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Econometric Analysis of the Formation of Deposit Resources of Households and Their Role in Ensuring Financial Security of the State

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ABSTRACT

Within the article, the formation of deposit resources of households and their role in ensuring financial security of the state is considered. Significant attention is paid to the formation of such resources within the financial system. To this end, a statistical analysis from 2007 to 2020 of the main trends in the formation of deposits by households in Ukraine, a study of the impact of macroeconomic factors on this process is carried out, peculiarities of the deposit market in periodic economic and political instability are substantiated. The econometric analysis of the impact of certain macroeconomic factors on the creation of these resources within the national economy was also conducted. Accordingly, the article included the national currency exchange rate, the level of the average wage and the level of the real weighted average interest rate on time deposits. The methodology for constructing a multifactor linear regression model was chosen for econometric modeling. This model was also tested for adequacy. In the article, the role of household deposit resources in ensuring financial security of the state is also described in detail, the importance of providing stable conditions for the functioning of the deposit services market in order to resist external and internal threats is substantiated.

1. INTRODUCTION

One of the important areas of the country's financial system, which can influence the rate of economic growth, ensuring financial security of the state is household finances. Households shape financial behavior of the population by determining the state of consumer markets and the situation in the country's financial sector. Citizens' savings are an important source of investment in economy of any country. The growth of organized savings of households, which also includes funds placed on deposit accounts in financial institutions, not only increases investment potential of their owners, but also stimulates through the banking system to revive business activity in almost all sectors of the national economy. Synergetic effects of economic growth of the country as a whole are formed.

Deposit resources are especially important in those countries where the development of the investment market is difficult and deposits remain one of the most stable sources of funds for financial institutions with their gradual transformation into credit and investment resources. Such countries include Ukraine, which deposit services market is constantly evolving in a changing complex environment of macroeconomic instability.

In Ukraine today, the investment market is underdeveloped, so the only way to attract financial resources for economic agents is the credit market. However, credit resources can be created within the country only through the transformation of temporarily free funds of economic entities through the functioning of financial intermediaries. Households play a key role in this process. Thus, these economic entities can influence the financial security level of the country, the content of which is to create conditions for the formation of the necessary financial resources for stable development of the national economy of any country, including Ukraine.

It the importance of the role of households in the development of the country's financial system, the national economy that necessitates the study of the peculiarities of the deposit resources formation, the factors influencing this process. An important role among such factors is played by macroeconomic factors, which directly and indirectly influence households' decisions on the transfer of own funds for temporary use to financial institutions. Defining and operating the information on the impact of various factors on the formation of deposit resources allows further implementation of measures to stimulate the creation of such resources, reducing the impact of destructive factors and increasing the positive impact of other factors.

The analysis of the formation of deposit resources of households is an important component of the study of the role of these economic entities in the economy development, and in the formation of the appropriate level of the national economic security. We will study the impact of certain macroeconomic factors on the formation of households'

deposit resources in Ukraine based on the use of statistical and macroeconomic methods and specify the role of such resources in the formation of financial security of the state.

2. LITERATURE REVIEW

It should be noted that the field of household finance in recent years has been the subject of many economic studies, and the study of various aspects of deposit behavior, including financial security, taking into account modern processes of innovation and digitalization, covered by many foreign and domestic scholars, such as: Danylyshyn et al. [1]; Dubyna et al. [2]; Gavurova et al. [3]; Grigoraș-Ichim et al. [4]; Grosu et al. [5]; Haber et al. [6]; Ivanov et al. [7]; Kochaniak [8, 9]; Linderhof et al. [10]; Lyons et al. [11]; Marhasova et al. [12]; Odintsova [13]; Popelo et al. [14]; Ramsky [15]; Revko et al. [16]; Shkarlet et al. [17]; Hrubliak et al. [18]; Shpak et al. [19]; Tulchynska et al. [20]; Tulchynska et al. [21]; Vasylieva et al. [22]; Viknianska et al. [23]; Vovk et al. [24] and other.

The authors of the study [7] proposed the improved approaches to determining the impact of a system of factors on household deposits based on the correlation-regression analysis. The researchers say that the results of their study will help optimize the choice of tools for effective management of deposit resources and develop approaches to assessing the level of domestic deposits. The researchers [3] found that the regression model determined that increasing concentration, lowering the interbank interest rate, disinflation, liquidity had a significant impact on lowering interest rates on deposit products. The authors found that when the market rate decreases, the deposit rate of the highly capitalized banking sector should also decrease, and this decrease should be higher than the reduction of the market rate. The aim of the article [10] is to model the impact of the introduction of mandatory deposit-refund schemes for small appliances and batteries in the Netherlands based on the use of the Fullerton-Wu partial equilibrium model. The authors proved that the productivity of deposit-refund schemes for additional processing is higher in cases where the current processing performance is relatively low. Thus, these studies prove the possibility of determining the level of influence of different determinants on the deposit behavior of households using correlation-regression analysis. In our opinion, these results of the research will help optimize the management of deposit resources.

