

MODELLING THE INFLUENCE OF FACTORS ON THE FORMATION OF LOCAL BUDGET INCOME

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ABSTRACT

One of the important tasks of the functioning of the financial system and democratic society is the effective management of budgetary resources of local self-government bodies. Which, in turn, depends on the amount of budget resources available to local authorities. The main sources of the formation of financial resources are tax and non-tax revenues, income from capital transactions and official transfers.

In this article, an objective quantitative analysis of the influence of factors on the formation of local budget revenues is carried out using economic and mathematical modeling on the example of local budgets of the Volyn region. To build a model of dependence the volume of local budget revenues and the constituents of revenue receipts, the method of principal components was used, which made it possible to replace correlated factors with uncorrelated components.

Based on the formed model, it is proposed to forecast income indicators for future periods. Modeling positive and negative scenarios for the formation of the community's budgetary resources will enable for local self-government bodies to develop, accordingly, plans for the development of the territory, to optimize the sources of income and directions for the use of budgetary resources, and also to implement measures to smooth out negative impacts.

Keywords: modeling, local budgets, revenues and expenditures of local budgets, instability, tax revenues, non-tax revenues, territorial communities, local self-government authorities

1. INTRODUCTION

The optimal distribution and effective management of budgetary resources of local self-government bodies is one of the urgent and important tasks of the functioning of the financial system and democratic society. However, this process largely depends on the socio-economic situation in the country, especially in war conditions, so it is impossible without a thorough study of the factors and a general assessment of the state of the local budget. In the process of managing budget resources, local financial bodies constantly monitor the implementation of local budgets. However, among scientists, there are no unified approaches to the methodology of assessing the formation and planning of local budget revenues, and the normative documents of the methodology for the study the financial capacity of local self-government bodies are imperfect. This especially applies to taking into account such new economic factors related to Russia's war

against Ukraine, such as: assessment of financial losses of local budgets of territories that were recently liberated or are in the front-line zone; the impact of revenues of localized enterprises from the East and South of Ukraine to relatively safe regions of our country on their budgets; the role of industrial parks in filling the budgets of relatively safe areas of Ukraine, etc. Variable factors (internal) are: transparency of government bodies; effective mediation of local self-government bodies between business representatives and potential investors; the ability to set local taxes and fees and finance local territorial development programs; provision of administrative services.

2. LITERATURE REVIEW

The works of Ukrainian and foreign scientists are devoted to the study of the conceptual foundations of the formation of local budgets: V.Kravchenko, 1998 defined the essence and role of local budgets in ensuring the development of territorial communities; O. Kyrylenko, 2014 investigated the problems of formation and development of local budgets and inter-budgetary relations; T. Bondaruk, 2009 highlighted trends and the role of the budget mechanism in regulating local budgets. The problems of ensuring the financial base of local self-government bodies and the peculiarities of fiscal decentralization in Ukraine were investigated by G. Vozniak, 2020; peculiarities of financial provision of territorial communities are highlighted in the works of I. Grynchysyn, 2020. I. Storonienska & A. Pelehatyi, 2014 clarified the main problems of formation and use of financial resources of rural territorial communities in the context based on the principles of the concept of budget federalism.

Decentralization as a phenomenon and an economic idea stimulates the development of economic systems and concerns many areas and contexts, and the need for its application is determined by the need to reform due to inefficient existing power and financial relations (Bodó, Brekke & Hoepman, 2021). According to Christopher Dick-Sagoe, 2020 decentralization is fiscal, administrative and political. Its fiscal dimension focuses on the financial and expenditure relations between local authorities and the central government, therefore local authorities have the greatest opportunities to determine the highest priority areas for the development of their territorial community, which increases the efficiency of the distribution of financial resources. In many countries with a transition economy, fiscal decentralization does not reflect its content load from the point of view of the peculiarities formation the revenue and expenditure parts of local budgets and is mainly reduced to geographical deconcentration and provision of services (Jorge Martinez-Vazquez, Robert M. McNab, 2003).

The authors Vinnytska O., Korniienko T. & Chvertko L., 2021 determined that the main source of local budget revenues are local taxes and fees, which should exist in such a volume to be able to fully provide local authorities with the financial resources necessary for their own needs. At a time when there are many different discussions among scientists and practitioners regarding the assessment of the impact of fiscal decentralization on the socio-economic development of territorial communities, there are practically no empirical studies that would investigate the influence of the most relevant factors in planning the revenue part of the budgets of territorial communities. This causes the need for further research, since it is the sufficient amount of financial resources formed at the local level that can ensure and guarantee the implementation of the development programs of each territorial community. At the same time, the issue of establishing the influence of martial law caused by Russia's war against Ukraine on the state of local budget revenues

3. AIM OF THE RESEARCH

The purpose of our research is an objective quantitative analysis of the influence factors on the formation of local budget revenues using economic and mathematical modeling in conditions of instability on the example of local budgets of the Volyn region. This will make it possible to identify the most relevant of them and to predict their possible changes in prospective periods, including in the conditions of martial law.

