are saved by citizens or invested by other countries, in the areas where these resources are the most productive. Thus, the economy needs a financial sector that provides capital asset for the investment financing of the private sector through the loans from reliable banks, developed stock market, venture capital and other financial instruments.

Moreover, among the 16 items of competitive advantages of Ukrainian economy there is no one that would concern banking sector. And the first among the most problematic factors for doing business is banks' capacity and the stock markets' regulation. Factor of "regulation of stock market" is also referred to the list of topical

issues.

The above-mentioned factors indicate the need for solution of significant problems in the sphere of financial market development and, in particular, improvement of the efficiency of the banking sector.

Thus, an efficient banking system is possible only with a high level of reliability and prospects. Furthermore, the first step towards the improving of the competitiveness of Ukrainian financial market is the development of an adequate methodology for assessing and predicting the relative level of effectiveness of the state banking system and identification of threats.

For a quantitative evaluation of the competitiveness level of financial market, it is necessary to develop indicators - effectiveness indexes in terms of subject of research. In such a case, the assessment of the effectiveness level of the system is reduced to the problem of the numeral values of the reliability and viability of the system and comparison of the found values which are called boundary at which the effects from possible losses of working capacity of systemic elements are minimal.

The determination of the actual indexes allow to study and analyze the principles of change of financial market's efficiency in the course of time, to find ways to use these principles to ensure minimum loss of time and money to maintain efficiency of the banking system in terms of what is actually formed, and to apply these methods in strategic plans' development.

Reliability analysis of the banking system, as a measure of competitiveness, aims to identify ways to provide effective long-term functioning of the banking system and its components at the lowest possible cost of time, labor and funds for their renewal; providing customers and contractors with adequate prediction in terms of probability of the effective long-term operation of the system; providing banking institution regulation and supervision of the theoretical and practical basis for creating secure conditions for the effective functioning of the banking sector.

Accordingly, the main issue of the theory of the financial market's efficiency, its theoretical developments and practical recommendations, is predicting behavior system and its elements for some particular time, finding ways to ensure their effective

functioning and support the required level of reliability and perspective.

In general case, the financial market efficiency is the optimal allocation of scarce resources by economic subjects in achieving a given level of production of goods and/ or services. Taking into consideration the financial institutions, you will notice that the efficiency can be viewed in different aspects: as efficiency concerning cost, efficiency concerning incomes and efficiency concerning profits.

Research of the banking efficiency attracts many national and foreign researchers and practitioners. There are lots of works of Ukrainian and Russian scientists which are devoted to the question of determination of the effectiveness of general economic concepts and financial market efficiency: O. Vovchak [3], D. A. Kruglov [4], M. M. Kuzmin [4], Yu. Matsiv [3], S.R. Moyiseyev [4], A. Pilyavskyy [3], V.R. Sargsyan [5], K.V. Tolchyn [6], T. Homa [3]. Works of foreign scientists can be divided into two groups, namely, the theory and methods for evaluating the effectiveness and practical use of methods to assess the effectiveness of the financial institutions. The first group should include the following works C.Weiner [7], S. Grosskopf [8], Z. Zhang [9], WilliamW. Cooper [10, 12], E. Rhodes [10**Ошибка! Источник ссылки не найден.**], B. Park [7], L. Simar [10], M. Farrell [11], A. Charnes [10, 12] та ін. Серед авторів робіт другої групи доцільно відзначити: A. N. Berger [13], A. Bhattacharya [14], R. DeYoung [13], R. F. Eisenbeis [15], E. Elyasiani [16], G. D. Ferrier [15], F. Forsund [17**Ошибка! Источник ссылки не найден.**], D.B.Humphrey [13], W. Hunter [18, 19], S. H. Kwan [15], L. J. Mester [20], S. G. Timme [18, 19].

Scientific results in the general theory of the effectiveness, recommendations in terms of assessment methods are quite large, but the problem of determination of the effectiveness of specific banking operations remain under-developed in theoretical, methodological and practical aspects. One of the major unsolved problems is the choice of method for the assessment of the effectiveness of the financial institution that gives a possibility to receive adequate results.

The choice of methods for banking effectiveness assessment, primarily, depends on its purpose. Each method has its advantages

and disadvantages, which determine the acceptability or unacceptability of its use in specific conditions to achieve certain goals:

– financial coefficient approach that includes traditional calculation indexes - indexes of effectiveness and performance calculation indexes;

– expert methods based on the judgmental estimation of the specialists of particular direction;

– parametric techniques based on econometric analysis also require the determination of functional form of the bank production function or expenditure, profits, income functions;

– nonparametric methods use mathematical programming and do not require the determination of functional form of production exposures.

