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ASSESSMENT OF CAPITAL CONCENTRATION IMPACT ON THE BANKING SYSTEM EFFICIENCY UNDER MODERN TRANSFORMATION

Abstract. The article proposes methodological aspects of the banking system efficiency evaluating in the direction of the influence on capital concentration factor under modern transformation conditions. Capital efficiency was investigated as the dependence of Ukrainian banks' total income on the volume of its equity and liabilities on the basis of Cobb-Douglas nonlinear regression models for for data according Ukrainian banks' records for 8 years, which were classified into four groups by the size of regulatory capital and assets.

The bank`s inefficiency measure is calculated on the basis of real data and standart values for each factors as Euclidean space distance to the efficiency level.

The forecasted characteristics of banks' activity efficiency in groups using exponential smoothing methods and piecewise models are determined.

According to the results of the prognosis of the estimates of capital efficiency according to the model of piecewise linear regression, a general drop in the capital efficiency of the banking system as a whole in groups is envisioned.

To evaluate the overall efficiency of banks, the matrix "productivity — efficiency" was created. The obtained estimates confirm the uneven distribution of banks by quadrants, the absolute majority of which are concentrated in a quadrant with a critical level of efficiency. The implementation of the proposed toolkit on the basis of models of evaluation of the productivity and efficiency of the banks' allows us to identify banks that require a radical change in strategy, revision of the process of using resources with the aim of reduction of the dependence of banks' profitability on negative external influences.

Keywords: bank, banking system, capital concentration, efficiency, capital efficiency, econometric models, deposit corporations, nonlinear models.

JEL Classification C31, C51, G21

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ОЦІНКА ВПЛИВУ ФАКТОРУ КОНЦЕНТРАЦІЇ КАПІТАЛУ НА ЕФЕКТИВНІСТЬ БАНКІВСЬКОЇ СИСТЕМИ В СУЧАСНИХ ТРАНСФОРМАЦІЙНИХ УМОВАХ

Анотація. Запропоновано методологічні аспекти оцінки ефективності банківської системи в напрямі впливу фактору концентрації капіталу в сучасних трансформаційних умовах. Досліджено капітальну ефективність як залежність сукупного доходу банків України від обсягів власного капіталу і зобов'язань на основі побудови моделей нелінійної регресії Кобба — Дугласа для даних за банками України за вісім років, які класифіковано на чотири групи за розміром регулятивного капіталу і активів. Розраховано міру неефективності банку на основі реальних даних та еталонних значень для кожного з факторів як відстань в евклідовому просторі до межі ефективності групами. Визначено прогнозні характеристики ефективності діяльності банків за групами з використанням методів експоненційного згладжування і моделей із переключеннями. Відповідно до результатів прогнозу оцінок капітальної ефективності за моделлю кусково-лінійної регресії передбачено загальне падіння капітальної ефективності банківської системи в цілому за групами.

Для оцінки загальної ефективності банків побудовано матрицю «продуктивність — результативність». Отримані оцінки підтверджують нерівномірність розподілу банків за квадрантами, абсолютна більшість з яких сконцентрована у квадранті з критичним рівнем ефективності. Реалізація пропонованого інструментарію на основі моделей оцінки продуктивності та результативності діяльності банків дозволяє визначити банки, які потребують кардинальної зміни стратегії, перегляду процесу використання ресурсів з ціллю зменшення залежності прибутковості банків від негативних впливів зовнішнього середовища.

Ключові слова: банк, банківська система, концентрація капіталу, ефективність,

капітальна ефективність, економетричні моделі, депозитні корпорації, нелінійні моделі.
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ОЦЕНКА ВЛИЯНИЯ ФАКТОРА КОНЦЕНТРАЦИИ КАПИТАЛА НА ЭФФЕКТИВНОСТЬ БАНКОВСКОЙ СИСТЕМЫ В СОВРЕМЕННЫХ ТРАНСФОРМАЦИОННЫХ УСЛОВИЯХ

Аннотация. Предложены методологические аспекты оценки эффективности банковской системы в направлении влияния фактора концентрации капитала в современных трансформационных условиях. Исследована капитальная эффективность как зависимость совокупного дохода банков Украины от объемов собственного капитала и обязательств на основе построения моделей нелинейной регрессии Кобба — Дугласа для данных банков Украины за восемь лет, которые классифицированы на четыре группы по размеру регулятивного капитала и активов. Рассчитана мера неефективности банка на основе реальных данных и эталонных значений для каждого из факторов как расстояние в евклидовом пространстве до эталона эффективности. Определены прогнозные характеристики эффективности деятельности банков по группам с использованием методов експоненциального сглаживания и моделей с переключениями. В соответствии с результатами прогноза оценок капитальной эффективности по модели кусочно-линейной регрессии предсказано общее падение капитальной эффективности банковской системы в целом по всем группам.