4. METHODS

The study of local budget revenues in conditions of instability and their role in the financial support of local self-government bodies required the use of adequate methodological tools. In particular, the following methods were used in the work:

- the method of analysis and synthesis - for substantiating and generalization the problems of financial support of local self-government bodies;
- theoretical generalization - to establish a theoretical basis for financial support of local self-government bodies;
- system analysis - to substantiate the identified structural connections between the factors of local budget revenue formation;
- comparative method - for conducting a comparative analysis of the degree influence of individual factors on the level of income to local budgets;
- methods of economic and mathematical modeling - when building a correlation-regression matrix of the influence of such factors as: personal income tax; rent and fees for the use of other natural resources; internal taxes on goods and services; local taxes; official transfers; non-tax revenues at the level of aggregate revenues to local budgets of the Volyn region using the principal components method;
- tabular and graphic method - for visual display the results of the conducted research;
- functional analysis - to analyze the effectiveness of the formation financial resources of territorial communities. Calculations and construction of the model were carried out using the "Excel" function (Data-Analysis, Data-Correlation).

This study makes it possible to identify the main dependencies between the factors of budget revenue formation at the local level and their total volume. Such a factor analysis determines groups of interdependent variables (in our study – types of revenues to local budgets) and structures of mutual relations between them. Factor analysis provides a more concise and accurate model of the structure of dependencies between variables (Ruska R, 2012).

When building a multifactorial model of the relationship between groups of revenues to local budgets of the Volyn region, the closeness of their connection was assessed. A strong connection is possible between the specified factor characteristics, if $r_{xi} x_j > [0,7]$, but this is not always a condition for the presence of multicollinearity. Therefore, based on the Farrar-Glober method, the indicator was calculated χ^2 – to determine the presence of multicollinearity in an array of independent variables (Gerich M.S., Sinyavska O.O., 2021).

$$\chi^2 = - \left[n - 1 - \frac{1}{6} * (2m + 5) \right] * \ln_{(r)} \quad (1)$$

To establish the presence or absence of multicollinearity, the calculated value χ^2 we compare with the tabular one. Provided: $\chi^2 > \chi^2_{table}$ - is evidence of confirmation of multicollinearity in the array of independent variables and the hypothesis about the significance of the correlation matrix is accepted.

$\chi^2 > \chi^2_{table}$ - therefore, there is multicollinearity between the independent variables, which

confirms the close relationship between the groups of revenues of the local budgets of the Volyn region and means changes in the volume of revenues in one group when revenues in the correlated group change. There is also a complex interrelationship of the influence of income groups on the resulting indicator - the volume of revenues of local budgets of the Volyn region. To analyze the nature of the influence of each group of incomes on the resulting characteristic, it is necessary to use the method of principal components, which will be appropriate for building such a model under the condition of multicollinear relationships between factor characteristics and will make it possible to replace correlated factors with uncorrelated components.

The advantages of using this model in our study are: overcoming multicollinearity of variables in regression analysis; addition of missing values of sparse matrices for use in recommender systems; latent semantic analysis, which allows conducting an information search and analyzing a large number of documents for the purpose of their indexing, classification, etc., where there is a need to identify the main factors from an array of information data.

The study of factors influencing the formation of local budget revenues was carried out using the statistical analysis method, which involves the consideration of a group of objects that have certain characteristics common to them. In our case, these are elements of local budget revenues. The quantitative assessment of these features is called the values of their parameters (Bazilevich V., Ilyin V., 2007). Thus, each object is characterized by a set of a certain number of parameter values z_j . This characteristic of the object is a multidimensional random variable with z_{ij} components. The measurement of n parameters for N objects is recorded in the form of a table or data matrix (Table 1).

Table 1. Matrix of n parameters (income sources) for N objects (years of observation)

N_0	X_1	X_2	...	X_j	...	X_n
1	X_{11}	X_{12}		X_{1j}	...	X_{1n}
2	X_{21}	X_{22}		X_{2j}	...	X_{2n}
...	...	...	...	...	...	...
i	X_{i1}	X_{i2}	...	X_{ij}	...	X_{in}
...	...	...	...	...	...	...
N	X_{N1}	X_{N2}	...	X_{Nj}	...	X_{Nn}

Source: (Bazilevich V., Ilyin V., 2007)

The algorithm for calculating normalized values of local budget revenue parameters has the following form:

1. calculation of the average value of each element of local budget revenues;
2. finding the deviation of the value of each element of local budget revenues from its average value;
3. establishment of a sample variance for each element of local budget revenues;
4. determining the normalized value of the j -element for each i -budget income;
5. determination of covariance for any arbitrary parameters;
6. correlation coefficient calculation for any arbitrary parameters.

After, the raw data were normalized in the study. To do this, we use the mathematical expectation of the normalized parameter $z_j - M(z_j) = 0$, and variance - $D(z_j) = 1$.

