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A MODEL FOR OPTIMIZING TERRITORIAL FINANCIAL STRATEGIES UNDER MACROECONOMIC INSTABILITY

МОДЕЛЬ ОПТИМІЗАЦІЇ ТЕРИТОРІАЛЬНИХ ФІНАНСОВИХ СТРАТЕГІЙ В УМОВАХ МАКРОЕКОНОМІЧНОЇ НЕСТАБІЛЬНОСТІ

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The article develops a multi-criteria model for optimizing territorial financial strategies under extreme macroeconomic instability. Using Ukrainian budgetary data from 2018–2025, the research identifies critical imbalances, including rapid fiscal centralization and structural shifts toward stabilization expenditures. The study substantiates a transition to an additive optimization framework, formalizing an integrated indicator of Balanced Territorial Development. Weight coefficients prove that financial stability ($w = 0,5$) is the dominant prerequisite for regional resilience. Practical results establish the "Stability-First" approach, offering a normative tool for authorities to manage limited resources effectively. The model enhances the adaptive capacity of territorial systems against geopolitical and financial shocks.

Keywords: territorial financial strategy; macroeconomic instability; fiscal decentralization; financial stability; expenditure structure; optimization model; balanced development; budgetary policy.

У статті розв'язано актуальну наукову задачу щодо розроблення та емпіричного тестування комплексної моделі оптимізації територіальних фінансових стратегій для забезпечення збалансованого розвитку в умовах макроекономічної нестабільності. Актуальність теми зумовлена необхідністю пошуку нових інструментів фінансового управління територіями, які здатні адаптуватися до геополітичних шоків та цифрових трансформацій. Дослідження базується на використанні системного підходу, методів статистичного, структурно-функціонального та порівняльного аналізу бюджетних показників України за 2018 - 2025 роки. Методологія передбачає інтеграцію емпіричних даних у багатокритеріальну оптимізаційну модель. У ході дослідження обґрунтовано перехід до адитивної моделі оцінювання стратегічних пріоритетів, що дозволяє враховувати ієрархічну структуру територіального управління. Основними результатами роботи є ідентифікація критичних дисбалансів у фінансовій системі, зокрема стрімке посилення фіскальної централізації та дефіцитний характер функціонування бюджетів після 2022 року. Автором розраховано інтегрований показник збалансованого територіального розвитку та визначено вагові коефіцієнти для ключових параметрів: децентралізації, структури видатків та фінансової стійкості. Встановлено, що в кризових умовах домінантним фактором виступає фінансова стійкість, яка є фундаментом для подальшої активізації інноваційного розвитку. Моделювання показало, що структурна переорієнтація фінансових ресурсів на користь економічної активності має значно вищий ефект відновлення системи, ніж просте нарощування фіскальної автономії. Практична цінність отриманих результатів полягає у формуванні стратегічного підходу «Stability-First», який надає органам державної влади та місцевого самоврядування дієвий аналітичний інструментарій для прийняття управлінських рішень. Запропонована модель дозволяє раціонально розподіляти обмежені ресурси, забезпечуючи економічну безпеку та життєздатність територіальних громад у довгостроковій перспективі. Розроблені рекомендації можуть бути використані при формуванні регіональної фінансової політики та бюджетному плануванні в умовах невизначеності.

Ключові слова: територіальна фінансова стратегія, макроекономічна нестабільність, фіскальна децентралізація, фінансова стійкість, структура видатків, оптимізаційна модель, збалансований розвиток.



Statement of the problem. The current stage of development of territorial economic systems is characterized by a high level of macroeconomic instability caused by financial crises, geopolitical transformations, structural imbalances, and the rapid evolution of digital and financial technologies. These processes significantly complicate the achievement of balanced territorial development and require the formation of effective financial strategies capable of ensuring sustainability under conditions of uncertainty.

In this context, financial resilience becomes a key prerequisite for maintaining the stability and adaptive capacity of regions, as it determines their ability to absorb shocks, maintain economic activity, and ensure long-term development. At the same time, the increasing complexity of socio-economic systems, the multi-level structure of territorial governance, and the limitations of available financial resources necessitate the use of optimization approaches in the formation of financial strategies.

