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MACROECONOMIC DETERMINANTS OF ENSURING FINANCIAL STABILITY OF THE BANKING SYSTEM OF UKRAINE

Abstract. The system paradigm, which is the basis of the concept of ensuring the financial stability of the banking system, involves the definition of external relations and macroeconomic factors. This necessitates an appropriate assessment of the volatility of the financial stability index from determinants.

Using multidimensional factor analysis and selection of indicators with the highest values of factor loads, it is established that the first factor has the highest correlation with the exchange rate, minimum wage, deposit interest rate in foreign currency, loan interest rate in foreign currency, gold reserves; the second factor is formed by indicators of real GDP and consumer price index; the third factor is closely related to the deposit interest rate in hryvnia.

Determining macroeconomic factors to ensure the financial stability of the banking system are: deposit interest rate in foreign currency, exchange rate, consumer price index and the size of gold and foreign exchange reserves. The assessment of the level of sensitivity of the financial stability of the banking system to changes in determining macroeconomic factors should be based on the coefficients of elasticity obtained taking into account the results of regression analysis. An increase in the parameters that characterize macroeconomic factors by 1% of the average level, both positively and negatively affects the value of the index of financial stability of the banking system.

Determining the sensitivity of the financial stability index of the banking system to changes in determinants through the calculation of elasticity factors allowed us to state that among macroeconomic factors, changes in the level of stability of the banking system of Ukraine are most determined by consumer prices and exchange rates.

Keywords: financial stability, macroeconomic determinants, factor analysis, deposit interest rate, exchange rate, consumer price index, gold and foreign exchange reserves.

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МАКРОЕКОНОМІЧНІ ДЕТЕРМІНАНТИ ЗАБЕЗПЕЧЕННЯ ФІНАНСОВОЇ СТАБІЛЬНОСТІ БАНКІВСЬКОЇ СИСТЕМИ УКРАЇНИ

Анотація. Системна парадигма, покладена в основу концепції забезпечення фінансової стабільності банківської системи, передбачає визначення зовнішніх зв'язків

і макроекономічних факторів впливу. Це зумовлює необхідність відповідної оцінки волатильності індексу фінансової стабільності від факторів-детермінантів.

За допомогою багатовимірного факторного аналізу і відбору показників із найвищими значеннями факторних навантажень встановлено, що перший фактор має найбільший кореляційний зв'язок із валютним курсом, мінімальною заробітною платою, депозитною процентною ставкою у валюті, кредитною процентною ставкою у валюті, обсягом золотовалютних резервів; другий фактор сформовано показниками реального ВВП та індексу споживчих цін; третій фактор перебуває в тісному взаємозв'язку з депозитною процентною ставкою у гривнях.

Детермінуючими макроекономічними факторами забезпечення фінансової стабільності банківської системи є: депозитна процентна ставка у валюті, валютний курс, індекс споживчих цін і розмір золотовалютних резервів. Оцінка рівня чутливості фінансової стабільності банківської системи до зміни детермінуючих макроекономічних факторів має базуватися на коефіцієнтах еластичності, отриманих з урахуванням результатів регресійного аналізу. Збільшення параметрів, які характеризують макроекономічні фактори, на 1 % від середнього рівня як позитивно, так і негативно позначається на значенні індексу фінансової стабільності банківської системи.

Визначення чутливості індексу фінансової стабільності банківської системи до зміни факторів-детермінантів через розрахунок коефіцієнтів еластичності дозволило констатувати, що серед макроекономічних чинників зміну рівня стабільності банківської системи України найбільше зумовлюють рівень споживчих цін і валютний курс.

Ключові слова: фінансова стабільність, макроекономічні детермінанти, факторний аналіз, депозитна процентна ставка, валютний курс, індекс споживчих цін, золотовалютні резерви.

Формул: 3; рис.: 2; табл.: 6; бібл.: 10.

Introduction. The banking system of Ukraine is an open system that constantly interacts with other components of the national economic system and the global financial market, constantly feeling the influence of many external factors. Given the objective impossibility of any significant impact on global international processes arising from globalization and integration processes, it is advisable to focus on analyzing the impact of key macroeconomic indicators at the national level to ensure and maintain financial stability of the domestic banking system.

Analysis of recent research and problem statement. Many works of domestic and foreign scientists are devoted to the study of macroeconomic factors to ensure the banking system financial stability [1—6]. Despite their significant contribution to the development of theoretical and methodological foundations of the research issue, the identification of determining macroeconomic factors that have the greatest impact on the banking system financial stability of Ukraine requires constant attention.