The result of the research [9] is the analysis of the impact of welfare and socio-demographic characteristics of households on their propensity to own deposits. The authors found that for some member states, the adoption of a single limit under guarantee schemes was assessed as an incentive that could increase the resilience of deposits to withdraw funds, which will contribute to the stability of the credit institutions financing. The authors [8] analyzed the impact of household wealth, financial market activity, socio-demographic characteristics and subjective beliefs on the level of their savings deposits in the euro area. It was found that the differences between the levels of savings deposits in individual countries were primarily due to the heterogeneity of domestic conditions. The article analyzes [19] the problem of the shadow industry in the regions of Ukraine, in particular by assessing the integrated indicator of financial and economic security of the industry. Based on the analysis, the authors constructed a matrix of strategic zones "The level of the shadow economy - the level of financial and economic security." We agree with the authors 'research that households' propensity to deposit depends largely on their well-being. We also support the vision of scientists who prove the impact on deposit behavior of factors such as financial market activity, socio-demographic characteristics and personal beliefs of households.

The article [22] is based on the issue of identifying the key issues of financial security of the country. In the process of calculations, the authors included 47 variables, grouped into 10 aggregates. The results of the study show that the levels of financial security in the studied countries have wide variations from minimum to maximum values. It has been proven that financial inclusion and the use of technology also have a significant and positive impact on financial security. The authors [11] argue that the results of the study have important political implications due to the pressures that some countries' social support and public transfer systems will face in the coming years. Scholars [6] have studied the state of financial security of the country as a component of economic security in its key elements. Author' proposals have been developed to improve the "Guidelines for calculating the level of economic security of Ukraine", which in their opinion will help solve the problem of mathematical justification of the choice of indicators for the financial security assessment, minimize risks, eliminate subjectivity, and improve efficiency and quality of the financial security assessment. In our opinion, the above studies prove the significant role of deposit behavior of households in ensuring the financial security of the country. We are convinced that providing stable conditions for the functioning of the deposit services market will contribute to resilience to external and internal threats.

However, many issues of the theory and practice of financial behavior of the population remain controversial or underdeveloped. Political and economic instability, the probabilistic nature of the external economic environment and uncertainty in financial decision-making require improved methods and ways to study their impact on the household financial behavior. High level of the dependence of household deposit behavior in the financial services market on several macroeconomic factors requires focusing on identifying and analyzing relevant determinants of deposit behavior using econometric modeling.

The purpose of the article is to conduct the econometric analysis of the impact of the key macroeconomic indicators on the formation of deposit resources of households and substantiate the role of these resources in ensuring financial security of the country.

3. METHODOLOGY

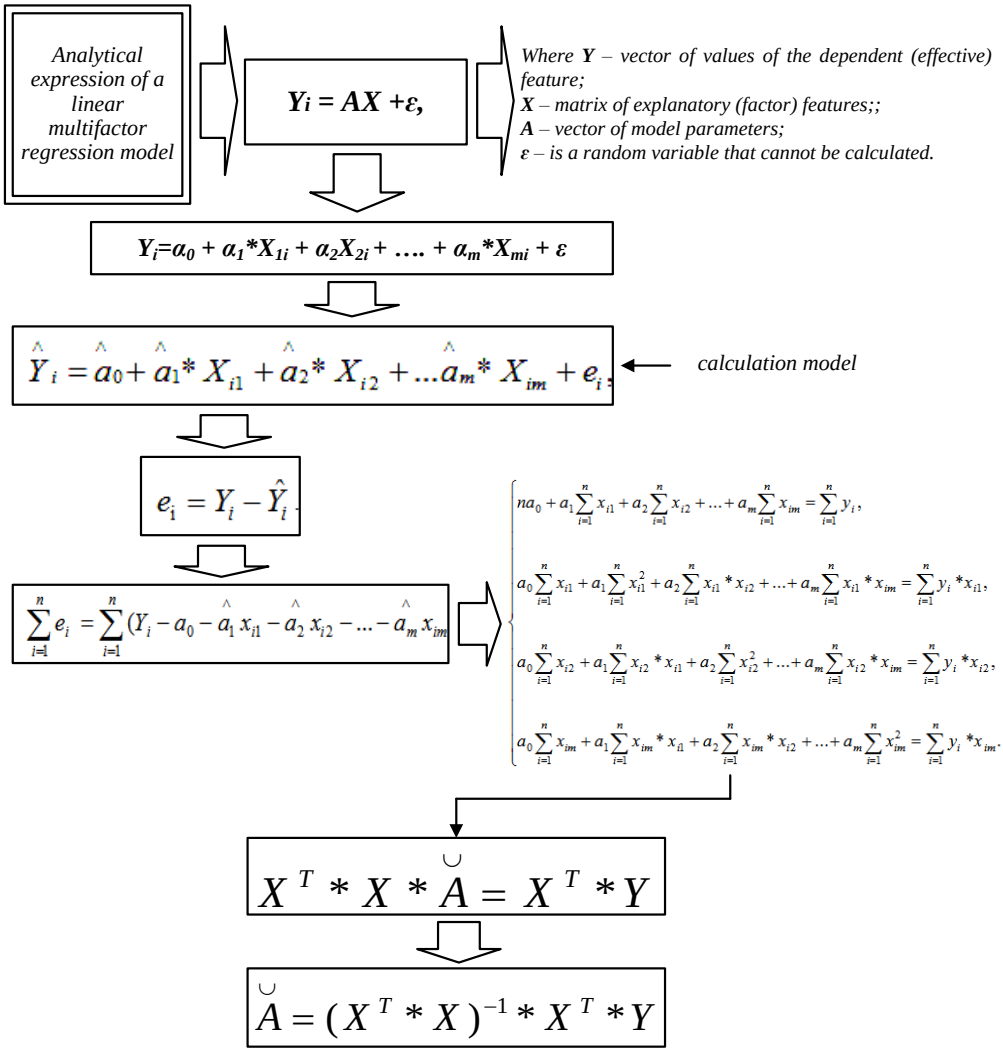
To conduct the outlined research in the article we use a range of different scientific methods. First of all, a set of statistical and econometric methods will be used, which will allow building a model of the dependence of household deposit resources in Ukraine on a number of macroeconomic indicators and identify the most important factors. The paper will also use classical methods of analysis, namely: measurement, comparison, abstraction, analysis and synthesis. These methods will be used to generalize and interpret the results, describe the role of household deposit resources in ensuring financial security of Ukraine.

