Modelling and Forecasting the Net Income Dynamics

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Abstract. This paper addresses modelling and forecasting the net income, as one of the key indicators for characterizing the banking system of a country. The article discusses the net income time series for the United States from 2010 to 2018. The objective of this work is to select the most appropriate model for modelling trends in net income. The result of this study actually established that the change in net income is due to two main factors, the nature of the dynamics of each of which differ significantly. It is concluded that the resulting model can be used to forecast the value of the net income in the United States. The paper presents the forecast for the considered indicator for four quarters in advance. The authors used methods for generalization and comparative analysis of alternative approaches to modelling and forecasting net interest income, as well as logical, mathematical and economic and statistical methods and techniques using *Statistica 10.0* to make the necessary calculations.

Keywords: net income, net interest income, noninterest income, trend-seasonal model, modelling and forecasting.

1 Introduction

The authors of the article examined the theoretical and practical aspects of research and development of methods for predicting the net interest income of banking systems. The analysis revealed that despite a large number of scientific works devoted to this issue, a unified and generally accepted methodology for modelling and forecasting net income, net interest income and noninterest income has yet to be developed.The article substantiates the choice of a model for modelling trends in net income, identifies factors affecting the change in net income (net interest income and noninterest income). The paper presents the results of net income forecasting using a multiplicative trend-seasonal model, measures the correlation of fluctuations of series characterizing the dynamics income and net interest income, based on the measurement of the correlation between deviations from trends. The essence of modelling using economic and statistical methods is that the predicted indicator is determined based on specific models that show its functional dependence on certain factors.

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As objects of the empirical base of the study, the authors selected a database of the International Monetary Fund.

Section 8 deals with open interfaces, and Section 9 deals with training issues for the digital economy.

2 Literature Review

Financial development, economic growth and bank efficiency are inextricably interconnected. Several studies have provided empirical evidence of the nonlinear impact of financial development on economic growth [1-9]. The banking sector is a key segment of the country's financial system, while in some works the authors have repeatedly noted that the prerequisites for dynamic economic growth are provided by an efficiently functioning financial system [10].

In his article, N.A. L'vova and I.A. Darushin disclose the content of the emerging financial market in conjunction with the category "emerging financial system". They reveal the functional and institutional signs characteristic of the emerging financial systems and analyses the criteria for assessing the level of financial development [11]. The authors refer to the opinion of B.B. Rubtsov that the emerging financial markets are more characterized by a model focused on the banking system [12], which, like any economic system, must be managed. In this regard, it is necessary to take into account the forecast of its development for the future [13].

In [14] it is noted that the banking sector as a whole is highly sensitive to changes in economic development. During financial crises, this relationship is particularly pronounced [15]. In publications [16-18], the authors note that the activities of banks are associated with credit risks, solvency, interest rate, liquidity and other financial transactions.

The indicator that most clearly reflects the efficiency of banking is net interest income, which is one of the most stable and sustainable components of the bank's profit. The use of econometric and economic-statistical methods in predicting the results of the banking system has specific features. The dynamics of the net income of commercial banks, as a financial result of banking activities, can vary within a fairly wide range, bringing the bank both a significant profit and a considerable loss. The analysis of the models for forecasting the income of commercial banks showed that they are often based on the extrapolation method, i.e. the studied indicator is put in dependence on the time factor, without reflecting the connection of the studied indicator with internal and external factors that can affect its value. For specific purposes, this approach can be considered quite justified.

The first attempts to build predictive models of the profit of the Russian banking sector are given in the works [19-23]. In the work of V.M. Gumerov [19], was proposed a mathematical model for forecasting the net income from foreign exchange transactions of a commercial bank, the modelled indicator in which is the average conversion income of the bank, pairwise correlation coefficients were calculated between the modelled indicator and specific factors, as well as in pairs the factors themselves. The author concluded that it is inexpedient to model the dependence of the studied indicator on any internal or external factors. It is proposed to include in the final model for forecasting the net income of a particular bank the average value of the adjustment factor, which is equal to the ratio of the net convertible income of a specific bank to the average value of the indicator. A similar scheme for constructing the forecast model is used for the indicator net income of banks from loan and deposit operations in foreign currency. However, as a result, the author concludes that in both variants of the proposed final models for predicting the overall financial result from the bank's activities, there are quite significant deviations, i.e. theoretical values when testing a model for significance exceed empirical ones. At the same time, the model is focused on assessing the activities of individual banks, and not the banking system as a whole.