Calculated in [7], the index of financial stability of the banking system allows for its quantitative assessment in the dynamics and qualitative interpretation of such assessment, given the volatility of the index and the state of the institutional components of the banking system. At the same time, the systemic paradigm underlying the proposed concept of ensuring the financial stability of the banking system, along with the assessment, involves the definition of external relations and macroeconomic factors influencing financial stability.

Methodology and research methods. Having previously determined the presence of correlations between the studied indicators and to identify the most influential of them (in terms of ensuring the financial stability of the banking system) and reducing the number of analyzed factors in the work, multidimensional factor analysis was used. It is a means of identifying the relationship between metrics and data reduction. Its application allowed extracting and quantify the latent generalizing characteristics of the development of the studied process on the basis of real connections of indicators-features.

The obtained results allowed to establish the dependence of the financial stability index of the banking system on macroeconomic factors and to determine its sensitivity to changes in determinants through the calculation of elasticity coefficients.

Research results. The implementation of the task of determining the macroeconomic determinants of ensuring the financial stability of the banking system of Ukraine will be carried out in the following stages (*Fig. 1*).

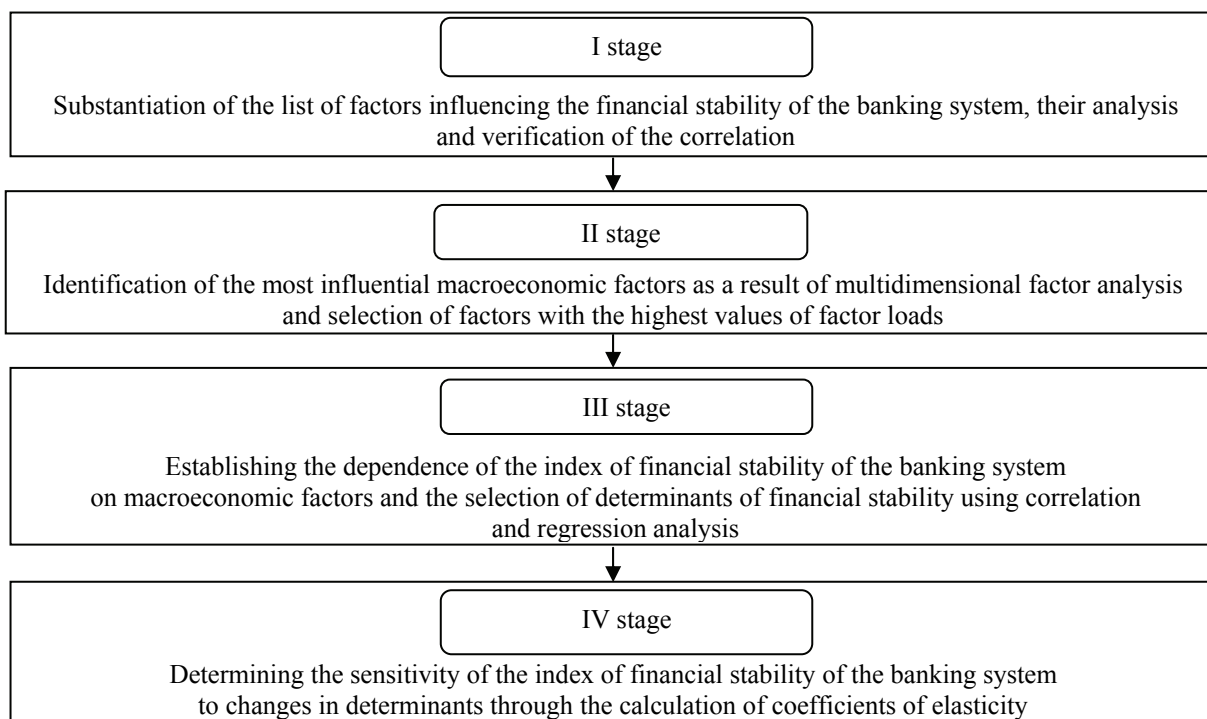


Fig. 1. The sequence of determining the macroeconomic determinants of financial stability of the banking system (developed by the authors)

According to the procedure shown in *Fig. 1*, to identify the main determinants of financial stability of the banking system among the macroeconomic factors analyzed above, a factor analysis should be conducted, having previously determined the presence of correlations between the indicators. The list of factors and the dynamics of their values (for the period 2009—2018) are formed according to the official website of the National Bank of Ukraine.