The main stages of assessment of the financial market effectiveness:

1) Definition of set of characteristics $x_h = (x_{h,1}, \ldots, x_{h,mh})$ that are the most informative in assessing the effectiveness of q subject of research $G(q)$ on the grounds of feature h, $h = 1, \ldots, H$.

2) On the basis of all the available information, ordinate vector of original values $x_h^{(q)} = \left(x_{h,1}^{(q)}, \ldots, x_{h,m_h}^{(q)}\right)$ of each subject of research q from all the object multitude Q, that is regarded, taking into account all features h, $h = 1, \ldots, H$. Whereas the indexes x_i can have different units of measure and different degrees of informativity.

3) For each input feature there are set acceptable thresholds, i.e. intervals $x_{h,i}^{н}, x_{h,i}^{в}$, $h = 1, \ldots, H$, $i = 1, \ldots, m_h$, within which their values must be mentioned and additional conditions in terms of set characteristics value must be specified. Experts considered the implementation of additional conditions as a positive sign of the functioning and development of the subject of the research.

In the case of fulfillment of all conditions of the initial characteristics value, it is considered as a positive sign of functioning and development of the subject of the research.

Taking into account the uncertainty, incompleteness and inaccuracy of the information, in order to reduce errors that can occur when putting scores, assessment of baseline characteristics

$z_{h,i} = \psi\left(x_{h,i}\right)$, *h, h =1,…,H,* $i = 1, \ldots, m_h$, h, h = 1, ..., H, it is offered to assess on a binary scale. In other words $z_{h,i}^{(q)} = 1$, if the value of i characteristic of *q* object on the basis of *h* $x_{h,i}^{(q)}$ falls within the boundaries of permissible values and performed all set additional conditions $z_i^{(q)} = 0$ if not. Thus, the characteristics which were rated as "1", indicating on the positive aspects of the banking system effectiveness and those that received "0" - negative aspects.

4) Making a priori classification from the whole selection of the subjects of research *Q* into two groups - those objects that function "effectively" $G_h^{Eff,eksp}$ are based on *h, h =1,…,H,* and those that are "ineffective" function as $G_h^{NEff,eksp}$ and are based on *h, h =1,…,H.* Of course, the assessment of efficiency G_h^{eksp} can be carried out only by experts and should not be completely accurate but it should be adjusted to reality.

The general pattern of expert judgment includes the following fundamental steps:

- selection of experts and the formation of expert groups;
- formation of issues and questionnaire constructions;
- formation of rules of the evaluation based on the individual experts conclusions;
- analysis and processing of expert judgments.

There are special features of the expert judgments' methods and models of their implementation as scientific tools for solving complex problems. These are: scientifically based organization of all stages of expert operation, ensuring the effectiveness of each of them, and the use of quantitative methods in the expert operation organization and in the assessment of experts' findings under the formalized process of the results of their judgments.

With this objective in view, judgments matrix of each *S* expert is formed, *s=1,…,S,* by pairwise equation of the effectiveness of *q* subject of research on grounds of its defined characteristics *h, h=1,…,H* Thus, in the initial stage matrix is formed. It has a dimension *Q*Q of* pairwise equation of each expert $X_s^h = \{x_{ij}^h\}_s$ objects A_q, $q = 1,..,Q$ by the following rule $x_{ij}^{h,s} = 1$: if in

the opinion of S expert subject A_i is better than A_j on the grounds of h, $x_{ij}^{h,s} = 0{,}5$, if they are equivalent and 0 otherwise, i.e.

$$x_{ij}^{h,s} = \begin{cases} 0, & A_i{}^h \prec A_j{}^h \\ 0{,}5, & A_i{}^h \cong A_j{}^h \\ 1, & A_i{}^h \succ A_j{}^h \end{cases}.$$

(**Ошибка! Текст указанного стиля в документе отсутствует.**1)

Taking into consideration that all the features are equivalent, matrix of X_s of pairwise equation of subjects A_q on the grounds of each S experts

$$X_s = \left\{x_{ij}^s\right\},\ x_{ij}^s = \sum_{h=1}^{H} x_{ij}^{h,s},\ s = 1,\ldots,S \tag{2}$$

by the results of which vector of rank advantages of subject of research of each S expert (3) is formed.