One of the first attempts to construct a factor-second model for forecasting the profit of the Russian banking sector was proposed by M.E. Mamonov [20]. In the work of O.V. Radeva [21], diffuse indices of the Bank of Russia were used to predict the volumes of the corporate and retail portfolios of the domestic banking system. D.V. Shimanovsky, in his works [13, 24], devoted to the methods of forecasting the total net interest income using the example of the banking system of the Russian Federation, proposes to include in the forecast scenarios corresponding to the most likely shocks for the domestic economy. The econometric model proposed by the author allows for short-term forecasting of the dynamics of the net interest income of the banking system, based on which the study concludes that the main exogenous sources of the dynamics of net interest income are exchange rate fluctuations. In his research, the author analyzes the macro-financial modelling of trends in the national banking system, considered in the domestic scientific literature and notes that the works devoted to forecasting the indicators of the banking system of Russia are somewhat scattered and do not take into account the previous experience.

The works of foreign authors have a much wider variety of approaches to modelling and forecasting banking indicators. Publication [25] considers a vector autoregression model or VAR model with four variables: the rate of GDP growth and the volume of the loan portfolio of commercial banks, the rate of federal funds and supply in the credit market. The authors of the article [26] analyze panel data using estimates of both demand and supply of credit resources. The work [27] proposes a forecasting approach for multiple yield curves that use the characteristics of modern interest rate markets, represented by cross-tenor dependencies.

The article by S.V. Shchurina and M.A. Vorobyeva [28] considers the importance of financial forecasting for ensuring the activities of banks. In it, the authors note that the development of econometric research contributes to forecasting various statistical indicators of banks. Analyzing the existing research methods of various aspects of banking, the author of publication [29] concludes that even the most avant-garde research in this area using complex economic and mathematical methods requires further refinement. Furthermore, there are problems related to external risks, credit risks and liquidity risks [30-34]. It would be advisable to take them into account in forecasting models, but this is associated with some difficulties, in particular, the fact that it is hard to separate factors of credit risk and liquidity risk using purely statistical methods [35].

A.A. Shirov in his work [36] draws attention to the fact that one should not overestimate the capabilities of the forecasting and analytical tools. Strictly speaking, no econometric model can serve as a criterion for the correctness of certain actions and inactions. Rather, the task of economic modeling is to transform theses into a more or less coherent set of arguments supported by quantitative estimates. The problems of constructing predictive models, assessing their quality, adequacy and accuracy are the subject of discussion, primarily in foreign literature [37-42], where their open discussion contributes to improving models and eliminating shortcomings. In Russian practice, the methodology of most predictive models remains closed, and therefore, as noted in [43], a comparative analysis of their quality is difficult or impossible.

3 Methodological framework, data and model specifications

The main forecasting methods include trend extrapolation methods, methods of analysis of cause-and-effect relationships and their modelling [44]. The seasonality index is most commonly used to measure seasonal fluctuations, the calculation procedure of which depends on the type of dynamic series [45].

Graphic analysis of changes in quarterly values of the net income for the period from the first quarter of 2010 to the first quarter of 2018 attests to trend and seasonal component (see Fig. 1). There is a steady recurring increase in net income in the second quarter and a decrease in its value in the fourth quarter of each year.

