



Assessment of digital banks' performance

Evaluación de desempeño de la banca digital

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ABSTRACT:

One of the innovative forms of a financial institution – digital banks – is reviewed in this article. Performance evaluation is one of the main tasks in banks of a new type. No single approach to this evaluation exists today. Methods and models used to evaluate the efficiency of financial institutions are analyzed in this article. After the conducted analysis, methods based on the development of econometric models are proposed as basic approaches for evaluating the efficiency of digital financial institutions. Their applicability to evaluating the efficiency of digital banks are analyzed in this study. An econometric model with a variable structure is proposed on the basis of the conducted study, which allows evaluating the performance of digital financial institutions. Factors influencing the performance of a digital financial institution are identified, based on the proposed model, the main of which being the size of the financial institution determined by its assets, bank's information department headcount, and the size of the client base; all other parameters such as age of a financial institution are insignificant in terms of their influence on the efficiency of a digital financial institution.

Keywords: innovations, digital banks, efficiency, econometric model with variable structure.

RESUMEN:

Una de las formas innovadoras de una institución financiera, los bancos digitales, se revisa en este artículo. La evaluación del desempeño es una de las tareas principales en los bancos de un nuevo tipo. Hoy no existe un enfoque único para esta evaluación. En este artículo se analizan los métodos y modelos utilizados para evaluar la eficiencia de las instituciones financieras. Después del análisis realizado, se proponen métodos basados en el desarrollo de modelos econométricos como enfoques básicos para evaluar la eficiencia de las instituciones financieras digitales. Su aplicabilidad para evaluar la eficiencia de los bancos digitales se analiza en este estudio. Se propone un modelo econométrico con una estructura variable sobre la base del estudio realizado, que permite evaluar el desempeño de las instituciones financieras digitales. Los factores que influyen en el desempeño de una institución financiera digital se identifican, según el modelo propuesto, el principal de los cuales es el tamaño de la institución financiera determinado por sus activos, el personal del departamento de información del banco y el tamaño de la base de clientes; Todos los demás parámetros, como la edad de una institución financiera, son insignificantes en términos de su influencia en la eficiencia de una institución financiera digital.

Palabras clave: innovaciones, bancos digitales, eficiencia, modelo econométrico con estructura

1. Introduction

Emergence of neobanks was a landmark in the creation of a new business model for future digital banks using only remote access channels for customer service through modern hardware and software. The number of network banks has increased several times over the past few years and today amounts to over 800 credit organizations (Casu 2016; Larsson 2017).

One of the main tasks in the banking sector is to evaluate the efficiency of financial institutions. There are quite a few dimensions in this area, and lots of methods have been created to evaluate the economic efficiency of the bank's activities: for example, these methods are described in the works of the following authors: Akinboade and Makina (2010); Ikhsanova and Protsko (2016); Wheelock and Wilson (2017), but it must be noted that there are almost no papers that allow to evaluate the digital bank performance today.

The methods proposed for evaluating traditional financial institutions cannot be used in full, because despite being a credit institution, a digital bank can be and is often regarded as an IT company that provides financial services to a greater extent. Due to this, new approaches in the field of evaluating the network banks' performance should be found (The challenge for the challenger banks; Tripathi 2017).

Econometric modeling is one of such approaches to evaluating the digital banks' efficiency, which allows to evaluate the contribution of certain parameters of a credit institution to improving the performance of the financial institution.

The aim of the study is to build an econometric model to evaluate the digital bank performance expressed as the profit of a credit institution from the key characteristics of a financial institution.

The following tasks should be solved to achieve this goal:

- conduct a comparative analysis of approaches to evaluating the efficiency of financial institutions;
- define the parameters influencing the assessment of the digital bank efficiency;
- collect a database for conducting an econometric study on evaluating the digital banks' performance;
- formulate the econometric model specification for analyzing the network banks' performance evaluation;
- analyze the influence of parameters describing the digital financial institution on its performance.

Solution of the above tasks should result in an econometric model, which allows to analyze and evaluate the digital bank performance from its parameters.

2. Key theoretical aspects of the problem

2.1. Definition of the financial institution efficiency

One of the main tasks of the modern studies is to evaluate the performance of financial institutions.

There are many definitions of the economic efficiency today. Let us consider several definitions that are most often found in the scientific literature (Valipour 2017).

Economic efficiency is the result of the economic activity, economic programs, and measures described by the ratio of the economic effect obtained to the cost of factors and resources that secured this result and the greatest volume of production using resources of a certain value (Rudskaia 2017; Sun 2017).