To explain the level of influence of each element of income on the total amount of income to local budgets, the method of main factors developed by H. Thomson based on the formula was used:

$$S_{zj}^2 = 1 = \sum_{p=1}^m (a_{pj}^2 + d_j^2 = a_{1j}^2 + a_{2j}^2 + \dots + a_{mj}^2) + d_j^2 \quad (2)$$

Coefficients for factors $a_{1j}, a_{2j}, \dots, a_{mj}$ are called loads. Loads determine the influence of a single factor on this component, and their value is the subject of calculations in factor analysis. This model shows the structure of the dispersion of the indicator, which has two parts:

$$h_j^2 = \sum_{p=1}^m a_{pj}^2 = a_{1j}^2 + a_{2j}^2 + \dots + a_{mj}^2 \quad (3)$$

and d_j^2 . The first, commonality h_j^2 - shows what part of the dispersion of the indicator is explained by factors, and the second, characteristic d_j^2 - shows what part of the dispersion of the indicator cannot be explained by factors. The larger the first part and the smaller the second, the better the factor analysis result. The condition under which the factors are determined sequentially requires the maximum contribution of each of the factors to the total value. (KASlaRUM, O. P., KASlaRUM, Ya. O., 2016).

The method of principal components is based on the construction of factors (as a method of selecting informative features). The main idea of the method is to combine several correlated variables into one, which will represent a linear combination of the original variables. The purpose of the method is to study the internal structure of the studied system of values, to «compress» this system without significant loss of information by identifying a small number of factors that explain the variability and interrelationship of values (Principal Component Analysis). STATISTICA software was used for calculations. (Borychenko, O., Cherniavskyi, A., Ostapchuk, Y., 2018)

5. RESULTS

Local budgets are a means of accumulating and redistributing income, necessary to ensure the influence of local self-government bodies on the socio-economic development of territories and financing regional programs (Prots N., 2015). Planning of the revenue part of local budgets is carried out on the basis of preliminary forecast macro-indicators of the economic and social development of Ukraine, taking into account current norms and proposed changes to the budget and tax legislation of Ukraine. Indicators that are decisive in the planning of local budget revenues include: the volume of budget revenues from personal income tax, local taxes and fees for previous years; the size of the average salary in the region and Ukraine; the amount of overdue salary arrears due to lack of budget funding; dynamics of gross regional product; unemployment rate.

According to the Budget Code of Ukraine, the local budget includes revenues and expenses for the performance own and delegated powers of local self-government bodies. According to the budget classification, the main groups of income are: tax, non-tax revenues, income from capital transactions and official transfers. Tax revenues include the following taxes: personal income tax, corporate income tax; rent and fee for special use of natural resources; internal taxes on goods and services; local taxes and fees; environmental tax and other revenues. The Budget Code of Ukraine defines the standards for deductions from statewide taxes (Table 2)

Table 2. Norms for splitting basic taxes and payments to local budgets, %

Tax name	Kyiv, Sevastopol city budgets	Regional budgets and Autonomy Republic of Crimea	District budgets	Budgets of territorial communities
Income tax	40	15	-	60
Corporate income tax of utility companies	100	100	100	100
Corporate income tax	10	10	-	-
Rent for special use of forest resources of state importance (local importance*)	37	-	-	37
Rent for the special use of forest resources of state importance (local importance*)	45	45	-	-
Rent for the use of subsoils of state (local) importance	25	25	-	-
Ecological tax	55	30	-	25
Local taxes and fees	100			100

Source: complied by the authors according to Budget Code of Ukraine

The main components of non-tax revenues are: own revenues of budgetary institutions, income from property and business activities, fees for providing administrative services, state duty. To build a model of the dependence the volume of revenues to the local budgets of the Volyn region and the constituents of revenue receipts ([About administrative services, 2013](#)), we will use the method of principal components, which will make it possible to replace correlated factors with uncorrelated components. Using this method, it is possible to single out the most influential components on the resulting characteristic. We include in the matrix of factors 4 main components (Table 3), which explain 99.9% of the total dispersion. The basis for calculating these indicators is the data of the Consolidated budget of the Volyn region 2006 – 2020 & Annual Report of Execution the State Budget of Ukraine, 2006 – 2020.

The eigenvalues of the correlation matrix of the main components show the magnitude of the explained variation in the revenues of the local budgets of the Volyn region by the corresponding component, which, in turn, is explained by the variation of the independent variables (revenues of the local budgets). Each subsequent one increases the volume of the total cumulative dispersion, but its value in the overall structure decreases, as evidenced by the smaller values of the own correlation. The eigenvalue of the dispersion of the first component is more than 71%, which is sufficient for a practical explanation of the resulting feature (incomes of local budgets of the Volyn region). Since the vectors are orthogonal, independent of each other, the exclusion of the additional component does not affect the change in the eigenvalues of the components.