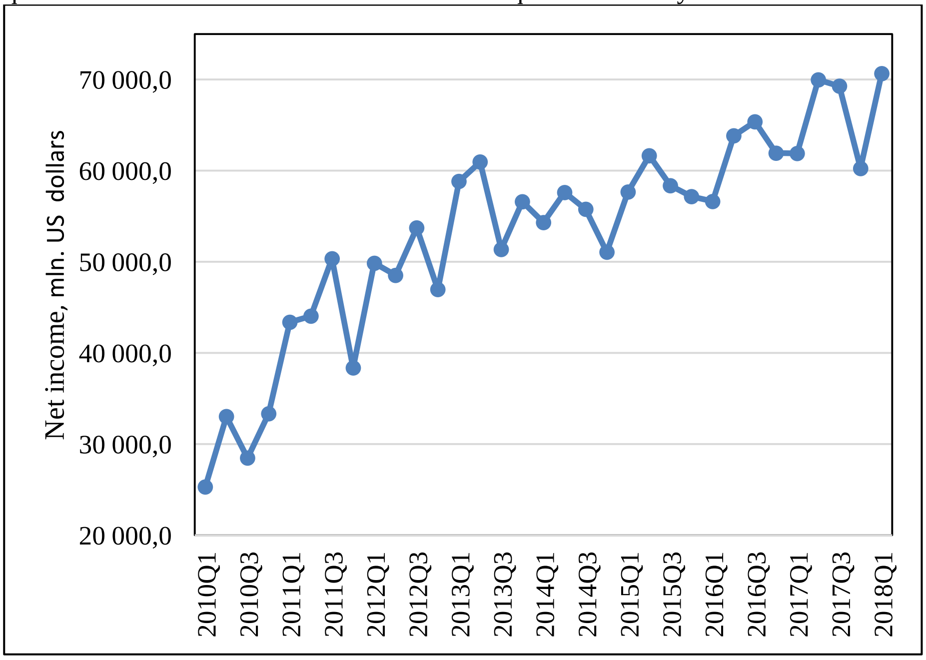


Fig. 1. Dynamics of US interest income for the period from the first quarter of 2010 to the first quarter of 2018

The amplitude of seasonal fluctuations during the period under consideration increases; therefore, a model with multiplicative seasonality is best suited for modelling the trend of net income (see Table 1).

Table 1. Multiplicative model of net income dynamicsfor the period from the first quarter of 2010 to the first quarter of 2018.

Period	Net income, mln. US dollars	Moving average	Seasonal component	Seasonal index	Dezonalized row
2010Q1	25302,25	-	-	101,1	25022,65
2010Q2	33029,05	-	-	104,1	31738,40
2010Q3	28475,05	30035,14	94,8	101,7	27996,47
2010Q4	33334,20	34553,34	96,5	93,1	35802,17
2011Q1	43375,05	37307,18	116,3	101,1	42895,74
2011Q2	44044,41	42774,55	103,0	104,1	42323,33
2011Q3	50344,54	44031,68	114,3	101,7	49498,39
2011Q4	38362,70	45649,64	84,0	93,1	41202,97
2012Q1	49846,92	46767,31	106,6	101,1	49296,09
2012Q2	48515,07	47612,64	101,9	104,1	46619,29
2012Q3	53725,85	49763,55	108,0	101,7	52822,87
2012Q4	46966,36	52009,04	90,3	93,1	50443,62
2013Q1	58828,90	55120,26	106,7	101,1	58178,82
2013Q2	60959,93	54528,19	111,8	104,1	58577,85
2013Q3	51357,57	56935,90	90,2	101,7	50494,40
2013Q4	56597,21	55806,92	101,4	93,1	60787,51
2014Q1	54312,97	54968,43	98,8	101,1	53712,79
2014Q2	57605,99	56071,42	102,7	104,1	55354,97
2014Q3	55769,50	54687,76	102,0	101,7	54832,17
2014Q4	51062,59	55525,95	92,0	93,1	54843,12
2015Q1	57665,71	56535,41	102,0	101,1	57028,48
2015Q2	61643,84	57181,63	107,8	104,1	59235,04
2015Q3	58354,37	58705,67	99,4	101,7	57373,60
2015Q4	57158,77	58444,96	97,8	93,1	61390,64
2016Q1	56622,85	58991,91	96,0	101,1	55997,14

Period	Net income, mln. US dollars	Moving average	Seasonal component	Seasonal index	Dezonalized row
2016Q2	63831,64	60745,07	105,1	104,1	61337,35
2016Q3	65367,01	61936,23	105,5	101,7	64268,38
2016Q4	61923,41	63253,46	97,9	93,1	66508,04
2017Q1	61891,80	64788,00	95,5	101,1	61207,87
2017Q2	69969,76	65766,47	106,4	104,1	67235,61
2017Q3	69280,92	65345,67	106,0	101,7	68116,51
2017Q4	60240,21	67536,20	89,2	93,1	64700,22
2018Q1	70653,89	-	-	101,1	69873,13

Source: For the calculations, the authors used Statistica 10.0.

Fig. 2 presents the trend and seasonal component of the multiplicative model of net income.