The correlation matrix of the relationships of macroeconomic factors to ensure the financial stability of the banking system of Ukraine is given in *Table 1*.

Table 1

Correlation matrix of interrelations of macroeconomic factors of ensuring financial stability of the banking system of Ukraine

Factor	Real GDP, %	Producer price index, %	Exchange rate for the period, UAH / USD	Minimum wage, UAH	Consumer price index, %	Deposit interest rate in UAH, %	Credit interest rate in UAH, %	Deposit interest rate in foreign currency, %	Credit interest rate in foreign currency, %	Gold and foreign exchange reserves, mln USD	Consumer spending, % of GDP	Gross savings, % of GDP	Current account balance, billion USD
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Real GDP, %	1,00	-0,14	0,13	0,35	-0,51	-0,13	-0,59	-0,55	-0,25	0,30	-0,12	0,28	-0,22
Producer price inflation, %	-0,14	1,00	0,25	-0,00	0,58	-0,18	-0,09	0,00	0,02	-0,32	0,01	-0,44	0,43
Exchange rate for the period, UAH / USD	0,13	0,25	1,00	0,79	0,27	0,18	0,15	-0,72	-0,79	-0,72	0,02	-0,24	0,35
Minimum wage, UAH	0,35	-0,00	0,79	1,00	0,00	0,08	-0,07	-0,88	-0,86	-0,39	0,07	-0,01	0,13
Consumer price index, %	-0,51	0,58	0,27	0,00	1,00	0,13	0,31	0,14	-0,09	-0,51	0,26	-0,41	0,36
Deposit interest rate in UAH, %	-0,13	-0,18	0,18	0,08	0,13	1,00	0,60	0,06	-0,24	-0,47	0,21	0,04	-0,07
Credit interest rate in UAH, %	-0,59	-0,09	0,15	-0,07	0,31	0,60	1,00	0,22	-0,08	-0,37	0,21	-0,17	0,13

Table 1 (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Deposit interest rate in foreign currency, %	-0,55	0,00	-0,72	-0,88	0,14	0,06	0,22	1,00	0,84	0,25	-0,01	-0,04	0,06
Credit interest rate in foreign currency, %	-0,25	0,02	-0,79	-0,86	-0,09	-0,24	-0,08	0,84	1,00	0,49	-0,06	-0,07	-0,01
Gold and foreign exchange reserves, million dollars	0,30	-0,32	-0,72	-0,39	-0,51	-0,47	-0,37	0,25	0,49	1,00	-0,25	0,44	-0,28
Consumer spending, % of GDP	-0,12	0,01	0,02	0,07	0,26	0,21	0,21	-0,01	-0,06	-0,25	1,00	-0,13	0,02
Gross savings, % of GDP	0,28	-0,44	-0,24	-0,01	-0,41	0,04	-0,17	-0,04	-0,07	0,44	-0,13	1,00	-0,43
Current account balance of payments balance, billion dollars	-0,22	0,43	0,35	0,13	0,36	-0,07	0,13	0,06	-0,01	-0,28	0,02	-0,43	1,00

Source: according to the author's calculations.

As can be seen, there is a close correlation between some factors, as indicated by correlation coefficients greater than 0.7.

This confirms the need for multidimensional factor analysis to reduce the number of analyzed factors and identify the most influential in terms of ensuring the financial stability of the banking system. Factor analysis is a means of identifying the structure of relationships between indicators and data reduction. Its application allows to extract and quantify the latent generalizing characteristics of the mechanism of development of the studied phenomena and processes on the basis of really existing connections of indicators-signs.

For factor analysis there is no need to divide the variables into dependent and independent, as they are all considered equivalent [8]. One of the most popular methods of identifying factors is the method of main components, the essence of which is to determine the most informative components. The use of this method makes it possible to reduce the dimensionality of the studied sample without losing information.

In this case, we can identify a maximum of thirteen factors, each of which corresponds to the variance explained by him. When determining the number of principal components, the Kaiser criterion is used, according to which the principal are components whose eigenvalues are greater than 1. If the factor does not allocate a variance equal to the value of at least one variable, it is removed [9].