Economic efficiency is the correlation between the expenses for rare resources, on the one

hand, and the volume of goods produced or services provided by using them, on the other hand; the production of a certain value under the least expenses of the resources; the greatest volume of goods production or service provision by using resources of a certain value (Buevich 2017; Valickova 2015).

According to the above definitions, the economic efficiency of any company represents the achievement of an economic result expressed as profit by using a certain amount of resources (Sorokin 2016; Budanov, 2017).

When the efficiency of a banking organization is considered, the problem of its evaluation is always complicated by a number of aspects that need to be addressed (Reddi 2016; Zineldin 2015).

Firstly, a financial institution is a multiproduct company the performance of which cannot be evaluated without analyzing its goals. (Kiseleva, 2017; Morozova, 2017)

Secondly, financial institutions are a complex system that has no clear distinction between variables describing the performance of a credit institution (Berger 1997; Lavrushin 1996).

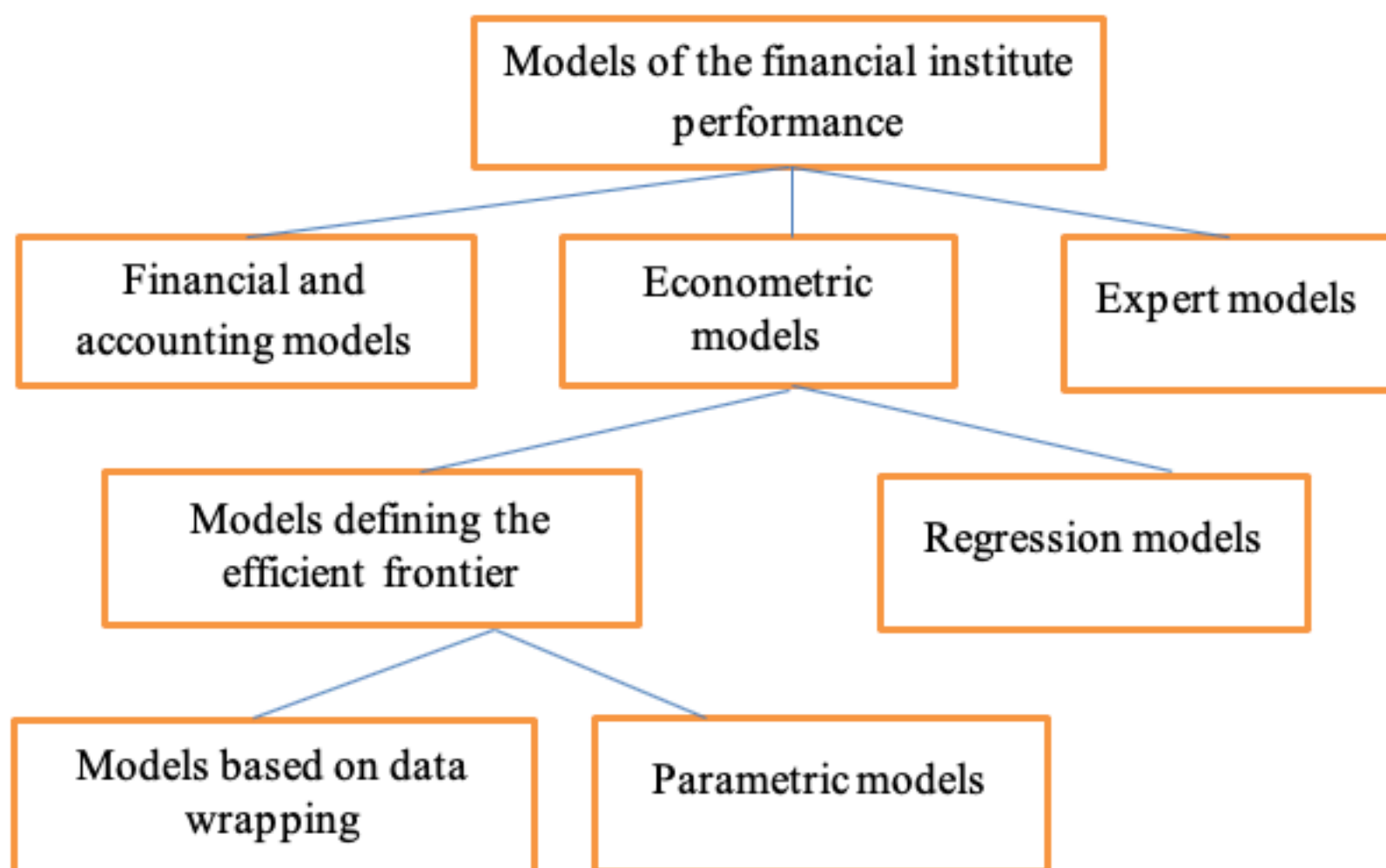
Despite the organizational complexity of a financial institution, its economic efficiency can also be considered as a result of maximizing profits using the optimal amount of resources (Orazalin 2016; Pradhan 2014).