Analytical and statistical data of the National Bank of Ukraine, the Ministry of Economy of Ukraine, which reflect the generalized consequences of the processes of the deposit resources formation and some aspects of economic life in Ukraine, were chosen as the information base for the study.

As already mentioned in the paper, among all research methods, the greatest attention is paid to the use of econometric and statistical methods. Namely these methods make it possible to obtain information about actual economic processes, which is expressed in the mathematical form that allows a deeper understanding of these processes and better use of available and necessary tools to influence them. Given that the objective number of parameters that influence within the market economy on the formation of deposit behavior of households is significant, the article will use three main ones: the national currency (UAH to 1 USD), the level of average wages fees (USD) and the level of real weighted average interest rates on time deposits (%). Thus, given the presence of several factors, the article will use the methodology of regression analysis and build a multifactor regression model of the dependence of household deposit resources on such indicators.

A multivariate regression model is a model that is actively used in economic research to determine and assess the impact of individual factors on a particular object under study. Building such a model allows us to mathematize the relationship between different economic indicators and formalize it by determining the algebraic equations of such a relationship. An important aspect of building any adequate regression model is to check it for correctness, which is realized through the use of a number of relevant statistical indicators. In Figure 1, the methodology of the regression analysis, which will be used by us in the study, is presented.

Thus, the use the presented in Figure 1 algorithm for finding the equation of the dependence between the above indicators will allow to obtain models of such dependence and thus understand the strength of each of the indicators and predict changes in household deposits from changes in the factors affecting them. We will conduct a relevant study.



Where X – the matrix of dimension n(m+1) of the original data on the independent variables x_1, x_2, …. x_m;*

X^T – transposed X matrix;

$\breve{A}$ – vector column dimension (m + 1) of the regression parameters to be determined;

Y –vector column of dimension n of the actual values of the dependent variable

Figure 1. Methodology of the regression analysis in the study of the impact of macroeconomic factors on the amount of deposit resources of households