Factor analysis of macroeconomic factors to ensure the financial stability of the banking system of Ukraine by the method of main components was carried out in the program Statistica 10.0 (module Factor Analysis). Statistical characteristics of the obtained factors are given in Table 2.

Table 2

The results of factor analysis of macroeconomic factors to ensure the financial stability of the banking system of Ukraine

Factor	Eigenvalue of the factor	Share of total variance, %	Cumulative eigenvalue	Cumulative variance, %
1	4,033691	31,02839	4,033691	31,02839
2	3,232341	24,86416	7,266032	55,89256
3	1,924387	14,80298	9,190419	70,69553

Source: according to the author's calculations.

The results of factor analysis showed that the analysis of macroeconomic determinants of ensuring the financial stability of the banking system should be carried out on the basis of three factors. Their share in the total variance is significant (31.03%, 24.86%, 14.80% respectively), which indicates a fairly high completeness of factorization — 70.7%.

Each of the selected factors includes all the analyzed indicators, but to reduce the dimensionality should assess their significance based on the magnitude of factor loads (Table 3).

As can be seen from Table 3, the first factor has the highest correlation with 5 indicators (exchange rate, minimum wage, deposit interest rate in foreign currency, credit interest rate in foreign currency, gold and foreign exchange reserves).

The second factor is most correlated with 2 indicators — real GDP and consumer price index. The third factor is closely related to the deposit interest rate in hryvnia.

Table 3

Matrix of factor loads of macroeconomic factors to ensure the financial stability of the banking system of Ukraine

Indicator	Factor 1	Factor 2	Factor 3
Real GDP, %	0,065435	0,811836	-0,185668
Producer price inflation, %	0,295302	-0,441659	-0,648405
Exchange rate for the period, UAH / USD	0,945308	0,088072	-0,068012
Minimum wage, UAH	0,824731	0,451908	-0,008132
Consumer price index, %	0,381303	-0,705704	-0,172470
Deposit interest rate in UAH, %	0,292410	-0,245053	0,754172
Credit interest rate in UAH, %	0,214962	-0,575906	0,622263
Deposit interest rate in foreign currency, %	-0,723161	-0,630383	0,082885
Credit interest rate in foreign currency, %	-0,846544	-0,378727	-0,180992
Gold and foreign exchange reserves, million dollars	-0,777439	0,411986	-0,145814
Consumer spending, % of GDP	0,189233	-0,260157	0,265786
Gross savings, % of GDP	-0,313117	0,551599	0,381636
Current account balance of payments balance, billion dollars	0,336829	-0,440446	-0,449314

Source: according to the author's calculations.

The next step is to establish the dependence of the index of financial stability of the banking system on macroeconomic factors and to establish the determinants of financial stability using correlation and regression analysis.

Correlation-regression analysis allows you to quantify the density, the direction of communication (correlation analysis), as well as to establish an analytical expression of the dependence of the result on specific factors with the constant action of other factor features on the resultant feature (regression analysis) [10].

In general, the linear regression equation has the form:

$$Y = a_0 + a_1 \cdot X_1, \tag{1}$$

where Y — theoretical value of the resulting feature (Y) at certain values of factor features (X_1);

a_0 — free member of the equation;

a_1 — regression coefficient.

The results of calculations in the Statistica program, on the basis of which a linear regression model of the dependence of the financial stability index of the banking system (calculated in [7]) on macroeconomic factors, are given in *Table 4*.

Table 4

Parameters of the regression model of the dependence of the index of financial stability of the banking system on macroeconomic factors

Model parameter	β -coefficients (Beta)	Standard error of β -coefficients (St. Err. of Beta)	Regression coefficient (B)	Standard error of regression coefficient (St. Err. of B)	Student's t-test (t-27)	Significance level (p-level)
			1,938861	0,507808	3,81810	0,000715
X_1	-0,131178	0,067525	-0,002283	0,001175	-1,94264	0,062556
X_2	-0,751541	0,093848	-0,012235	0,001528	-8,00803	0,000000
X_3	-0,004666	0,079556	-0,000001	0,000014	-0,05865	0,953660
X_4	-0,135400	0,054071	-0,012080	0,004824	-2,50413	0,018618
X_5	0,062533	0,059700	0,003139	0,002997	1,04746	0,304172
X_6	-0,349042	0,106975	-0,029644	0,009085	-3,26283	0,002988
X_7	-0,008031	0,085778	-0,000799	0,008533	-0,09363	0,926097
X_8	0,404216	0,090195	0,000006	0,000001	4,48160	0,000123
$R^2 = 0,95560$						

Source: according to the author's calculations.