2.2. Approaches to evaluating the performance of a financial institution

Three main approaches have been formed that allow for the economic efficiency of a credit institution in the current context (Figure 1) (Berger 1993; Mead 2016).

Figure 1

Classification of models for evaluating the performance of financial institutions



The following models determining the financial institutions performance can be highlighted:

- financial and accounting models that allow to evaluate the bank performance on the basis of financial and accounting statements;
- econometric models that allow to evaluate the bank performance on the basis of econometric analysis using various econometric constructions; and

– expert models based on evaluation involving highly qualified professionals from the financial sector.

Each of these approaches has advantages and disadvantages that determine their use in a certain situation (Louzis 2012; Shvetsova, 2018).

The models based on financial statements are quite simple, but they provide only a specific insight without a probabilistic assessment of results.

The expert methods are the most often applicable in performance evaluation, but at the same time not without drawbacks – in particular, of subjectivity in evaluations (Buevich 2014; Ikhsanova 2016).

The econometric models have recently been applied more and more often. Despite the construction difficulties, they provide objective information, which can help understand the current situation and also build long-term trends (Mester 1997; Yeremenko 2016).

Econometric analysis of the financial institutions' performance is reflected in the papers of many foreign authors: A.N. Berger, A. Bhattacharya, G.D. Ferrier, D.B. Humphrey, W.C. Hunter, S.H. Kwan, L.J. Mester, and S.G. Timme.

Results in the financial sector are also studied in numerous papers of the domestic scientists: S.Y. Buevich, O.I. Lavrushin, V.S. Lviv, M.Y. Matovnikov, A.A. Peresetskiy, and A.A. Zamkovoy.

A large number of studies in the evaluation of financial institutions performance indicates considerable interest in this field – both scientific and practical (Belin 2011; Chen 2014).

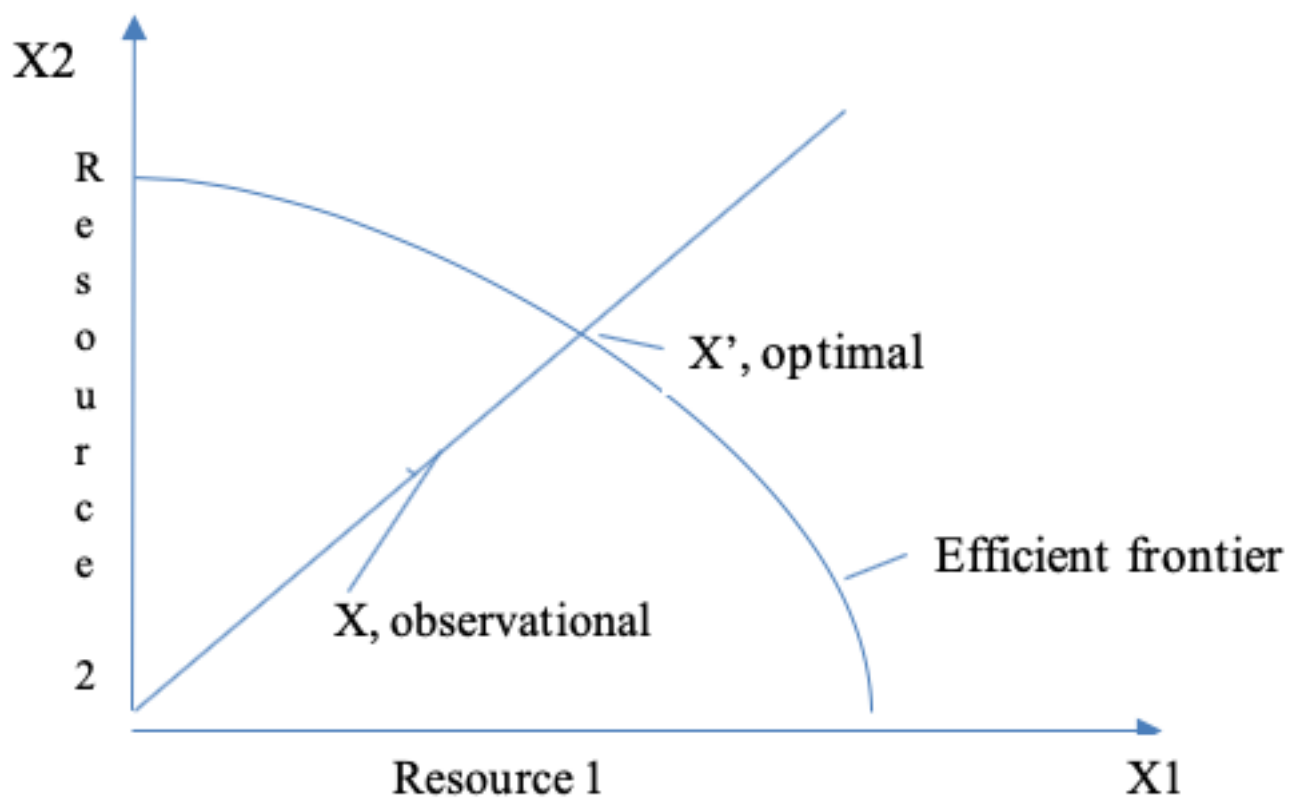
2.3. Choosing a model for evaluating the digital bank performance.