Для оценки общей эффективности банков построена матрицу «производительность — результативность». Полученные оценки подтверждают неравномерность распределения банков по квадрантами, абсолютное большинство которых сконцентрировано в квадранте с критическим уровнем эффективности. Реализация предлагаемого инструментария на основе

моделей оценки эффективности и результативности деятельности банков позволяет выделить банки, которые нуждаются в кардинальной смене стратегии, пересмотра процесса использования ресурсов с целью уменьшения степени зависимости прибыльности банков от негативных воздействий внешней среды.

Ключевые слова: банк, банковская система, концентрация капитала, эффективность, капитальная эффективность, эконометрические модели, депозитные корпорации, нелинейные модели.

Формул: 2; рис.: 4; табл.: 3; библ.: 17.

Introduction. The topic of ensuring efficiency of the banking system in real conditions of the country economy functioning is very acute. Effective functioning of the banking system depends on the efficiency of monetary regulation of the economy, the efficiency of credit and settlement servicing of economic turnover, the stability of the activity of various economic entities, and others like that. Therefore, all techniques and tools that promote smooth operation of the banking system should be used effectively [1]. The effectiveness of the banking system can be considered in two strategic aspects: the economic and social-economic efficiency of each banking institution in particular; the banking system as a whole as factors contributing to the efficiency of the functioning of the socio-economic system [1, 6].

Negative tendencies in the development of the banking system of Ukraine, which, in particular, appear in the low profitability of assets due to their overall low quality, a high share of non-profitable assets in total assets of banks and unreasonably high business costs, put forward the problem of assessing the effectiveness of banking activities in the direction of the factor of concentration of capital influence and the formation of adequate tools for management, planning, choosing a development strategy. All the above mentioned emphasize the fact that the most important tasks being faced by the domestic banking sector today are related to the notion of the efficiency of the functioning of the banking system and its individual components under the influence of system factors such as aggregate bank revenues, equity capital and loan capital, the size of regulatory capital and assets [16, 17]. Consequently, researching the efficiency of the banking system is important due to the fact that it serves as an integral part and indicator of the security of the entire financial system of the country, and the factor of concentration of capital in the markets is decisive and systemically generating.

Analysis of research and problem statement. Problems of bank efficiency are given a lot of consideration by domestic and foreign scholars and practitioners, in particular: Dreksler L., Bolotin B., Gerasimovich A., Gromov L., Kirichenko O., Kochetkov V., Maslenchenkov Y., Panova G., Primosta L., Cherkasova V., Chetyrkin Ye., Yehorina E., Porter M., Coelli T. and others [1, 7, 12, 13]. In their writings, the researchers determine the efficiency of banks indicators, the methods of forming the boundaries of the effectiveness of systems, and analyze the advantages and disadvantages of using one or another method in modern practice. However, the development of methodological tools for evaluating bank efficiency and dimensional-dynamic diagnostics, taking into account the factors of increasing the concentration of capital and the growth of level of foreign capital, which are consistent with modern Ukrainian realities of transformation processes, are not considered sufficiently.

The aim of the work is to improve the methodology for assessing the efficiency of the banking system, taking into account the influence of the factor of concentration of capital on the basis of methods of multidimensional analysis, parametric and nonparametric methods that allow to perform an assessment of structural efficiency in conditions of a non-stationary external environment.

Research methods: production functions, construction of borders of the efficiency, method of level of development, adaptive methods of forecasting, models with switching. The object of the research — the processes of assessing the efficiency of the banking system as a component of financial security.

The information base of the research is the data of the financial reporting of banks provided by NBU [4, 10, 11], statistical data of the State Statistics Service of Ukraine [5, 11] and the Ministry of Finance of Ukraine [9]. The whole period of the research is divided into certain stages, which correspond to the dynamics of the transformational processes of the Ukrainian economy as a whole.