The analysis showed that the density of the relationship between the resulting factor (index of financial stability of the banking system) and macroeconomic factors is 95.56%, which indicates a direct strong relationship.

Student's t -test was used to assess the significance of the obtained coefficients of the regression equation. In the Statistica 10, the value of the t -test (tr) is defined as the ratio of the modular regression coefficient to its standard error.

The tabular value of the t-test with the significance level $\alpha = 0.05$ and the number of degrees of freedom 27 was $t_{table} = 2,052$.

The values t_p and t_{table} are checked for each of the obtained parameters:

$t_p = 1,94264 < t_{table}$ — for the coefficient X_1 ;

$t_p = 8,00803 > t_{table}$ — for the coefficient X_2 ;

$t_p = 0,05865 < t_{table}$ — for the coefficient X_3 .

$t_p = 2,50413 > t_{table}$ — for the coefficient X_4 ;

$t_p = 1,04746 < t_{table}$ — for the coefficient X_5 ;

$t_p = 3,26283 > t_{table}$ — for the coefficient X_6 .

$t_p = 0,09363 < t_{table}$ — for the coefficient X_7 ;

$t_p = 4,48160 > t_{table}$ — for the coefficient X_8 .

Thus, the ratios for the exchange rate, consumer price index, deposit interest rate in foreign currency and gold and foreign exchange reserves are statistically significant, and the ratios for real GDP, minimum wage, deposit interest rate in hryvnia and loan interest rate in foreign currency are not statistically significant.

According to the calculations, the value of the Fisher test is $F_p = 72.63$. Its compared with the tabular value of the F -criterion, which corresponds to the value of $F_{table} = 2.3053$ for a given level of significance $\alpha = 0.05$. Since $F_p > F_{table}$, The probability of a random value of F_p is much less than 5% (calculated in Statistica $p < 0,00000$). Thus, the statistical significance of the regression equation, its parameters and the density index R is determined.

The results of correlation and regression analysis showed that the index of financial stability of the banking system is significantly influenced by the following macroeconomic factors: exchange rate, consumer price index, deposit interest rate in foreign currency and gold and foreign exchange reserves. Factors such as real GDP, minimum wage, deposit interest rate in hryvnia and loan interest rate in foreign currency are not statistically significant, based on which it is necessary to exclude these factors from the model and build a new model with significant factors.

The results of building a new model in Statistica 10.0 are given in *Table 5*.

Table 5

Parameters of the regression model of the dependence of the index of financial stability of the banking system on macroeconomic factors

Model parameter	β -coefficients (Beta)	Standard error of β -coefficients (St. Err. of Beta)	Regression coefficient (B)	Standard error of regression coefficient (St. Err. of B)	Student's t -test (t -32)	Significance level (p -level)
exchange rate (X_1)	-0,379979	0,051640	-0,012629	0,001716	-7,35827	0,000000
consumer price index (X_2)	1,363164	0,154613	0,007166	0,000813	8,81664	0,000000
deposit interest rate in foreign currency (X_3)	-0,335099	0,081721	-0,025817	0,006296	-4,10050	0,000264
gold and foreign exchange reserves (X_4)	0,284700	0,054390	0,000006	0,000001	5,23443	0,000010
$R^2 = 0,996$						

Source: according to the author's calculations.

Based on the data in *Table 5* constructs a linear regression equation of the dependence of the index of financial stability of the banking system on macroeconomic factors (*formula 2*):

$$Y = -0,0126 \cdot X_1 + 0,0072 \cdot X_2 - 0,0258 \cdot X_3 + 0,000006 \cdot X_4, \tag{2}$$

where Y — index of financial stability of the banking system;

X_1 — exchange rate, UAH / USD;

X_2 — consumer price index, %;

X_3 — deposit interest rate in foreign currency, %;

X_4 — gold and foreign exchange reserves, million dollars;

The tabular value of the t -test with the significance level $\alpha = 0.05$ and the number of degrees of freedom 32 was $t_{table} = 2,037$.

The values of t_p and t_{table} are checked for each of the obtained parameters:

$t_p = 7,35827 > t_{table}$ — for the coefficient X_1 ;

$t_p = 8,81664 > t_{table}$ — for the coefficient X_2 ;
 $t_p = 4.10050 > t_{table}$ — for the coefficient X_3 ;
 $t_p = 5,23443 > t_{table}$ — for the coefficient X_4 ;
 Thus, all the obtained coefficients are statistically significant.