Table 3. Eigenvalues of the correlation matrix of the principal components

Main components	Eigenvalues of the correlation, R^2X	% of total dispersion, $R^2X(\text{Cumul.})$	Eigenvalue of the component
1	0,711291	0,711291	4,267746
2	0,183599	0,894890	1,101593
3	0,086210	0,981099	0,517258
4	0,017608	0,998707	0,105646

Source: complied by the authors according to Consolidated budget of the Volyn region, 2006 – 2020

Table 4 contains information on the influence of each variable in the structure of the principal component. We write down the first component, taking its value modulo:

$$F_1 = 0,90844 \times X_1 + 0,0004 \times X_2 + 0,95193 \times X_3 + 0,69545 \times X_4 + 1,1169 \times X_5 + 1,09229 \times X_6 \quad (4)$$

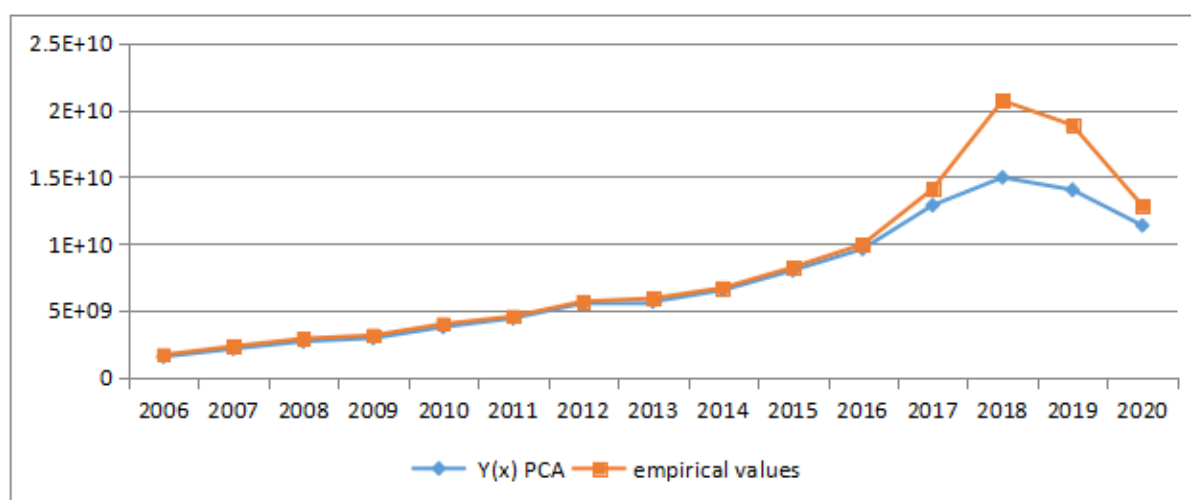
Table 4. Eigenvectors of the correlation matrix of factors the volume of revenues to local budgets of the Volyn region

Factor Variables	Component 1	Component 2	Component 3	Component 4
X ₁ (Income tax)	0,90844	0,010673	0,039342	0,196659
X ₂ (Rent fee)	0,00040	0,743053	0,000214	0,001174
X ₃ (Internal taxes on goods and services)	0,95193	0,034517	0,000019	0,000010
X ₄ (Local taxes)	0,69545	0,001277	0,116521	-0,073868
X ₅ (Official transfers)	1,11690	-0,008114	-0,212960	-0,010233
X ₆ (Non-tax revenues)	-1,09229	-0,000262	-0,066214	-0,016652

Source: compiled by the authors according to Consolidated budget of the Volyn region, 2006 – 2020

The component explains the variation of local budget revenues and the share of each factor, the variation of which explains the change in the outcome measure. On the basis of the equation of the first component, we build a graph of the resulting characteristics Y and compare it with empirical values (Fig. 1).

Figure 1. Graph of revenues of local budgets of the Volyn region for the period 2006–2020 and estimated values of Y(x), calculated by the method of principal components



Source: compiled by the authors in Microsoft excel according to Consolidated budget of the Volyn region, 2006 – 2020

Estimated values of revenues by the method of main components coincide with empirical values, with the exception of 2018–2019, but repeat the general trend, which indicates that the first component can be used to analyze and forecast the impact of factors in the formation of revenues of local budgets to the Volyn region:

$$F1 = 0,90844 \times X_1 + 0,0004 \times X_2 + 0,95193 \times X_3 + 0,69545 \times X_4 + 1,1169 \times X_5 + 1,09229 \times X_6 \quad (5)$$

Variations in the revenues of local budgets of the Volyn region are most influenced by: official transfers ($1,1169 \times X_5$) and non-tax revenues ($1,09229 \times X_6$) - the weighting coefficients of the influence of these factors on the resulting > 1 , it shows a significant dependence on them the volume of revenues of local budgets of the Volyn region.

It is worth paying attention to the factor sign of official transfers, which in recent years have a

tendency to decrease in the general structure of income, which proves empirical values. However, from the obtained dependence, we see that with a decrease in the volume of official transfers, in order to maintain the volume of income at an unchanged level, other types of income must grow by a larger amount.

This statement is also valid for non-tax revenues. Taking into account the importance of the non-tax revenue factor and its impact on the total amount of local budget revenues, the initiative to increase the number of paid services provided in the centers of provision of administrative services, it is an important factor in increasing the level of financial support of local communities ([About administrative services, 2013](#)).

At the same time, it is necessary to pay attention to such a trend as a significant gap in the number of staff in certain territorial communities and their average salary, which may lead to a potential lack of interest in effective work and community development ([I. Grynychyn, 2020](#).) That is, when modeling the influence of certain factors on the revenues of local budgets, it is necessary to take into account the specified management factor, since the volume of non-tax revenues depends on the effectiveness of management.