$$Xb_s = \left\{x_i^s\right\},\ x_i^s = \sum_{j=1}^{Q} x_{ij}^s,\ i = 1,\ldots,Q,\ s = 1,\ldots,S \tag{3}$$

As far as the views of various experts regarding levels of efficiency of research objects are different, so before finding a common assessment of the efficiency it is necessary to check the consistency of expert judgments, which can be conducted with the help of concordance factor W [21, 22, 23, 24]

$$W = \frac{12\sigma}{S^2\left(Q^3 - Q\right)} \tag{4}$$

where $\sigma = \sum_{q=1}^{Q}\left(\sum_{s=1}^{S} x_i^s - \frac{1}{2}S(Q+1)\right)$ - the sum of squares of deviations of all ranks estimation of each subject of the mean from the average value;

S – the number of experts conducting the assessment;

Q – the number of subjects of research.

As far as some experts can not set the rank difference between the subjects of research and provide the same rank, the concordance coefficient calculation in this case is the following

$$W = \frac{\sigma}{\frac{1}{12}S^2\left(Q^3 - Q\right) - S\sum_{s=1}^{S} T_s} \tag{5}$$

$$T_j = \frac{1}{12}\sum_{t_j}\left(t_j{}^3 - t_j\right)$$

where (6)

and t_j - the number of the same rank in j row.

Concordance coefficient, calculated by the formula 4 or 5, is the estimation of true value, is a random variable, so it is needed to be verified. Since the number of subjects of research is $Q > 7$ usually, the importance of coefficient evaluation concordance that takes values in the range $0 \le W \le 1$ (0 - complete lack of coordination, 1 - the same assessment of all experts) is checked using a criterion χ^2 [21, 22, 23, 24]. Whereas, the value

$$\chi^2 = WS(Q-1) \quad (7)$$

has χ^2-distribution with $v = Q - 1$ degrees of freedom

However, this method, in case of some inconsistencies in the expert judgments, gives possibility to get a numeric value of complex latent index that may be used in the construction of extrapolation functions on the basis of statistical information of the object.

5) Weighing coefficients of model $d_{h,i}, b_{h,i}$, $h = 1, \ldots, H$, $i = 1, \ldots, m_h$,. are estimated. They depend on thresholds of output characteristics, defined by experts. Weighing coefficient of certain characteristic $x_{h,i}$, $h=1,\ldots,H$, $i=1,\ldots, m_h$ is clearly expressed in the probability of hitting for the effective and ineffective system in terms of limit values. With the aim of further determination of these probabilities the following indicators are calculated:

$D_{h,i} = \sum_{q=1}^{Q} \left\{1 : G_h^{(q)} = G_h^{Eff,eksp}\right\}$ – the number of subjects of research, described by experts as effectively acting on the basis of *h*;

$B_{h,i} = \sum_{q=1}^{Q} \left\{1 : G_h^{(q)} = G_h^{NEff,eksp}\right\}$ – the number of subjects f research, characterized by experts as inefficiently operating on the basis *h*.

The next step is the selection of such subjects for which the characteristics are $x_{h,i}$, falls within the boundaries of acceptable range. Then the following marks are mentioned:

$D_{h,i}^1 = \sum_{q=1}^{Q} \left\{1 : G_h^{(q)} = G_h^{Eff,eksp} \cap z_{h,i} = 1\right\}$ – the number of subjects of research that on the grounds of *i* characteristic signs *h* are evaluated as $z_{h,i}=1$, the overall assessment on the basis of *h* is characterized by experts as operating effectively $G_h^{Eff,eksp}$;

$B_{h,i}^1 = \sum_{q=1}^{Q} \left\{1 : G_h^{(q)} = G_h^{NEff,eksp} \cap z_{h,i} = 1\right\}$ – the number of subject of research that for the *i* characteristic signs *h* with the assessment $z_{h,i}=1$, is characterized by experts as operating inefficiently $G_h^{NEff,eksp}$.