Research results. The purpose of the research is to evaluate, analyze and forecast the impact of the capital concentration factor on the efficiency of the banking system. The research paper analyzes the capital efficiency of banks in four groups: from the largest to the smallest, based on the methodology of NBU, by the size of the regulatory capital and assets. The result of this stage is the model of integrated assessment and the dynamics of capital efficiency.

Efficiency is considered through a combination of productivity and efficiency of the banking system. On the basis of the application of production functions, a performance matrix is formed — the performance by which the bank is included in one of four groups, for each of which the main directions of increasing the efficiency of banking activity are determined. The basic concepts of efficiency evaluation used in the work are the concepts of boundary methods [8], parametric and nonparametric analysis [14, 15]. The essence of the boundary methods [14, 15] for the analysis of efficiency is that the efficiency of the bank is compared with the limit of efficiency (or production capacity curve), which is determined by the most effective units of this class. Nonlinear analysis [8] is based on the equation with a certain average level in the given class, which is determined by the calculation of indexes or using the method of least squares.

The research algorithm has the following sequence: construction of the limits of efficiency; calculation of integral efficiency indicators based on parametric methods; analysis of the characteristics of the distribution of estimates of the capital efficiency of the banks.

Capital efficiency is considered as the dependence of the aggregate income of Ukrainian banks on the level of its own capital and loans on the basis of the Cobba-Douglas nonlinear regression function [8]:

$$Y = a_0 \cdot X_1^{a_1} \cdot X_2^{a_2}, \quad (1)$$

where a_0, a_1 і a_2 — model parameters, X_1 — level of the own capital, X_2 — volume of the loans.

The model allows to calculate theoretical values of one of the factors with given empirical values of the initial variable and the value of another factor. The calculation of requirements in one of the factors is necessary for constructing the limits of efficiency. The degree of inefficiency of the bank can be calculated on the basis of real data and standard value for each of the factors, which is defined as the distance in the euclidean space to the efficiency.

Generally, models have been constructed in APP Statistica [2] for the research period, their characteristics and adequacy are given in *Table 1*. The analysis of the above-mentioned criteria of statistical significance allows us to conclude that the models are highly adequate and that the results of modeling correspond to real data, and therefore confirms the hypothesis that changes in the banks' income have a significant dependence on the selected factors — the level of their own capital and loans.

Table 1

Dependence of aggregate income of banks of Ukraine on the function of Cobb — Douglas

Year	Coefficients of the model of production function	Adequacy (R2)
2009	$Y = 0{,}3882 \cdot X_1^{\,0{,}3271} \cdot X_2^{\,0{,}6127}$	0,9705
2010	$Y = 3{,}6802 \cdot X_1^{\,0{,}0361} \cdot X_2^{\,0{,}7605}$	0,9447
2011	$Y = 0{,}1665 \cdot X_1^{\,0{,}3949} \cdot X_2^{\,0{,}6481}$	0,9774
2012	$Y = 0{,}5664 \cdot X_1^{\,0{,}097} \cdot X_2^{\,0{,}8217}$	0,9565
2013	$Y = 1{,}8011 \cdot X_1^{\,0{,}1476} \cdot X_2^{\,0{,}7011}$	0,9349
2014	$Y = 0{,}2712 \cdot X_1^{\,0{,}4994} \cdot X_2^{\,0{,}5130}$	0,9341
2015	$Y = 4{,}7251 \cdot X_1^{\,0{,}0361} \cdot X_2^{\,0{,}7423}$	0,8936
2016	$Y = 10{,}7725 \cdot X_1^{\,0{,}0477} \cdot X_2^{\,0{,}6702}$	0,9111

In fig. 1 Diagram of the dynamics of changes in the coefficients of the model of production function with maximum, minimum and average estimates, and their comparative analysis.