A significant part of the variation in local budget revenues is explained by tax revenues. The most positive influence on the volume of revenues of the local budgets of the Volyn region in the indicated years was such as the growth of the volume of the factor “internal taxes on goods and services” - $(0,95193 \times X_3)$, the factor “Tax on the income of individuals” had a slightly smaller effect - $(0,90844 \times X_1)$.

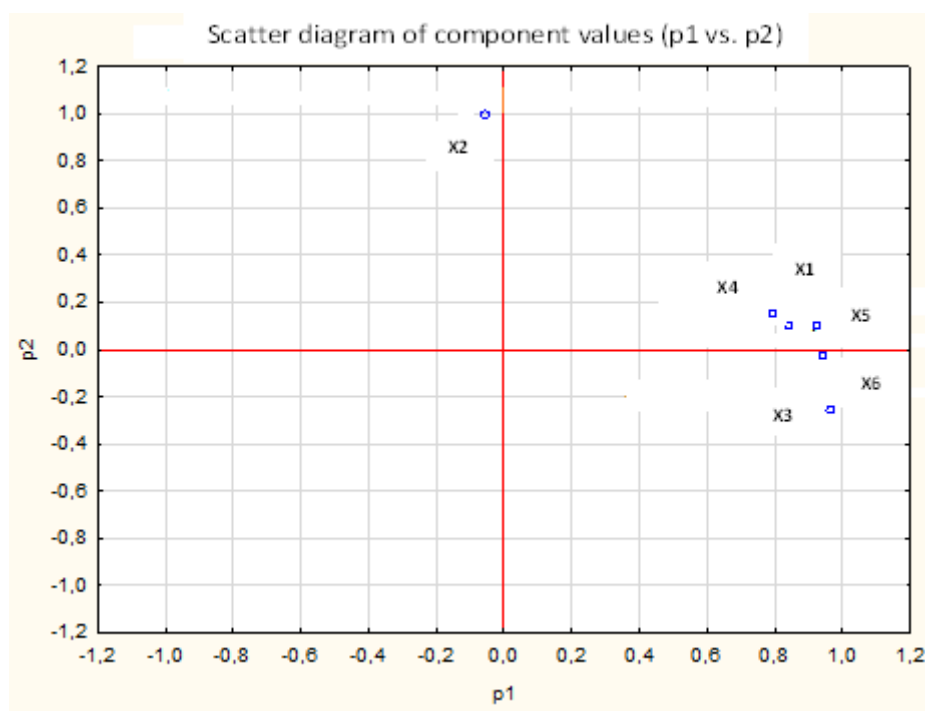
The share of internal taxes on goods and services, despite the increase in absolute value, in the structure of revenues decreased every year, which indicates a slower rate of their growth compared to other sources of income. In addition, the amount of revenue from them depends on the number of registered tax payers and the volume of sales of excise goods, which directly depends on consumption and the level of prices for excise goods. Considering the significant importance of the factor “Domestic taxes on goods and services” $(0.95193 \times X_3)$, a possible downward revision of the share of their inclusion in local budgets may cause significant risks of reducing the level of financial support local self-government.

The indicator of the influence of the factor “Local taxes” ≈ 0.7 $(0.69545 \times X_4)$ also significantly affects the change in the resulting characteristic, but compared to the influence of other factors, its role is less decisive. For example, the impact of an increase in the volume of official transfers is almost twice as large as that of local taxes, which partially explains the existing practice over the past 15 years of relying more on transfer revenues than on local tax revenues. Among property taxes, the land fee is of great importance, accounting for almost 80%. However, the problem of land taxation is the lack of regulatory monetary assessment indexing of agricultural land and non-agricultural land. In addition, part of the distributed lands are not fully or partially used by their owners (lack of funds for the purchase of appropriate agricultural machinery, age restrictions on the ability to work for many owners of these lands, unfavorable lease terms from large agricultural enterprises, mobilization of part of the younger male population to the Defense Forces of Ukraine, etc.).

In the conditions of decentralization, local taxation should become the basis of financial support of local self-government bodies and the capacity of territorial communities. The experience of many democratic countries just proves this. At the same time, one of the main local taxes in these countries is real estate tax (property tax). In addition, in these countries, the value of this property is taken into account, and not the total area, as in Ukraine, when taxing residential or non-residential real estate. Based on the experience of taxing this real estate in the cities of many democratic countries, it is possible to predict a significant increase in the revenues of

local budgets in Ukraine when using their approaches in taxing real estate at its market value. The “Rent fee” factor in the first component has almost no effect on the change in revenues of local budgets of the Volyn region - ($0.0004 \times X_2$). However, the variation of the resulting characteristic explained by the second component changes mainly due to the change in the amount of rent payments - (0.743053), which can be seen in the diagram (Fig. 2).