Source: Systematized by the authors

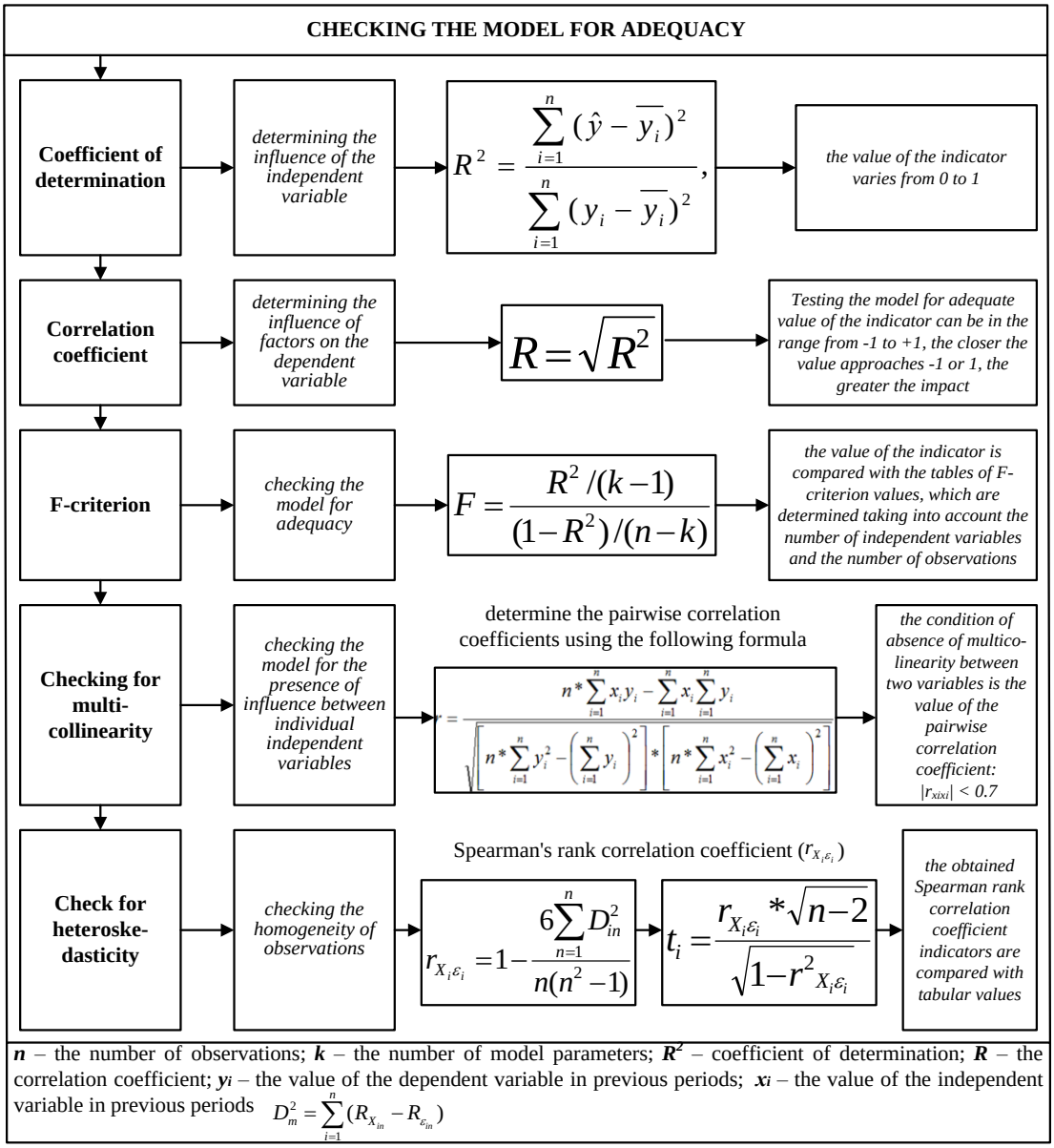


Figure 2. Methods for the estimation of econometric models on adequacy
Source: Systematized by the authors

Also, any model needs to be tested for adequacy. This test allows you to establish the correctness or error of the regression of the econometric model. The adequacy of the model is usually checked using a number of indicators and parameters. In the article, we will check the model obtained during the calculations for correctness with the help of the correlation coefficient, the coefficient of determination, F-criterion, verification of models for the presence of multicollinearity and heteroskedasticity.

The use of the methods used in Figure 2 for checking the model obtained after the econometric analysis for the correctness and compliance with real economic processes, their interaction allows us to assert the existence of a set of correlations between different financial parameters. Checking the adequacy of the model is one of the important stages of its search and justification.

4. PRESENTING MAIN MATERIAL

As already mentioned, the development of the deposit services market in Ukraine is developing periodically in difficult economic conditions, which are due to a number of external and internal factors. The dynamics of household deposit resources that have been accumulated by financial institutions in Ukraine should be considered in detail. Relevant information is presented in Figure 3.

Thus, if we analyze the amount of deposit resources of households in Ukraine over the past fifteen years, we can observe a significant impact of macroeconomic factors on the formation of these resources, maintaining their real value. Thus, if at the beginning of 2007 the amount of these funds amounted to UAH 111.27 billion or 22.03 billion US dollars, then at the end of 2020, respectively, 730.31 billion UAH or only 25.93 billion US dollars. The corresponding real value of citizens' deposits decreased significantly during the specified period and, despite the increase in the absolute indicators of accumulated such funds by more than 7 times, their real value increased by only 15%. This situation has a negative impact on the development of the entire deposit market, does not encourage people to invest in the country's financial system, leads to a long resumption of processes on attracting

household deposits, which ultimately negatively affects the formation of appropriate financial security.