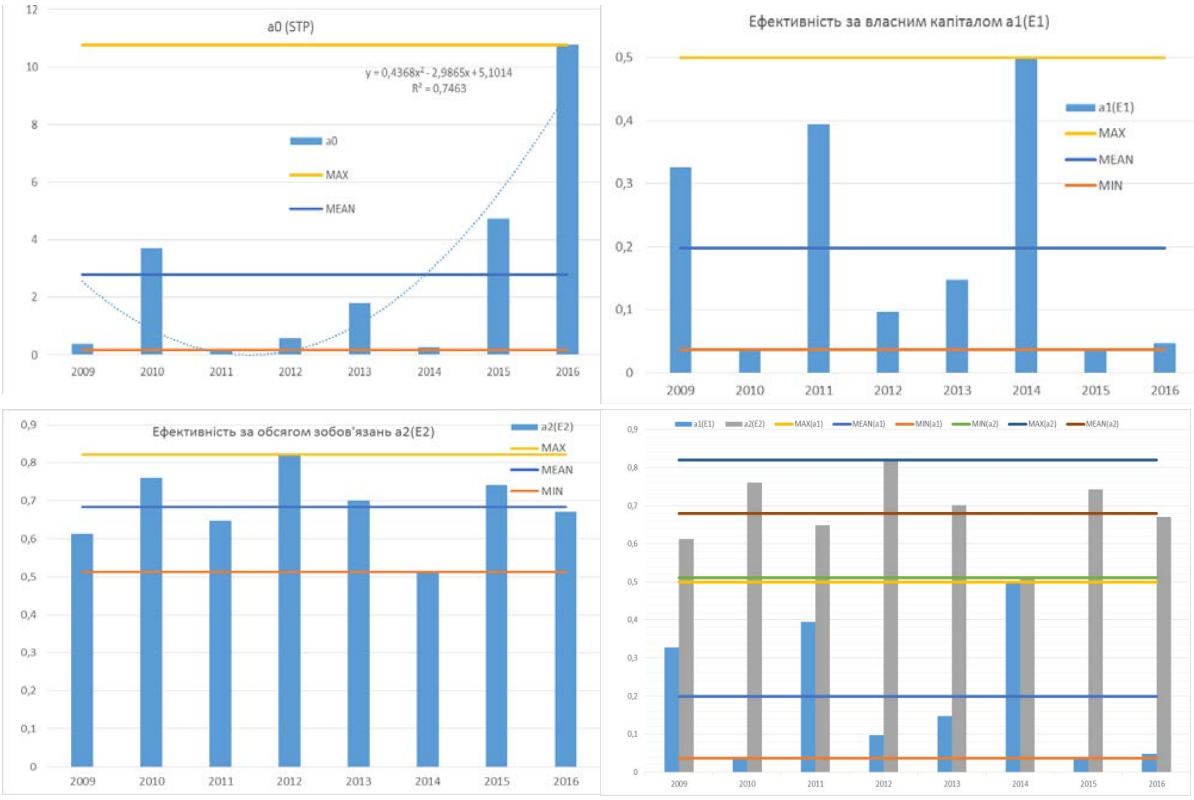


Fig. 1. Diagrams of dynamics of changes in the coefficients of the model of production function

They characterize the effectiveness of using the investigated factors of the amount of their own capital and loans to the bank's income. There is a significant difference according to the coefficient of elasticity to the increase of income of the bank in favor of the factor of loans.

Based on the results of the efficiency assessment, the average normed valuation of the efficiency of deposit-taking corporations of banks by groups with forecast estimates for trend models [8] (Fig. 2) was calculated.