In such a case the calculation of the probability of an event $z_{h,i}=1$ for the "effective" and "ineffective" functioning of banking system is represented either as

$$d_{h,i} = \frac{D_{h,i}^1}{D_{h,i}},\ b_{h,i} = \frac{B_{h,i}^1}{B_{h,i}} \tag{4}$$

The calculation of probabilities of effective functioning of subject of research on different grounds. The probability that the subject of research is effective on the basis of *h*, subject to availability of information about it z_h, can be determined by Bayes formula:

$$p_h(z_h) = \frac{1}{1 + \frac{P_{h,B}}{P_{h,D}} \cdot \frac{P\left\{z_h \middle| G_h^{NEff}\right\}}{P\left\{z_h \middle| G_h^{Eff}\right\}}} \tag{5}$$

where $P_{h,D}$ – the probability that an subject of research that is investigated, in case of lack of some information about it, on the basis of *h* feature is effective;

$P_{h,B}$ – the probability that the subject of research that is investigated, in case of lack of all information about it, on the basis of *h* feature is ineffective;

$P\left\{z_h \middle| G_h^{Eff}\right\}$ – the probability that for a priori effective banking system on the basis of, the information z_h will be received;

$P\left\{z_h \middle| G_h^{NEff}\right\}$ – the probability that for a priori inefficient banking system on the basis of *h*, the information z_h will be received.

$$\frac{P_B}{P_G} = \frac{n_2}{n_1} \tag{6}$$

In case of making assumptions about the independence of binary features, the product formula of probabilities can be used, followed by

$$\frac{P_{h,B}}{P_{h,D}} \cdot \frac{P\left\{z_h \middle| G_h^{NEff}\right\}}{P\left\{z_h \middle| G_h^{Eff}\right\}} = \frac{P_{h,B}}{P_{h,D}} \cdot \frac{\prod_{i=1}^{m_h} P\left\{z_{h,i} \middle| G_h^{NEff}\right\}}{\prod_{i=1}^{m_h} P\left\{z_{h,i} \middle| G_h^{Eff}\right\}} = \frac{P_{h,B}}{P_{h,D}} \prod_{i=1}^{m_h} \frac{P\left\{z_{h,i} \middle| G_h^{NEff}\right\}}{P\left\{z_{h,i} \middle| G_h^{Eff}\right\}} = \quad (7)$$

$$= \frac{P_{h,B}}{P_{h,D}} \prod_{i=1}^{m_h} \left(\frac{b_{h,i}}{d_{h,i}}\right)^{z_{h,i}} \left(\frac{1-b_{h,i}}{1-d_{h,i}}\right)^{1-z_{h,i}}$$

where b_i – the probability of an event $z_i = 1$ for "inefficient" functioning banking system and d_i– for "efficient".

With the help of mathematical transformations of ratio 11, it can be reduced to the equivalent form:

$$\frac{P_{h,B}}{P_{h,D}} \cdot \frac{P\left\{z_h \middle| G_h^{NEff}\right\}}{P\left\{z_h \middle| G_h^{Eff}\right\}} = \frac{P_{h,B}}{P_{h,D}} \prod_{i=1}^{m_h} \left(\frac{b_{h,i}}{d_{h,i}}\right)^{z_{h,i}} \left(\frac{1-b_{h,i}}{1-d_{h,i}}\right)^{1-z_{h,i}} =$$

$$= \frac{P_{h,B}}{P_{h,D}} \prod_{i=1}^{m_h} \left(\frac{1-b_{h,i}}{1-d_{h,i}}\right) \left(\frac{b_{h,i}\left(1-d_{h,i}\right)}{d_{h,i}\left(1-b_{h,i}\right)}\right)^{z_{h,i}} = \quad (8)$$

$$= \exp\left\{\ln\left(\frac{P_{h,B}}{P_{h,D}}\right) + \sum_{i=1}^{m_h} \ln\left(\frac{1-b_{h,i}}{1-d_{h,i}}\right) + \sum_{i=1}^{m_h} z_{h,i} \cdot \ln\left(\frac{b_{h,i}\left(1-d_{h,i}\right)}{d_{h,i}\left(1-b_{h,i}\right)}\right)\right\}$$

so,

$$\frac{P_{h,B}}{P_{h,D}} \cdot \frac{P\left\{z_h \middle| G_h^{NEff}\right\}}{P\left\{z_h \middle| G_h^{Eff}\right\}} = \exp\left\{\lambda_{h,0} + L_h\right\}, \quad h = 1, \ldots, H \quad (9)$$

where L_n is an integral factor (weighted sum) of binary characteristics z_h

$$L_h = \sum_{i=1}^{m_h} \lambda_{h,i} z_{h,i} \quad (10)$$

$$\lambda_{h,i} = \ln\left(\frac{b_{h,i}\left(1-d_{h,i}\right)}{d_{h,i}\left(1-b_{h,i}\right)}\right), \quad (11)$$

$$\lambda_{h,0} = \ln\left(\frac{P_{h,B}}{P_{h,G}}\right) + \sum_{i=1}^{m_h} \ln\left(\frac{1-b_{h,i}}{1-d_{h,i}}\right), \quad h = 1, \ldots, H, \; i = 1, \ldots, m_h \quad (12)$$