The main reason for this situation is the devaluation of the national currency hryvnia against the world's leading currencies. This, in turn, is due to a number of complex political and economic processes, the causes of which are both external and internal destructive factors. The financial and economic crisis, the Revolution of Dignity, the annexation of Crimea and the war in eastern Ukraine led to a significant deterioration of the economic situation, which was reflected in the development of the entire financial system. During 2007-2020, the value of the hryvnia compared to USD US fell from 5.05 UAH for 1 US dollar up to UAH 28.17 per 1 US dollar (Figure 3), more than 5 times.

Of course, the outlined economic problems have also negatively affected the level of real average wages in the country, which has risen from just US $ 220 to US $ 502 over the past fifteen years. (a maximum of 2.28 times). In hryvnia equivalent, the growth took place from UAH 1,112 in early 2007 to UAH 14,141 at the end of 2020 (more than 12.7 times). The decline in real average wages amid rising inflation has led to a decline in real savings opportunities for households.

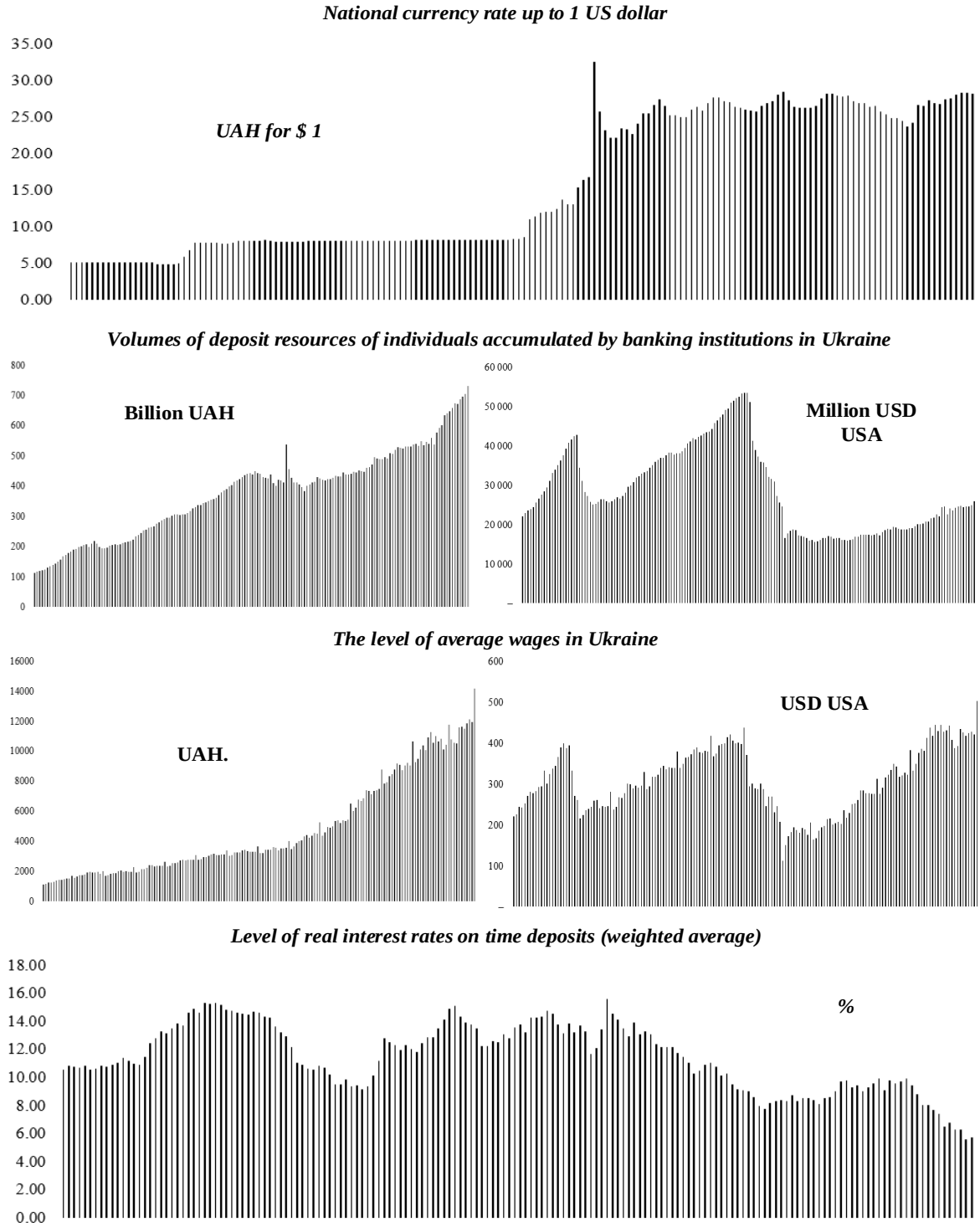


Figure 3. Statistical information on the volume of deposits resources of households in Ukraine in 2007-2020
Source: Compiled on the basis of data from the National Bank of Ukraine: https://bank.gov.ua/