There are two large groups of econometric models that allow to evaluate the performance of a financial institution. They are models that define the efficient frontier in the banking sector, against which indicators of credit institutions and regression models are considered, which allow to determine the contribution of each parameter describing a financial institution in performance (Kwan 1996; Malikov 2016).

The approach based on the consideration of a bank as a profit-oriented intermediary is often regarded as an evaluation of performance of credit institutions. In this case, the financial institution is represented as a financial system that raises monetary resources and issues them as loans in order to obtain maximum profit (Menicucci 2016; Wheelock 2017).

Models based on the definition of the efficient frontier are quite complex and involve the construction of the efficient frontier for the majority of credit institutions operating as efficiently as possible, i.e. receiving the most profit. In this case, the distance of each individual financial institution to the efficient frontier can be found and its specific indicators relative to the obtained frontier can be determined (Figure 2) (Akinboade 2010; Giordani 2014).

Figure 2
Defining the efficient frontier



Stochastic frontier models are used when building the models defining the efficient frontier, using the following translogarithm function (Chen 2014; Kwan 1996):

$$f(X, b) = b_0 + \sum_{i=1}^n b_i \ln(X_i) + 1/2 * \sum_{i=1}^n \sum_{j=1}^n b_{ij} \ln(X_i) \ln(X_j), b_{ij} = b_{ji} \quad (1)$$

where

b_0, b_i are the coefficients used for determination, and X_i is the input parameters.

Efficient frontier construction is quite challenging and labor-intensive. Building such econometric models allows to evaluate the performance of any financial institution, but the creation of such models is subject to many conditions that must be met when building the models. For example, a large amount of panel data is required for obtaining the necessary econometric modeling results, i.e. data distributed over long time (Malikov 2016; Wheelock 2017).

Regression models are the simplest models in econometric studies, but quite efficient in terms of analyzing trends and indicators that influence performance evaluation and ensure forecasts based on econometric models for specific financial institutions (Bolch 1979; Mester 2003).

A multidimensional regression model can be represented as follows:

$$Y = b_0 + \sum_{i=1}^n b_i * X_i + \varepsilon \quad (2),$$

where

X_i are the independent variables (argument factors),

b_0, b_i are a set of $(n+1)$ parameters of the model to be determined,

ε is the random deviation (error), and

Y is the dependent (explanatory) variable.

It is more expedient to use a regression model to evaluate the digital banks' efficiency, as it allows to evaluate the influence of all the parameters considered in the model on profit and requires no stringent conditions and restrictions, unlike the stochastic frontier models.

The task of this study is to evaluate factors influencing the digital bank performance evaluation as a poorly understood structure that lacks standard approaches for research. Despite its relative simplicity, a regression model can be an efficient way to evaluate the performance of financial institutions, allowing for forecasting in the credit institution operation.