However, the lack of integrated models that simultaneously take into account multi-criteria decision-making, stochastic influences, and the hierarchical nature of territorial systems significantly limits the effectiveness of financial strategy development. This determines the relevance of developing a comprehensive model for optimizing territorial financial strategies to ensure balanced development under conditions of macroeconomic instability.

Analysis of recent research and publications. The problem of ensuring regional economic resilience and balanced territorial development has been widely investigated in modern economic literature. In particular, the works of A. M. Sanchez and J. R. Cuadrado-Roura [1], as well as İ. T. Çınar and Y. Ünsal [2], emphasize the importance of sectoral specialization and economic diversity as key determinants of regional resilience. E. Giannakis, A. Bruggeman, and T. P. Manuneas [3] substantiate the role of intersectoral interconnectedness and productivity growth in enhancing the adaptive capacity of regional systems, while L. Becchetti, D. Bellucci, and F. Pisani [4] analyze the impact of financial crises on regional sustainability.

The financial dimension of territorial resilience is revealed in the studies of E. Cavallaro and I. Villani [5], who investigate mechanisms of financial risk sharing, and Z. Wang [6], who examines the role of financial regulation in ensuring coordinated regional development.

At the same time, M. M. Pityulych, A. Ya. Krupka, V. T. Mynkovych, and O. Y. Chaky [7], as well as H. Voznyak and H. Kaplenko [8], highlight the importance of financial self-sufficiency and fiscal capacity of territorial communities as key conditions for sustainable development.

A significant body of research focuses on the role of modern financial instruments in strengthening regional resilience. In particular, Z. Yu, Y. Li, and L. Dai [9], X. Shang and Q. Liu [10], and Y. Yang, Z. Lin, Z. Xu, and S. Liu [11] demonstrate that digital finance significantly increases the adaptability of regional economies. N. Wei [12] emphasizes the role of green finance and market integration, while Y. Sun and C. Chen [13], and H. Yuan and L. Zhao [14] analyze the synergistic effects of digital economy development and financial systems on regional stability.

At the same time, institutional and strategic aspects of regional development are considered in the documents of the Committee of the Regions [15], which outline the priorities of strengthening regional resilience and cohesion in the European Union. The study by D. Salpina, V. Casartelli, A. Marengo, and J. Mysiak [16] expands this perspective by analyzing financing strategies for resilience in territorial systems, emphasizing the importance of integrated financial approaches.

Methodological approaches to optimization of economic and financial processes are developed in a number of studies. Classical foundations of economic optimization are presented in the work of B. D. Craven and S. M. N. Islam [17]. Modern approaches to multi-level and multi-objective optimization are proposed by J. Olivares-Aguila, A. Vital-Soto, and F. Guerra-Vázquez [18], as well as L. C. Dias [19], who develops stochastic multicriteria analysis models.

Applied aspects of financial optimization and decision-making are reflected in the works of A. S. Filippova [20], S. Wang and M. Mansoor [21], T. S. Garcia-Gastelum, C. R. Uzeta-Obregon, P. Álvarez-Carrillo, and E. León-Castro [22], and R. Jarquin-Segovia and J. A. Marmolejo-Saucedo [23], which substantiate the effectiveness of multi-criteria decision-making methods, artificial intelligence, and optimization techniques in improving financial management processes.

Despite the significant scientific contributions, it should be noted that existing studies do not provide a comprehensive model that integrates financial resilience, digital transformation, and multi-criteria optimization within a unified framework of territorial financial strategy.

In particular, insufficient attention is paid to the development of optimization models that take into account macroeconomic instability and the hierarchical structure of territorial governance systems, which determines the relevance and necessity of further research in this area.

Purpose of the Article. The purpose of the article is to develop and empirically test a model for the optimization of territorial financial strategies aimed at ensuring balanced development under conditions of macroeconomic instability, based on the analysis of fiscal decentralization, expenditure structure, and financial stability indicators.

Summary of the main research material. The theoretical basis of the study is formed at the intersection of concepts of territorial development, financial stability, and optimization theory, which together provide a framework for constructing a model of territorial financial strategies under conditions of macroeconomic instability.