According to the calculations performed in the Statistica program, the value of the Fisher test is $F_p = 1796.1$. It is compared with the tabular value of the F -criterion, which corresponds to the value of $F_{table} = 2.6896$ for a given level of significance $\alpha = 0.05$. Thus, the statistical significance of the regression equation, its parameters and the closeness index R is determined.

The results of the correlation-regression analysis showed that the density of the relationship between the financial stability index of the banking system and the exchange rate, consumer price index, deposit interest rate in foreign currency and gold and foreign exchange reserves is 99.6%, indicating a strong link.

It is also advisable to determine the sensitivity of the index of financial stability of the banking system when changing other parameters, for which we propose to calculate the elasticity index.

Elasticity is a measure of the response of one variable (or function) to a change in another (argument), and the coefficient of elasticity is a number that shows the percentage change in the function as a result of a one percent change in the argument.

Therefore, when interpreting the results of correlation-regression analysis, a partial coefficient of elasticity (E_{chi}) was used.

The coefficient of elasticity, formula (3), shows how much the average change in the value of the resulting feature (in this case — the index of financial stability of the banking system) when the factor change by 1%.

$$Ex_i = a_i \cdot \frac{\bar{x}_i}{\bar{y}}, \tag{3}$$

where Ex_i — partial coefficient of elasticity;
 a_i — regression coefficients;
 \bar{x}_i — the average value of the factor feature;
 \bar{y} — the average value of the resulting feature.

The advantage of such an indicator as the coefficient of elasticity over others is that its value does not depend on the choice of units of measurement of various factors.

Than the greater the value of the coefficient of elasticity of the economic indicator, than the higher will be the degree of sensitivity, and hence the risk of changing a certain factor on which this indicator depends.

The calculation of the partial coefficient of elasticity is given in *Table 6*.

Table 6

Calculation of the partial coefficient of elasticity of the index of financial stability of the banking system from macroeconomic factors

Indicator	Financial Stability Index of the banking system	Exchange rate, UAH / USD	Consumer price index, %	Deposit interest rate in foreign currency, %	Gold and foreign exchange reserves, million dollars
Regression coefficient (a_i)	-	-0,0126	0,0072	-0,0258	0,000006
Average value (\bar{x}_i, \bar{y})	0,51575	13,95	101,02	6,73	22456
Partial coefficient of elasticity (Ex_i), %	-	-0,341	1,410	-0,337	0,261

Source: according to the author’s calculations.

The obtained coefficients of elasticity show that with the growth of the exchange rate (X_1) by 1% of its average level, the index of financial stability of the banking system (Y) will decrease by 0.341%; with an increase in the consumer price index (X_2) by 1% of its average level, the index of financial stability of the banking system (Y) will increase by 1.41%; with an increase in the deposit interest rate in foreign currency (X_3) by 1% of its average level, the financial stability index of the banking system (Y) will decrease by 0.337%; with an increase in gold and foreign exchange reserves (X_4) by 1% of its average level, the index of financial stability of the banking system (Y) will increase by 0.261%.

The stages of implementation of the scientific and methodological approach to determining the macroeconomic determinants of ensuring the financial stability of the banking system and the generalization of the obtained calculation results are given in Fig. 2.