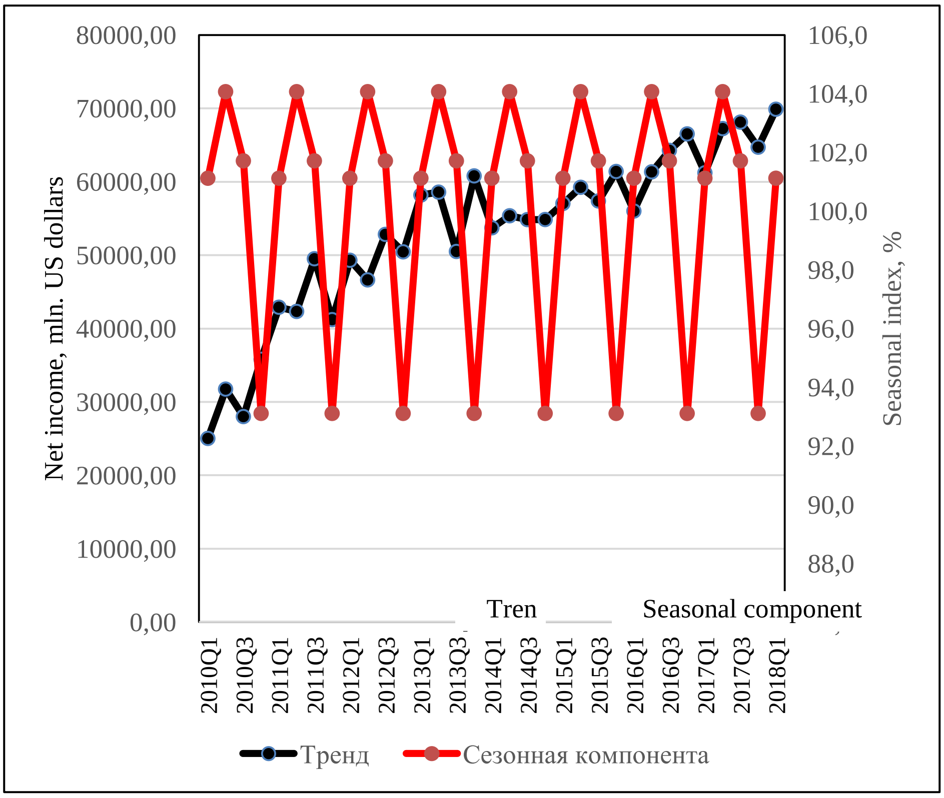


Fig. 2. Components of the multiplicative net income model: trend and seasonality indices

The quadratic trend was best suited to describe the trend line of net income:
$\hat{y}_t = -32{,}6 \cdot t^2 + 2181{,}1 \cdot t + 28250$

Both the parabola equation itself and its parameters were statistically significant. The verification of the model adequacy involved testing for independence, normality and randomness of the distribution of the residual component.

The equation and its parameters are statistically significant. The model is adequate. The Shapiro-Wilk test showed that the remnants of the model are distributed normally. The Durbin-Watson test confirmed the independence of the residues. Using the turning peak criterion was revealed the randomness of the distribution of the model residuals.

The values of the obtained seasonality indices (see Fig.3).