After the Revolution of Dignity, the Ukraine's financial system was in a very difficult situation of its own development. It was at this time that, with the support of the IMF, the country began the process of reforming the country's banking system in order to increase its financial resilience to external threats. As a result of this reform, the number of banking institutions in Ukraine has more than halved, and the system has moved to market conditions, liberalizing foreign exchange legislation and increasing competition between really stable banking institutions that meet new, stricter NBU requirements. The banking system has undergone a period of profound transformations and changes. The liquidation of a significant number of banks has led to processes of non-repayment of funds to households that have been invested in such banking institutions. Accordingly, this required government intervention and the allocation of significant funds to return these resources. However, such a return was made gradually, over a long period, during which the real value of these resources decreased again. This situation has also had a destructive impact on the formation of household deposit resources in Ukraine.

The analysis only confirms the important role of macroeconomic factors in the formation of household deposit resources, the presence of which, in turn, has a positive effect on increasing the country's financial security, economic stability and its ability to counter external and internal threats. Let's analyze the features of the influence of the outlined factors on the volume of household deposits. Using the basic method of the econometric analysis, we will conduct such a study, namely, determine the algebraic equation of this effect. We introduce some notation for the corresponding calculations, namely:

D_{ind}^{Σ} – cumulative amount of deposit resources of individuals;

ERnc – national currency rate (UAH up to USD 1);

AW – level of average wages (USD);

IRtb – level of real weighted average interest rates on time deposits (%).

Given that the equation of the multifactor regression model is an equation of type $Y = AX + \varepsilon$, we can write the following equation:

$$\begin{bmatrix} D_{1ind}^{\Sigma} \\ D_{2ind}^{\Sigma} \\ D_{3ind}^{\Sigma} \\ ..... \\ D_{mind}^{\Sigma} \end{bmatrix} = \begin{bmatrix} a_0 \\ a_1 \\ a_2 \\ ..... \\ a_m \end{bmatrix} * \begin{bmatrix} ERnc_1 & AW_1 & IRtb_1 \\ ERnc_2 & AW_2 & IRtb_2 \\ ERnc_3 & AW_3 & IRtb_3 \\ .... & ..... & .... \\ ERnc_m & AW_m & IRtb_m \end{bmatrix} \quad (1)$$

Accordingly, the equation of the linear multifactor regression model of the dependence of household deposits on the set of macroeconomic indicators can be written as follows:

$$D_{ind}^{\Sigma} = \alpha_0 + \alpha_1 * ERnc + \alpha_2 * AW + \alpha_3 * IRtb + \varepsilon \quad (2)$$

where, $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ – unknown parameters to be determined;

ε – unobserved random variable.

To estimate the unknown parameters α0, α1, α2, α3, we form a calculation model for the above dependence. Its appearance can be written as follows:

$$\begin{aligned} \hat{D}_{iind}^{\Sigma} &= \hat{a}_0 + \hat{a}_1 * ERnc_i \\ &+ \hat{a}_2 * AW_i + \hat{a}_3 * IRtb_i + e_i, \end{aligned} \quad (3)$$

where, $\hat{a}_0, \hat{a}_1, \hat{a}_2, \hat{a}_3$ – parameters of the calculation model;

e_i – a mistake.

Given that $e_i = D_{ind}^{\Sigma} - \hat{D}_{ind}^{\Sigma}$, $e_i \to \min$, then

$$\sum_{i=1}^{n} e_i = \sum_{i=1}^{n} (D_{ind}^{\Sigma} - (\hat{a}_0 + \hat{a}_1 * ERnc_i + \hat{a}_2 * AW_i + \hat{a}_3 * IRtb_i + e_i)) \quad (4)$$

As noted, a necessary condition for the minimum of this function is the equality of its derivative to zero for all parameters a_0, a_1, a_2, a_3. Thus, taking into account this property, we obtain a system of equations, which can be written as follows:

$$X^T * X * \breve{A} = X^T * D_{ind}^{\Sigma} \quad (5)$$

$$\breve{A} = (X^T * X)^{-1} * X^T * Y \quad (6)$$

where, X – the matrix of source data for independent variables *ERnc, AW, IRtb;*

X^T – transposed to X matrix;

$\breve{A}$ – vector column of the required regression parameters;

D_{ind}^{Σ} – vector-column of values of the volume of attracted resources by individuals.