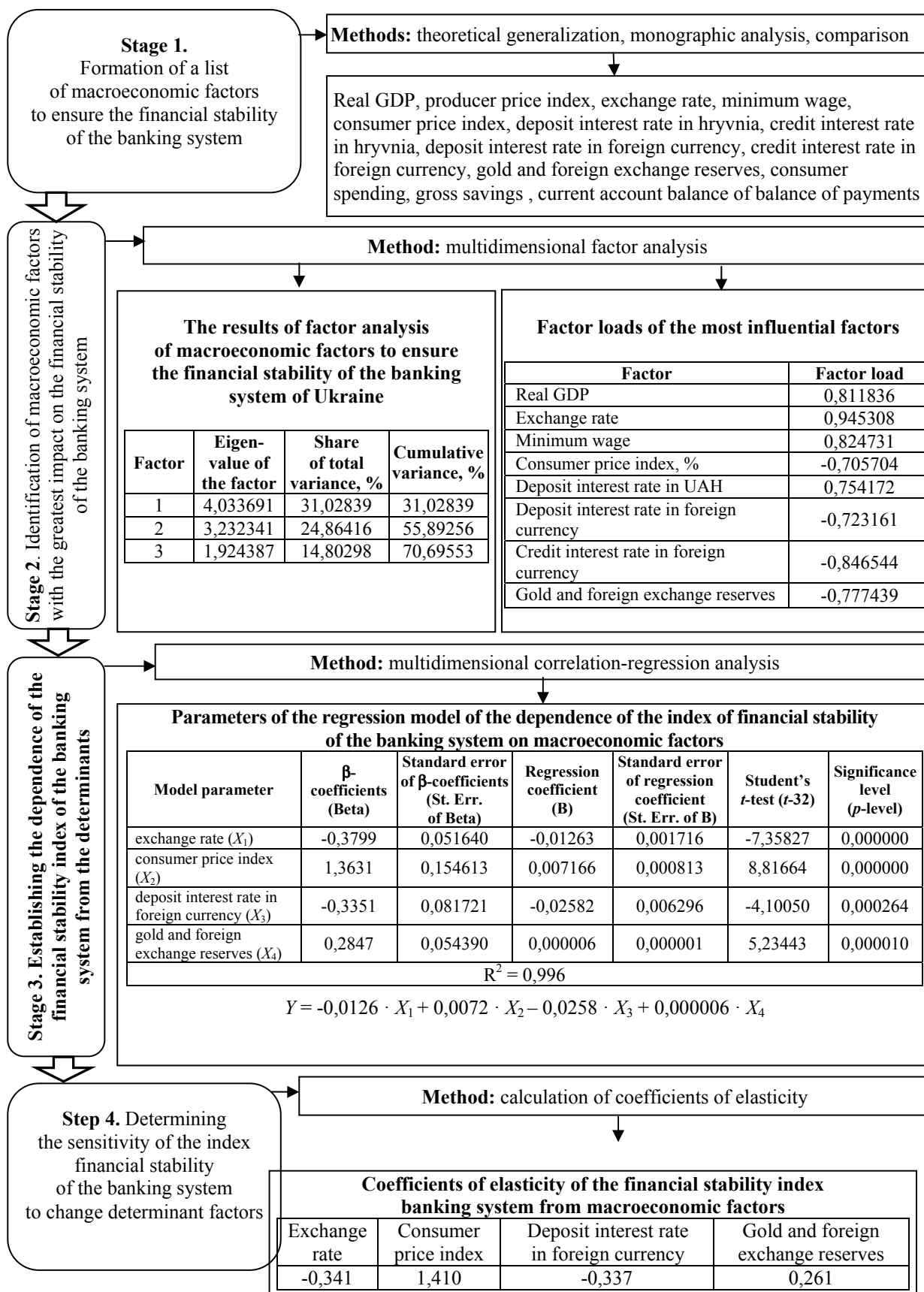


Fig. 2. Stages of implementation of scientific and methodological approach to determining the macroeconomic determinants of financial stability of the banking system

Source: Author's development

Conclusions. The analysis of macroeconomic factors that affect the financial stability of the banking system, revealed that the main ones are: real GDP, producer price inflation, exchange rate, minimum wage, consumer price index, deposit interest rate in UAH, loan interest rate in hryvnia, deposit interest rate in foreign currency, credit interest rate in foreign currency, gold and foreign exchange reserves, consumer spending, gross savings, current account balance.

With the help of multidimensional factor analysis and selection of indicators with the highest values of factor loads, the following is established. The first factor has the largest correlation with the exchange rate, minimum wage, deposit interest rate in foreign currency, loan interest rate in foreign currency, gold and foreign exchange reserves, the second — with real GDP and consumer price index, the third — with the deposit interest rate in hryvnia.

The results of correlation and regression analysis of the dependence of the integrated index of banking system financial stability on macroeconomic factors showed that the density of the relationship between the index of banking system financial stability and the exchange rate, consumer price index, deposit interest rate and foreign exchange reserves is 99.6% indicating a direct strong connection. Thus, these factors are macroeconomic determinants of banking system financial stability.

Determining the sensitivity of the banking system financial stability index to changes in determinants through the calculation of elasticity factors allowed us to state that among macroeconomic factors, changes in the level of stability of the banking system of Ukraine are most determined by consumer prices and exchange rates.

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