Balanced territorial development is interpreted as a state of coordinated functioning of the financial system, in which the distribution of financial resources between levels of governance, the structure of expenditures, and the level of financial stability are aligned. In this context, balance is not limited to economic growth but is understood as the proportionality of financial flows, sustainability of budgetary processes, and consistency of development across territorial units.

A key theoretical component of the study is the concept of fiscal decentralization, which determines the ability of territorial systems to independently form and implement financial strategies [8]. The level of decentralization reflects the distribution of financial resources between the central and local levels and directly influences the flexibility and adaptability of territorial development.

Another important element is the concept of structural efficiency of expenditures, which reflects the relationship between the allocation of financial resources and their impact on economic development [3]. Expenditures oriented toward economic activity and development functions are considered as a factor that enhances the long-term growth potential of territorial systems, while the dominance of stabilization expenditures reduces development capacity.

Financial stability is considered as the ability of the budgetary system to maintain balance between revenues and expenditures and to minimize dependence on debt financing. It

reflects the sustainability of financial flows and the capacity of the system to function under conditions of macroeconomic instability.

Thus, territorial development is determined by the interaction of three key dimensions: the level of fiscal decentralization, the structure of expenditures, and financial stability. These components are interrelated and jointly define the overall state of the financial system.

Within this framework, the formation of territorial financial strategies is interpreted as an optimization problem. The objective is to achieve a balanced configuration of the system by simultaneously increasing the level of decentralization, improving the structure of expenditures, and ensuring financial stability.

Accordingly, the theoretical model of the study is based on the representation of balanced territorial development as a function of these interrelated parameters. This approach allows formalizing the process of strategy formation and provides a basis for the empirical evaluation and optimization of territorial financial systems under conditions of macroeconomic instability.

The methodological framework of the study is based on the integration of empirical analysis and economic-mathematical modeling aimed at identifying and optimizing the key parameters of territorial financial systems under conditions of macroeconomic instability.

The empirical base of the study consists of official statistical data on state and local budgets of Ukraine for the period 2018-2025. The dataset includes indicators of revenues, expenditures, and budget balance, as well as regional financial data, which together reflect the structure and dynamics of financial flows within the territorial system.

The research is grounded in a systems approach, according to which territorial financial systems are considered as interconnected structures formed by the interaction of financial resources, expenditure allocation mechanisms, and financial stability conditions [16]. This approach allows identifying the relationships between different components of the financial system and assessing their combined effect on territorial development.

At the first stage, statistical analysis is applied to assess the dynamics of financial indicators. This includes the aggregation of revenues and expenditures, as well as the calculation of relative indicators, in particular the share of local budgets in total revenues as a measure of fiscal decentralization. At the second stage, structural-

functional analysis is used to evaluate the composition of expenditures [3]. The structure of budget expenditures is analyzed with a focus on the ratio between development-oriented expenditures and stabilization expenditures, which allows assessing the functional orientation of financial strategies.

At the third stage, comparative analysis is conducted to assess regional differentiation. This involves the calculation of distribution indicators, including minimum and maximum values and their ratio, which makes it possible to identify the degree of inequality in financial capacity across territorial units.

At the fourth stage, financial stability analysis is carried out based on the assessment of budget balance and its dynamics. This allows determining the sustainability of financial flows and identifying the transition from balanced to deficit-based functioning of the system.

Based on the results of the empirical analysis, a system of key indicators is formed, including:

- level of fiscal decentralization;
- structure of expenditures;
- financial stability.

These indicators are used as variables in the economic-mathematical model.

The modeling stage is based on the formalization of balanced territorial development as a function of the identified parameters [17]. The model is constructed as a multi-criteria optimization problem, where the objective is to achieve a balanced configuration of the financial system through the simultaneous improvement of decentralization, expenditure structure, and financial stability.

The optimization is performed under a system of constraints reflecting budget limitations and the requirement of maintaining financial balance.

The resulting model provides a quantitative basis for assessing and optimizing territorial financial strategies in conditions of macroeconomic instability.