The performed analysis results in a suggestion that there is a linear relationship between the

digital bank's profit and its parameters, namely its equity, which determines the bank size, the ratio of the IT department headcount to the size of the bank equity, the number of clients of a financial institution, and the bank's age, which allows to build a multidimensional regression model.

Based on the constructed model, contribution of each parameter to the formation of the digital bank's profit can be determined, and, consequently, the criteria for evaluating the performance of the financial institution can also be determined.

3. Data and research method

3.1. Definition of input and output model parameters

Input and output variables should be defined to start building the model.

Profit is taken as the only output variable in determining the digital bank efficiency.

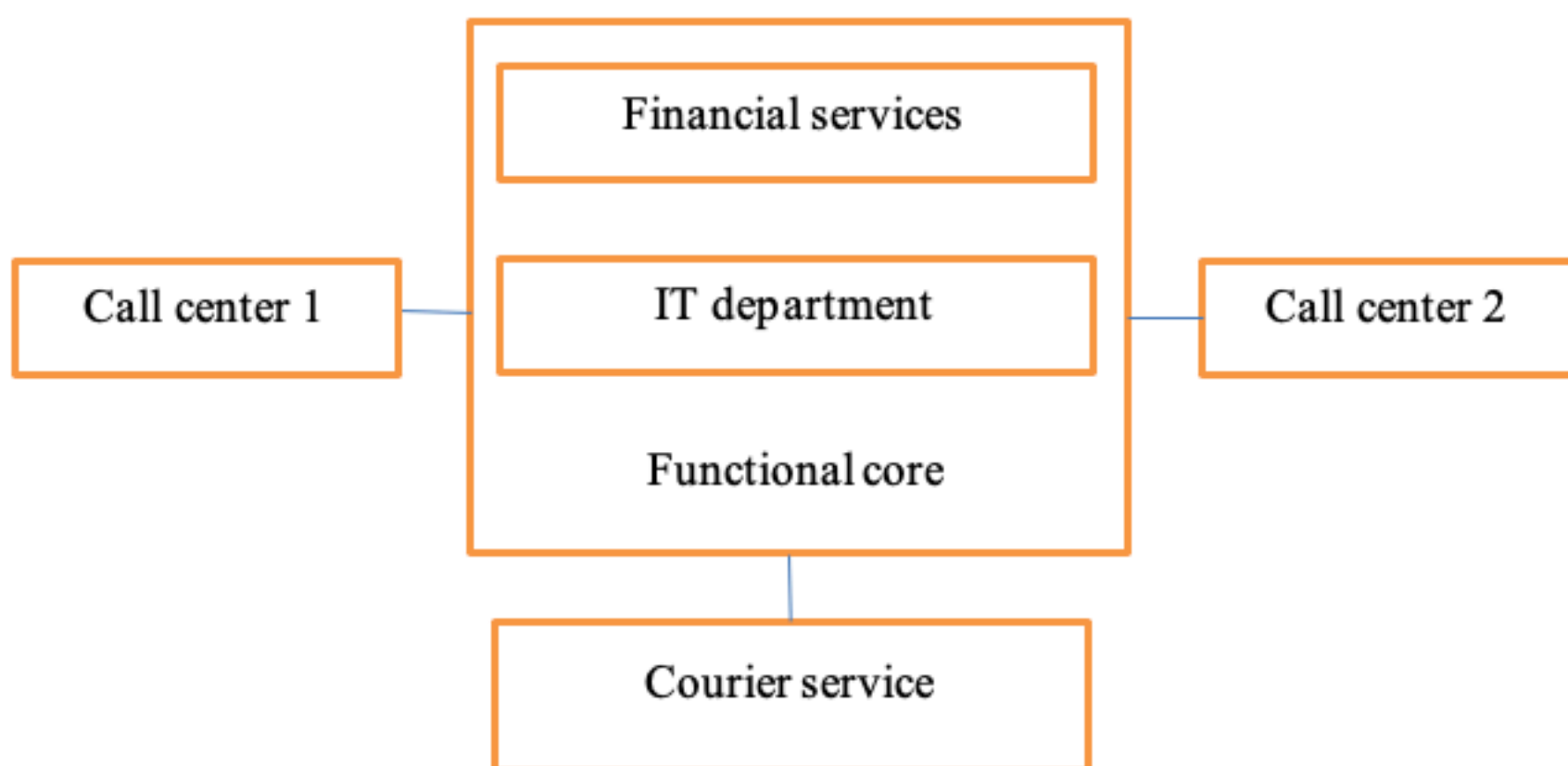
The following parameters are taken as input variables that influence the digital bank profit creation:

Firstly, it is the total volume of assets as a parameter reflecting the size of the digital institution.