Figure 2. Scatter diagram of component values (1, 2)



Source: compiled by the authors in Statistica 10

The order in which the variables are placed on the scatter plot indicates the strong influence of the variables on the component and their relationship to each other. The close placement of variables relative to each other indicates a close correlation between them, which is also confirmed by the matrix of correlation coefficients. However, there is almost no connection between the variable “Rent and fee for the use of other natural resources” with other variables. Therefore, a possible increase in the interest rates of rent payments and an increase in rent payments in general will not cause a negative impact on the amount of other income. Also, “Rent payments and fees for the use of other natural resources” have a relatively small fiscal value, and from 2015 to 2020, their share in the overall structure of revenues to local budgets of the Volyn region was less than 1% (Table 5). In accordance with the identified dependencies and the practice of rational nature management, it is worth revising the tax policy regarding the establishment of rent payments, in particular in the direction of increasing them and increasing their amount of inclusion in local budgets, according to the principle of localization of natural resources. The largest share among rent payments (more than 80%), according to the specifics of the Volyn region, is the rent for the special use of forest resources. An increase in fees for the use of water resources in the cultivation of blueberries and in fish breeding could become a significant income of the Volyn region budget.

Table 5. Data on the main sources of revenues to the local budgets of the Volyn region for the period 2006-2020 and their shares in the total amount of revenues in the corresponding year, UAH thousands

Year	Total Revenues	Income tax	Rent fee and fees for the use of other natural resources	Internal taxes on goods and services	Local taxes	Official transfers	Non-tax revenues
2006	1 696 077,1	286 806,5	32 233,5	20 806,4	11 160,0	1 063 124,1	68 028,1
		16,91%	1,90%	1,23%	0,66%	62,68%	4,01%
2007	2 335 928,1	448 562,5	37 605,2	24 185,8	12 205,1	1 423 836,9	96 365,4
		19,20%	1,61%	1,04%	0,52%	60,95%	4,13%
2008	2 911 944,7	604 156,2	50 555,4	25 879,4	12 534,1	1 817 735,7	73 080,8
		20,75%	1,74%	0,89%	0,43%	62,42%	2,51%
2009	3 149 153,2	568 883,7	72 641,3	18 832,4	12 745,7	2 015 258,4	136 741,5
		18,06%	2,31%	0,60%	0,40%	63,99%	4,34%
2010	4 000 048,5	642 861,0	82 141,6	16 891,1	12 861,7	2 671 082,4	157 954,1
		16,07%	2,05%	0,42%	0,32%	66,78%	3,95%
2011	4 566 667,1	761 633,6	98 573,3	0,0	38 050,9	3 153 917,1	190 139,7
		16,68%	2,16%	0,00%	0,83%	69,06%	4,16%
2012	5 683 594,3	851 874,1	116 351,1	0,0	84 169,8	3 965 275,8	249 921,8
		14,99%	2,05%	0,00%	1,48%	69,77%	4,40%
2013	5 913 563,6	887 925,8	126 723,4	0,0	108 434,3	4 109 828,0	239 376,5
		15,02%	2,14%	0,00%	1,83%	69,50%	4,05%
2014	6 702 589,0	967 698,1	142 494,6	0,0	142 494,6	4 699 725,1	272 063,5
		14,44%	2,13%	0,00%	2,13%	70,12%	4,06%
2015	8 233 627,1	927 330,8	39 149,7	211 329,3	250 479,0	5 736 399,6	501 434,9
		11,26%	0,48%	2,57%	3,04%	69,67%	6,09%
2016	9 952 523,6	1 436 518,5	44 112,0	308 155,9	352 267,9	6 430 828,6	528 388,3
		14,43%	0,44%	3,10%	3,54%	64,62%	5,31%
2017	14 075 950,9	2 119 756,7	46 789,2	340 657,6	387 446,8	8 901 963,7	618 507,6
		15,06%	0,33%	2,42%	2,75%	63,24%	4,39%
2018	20 688 411,1	2 696 339,4	76 814,5	341 787,0	418 601,5	9 991 939,7	658 284,2
		13,03%	0,37%	1,65%	2,02%	48,30%	3,18%
2019	18 861 975,0	3 218 819,0	80 793,0	325 913,5	406 706,5	9 151 553,7	518 555,6
		17,07%	0,43%	1,73%	2,16%	48,52%	2,75%
2020	12 836 992,7	3 459 332,6	88 481,4	355 559,7	1 193 241,7	5 847 320,4	474 137,0
		26,95%	0,69%	2,77%	9,30%	45,55%	3,69%

Source: compiled by the authors according to Consolidated budget of the Volyn region, 2006 – 2020

Taking into account the average value of the income factors of the local budgets of the Volyn region for the period 2006–2020 and their weighted influence on the variation of the resulting characteristic, it is possible to form their respective hierarchy of importance:

1. official transfers;
2. personal income tax;
3. non-tax revenues;
4. local taxes;
5. internal taxes on goods and services;
6. rent fee and fees for the use of other natural resources.