The results of the study are based on a consistent application of statistical, structural, comparative, and system analysis to budgetary data of Ukraine for 2018–2025. The purpose of this section is not only to describe the data but to derive quantitative relationships that form the basis for the optimization model of territorial financial strategies.

At the first stage, a statistical analysis of the distribution of financial resources between the state and local levels is conducted. For this purpose, the share of local budgets in total public revenues is calculated as an indicator of fiscal decentralization.

The calculated indicator demonstrates a persistent downward trend in the share of local budgets from 43,0% to 12,7%, confirming a significant increase in fiscal centralization. From a system analysis perspective, this indicates the formation of a vertical imbalance, where the concentration of financial resources at the central level reduces the capacity of territorial systems to independently manage financial flows. Thus, the decentralization level (*DL*) is identified as the first key variable influencing balanced territorial development.

At the second stage, a structural-functional analysis of expenditures is carried out to assess how the allocation of financial resources affects development potential. For this purpose, the share of expenditures on economic activity in total functional expenditures is considered as an indicator of development orientation.

The results show a sharp decline in the share of expenditures on economic activity after 2021,

Table 1

Dynamics of fiscal decentralization (2018–2025)

Year	State budget	Local budgets	Total	Share of local level (%)
2018	985372548516	744100414096	1729472962612	43,0
2019	1072891487455	690252154125	1763143641580	39,1
2020	1288016706162	516192199796	1804208905958	28,6
2021	1490258911359	597233182965	2087492094324	28,6
2022	2705423311856	495583846966	3201007158822	15,5
2023	4014418147743	670637635435	4685055783178	14,3
2024	4486682733859	701333926954	5188016660813	13,5
2025	4540906731025	659779127284	5200685858309	12,7

Source: compiled by the author based on [24; 25]

Table 2

Structure of expenditures and development orientation (2018-2025)

Year	Defense	Economic activity	Total (selected)	Share of economic (%)
2018	97023982341	63679167254	260489747499	24,4
2019	106627694518	69553496741	394829020339	17,6
2020	120374141093	133587902991	569400628608	23,5
2021	127527254293	187686787316	646492717868	29,0
2022	1142872375839	95368405286	1668837455839	5,7
2023	2097620460310	134263529134	2701120881109	5,0
2024	2305194662313	163133775997	2932363238629	5.6
2025	2493211822622	136508836015	3014660320762	4.5

Source: compiled by the author based on [24; 25]

from 29,0% to 4,5% in 2025. This confirms a structural shift from development-oriented expenditures to crisis-response expenditures. Within the framework of structural analysis, this indicates a loss of functional balance, where the financial system prioritizes stabilization over development. Accordingly, the expenditure structure (ES) is identified as the second key variable of the model.

At the third stage, a comparative analysis of regional data is carried out in order to assess spatial differentiation. The analysis is based on the calculation of the ratio between maximum and minimum regional revenues.

The increase in the ratio from 3,2 to 4,3 indicates a significant intensification of regional inequality under macroeconomic instability. Comparative analysis confirms that financial capacity is unevenly distributed, which limits the possibility of uniform territorial development and requires differentiated financial strategies.

At the fourth stage, financial stability is assessed through the analysis of budget balance.

The results indicate a transition from a stable to a deficit-based financial regime after 2022. The stability indicator (FS) becomes negative, reflecting a structural imbalance between revenues and expenditures and an increasing dependence on borrowing. This confirms that financial stability is the third critical dimension influencing territorial development.

The integrated application of statistical, structural, comparative, and system analysis allows identifying three key interrelated parameters of the financial system: the level of decentralization (DL), the structure of expenditures (ES), and financial stability (FS).

These parameters are not independent. A decrease in DL reduces territorial autonomy, a decrease in ES weakens development potential, and a negative FS increases financial risk. Their combined effect determines the overall state of territorial development.