Secondly, it is the IT department headcount to the bank assets. This parameter is used to assess the impact of information technology on the formation of a digital bank's profit, it is required for the analysis of the functional core of a digital financial institution, which determines its IT identity and allows to evaluate the information component (Ikhsanova 2016; Kuznetsova 2016).

This parameter can be clarified by considering the largest independent digital bank in the world in terms of the number of customers – Tinkoff Bank JSC. The organizational structure of Tinkoff Bank is presented in Figure 3 (Nikolova 2017; Yablonsky 2014).

Figure 3
Organizational structure of digital Tinkoff Bank JSC



The structure of the financial institution includes the following: IT department, which secures the entire operation of the digital bank; financial services directly responsible for the financial component of the credit organization; two call centers that support clients; and a courier service for the delivery of financial documents to the bank clients (Orazalin 2016; Rodionov 2017).

The IT department and financial services are the functional core of the digital bank, which is responsible for its performance (Starostin 2016).

The total headcount of Tinkoff Bank is about 12,000 people, the total number of call-center employees is 9,000 people, and the courier department is about 2,000 people. The functional core of the bank includes one thousand people, from which the IT department includes 580 people, so the IT department makes up most of the functional core (Orazalin 2016).

The number of IT staff in the modern digital banks (so-called neobanks) can be up to 80 % of the entire headcount, but they completely lack courier services and telephone support. This is why the IT department headcount is considered as a total figure for all digital banks (Starostin 2016).

Thirdly, the size of the client base of the financial institution, as a parameter that has a direct impact on bank profits.

Fourthly, the bank age: a clear relationship is assumed between the age and the performance of the financial institution.

The model specification is presented in Table 1.

Table 1
Specification of the model for evaluating
the digital banks' performance

Variable	Variable type	Units	Characteristics
Y	Output	million dollars	Bank profits
X1	Input	million dollars	Bank total assets
X2	Input	people/million dollars	IT staff headcount to bank assets
X3	Input	million people	Size of the bank client base
X4	Input	years	Bank age

3.2. Description of the model for evaluating the digital bank performance

The model for evaluating the bank performance can be described by the following equation:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 \quad (3)$$

where

b_0, b_1, b_2, b_3, b_4 are the factors to be determined,

X_1, X_2, X_3, X_4 are the input variables.

There is a concept of multicollinearity in multidimensional regression models, which influences the reliability of the data obtained using the econometric model. A natural logarithm of the bank total assets reflecting the size of the financial institution is taken to reduce this effect (Akinboade 2010).

In this case, the model is as follows:

$$Y = b_0 + b_1 \ln X_1 + b_2X_2 + b_3X_3 + b_4X_4 \quad (4)$$

To consider the quality characteristics that influence the digital bank's profits, its legal independence should be reviewed, i.e. whether a digital bank is an independent organization

or was created with the support of a traditional financial institution, and, therefore, is supported by it.

To include this parameter in the model, let us proceed to the regression model with a variable structure and introduce a dummy variable. Then the model can be represented as follows:

$$Y = b_0 + \alpha_1 D_1 + b_1 \ln X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 \quad (5)$$

where $D_1 = \begin{cases} 1, & \text{bank is affiliated} \\ 0, & \text{bank is independent} \end{cases}$

D_1 is a dummy variable that determines the affiliation or independence of a digital bank in relation to traditional financial institutions.

3.3. Theoretical, methodological and informational aspects of the study

The theoretical basis of this work consisted of the numerous studies of foreign and domestic scientists in econometric modeling of the evaluation of financial institutions and banking systems performance.

The developed econometric model is based on the multifactor regression analysis, which allows to evaluate the key parameters that influence evaluation of the digital banks' performance.

A nonlinear parameter is introduced to the econometric model to improve its quality and reduce the multicollinearity effect. (Balashova, 2017; Kosnikov, 2017)

To evaluate the impact of qualitative indicators on the evaluation of the digital banks' performance, the econometric regression model is transformed into a model with a variable structure by including a dummy variable, which allows to estimate the effect of the corresponding variable on the model structure (Bain and company).

The informational basis of the study includes statistical data of the Central Bank of the Russian Federation, the Central Bank of Great Britain, the US Federal Reserve Service, websites of financial institutions, and data of consulting companies (Bank of England; Bank of Russia).