Accordingly, it would be possible to predict their dynamics for the future, regardless of the war, but one must take into account the fact that with the beginning of Russia's aggression against Ukraine, a large part of this data is closed for analysis. The use of mathematical and statistical modeling methods makes it possible to forecast indicators for future periods on the basis of the formed model. (Koziuk, V., & Lipyana-Goncharenko, H. 2021). We extrapolate certain trends formed as a result of the influence of determinants on the revenues of local budgets the Volyn region. It is necessary to calculate the forecast value of each factor for the corresponding time interval. We determine the confidence intervals and standard deviations (forecast errors) of the actual forecast values of the dependent variables to construct an optimistic and pessimistic.

$$h_j^2 = \sum_{p=1}^m a_{pj}^2 = a_{1j}^2 + a_{2j}^2 + \dots + a_{mj}^2 \quad (6)$$

For forecast values of each individual type of income of local budgets, the forecast error was determined by the formula:

$$\varepsilon = \frac{x \cdot \sigma}{\sqrt{n}} \quad (7)$$

To construct a confidence interval, we assume the reliability of the forecast 95% $\gamma = 0,95$, need to find x that is, its corresponding value for a given level of reliability in the table of Laplace function values:

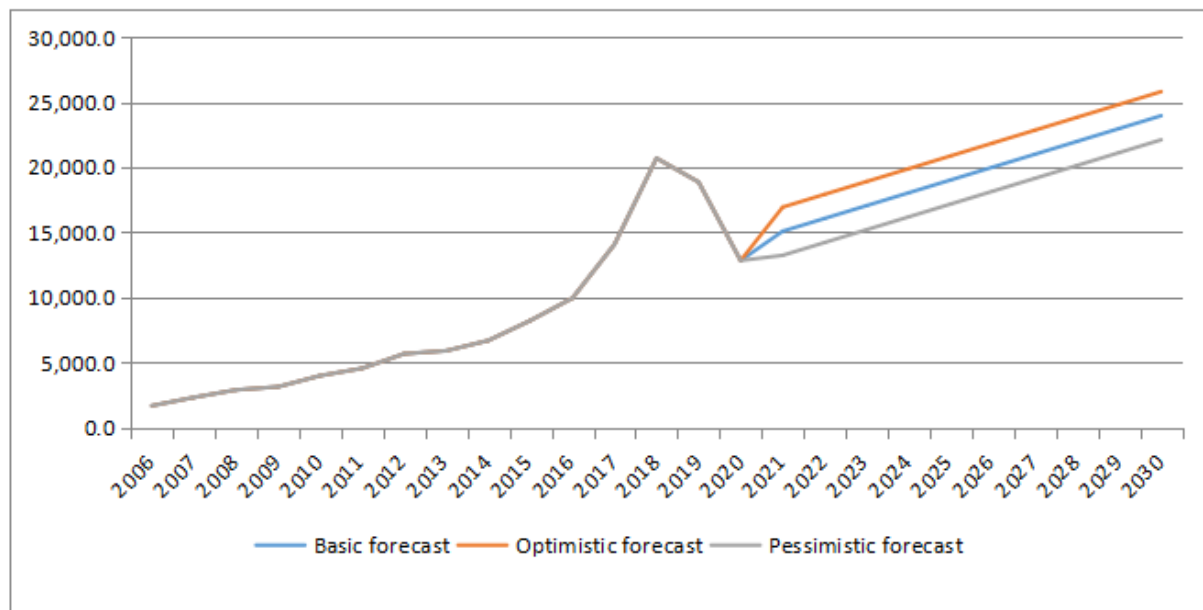
$$f(x) = 0,5\gamma = 0,5 \cdot 0,95 = 0,475 \rightarrow x \approx 1,96 \quad (8)$$

n - sample size of forecast data

Accordingly, for an optimistic forecast, we take into account the positive value of the error (+ ε) to the forecast value of the type (indicator) of the income of the local budget the Volyn region. For a pessimistic forecast, we take into account the negative value of the error (- ε).

Accordingly, the forecast of an increase in revenue is optimistic, and a decrease in revenue is pessimistic. Based on the calculations, we build a graph with possible variants of the development the specified trends. The graph clearly confirms the linear nature of dependence and the preservation of such a trend in the future, if there was no Russia's war against Ukraine. The proximity of the optimistic and pessimistic graphs to the main forecast indicates a narrow confidence interval and is a confirmation of the correctness and realism of the displayed data in the pre-war period (Fig. 3).

Figure 3. Forecasting the volume of revenues to local budgets of the Volyn region (2006-2030), mln. UAH



Source: compiled by the authors in Microsoft excel according to Consolidated budget of the Volyn region, 2006 – 2020

Modeling positive and negative scenarios of community development enables local self-government bodies to develop, accordingly, plans for the development of the territory, to optimize sources of income and directions for the use of budgetary resources, as well as to implement measures to smooth out negative impacts. It is advisable to use the development forecast for newly formed local self-government bodies, because a new administrative and financial configuration basis has been formed, as well as potential opportunities for this have been laid. The technical execution of territorial community development modeling can be carried out by their financial bodies.

The role of local self-government bodies in this process consists in considering the formed forecasts, their possible adjustment and, accordingly, approving on their basis the strategic directions of the development of the administrative unit. The presence of a strategic plan for the development of the community is also a certain guarantee for both business entities and the local population.

As we can see from Table 6, the projected volume of local budget revenues in 2026 (if there was no war) could increase by 34.5%, compared to 2020, which is explained by the increase in the absolute dimension of the forecast values of the determinants. The decisive influence in the forecast period would be maintained by official transfers – (+ UAH 6,566.37) million compared to the indicator of 2020, if there was no war.