Let's solve this equation and determine the values of the regression parameters $\breve{A}$. Thus, due to multiplication $X^T * X$ we get the following results:

$$X^T * X = \begin{bmatrix} 168 & 2637{,}79 & 51969 & 1922{,}51 \\ 2637{,}79 & 55916.4395 & 806483.5 & 28102.7608 \\ 51969 & 806483.5 & 17136957 & 583287.62 \\ 1922.51 & 28102.7608 & 583287.62 & 22933.5357 \end{bmatrix}$$

Multiply $X^T * Y$ and get:

$$X^T * Y = \begin{bmatrix} 4814201 \\ 63299114.99 \\ 1560891730 \\ 56643795.15 \end{bmatrix}.$$

Find the inverse matrix $(X^T * X)^{-1}$:

$$(X^T * X)^{-1} = \begin{bmatrix} 0{,}764 & -0{,}00684 & -0{,}000748 & -0{,}0367 \\ -0{,}00684 & 0{,}000117 & 4.873127 & 0{,}000316 \\ -0{,}000748 & 4.873127 & -3.281718 & 1.795704 \\ -0{,}0367 & 0{,}000316 & 1.795704 & 0{,}00209 \end{bmatrix}$$

Therefore, given the above, the parameters will be:

$$\overset{\cup}{A} = (X^T * X)^{-1} * X^T * Y = \begin{bmatrix} 2203.218 \\ -631.418 \\ 74.453 \\ 1165.333 \end{bmatrix}$$

So, we get that a_0 = 2203.218, a_1 = -631.418, a_2 = 74.453, a_3=1165.333. The model of the calculation equation of the linear multifactor regression model can be represented as:

$$D_{iind}^{\Sigma} = 2203.22 - 631,42 * ERnc_i + 74.45 * AW_i + 1165.33 * IRtb_i$$

We will now assess the adequacy of the model in accordance with the methodology. As mentioned above, this test will be performed by determining the correlation coefficients, determination, F-criterion, determining the presence of multicollinearity and heteroskedasticity in the obtained model. Using the method described above, we will perform the appropriate calculations.

Therefore, R = 0.95; R^2 = 0.88.

The coefficient of determination shows how the dependent variable changes from the change of the independent (external) variable. The value of this indicator can be from 0 to 1. The closer the value goes to 1, the more significant the influence of the factor on the dependent parameter. In our case, the coefficient of determination of the multifactor regression model is 0.95, which indicates a significant influence of the factors identified for modeling on the amount of deposit resources of households.

The correlation coefficient shows the strength of the influence of factors on the dependent variable. In the multifactor regression model, the total correlation coefficient is determined, although it is possible to determine these coefficients in part. The values of the correlation coefficient can be in the range from -1 to +1. In our case, the correlation coefficient in the model is 0.88, which is a high figure, which goes to 1 and confirms the high level of the influence of selected factors on the processes of the household deposits formation.

Let's calculate the F-criterion to check the adequacy level of the obtained multifactor regression model. The Fisher's test is used to check the equality of variances of two samples. Using the method of calculating this indicator, which is presented above, we obtain that the F-criterion is 222.03. To interpret this indicator, we use tabular values, considering the number of parameters in the model and the number of observations. Therefore, the F-criterion (tabular value) is 0.

$F_{fakt} > F_{tabl}$ – the obtained model is adequate.

Let's test our model for multicollinearity, which is the relationship between different independent factors in the multivariate regression model. If multicollinearity exists in the model, it indicates the incorrectness of this model and the need to improve it. To test multicollinearity, we define even correlation coefficients.

$$r_{x_1x_2} = \frac{4800.5 - 309.34 * 15,7}{79,466 * 9,29} = -0,0765;$$

$$r_{x_1x_3} = \frac{167.278 - 11,44 * 15,7}{2.357 * 9,29} = -0,566;$$

$$r_{x_2x_3} = \frac{3471,95 - 11,44 * 309,24}{2.357 * 79,47} = -0,363.$$

Given the condition that $|r_{xixi}| < 0,7 \rightarrow$ multicollinearity is absent, we obtain $r_{x_1x_2}$=|-0,0765| → <0,7; $r_{x_1x_3}$ = |-0,566| → <0,7; $r_{x_2x_3}$ = |-0,363| → <0,7.

All paired correlation coefficients are less than 0.7, which indicates the lack of multicollinearity between the selected factors that affect the formation of deposit resources.

Let us check the obtained econometric model for the presence of heteroskedasticity, which is a heterogeneity of observations, which is expressed in the non-constant variance of the random error of the regression (econometric) model. To determine heteroskedasticity, we use, as noted, the Spearman rank correlation coefficient (p). In accordance:

$$r_{X_i\varepsilon_i} = 1 - \frac{6 * 1037314.5 + 391.5}{168^3 - 168} = -0,313.$$

The correctness of the obtained result will be checked by determining the critical point $T_{kp.}$ Accordingly:

$$T_{kp} = 2.258 * \sqrt{\frac{1 - 0.313^2}{168 - 2}} = 0,17.$$

Let's find tabular values: t(α/2, *k*) = (0,05/2;130) = 1,972.

T_{kp}^{fact} = 0,17; T_{kp}^{tabl} = 1,972; $T_{kp}^{tabl} > T_{kp}^{fact}$ – no heteroskedasticity.