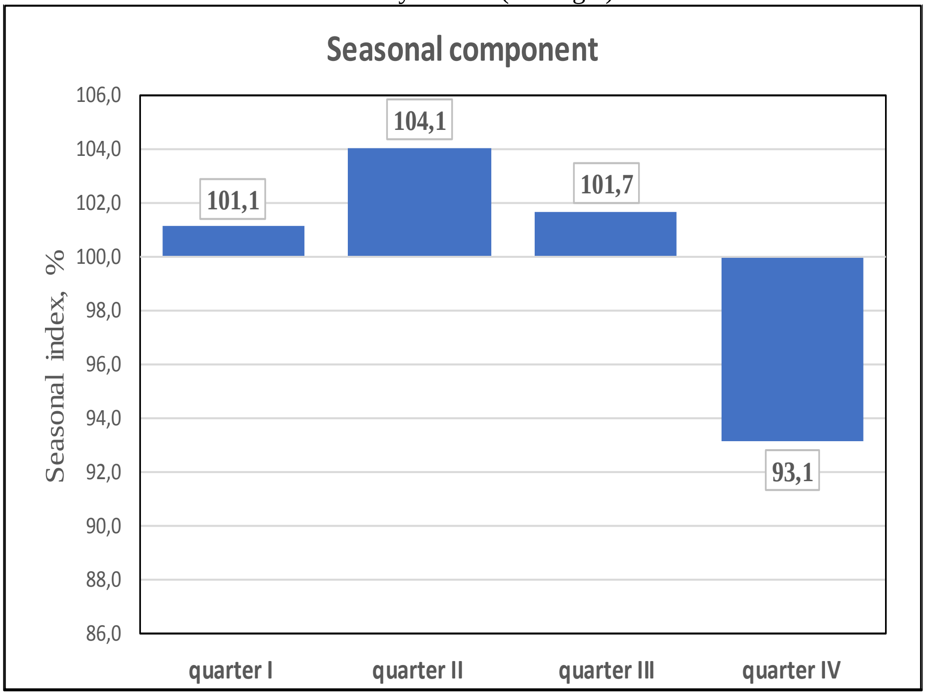


Fig. 3. Seasonality indices

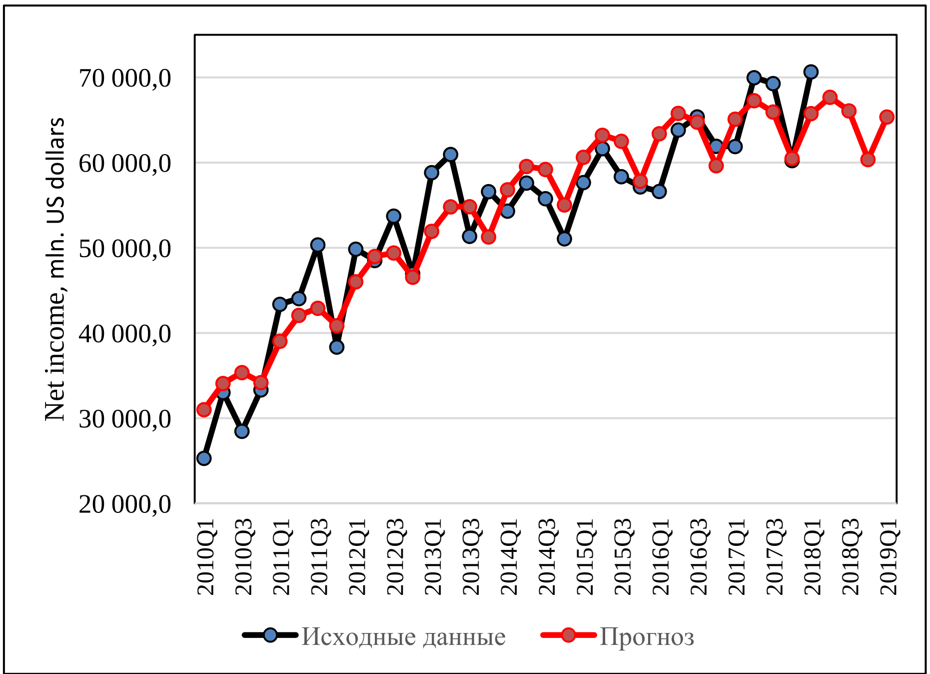
4 Empirical results and discussion

The results of net income forecasting using a multiplicative trend-seasonal model are presented in the following Table 2.

Table 2. Net income forecasting results usingmultiplicative trend-seasonal model

Period	Estimated values of interest income from the parabolic model, mln. US Dollars	Estimated values of interest income, with an account to seasonality, mln. US Dol-lars
2010Q1	30668,53	31011,22
2010Q2	32751,93	34083,79
2010Q3	34770,20	35364,56
2010Q4	36723,33	34191,84
2011Q1	38611,32	39042,77
2011Q2	40434,18	42078,44
2011Q3	42191,91	42913,14
2011Q4	43884,51	40859,37
2012Q1	45511,96	46020,52
2012Q2	47074,29	48988,57
2012Q3	48571,48	49401,76
2012Q4	50003,54	46556,59
2013Q1	51370,46	51944,47
2013Q2	52672,25	54814,17
2013Q3	53908,90	54830,42
2013Q4	55080,42	51283,51
2014Q1	56186,81	56814,64
2014Q2	57228,06	59555,24
2014Q3	58204,18	59199,12
2014Q4	59115,16	55040,12
2015Q1	59961,01	60631,01
2015Q2	60741,72	63211,79
2015Q3	61457,30	62507,86
2015Q4	62107,75	57826,41
2016Q1	62693,06	63393,59
2016Q2	63213,24	65783,81
2016Q3	63668,28	64756,63
2016Q4	64058,19	59642,41

Period	Estimated values of interest income from the parabolic model, mln. US Dollars	Estimated values of interest income, with an account to seasonality, mln. US Dollars
2017Q1	64382,97	65102,38
2017Q2	64642,61	67271,30
2017Q3	64837,12	65945,44
2017Q4	64966,49	60488,09
2018Q1	65030,73	65757,38
2018Q2	65029,83	67674,27
2018Q3	64963,80	66074,29
2018Q4	64832,64	60363,47
2019Q1	64636,34	65358,59