Table 6. Analysis of the change in the result indicator (volumes of revenues of local budgets the Volyn region) as a result of the influence the forecast values of the determinants, UAH million (without taking into account the consequences of the corona crisis pandemic and Russia's war against Ukraine in 2022-2024)

Indicator	Basic forecast for 2026	Optimistic forecast for 2026	Pessimistic forecast for 2026	Absolute change in the basic forecast relative to 2020.	Change in the basic forecast relative to 2020, %
Income tax	4033,03	4423,90	3642,17	573,70	14,23
Rent fee and fees for the use of other natural resources	97,70	100,88	94,53	9,22	9,44
Internal taxes on goods and services	518,81	574,55	463,07	163,25	31,47
Local taxes	1482,79	1646,47	1319,12	289,55	19,5
Official transfers	12413,69	13522,53	11304,86	6566,37	52,90
Non-tax revenues	875,31	955,63	794,99	401,18	45,83
The forecast volume of revenues of the local budgets of the Volyn region for 2026	19644,31	21451,65	17836,89	6807,32	34,65

Source: Calculated by authors

6. DISCUSSION

The use of modeling makes it possible to take into account the direct influence of objective factors on the level of financial support of local self-government bodies. But, in the process of implementing the decentralization reform, potential and existing problems should also be taken into account, where the human factor and consistency in management decision-making are decisive. With regard to the latter, it is important to take into account such a trend as the trend of greater efficiency in the use of budget potential in terms of expenditures in the group of communities without subsidies and communities with minimal subsidies. (I. Grynychshyn, 2020).

When forecasting the revenues of local budgets for the future, it is also important to take into account such a factor as the possible negative impact of the introduction of the so-called carbon footprint tax in the EU from 2026, which may lead to significant losses of revenues of Ukrainian enterprises, and, accordingly, to a decrease in revenues local budgets.

In the conditions of the war, a new factor of influence on the revenues of the local budgets of Ukraine was clearly manifested, which is connected with the increased bombing by Russia's troops the energy facilities of our country, which negatively affects the activities of the budget-generating enterprises of Ukraine at the local level.

The increase in financial instability of the state of local budgets in Ukraine is caused by the inconsistency of the level of expenses and taxation between the state and local self-government bodies. In the event that the central government implements a policy of curbing inflationary processes by limiting the level of public spending and increasing tax rates, local self-government bodies in their own interests may implement the opposite policy, for example, before local elections. And under conditions of significant fiscal decentralization and redistribution through local budgets of up to 20% of GDP, such uncoordinated actions, on the contrary, will have quite negative consequences for public finances in general, primarily in the conditions of Russia's

war against Ukraine. In view of the above, in conditions of financial instability, uncertainty and limited budgetary resources, there is a need for systematic planning of local budget revenues for the medium-term perspective using economic and mathematical modeling methods. When using these methods, it is necessary to take into account not only the trends that have developed until 2020, but also the negative consequences of a full-scale war of Russia against Ukraine in 2022-2024, which may continue in the following periods. On the other hand, the study of factors influencing on the revenues of the local budgets the Volyn region until 2020 allows us to single out the main ones for the future, regardless of Russia's war against Ukraine.

7. CONCLUSIONS

The income factors of the local budgets of the Volyn region during 2006–2020 and their weight of influence on the variation of the total amount of income, where the determining factors are: official transfers, non-tax revenues, internal taxes on goods and services, were studied. Based on the correlation-regression analysis, a model of the influence of factors on the variation of the total volume of revenues to local budgets was built, which is based on taking into account the following main indicators: official transfers; Income tax; non-tax revenues. The results of the calculations proved that the lowest level of influence on the formation of revenues to local budgets of the Volyn region had such factors as: rent fee and fees for the use of other natural resources, other revenues of local budgets. This approach made it possible to carry out quantitative forecasting of local budget revenues for the period up to 2030, as well as to develop pessimistic and optimistic scenarios for optimizing the sources of budget resources.

The analysis of the volumes of revenues local budgets of the Volyn region as a result of the influence of the forecast values of the determinants allowed us to calculate three types forecasts for 2026: basic, optimistic and pessimistic. According to the basic forecast, the volume of revenues of the local budgets of the Volyn region may amount to UAH 19,644.31 million. According to an optimistic forecast, the amount of income in 2026 will amount to 21,451.65 million hryvnias. and according to the pessimistic one, 17836.89. Official transfers of 63% in the structure of local budgets will have the greatest impact on the formation of the volume of revenues to local budgets of the Volyn region in 2026. This confirms the continued financial dependence of the regions on the center. In order to improve the structure of the volume of revenues of local budgets in Ukraine, we consider it expedient to increase the share of tax revenues, in particular, to divide part of the VAT between the center and the regions based on the consideration of foreign countries such as Germany, Austria, and Spain.

The proposed model makes it possible to deepen the comprehensive understanding of the processes and factors that influence the formation of revenues of the budgets of territorial communities in the process of their planning for their sustainable development, therefore, the state authorities should make changes to the budget legislation in order to increase the volume of revenues to local budgets based on the principle of localization of natural resources taking into account the consequences of Russia's war against Ukraine. In order to increase the total amount of income of local budgets, it is proposed to change the system of dividing rent payments according to the principle of localization natural resources.

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