Performance indicators of 61 digital bank are used to build the model, including financial parameters, along with the index of the network bank affiliation with traditional financial institutions (Federal Reserve System, n.d).

The statistical data is processed using computer technology and the modern software applications, namely with a specialized software application for processing statistical data Statistica 13.2 and MS Excel spreadsheet processor (Mamrayeva, 2018; Rybyantseva, 2017).

4. Results

When the econometric model with a variable structure was built to evaluate the performance of digital banks, a study of the presence of multicollinearity in the model was conducted first of all. The multicollinearity effect implies the existence of a relationship between the input variables, which may reduce the reliability of the results obtained from the econometric study in some cases.

For this purpose, a correlation analysis of input parameters of the model with a variable structure was carried out to provide the results presented in Table 2.

Table 2
Results of the correlation analysis
if multicollinearity is present

Variable	X1	X2	X3	X4
X1	1	0.19436	0.79579	0.58973
X2	0.19436	1	0.60468	0.47548
X3	0.79579	0.60468	1	0.62052
X4	0.58973	0.47548	0.62052	1

A nonlinear parameter – natural logarithm of a digital bank's equity – was introduced to reduce the multicollinearity effect. Results obtained from the correlation analysis are presented in Table 3.

Table 3
Results of the correlation analysis following the measures to reduce multicollinearity

Variable	X1	X2	X3	X4
X1	1	0.058826	0.67715	0.59108
X2	0.058826	1	0.60468	0.47548
X3	0.67715	0.60468	1	0.62052
X4	0.59108	0.47548	0.62052	1

The following results of the study of statistical data on digital banks were obtained for a variable structure model.

Table 4 presents the results of regression statistics.

Table 4
Regression statistics

Regression statistics	
Multivariate R	0.942286697
R-squared	0.887904219
Normalized R-squared	0.877713693
Standard error	8.805124128
Observations	61

Results of analysis of variance are presented in Table 5.

Table 5
Indicators of analysis of variance

	df	SS	MS	F	Significance of F

Regression	5	33776.17816	6755.235633	87.13036574	7.13536E-25
Remainder	55	4264.1616	77.53021091		
Total	60	38040.33976			

Tables 6 and 7 present the parameters of coefficients of the regression model with a variable structure.

Table 6
Values of the coefficients in the model

Coefficients	Values	Standard error	t-statistics	P-value
b0	-84.20602452	26.19112737	-3.215059182	0.002184604
a1	2.405458643	2.998714878	0.802163174	0.425911082
b1	15.48623461	5.062108475	3.059245901	0.003425548
b2	7.753286152	2.027679439	3.823723811	0.000337443
b3	5.840855021	1.229733238	4.749692731	1.49958E-05
b4	1.052747245	0.633582108	1.661579821	0.102287366

Table 7
Confidence intervals for the coefficients in the regression model

Coefficients	Lower 95 %	Higher 95 %	Lower 95.0 %	Higher 95.0 %
b0	-136.6942167	-31.71783235	-136.694	-31.71783235
a1	-3.604100264	8.415017551	-3.6041	8.415017551
b1	5.341542523	25.63092669	5.341543	25.63092669
b2	3.68972575	11.81684655	3.689726	11.81684655
b3	3.376414541	8.305295501	3.376415	8.305295501
b4	-0.216979673	2.322474162	-0.21698	2.322474162

The following model for evaluating the digital banks' performance was obtained as a result of the study:

$$Y = -84,21 + 2,41D_1 + 15,49LnX_1 + 7,75X_2 + 5,84X_3 + 1,05X_4 \quad (6)$$

The significance of the coefficients in the model for evaluating the digital banks' performance was found using the Student t-test. The obtained results are presented in Table 8.

Table 8
Characteristics of significance of the coefficients in the econometric model

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Coefficients	Significance
b0	significant
b1	significant
b2	significant
b3	significant
b4	insignificant
a1	It is considered whether the coefficient is positive or negative

The standardized regression coefficients were calculated to find the degree of influence of each parameter on the output variable, and their values are provided in Table 9.

Table 9
Values of the standardized regression model coefficients

Coefficients	Values
b'1	0.271340954
b'2	0.319223028
b'3	0.461818993

5. Discussion

An econometric model with a variable structure has been obtained as a result of the study, which allows to evaluate the performance of digital banks.