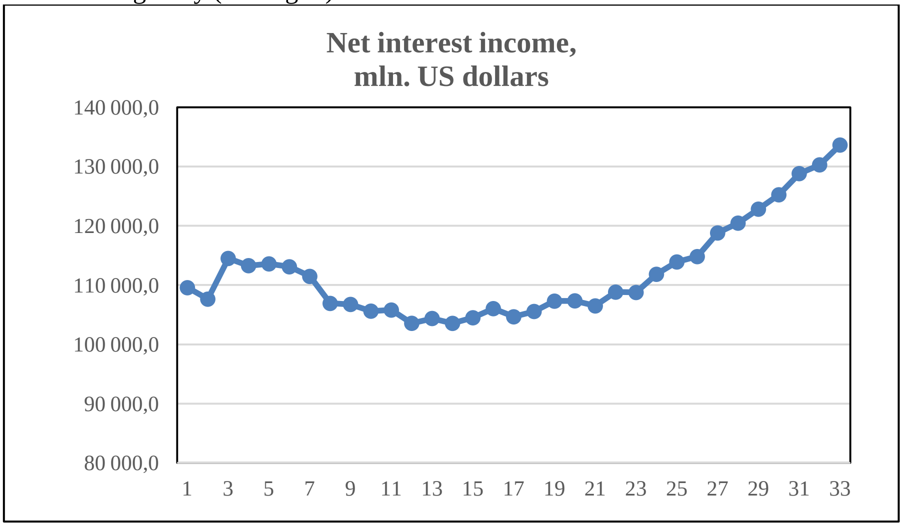


Source: For the calculations, the authors used Statistica 10.0.

Fig. 4. The forecast of net income using a multiplicative trend-seasonal model

The forecast accuracy was calculated using the mean absolute percentage error (MAPE). The error value was 6.6%, which indicates its high accuracy. According to the completed forecast, there can be expected an increase in net income in the second quarter of 2018 compared with the first quarter by 1916.89 million US dollars (or 2.9%), a decrease in the third and fourth quarters by 1599, 98 and 5710.83 million US dollars, respectively, then again growth in the first quarter of 2019 to 4995.12 million US dollars (or 8.3%). In the first quarter of 2019, net income will be 65,358.59 million US dollars.

Net income is made from the sum of net interest income and noninterest income less interest expenses and reserves. The nature of the dynamics of net interest and noninterest income for the period from the first quarter of 2010 to the first quarter of 2018 varies greatly (see Fig. 5).



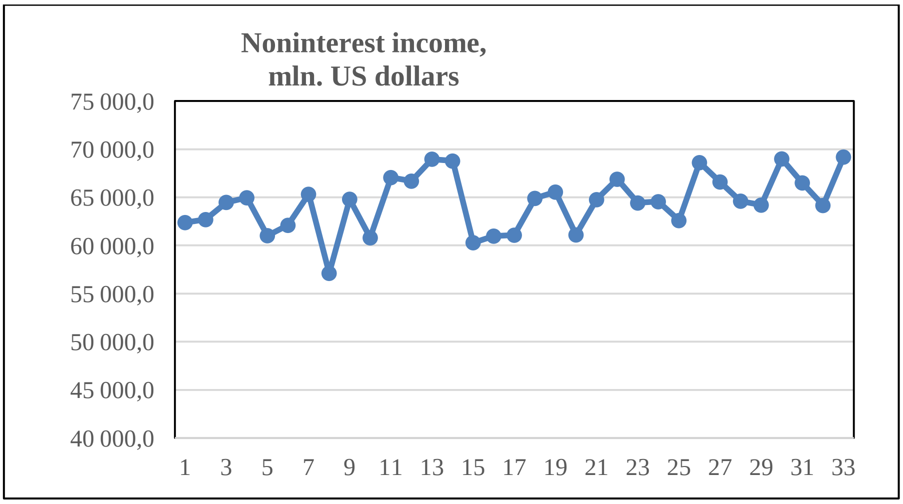


Fig. 5. Dynamics of net interest and noninterest income for the period from the first quarter of 2010 to the first quarter of 2018

In the dynamics of net interest income, there is a trend; there are no seasonal fluctuations. The quadratic trend $\hat{y}_t = 72{,}9 \cdot t^2 - 1947{,}9 \cdot t + 117559$ was best suited to describe the trend line. Both the equation itself and its parameters are statistically significant (see Fig. 6).