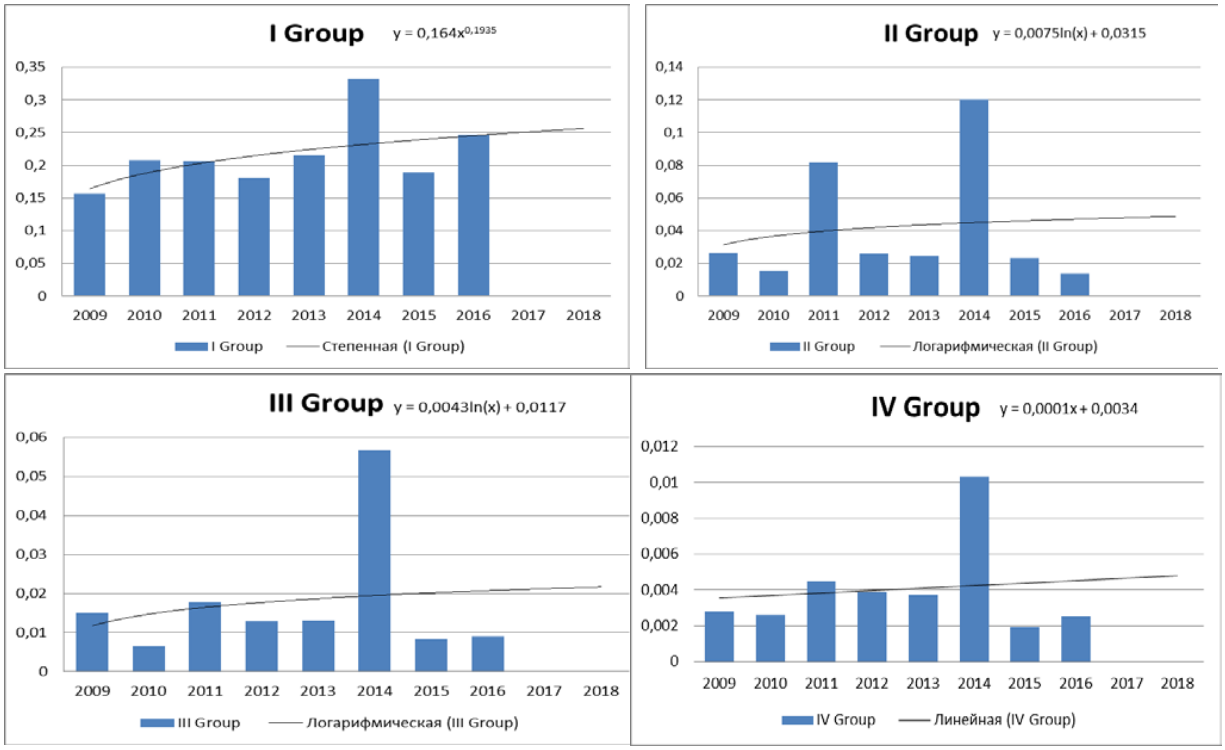


Fig. 2. **Average normed valuation of the efficiency of deposit-taking corporations by groups**

As can be seen from *Fig. 2*, there is a general decline in the efficiency of banks in all groups, especially over the last 2 years. Comparing the size of the banks, it's worth noting that the banks of the Group I are the most effective banks. However, the banks of Groups II—III are the most predictable, though less effective. Under normal circumstances, the high efficiency of "large" banks and the high rate of increase in the productivity of their operations are due to greater resource capabilities, which ensure the maintenance of highly skilled professionals, the use of promising and advanced technologies; widespread fiscal network; consolidated accounting and financial reporting that allows you to balance profits and losses within the network, etc. However, these same factors in the context of the crisis lead to a sharp decrease in the efficiency of work: a significant branch network involves significant initial costs and maintenance costs, which has led to the need to close a large number of branches and departments in crisis conditions; the expanded customer base has led to the emergence of a large hundred of troubled loans.

Methods of exponential smoothing and switching models [8] were used to determine the forecast performance characteristics of banks' activity. Estimates of the parameters of the resulting piecewise-linear regressions are given in Table 2.

Table 2

Results of the estimation of parameters of the model of the piecewise linear regression of the average normed estimates of the efficiency of deposit-taking corporations by groups

	I	II	III	IV
R	0,945709	0,993850	0,986780	0,972866
R^2	0,894366	0,987738	0,973736	0,946469
B0	0,180592	0,024590	0,012767	0,003260
t	0,003345	-0,000675	-0,000426	-0,000078
B0	0,586880	0,043650	-0,021268	-0,001308
t	-0,042479	0,012796	0,013008	0,001940
Breakpoint	0,2170	0,0415	0,0175	0,0040