As a result of the study, a linear relationship between the digital bank's profits and its parameters has been confirmed – namely, between the equity of a financial institution, which determines the size of a credit institution, the ratio of the IT department headcount to equity capital of a financial institution, and the number of the bank clients. The influence of the parameter determining the bank age on its profits has not been confirmed.

Multicollinearity has been revealed in the model under consideration as part of the correlation analysis, which is determined by the value of the pairwise correlation coefficient R_{ij} , which reached 0.8 in the correlation matrix for X_1 and X_3 – this indicates a rather high correlation, which should be less than 0.7 to leave correlation within acceptable limits. Multicollinearity can significantly distort the results of the econometric study. A nonlinear parameter of natural logarithm of the digital bank's equity has been introduced into the model to reduce the multicollinearity effect, which allowed to reduce the pairwise correlation coefficient to 0.67. This suggests a decrease in multicollinearity to an acceptable level in the econometric model.

The characteristics of the model, including the coefficient of determination, reach 0.88, which indicates a high degree of influence of the input parameters: digital bank's equity, the ratio of the IT department headcount to equity capital of a financial institution, and the number of the bank clients on the output variable – the financial institution's profit. The significance of the coefficient of determination is confirmed by the F test, the value of which

is significantly higher than the critical index, which confirms the qualitative indicators of the model.

Coefficient α_1 appeared positive as a result of the analysis of the resulting model for evaluating the digital banks' performance, which indicated that the average profit of affiliated banks is higher than that of independent ones. This can be explained by some kind of support from the classic parent bank that such banks enjoy.

Coefficient b_1 appeared significant, which indicated that the size of a digital bank had a direct influence on the amount of profit.

Coefficient b_2 appeared significant, which indicated a significant influence of the bank's IT department on the size of the profit indicators, which once again confirmed that digital banks were quite close to IT companies in terms of indicators.

Coefficient b_3 also appeared significant, which confirmed the influence of the client base size on the digital bank performance, because profits depended on the number of clients' transactions.

Coefficient b_4 appeared insignificant, which indicated that the age of a digital bank did not influence its profits, and, consequently, its efficiency. This was most likely due to the short existence of digital banks, as well as a fairly dynamic change in the situation on the market of digital financial institutions.

Based on the standardized coefficients of the econometric model for evaluating the digital bank performance, it was found that the number of clients of a financial institution influenced its profits the most.

6. Conclusion

New forms of financial institutions have emerged over the past few years – digital banks, the business models of which are largely based on providing services to clients mainly through remote access channels: the Internet and mobile apps. Evaluation of the performance of such financial institutions is under development.

As a result of the study, approaches for evaluating the performance of financial institutions have been identified, based on the creation of financial and accounting models, using econometric models and expert assessments models.

Based on the comparative analysis of the presented approaches, it has been found that the creation of econometric models is most efficient in terms of forecasting and objectivity and allows to evaluate the performance of credit institutions.

The analysis of econometric models has revealed that there are two large groups of econometric models that allow evaluating the performance of financial institutions: the models based on the determination of efficient frontiers and regression models.

The models that determine efficient frontiers are quite complex and require lots of statistical data, both in terms of financial institution's indicators and in the time range, but they also allow to determine a sufficiently accurate and objective performance indicator for each particular bank.

The regression models are simpler and require significantly less statistical data, but at the same time they allow to clearly track the influence of indicators describing a financial institution on the bank's performance, while allowing to forecast the results, which is quite important in their application.

The econometric regression model with a variable structure has been obtained in this study, which allows to evaluate the contribution to the evaluations of the digital bank performance expressed through its profit from the internal characteristics of the bank. It has been found that the indicator of the client base size of a digital financial institution makes the greatest contribution to the performance evaluation, which indicates the direct relationship between the number of bank clients and its profit.

The second most important indicator is the ratio of the IT department headcount to the total bank assets, which brings the digital bank closer to the IT company.

The indicator of the digital bank size expressed by the total bank assets is next in terms of the influence degree.

From the standpoint of digital banks' affiliation with traditional financial institutions, the modeling indicates that affiliated banks have an average profit margin higher than that of independent banks, which can be explained by the greater opportunities that network banks receive from parent banks.

The indicator of the bank age appeared to be insignificant and did not influence the digital bank's profits, which was explained by the unformed market of young digital financial institutions.

Further research in the field of evaluating the digital banks' performance can be made in building a stochastic frontier model, which requires a large amount of statistical data for a rather long time period and allows to evaluate the performance of each specific financial institution.

Acknowledgements

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