Then the formula 9 can be written as

$$p_h\left(z_h\right) = \frac{1}{1+e^{\lambda_{h,0}+L_h}} \quad (17)$$

Thus, the determination of the efficiency of financial market, as it is shown in the great number of methodology, is associated with the

expectation of certain integral index. However, the formula 14 allows conducting a transition to a qualitatively informative value, which makes it possible to compare the efficiency of the banking system in different periods or banking systems of different countries which do not allow conventional integrated indicators.

6) The calculation of probabilities of effective functioning of the subject of research in all its declared characteristics *h, h =1,…,H.*

In the final assessment of weighting coefficient, ω_h, $h = 1,\ldots,H$, reflecting the importance of the each value impact $p_h(z_h)$ on the resulting assessment *p(z)*

$$p(z) = \prod_{h=1}^{H} (p_h(z_h))^{\omega_h} = \prod_{h=1}^{H} \left(\frac{1}{1 + e^{\lambda_{h,0} + L_h}} \right)^{\omega_h} = \frac{1}{\prod_{h=1}^{H} \left(1 + e^{\lambda_{h,0} + L_h}\right)^{\omega_h}}, \quad \sum_{h=1}^{H} \omega_h = 1 \qquad (13)$$

Suggested algorithm of analysis and effectiveness evaluation of the financial market as an indicator of competitiveness provide identifying ways to ensure effective long-term functioning of the banking system and its constituents at the lowest possible cost of time, labor and money.

Judging by the 25-year experience in the formation of the financial market of Ukraine, unfortunately, liquid, competitive, efficient and transparent market could not be established. One of the main reasons is macroeconomic imbalances and lack of long-term strategy development of the financial market, as a constituent of the socio-economic strategy development of the state, and the inability to stabilize the social, political and economic situation in Ukraine. All that led to the formation of a narrow, functionally limited and illiquid market, which is dominated by bank operations and government securities transactions. Furthermore, preferably during the financial and economic crisis increasing bonds and uncontrolled bank refinancing fuel uncontrolled inflation, with most financial market participants experiencing significant losses, restrict their activities - all this leads to the inability to preserve and increase their savings, so current, insurance market and pension funds are significantly underdeveloped.

Other instruments (equity and debt corporate securities) are in the doldrums, which is connected with the lack of confidence in the

quality of these instruments and issuers that expose investors to risk while buying. Furthermore, for the foreign investors there are no clear and transparent rules, legal protection, guarantees from the state and issuers; there are no organized system of relations with foreign investors; there are no regular investment presentations that contribute to the effective privatization, long-term cooperation, attracting the best international practices and improvement of national legislation in this area, getting cheaper and long-term foreign capital, attracting international companies to the national financial market. Therefore, it is necessary to form and gradually implement an institutional strategy to ensure macroeconomic stability. In the future it will contribute to the development of the financial market of Ukraine on the assumption of deregulation and introduction of the investors' protection system.