The coefficients of determination confirm the adequacy of the constructed models, the regression equation for each of the groups will have the following form:

$$\text{for Group I: } \hat{y}_t = \begin{cases} 0{,}180592 + 0{,}003345 \cdot t, \text{якщо } y_t \le 0{,}2170, \\ 0{,}586880 - 0{,}042479 \cdot t, \text{якщо } y_t > 0{,}2170; \end{cases} \quad (2)$$

$$\text{for Group II: } \hat{y}_t = \begin{cases} 0{,}024590 - 0{,}000675 \cdot t, \text{якщо } y_t \le 0{,}0415, \\ 0{,}043650 + 0{,}012796 \cdot t, \text{якщо } y_t > 0{,}0415; \end{cases}$$

$$\text{for Group III: } \hat{y}_t = \begin{cases} 0{,}012767 - 0{,}000426 \cdot t, \text{якщо } y_t \le 0{,}0175, \\ -0{,}021268 + 0{,}013008 \cdot t, \text{якщо } y_t > 0{,}0175; \end{cases}$$

$$\text{for Group IV: } \hat{y}_t = \begin{cases} 0{,}003260 - 0{,}000078 \cdot t, \text{якщо } y_t \le 0{,}0040, \\ -0{,}001308 + 0{,}001940 \cdot t, \text{якщо } y_t > 0{,}0040. \end{cases}$$

For comparison Table 3 represents the value of absolute percentage error (m.a.p.e.) for the models of piecewise linear regression and exponential smoothing. According to the results of calculations (Table 3), in all cases, when constructing the forecast, preference is given to models of piecewise linear regression.

Table 3

Average absolute percentage error for models of piecewise-linear regression and models of exponential smoothing

	I	II	III	IV
Piecewise Linear Regression	12,2	17,29	19,46	15,94
Exponential Smoothing Grid Search Results				
NoTrend	15,94	98,23	69,03	47,65
LinearTrend	14,02	47,42	47,47	38,66
Exponential	25,69	50,55	55,15	37,31
DampedTrend	13,23	67,44	63,05	71,08

The best quality of the piecewise linear regression model is for the first group of banks. The forecast on the model of piecewise linear regression is shown in Fig. 3. The analysis of the estimates of capital efficiency for 2015—2016 and their predictive values indicate a significant drop in the capital efficiency of the banking system.

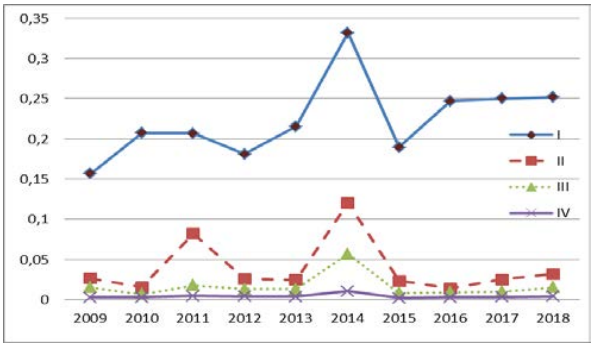


Fig. 3. Diagram of average normed performance of banks with predictions for groups according to the model of piecewise linear regression

The fastest pace (-34.39% over two years) of lowering of performance rates will have the first group of banks. Also, the decline will be observed for the third group of banks (-6.04% for 2017—2018). In two years, the capital efficiency of banks in the second and fourth groups should increase slightly (by 28.94% and 0.87% respectively). The conducted analysis of capital efficiency

allows us to conclude that banks gradually increase efficiency in the direction of stabilization of their own activities after the crisis phenomena of 2013—2014 years, but at the current moment show a decrease in efficiency compared to the turning point of 2014.

In accordance with the general concept of research for solving problems of determining areas for improving the efficiency of banks — using parametric methods of efficiency evaluation, method of level of development, production function and heuristic methods at the following stages: the formation of a system of indicators of productivity and efficiency of the banks; assessment of the productivity of the banks; assessment of the efficiency of the banks; comparison of evaluation results; development of recommendations for selecting areas for improving the efficiency of banking institutions.

According to the performance of the banking system, loans and customer debts were taken into account, and interest and commision costs were chosen as factors. In the model of performance evaluation, net profit / loss of the bank is a resultant change, and factors - loans and debts of legal entities and individuals [3]. In the models, the evaluation takes place according to the production function. As a result, the matrix "productivity - efficiency" is constructed, which has four quadrants: the most effective banks; effective enough; not effective; critical.