Regression statistics	
Multiple R	0,961
R Square	0,923
Adjusted R Square	0,917
Standard Error	2360
Observations	33

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	1990675820	995337910	178,7	0,0000
Residual	30	167074198	5569140		
Total	32	2157750018			

Equation coefficients

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Y-intercept	117559,0	1311,1	89,7	0,0000	114881,4	120236,5
Variable X 1	-1947,9	177,8	-11,0	0,0000	-2311,0	-1584,8
Variable X 2	72,9	5,1	14,4	0,0000	62,5	83,2

Fig. 6. Characteristics of the statistical significance of the parabola equation for describing the net interest income trend

Verification of the independence, normal distribution and randomness of the residual component of the model showed that the model is adequate and can be used for forecasting.

In contrast to the dynamics of net interest income, there was no trend in the dynamics of noninterest income, the levels of the series are independent (see Fig. 7).

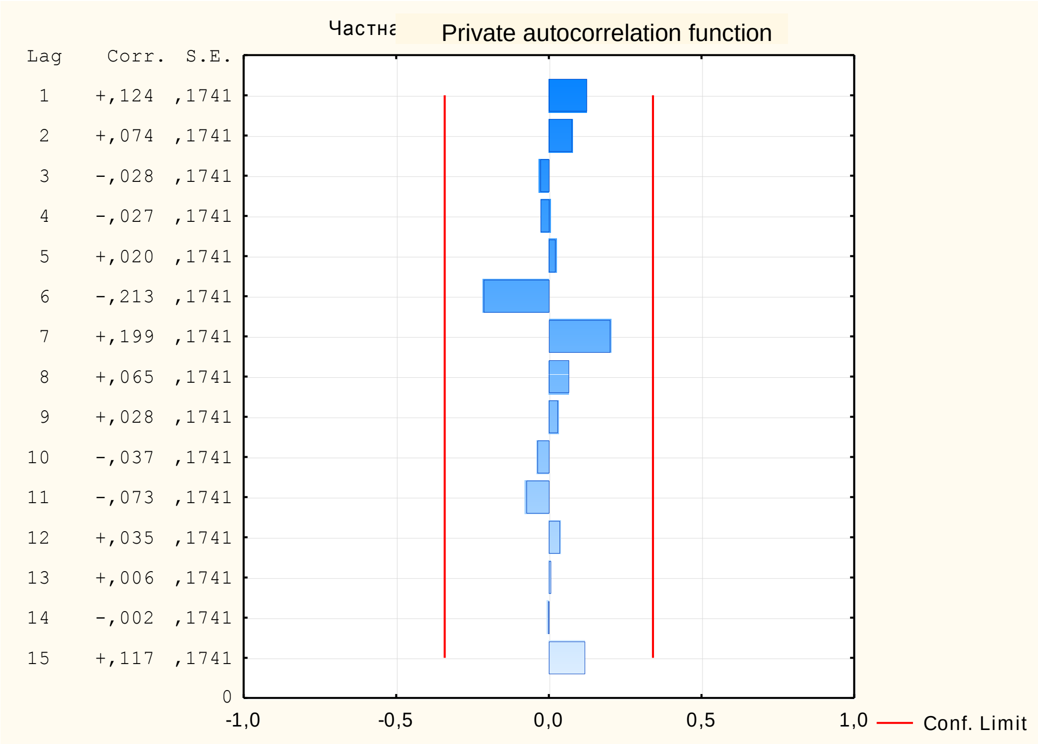


Fig. 7. Private autocorrelation function of noninterest income dynamics

To test the hypothesis about the existence of a trend, the original series was divided into equal parts, and the hypotheses about equality of dispersions were tested using a two-sample F-test for dispersions (see Table 3) and equality of means using the paired two-sample t-test for means (see Table 4).

Table 3. Two-sample F-test for the dispersion of the series "Noninterest income"

	Series 1	*Series 2*
Mean	63656	64972
Variance	10868264	5079056
Observation	16	16
df	15	15
F	2,140	
P(F<=f) one-tail	0,076	
F critical one-tail	2,403	

Table 4. Paired two-sample t-test for the mean of series "Noninterest income"

	Series 1	*Series 2*
Mean	64972	63656
Variance	5079056	10868264
Observation	16	16
Pearson correlation	0,042	
Hypothesized mean difference	0	
df	15	
t-stat	1,346	
P(T<=t) one-tail	0,099	
t critical one-tail	1,753	
P(T<=t) two-tail	0,198	
t critical two-tail	2,131	

The results of hypothesis testing confirmed the initial assumption about the absence of a trend in the dynamics of noninterest income.