References

1. Rlaus Schwab, World Economic Forum. The Global Competitiveness Report2016-2017. – http://www3.weforum.org/ docs/ GCR2016-2017/05FullReport/ TheGlobalCompetitiveness Report 2016-2017_FINAL.pdf
2. Competitiveness of Ukraine: Evaluation of the World Economic Forum (on the Global Competitiveness Report 2010-2017): [electronic resource] / Department of Economic Analysis and Forecasting National Bank - Access mode: www.bank.gov.ua
3. Pilyavskyy A. The efficiency of the banking system (2005-2009.). Frontal Analysis Methodology [Text] / A. Pilyavskyy, O.Vovchak, Yu. Maciw, T. Homa // Bulletin of the NBU. - 2010. - №4. - P. 16-22.
4. Moiseev, S.R. Efficiency of Russian banks [Text]: Analytical record/ [S. R. Moiseev, D. A. Kruglov, M.M. Kuzmin]; Center of economic research IFAS. - Moscow, 2007. - 19 p.
5. Sarkisian, V.R. Essence and meaning of the term "efficiency of the commercial bank" [Text] / V.R. Sargsyan; Coll. Science. Proceedings of the National University of the State Tax Service of Ukraine, 2009. - №1. - P. 251-258
6. Tolchyn, K.V. On the estimation of the bank efficiency [text] / K.V. Tolchyn. - Money and credit, №9, 2007. - P. 58-62
7. Park, B. The FDH estimator for productivity efficiency scores: Asymptotic Properties [Text] / B. Park, L. Simar, C. Weiner. – Econometric Theory, №16, 1999. – P. 855-877.
8. Grosskopf, Shawna, (1996), "Statistical inference and nonparametric efficiency: A selective survey", The Journal of Productivity Analysis 7, pp 161-176.
9. Zhang, Xiang-Sun and Jin-Chuan Cui, (1999), "A project evaluation system in the state economic information system of China: An operations research practice in public sectors", International Transactions in Operational Research 6(5), pp 441-452
10. Charnes, A. Measuring the efficiency of decision making units [Text] / A.

Charnes, W.W. Cooper, E. Rhodes // European Journal of Operational Research,1978. – № 2, pp. 429–444.

11. Farrell, M.J. The measurement of productive efficiency [Text] / M. J. Farrell // Journal of the Royal Statistical Society, 1957. – № 120, pp. 253–289.

12. Charnes, A. Data envelopment analysis: Theory, methodology, and applications. [Text] / A. Charnes, W. W. Cooper, A. Y. Lewin, L. M. Seiford. – Boston: Kluwer Academic publisher, MA. – 1994.

13. Fare, R. The measurement of effiency of production [Text] / R. Fare, S. Grobkopf, C. A. K. Lovell. // Kluwer Academic Publishers. – Boston, 1985.

14. Bhattacharyya, Arunava. The impact of liberalization on the productive efficiency of Indian commercial banks [Text] / Arunava Bhattacharyya, C. A. Knox Lovell, Pankaj Sahay // European Journal of Operational Research, 1997. – 98(2). – pp 332-345.

15. Eisenbeis, R., Ferrier, G. and Kwan, S. (1999) The informativeness of stochastic frontier and programming frontier efficiency scores: Cost efficiency and other measures of bank holding company performance. Federal Reserve Bank of Atlanta Working Paper #99-23

16. Elyasiani, E., S. Mehdian and R. Rezvanian, 1994, An empirical test of association between production and financial performance: The case of the commercial banking industry, Applied Financial Economics, 4, 55–59.

17. Forsund, Finn R., (1999), "Effective dissemination of research", Presented at: 5th international conference of the Decision Sciences Institute [in Dissemination of Research in DEA and Ways of Improving Assessments of Efficiency], Athens, Greece, 7/4 to 7/7

18. Hunter, W. C. and S. G. Timme, (1986), "Technical change, organizational form, and the structure of bank productivity", Journal of Money, Credit and Banking 18, pp 152-166.

19. Hunter, W.C., Timme, S.G. and Yang, W.K. (1990), “An Examination of Cost Subaddivity and Multiproduct Production in Large U.S. Banks,” Journal of Money, Credit and Banking 22, 504-525.

20. Mester, L.J., 1993, Efficiency in the savings and loan industry, Journal of Banking and Finance, 17, 267–286.

21. Kumar, Sunil. Measuring efficiency, effectiveness and performance of Indian public sector banks [Text] / Sunil Kumar, Rachita Gulati. // International Journal of Productivity and Performance Management. – 2010. – Vol. 59, №1. – P. 51-74.

22. Lim, G. H. Competition, liberalization and efficiency: evidence from a two-stage banking model on banks in Hong Kong and Singapore [Text] / G. H. Lim, D. S. Randhawa. // Managerial Finance. – 2005. – Vol. 31, №1. – P. 52-77.

23. Lothgran, M. How to bootstrap DEA Estimators: a Monte Carlo comparison [Text] / M. Lothgran. – Stockholm school of economics. Working paper series in economics and finance. – № 223. – P.

24. Mello, E. G. P. Total Factor Productivity Growth, Technical Progress, and Technical Efficiency Change in the Brazilian Industry in 1996-2000: A Firm-level DEA Approach. / E. G. P. de Mello, P. B. R. Macedo – www.anpec.org.br/encontro2003/artigos/D35.pdf