The received quadrants mutually exclude each other by their character and are separated by average values (mediums) of the evaluations of productivity and efficiency at the choice. Thus, the quadrant to which the i-th bank (Ef_Bi) has got into is determined in the following way:

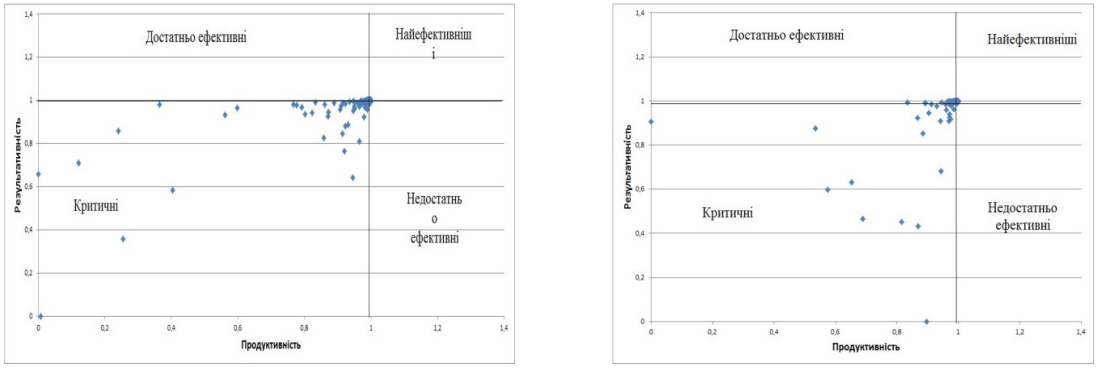
most profitable if

$$Ef\_Bi = \begin{cases} the\ most\ tffective\ if\ \Pi i \geq Med(\Pi)iPi \geq Med(P); \\ effective\ enough\ if\ \Pi i < Med(\Pi)iPi \geq Med(P); \\ not\ fective\ enough\ if\ \Pi i \geq Med(\Pi)iPi < Med(P); \\ critical\ if\ \Pi i < Med(\Pi)iPi < Med(P); \end{cases}$$

where *Med (П)* and *Med (P)* — respectively, are the measure of productivity and fficiency across the entire combination of investigated banks; $П_i$, R_i — evaluation of productivity and efficiency of *i*-th bank

When assessing the activity of banks in Ukraine as a whole, it should be noted that the average level of productivity increases, which allows us to draw conclusions about the optimization of their activities, but the average level of productivity has a steady tendency to decrease. That is, the priority direction of increasing efficiency is to reduce the risk of decline in the performance due to the increase of external conditions of functioning by improving the productivity.

In fig. 4 productivity-efficiency matrices in 2009 and 2016 are represented.



2009 2016

Fig. 4. Matrix "Productivity-Efficiency" based on the results of the assessment of the activities of banks

Each point in the picture reflects the position of a separate bank.

Thus, banks that fall into a quadrant with a critical level of efficiency need a radical change in strategy, reviewing the use of resources in order to minimize the recruitment of initial resources and maximize the volume of banking products at the outcome; review pricing policies for banking products with the aim of reducing the dependence of profitability on negative external influences. For banks that fall into a quadrant with a fairly high level of efficiency, it is expedient to continue the chosen development strategy in case of optimization of the use of resources, innovations, production of bank products; In order to ensure competitiveness and future development, it is necessary to increase the productivity of the activity while leaving prices at the current level.

Conclusions. As the issue of ensuring a sufficient level of efficiency of the banking system in the real conditions of functioning of the economy of the country is very acute, all the techniques and tools that facilitate the smooth operation of the banking system should be used effectively. The successful solution of the tasks of ensuring the efficiency of the banking system, first of all, requires the use of methods for determining the various aggregate efficiency characteristics, estimating and forecasting of the system and its elements in order to prevent the crisis phenomena and early implementation of measures to eliminate them, the effectiveness of which depends on the effectiveness of the monetary the regulation of the economy, credit-settlement service of economic turnover, the stability of the activity of various business entities, etc.

In this work, models of capital efficiency evaluation were implemented, which established the following gradations: the most effective banks are the largest banks, however, the most predictable, although less effective, are large and medium-sized banks.

The application of models of productivity appraisal and performance of the banks allowed banks to be identified that require a radical change in strategy, reviewing the process of using resources in order to minimize the recruitment of initial resources and maximize the volume of banking products at the outlet; review pricing policies on banking products with the aim of reducing the dependence of banks' profitability on negative externalities.

The results of the work can be implemented in banking regulation and supervision at the macroeconomic level in order to increase the level of reasonableness and efficiency of making managerial decisions.

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