Thus, the use of different econometric and statistical parameters to test the multifactor regression model for adequacy, we'll suggests that our model of the dependence of deposit resources on the national currency, the level of average wages, the real weighted average interest rate on time deposits, is correct and reflects the real economic processes within the financial system of Ukraine.

The importance of understanding the processes of the deposit resources formation within the financial system of the state is very important, because these funds, as noted, play an important role in providing financial resources for the development for the entire national economy. The stability of these funds also contributes to the stability and economy of the country, increases its ability to offset the impact of external destructive processes in the world markets for goods, services, and capital. In this context, it is the deposit resources in the leading countries in terms of economic development that play an important role in ensuring their financial security, stability of investment and credit funds produced within the financial system. In Figure 4, the theoretical structure of the impact of household deposit resources on the level of this type of security is presented.

Thus, households as a whole are a really important economic force that is able to form a stable financial basis for the country's development. At the same time, these economic entities are also able to form both positive, and but destructive centers of stochastic processes within the financial system. It also raises the issue of the importance of producing and implementing the effective monetary policy, which will be aimed at ensuring sustainable development of the deposit market, the banking system as a whole by minimizing the negative impact of macroeconomic factors on the deposits formation of these economic entities. Only with this approach it is possible to ensure an increase in financial security, normalization of financial relations in the country and the stability of the sources of financial resources for the development of economic processes in the country.

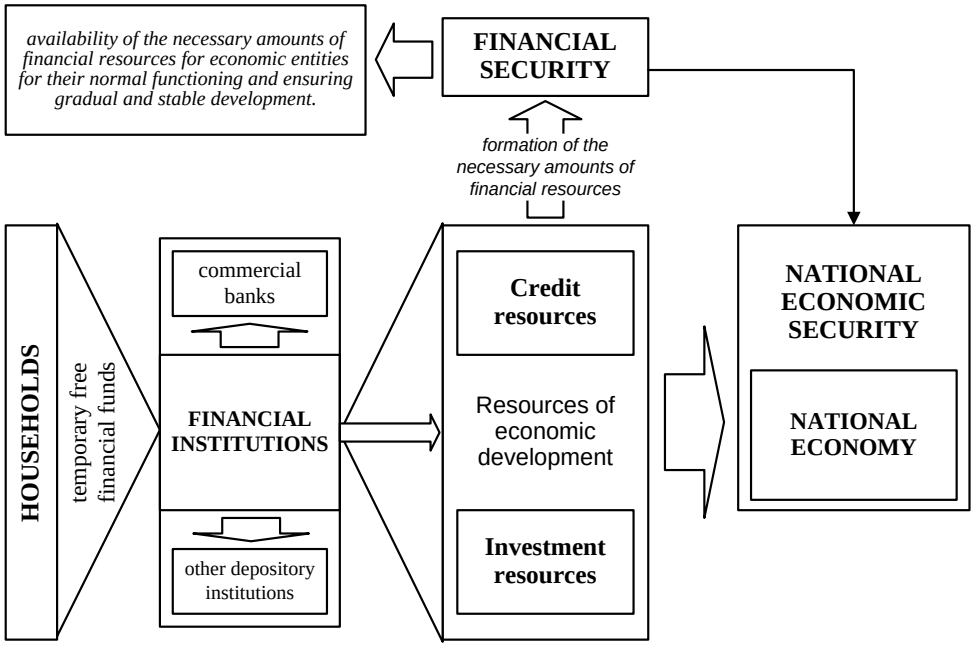


Figure 4. Theoretical construction of the impact of deposit resources of households on the financial security level of the state
Source: compiled by the authors

5. CONCLUSIONS

Thus, within the article, the econometric analysis of the impact of macroeconomic indicators on the formation of deposit resources of households in Ukraine is carried out, and the importance of such resources to ensure, first of all, the level of financial security of the state is substantiated. In particular, the algebraic equation of the dependence of the amount of deposit resources on the following parameters: the national currency rate (ERnc), the level of average wages (AW), the level of real weighted average interest rate on time deposits (IRtb), namely: analysis of this model suggests that the most important role in the formation of deposit resources of households is played by the level of their income, namely the number of wages received by household members.

It was also established that to ensure the country's financial security it is important to create conditions using monetary policy instruments for the formation of temporarily free funds of households with their subsequent involvement through a system of stable financial intermediaries in the country's financial system. Creating conditions for stable operation of financial institutions, ensuring the real value of money is also one of the most important conditions for the national economy development.

Another important issue for understanding the peculiarities of the growth of household deposits and increasing their role in ensuring financial security is the study of the formation of such funds of households, identifying the factors contributing to this. It is also advisable to investigate peculiarities of deposit behavior of households when choosing deposit products. This requires the use of its own system of scientific methods for conducting this study, which will also consider the methods of quantitative analysis of the relationships between parameters. It is the limited financial information in this direction, the difficulty in obtaining the information on quality indicators are some of the limitations that arise in the implementation of such a study.

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