The change in net income is determined by two main indicators, the nature of the dynamics of which varies greatly, and therefore there are differences in their modelling and forecasting. The first factor is the net interest income, in which there is a trend, described by a quadratic trend, and the dynamics of which can be forecasted. The second factor is non-interest income, in which there is no trend; its dynamics is difficult to model and forecast.

To continue the analysis, a measurement of the correlation of fluctuations of series characterizing the dynamics of net income and net interest income was made. It was based on the measurement of the correlation between trend deviation (see Fig. 8).

Regression Statistics	
Multiple R	0,992
R Square	0,984
Adjusted R Square	0,953
Standard Error	491
Observations	33

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	485774272	485774272	2013,2	0,0000
Residual	32	7721419	241294		
Total	33	493495692			

	Coefficients	*Standard Error*	*t-stat*	*P-value*	*Lower 95%*	*Upper 95%*
Variable X 1	0,989	0,022	44,87	0,0000	0,944	1,034

Fig. 8. The results of correlation and regression analysis of the dynamics of net income and net interest income

Net income fluctuations, therefore, are almost entirely (by 98.4 percent) related to net interest income fluctuations. On average, the deviation of net income from its trend is 0.989 of the deviation of net interest income from its trend.

To measure the correlation of the fluctuations in series, the differences in the levels of the two series were correlated as well. Both the regression models and the regression equation coefficients, however, turned out to be statistically insignificant and not interpretable. The fact that the correlation of deviations from trends showed statistically significant results indicates the correct selection of trend models and their good quality.

Fluctuations in non-interest income, despite the absence of a trend, also have a statistically significant effect on net income fluctuations (see Fig. 9).

Regression Statistics	
Multiple R	0,400
R Square	0,160
Adjusted R Square	0,133
Standard Error	3657
Observations	33

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	79016430	79016430	5,91	0,021
Residual	31	414479262	13370299		
Total	32	493495692			

	Coefficients	*Standard Error*	*t-stat*	*P-value*	*Lower 95%*	*Upper 95%*
Y- intercept	-34481,99	14198,45	-2,43	0,021	-63439,93	-5524,05
Variable X 1	0,53	0,22	2,43	0,021	0,09	0,98

Fig. 9. The results of the correlation and regression analysis of the dynamics of net income and non-interest income

Sixteen percent of net income fluctuations are associated with fluctuations in non-interest income. On average, the deviation of net income from its trend is 0.53 times the deviation of non-interest income from its trend.
The above results suggest that the models perform reasonably well with satisfactory predictive performance. However, the problems of building predictive models in general, as well as financial results of commercial banks as a whole, based on econometric modelling and a system-analytical approach, taking into account the entire set of factors affecting the process of their formation, is a subject of discussion, requires further development and coverage in the economic literature.

5 Conclusions:

Net income modelling and forecasting, therefore, allows to draw the following conclusions:

- To describe the net income trend, multiplicative seasonality model was best suited. In it, the trend is described by a quadratic trend $\hat{y}_t = -32{,}6 \cdot t^2 + 2181{,}1 \cdot t +$

28250, and seasonality indices 101 1 percent for the first quarter, 104.1 percent for the second quarter, 101.7 percent for the third quarter, 93.1 percent for the fourth quarter.

- Net income is formed from the sum of net interest income and noninterest income. The dynamics of net interest income has a trend. It is described by the quadratic trend $\hat{y}_t = 72{,}9 \cdot t^2 - 1947{,}9 \cdot t + 117559$, with no seasonal fluctuations. There is no trend in the dynamics of noninterest income; the levels of the series are independent.
- Net income fluctuations are almost entirely (by 98.4 percent) related to net interest income fluctuations. On average, the deviation of net income from its trend is 0.989 of the deviation of net interest income from its trend. The impact of noninterest income is reflected in the fact that the net income deviation from its trend is 0.53 times the non-interest income deviation from its.
- According to the completed forecast, there can be expected an increase in net income in the second quarter of 2018 compared with the first quarter by 1916.89 million US dollars (or 2.9 percent), a decrease in the third and fourth quarters by 1599, 98 and 5710.83 million US dollars, respectively, then again growth in the first quarter of 2019 to 4995.12 million US dollars (or 8.3 percent). In the first quarter of 2019, net income will be 65,358.59 million US dollars.

The practical significance of the work is in the developed method of forecasting the key indicators of the banking system, in particular, forecasting net income, interest and non-interest.

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