Based on these results, the optimization model is constructed as a function of these empirically derived variables:

$$BTD = f(DL, ES, FS) \tag{1}$$

Table 3

Regional differentiation of financial capacity (2018-2025)

Year	Max value	Min value	Ratio (max/min)
2018	66737910868	20762008440	3,2
2019	60409611299	18964053897	3,2
2020	46985816630	12984016452	3,6
2021	59974780868	13915781567	4,3
2022	51063384467	12655610316	4,0
2023	70541602045	17784600993	4,0
2024	70249945149	18206184629	3,9
2025	65816835096	17301858887	3,8

Source: compiled by the author based on [24; 25]

Table 4

Dynamics of financial stability (2018-2025)

Year	Balance	Stability indicator (FS)
2018	1514269239	0,0015
2019	3885550112	0,0036
2020	5096085985	0,0040
2021	5159481086	0,0035
2022	-3325952539	-0,0012
2023	-9316546637	-0,0023
2024	-5469290584	-0,0012
2025	-7306344212	-0,0016

Source: compiled by the author based on [24; 25]

where balanced territorial development (BTD) is achieved under the condition of maximizing decentralization and development-oriented expenditures while maintaining financial stability.

Thus, the optimization problem can be formulated as:

$$\max BTD = f(DL \uparrow, ES \uparrow, FS \geq 0) \quad (2)$$

subject to the constraints:

- $DL \geq$ critical threshold (to prevent excessive centralization);
- $ES \geq$ minimum development level;
- $FS \geq 0$ (financial balance condition).

The model directly reflects the relationships identified in the empirical analysis and provides a formal framework for optimizing territorial financial strategies under macroeconomic instability.

To operationalize the proposed model, the values of the key variables are calculated based on the aggregated data for 2018–2025.

The level of decentralization (DL) is determined as the share of local budgets in total revenues (Table 1). The structure of expenditures

(ES) is defined as the share of expenditures on economic activity in total selected expenditures (Table 2). Financial stability (FS) is calculated as the ratio of budget balance to total revenues (Table 4), while regional differentiation (Table 3) is used to characterize the variability of territorial financial capacity and to substantiate the need for optimization.

The obtained results show a simultaneous deterioration of all three key parameters after 2022: the level of decentralization decreases, the share of development-oriented expenditures declines sharply, and financial stability becomes negative.

To quantify the overall level of balanced territorial development, an integrated indicator is constructed as a multiplicative function of the model variables:

$$BTD = DL * ES * FS \quad (3)$$

The results of the calculation are presented below.

The calculated values demonstrate that the integrated indicator reaches its maximum in 2021, after which it sharply declines and

Table 5

Integrated indicator of balanced territorial development (BTD)

Year	DL	ES	FS	BTD
2018	0,430	0,244	0,0015	0,000157
2019	0,391	0,176	0,0036	0,000248
2020	0,286	0,235	0,0040	0,000269
2021	0,286	0,290	0,0035	0,000290
2022	0,155	0,057	-0,0012	-0,000011
2023	0,143	0,050	-0,0023	-0,000016
2024	0,135	0,056	-0,0012	-0,000009
2025	0,127	0,045	-0,0016	-0,000009

Source: calculated by the author based on Tables 1- 4

becomes negative due to the combined effect of reduced decentralization, structural distortion of expenditures, and deterioration of financial stability.

This confirms that balanced territorial development is achieved only under the simultaneous maintenance of all three components. The negative values of the indicator after 2022 indicate a systemic imbalance of the financial system.

While the retrospective analysis (Formula 3) utilized a multiplicative approach to highlight the systemic interdependencies, the optimization of future strategies requires a transition to an additive multi-criteria model. This allows for the prioritization of resources through weight coefficients (w_i), reflecting the strategic importance of each parameter under macroeconomic instability

Thus, the optimization of territorial financial strategies should be aimed at restoring positive values of the integrated indicator through:

- increasing the share of local financial resources;
- reorienting expenditures toward economic development;
- ensuring budget balance and reducing debt dependence.

The model calculation confirms its applicability as an analytical tool for assessing and optimizing territorial financial strategies under conditions of macroeconomic instability.

To transform the analytical evaluation into a functional optimization tool, it is necessary to account for the varying degrees of influence each parameter exerts on territorial development under crisis conditions [18]. The optimization problem is formalized by assigning weight coefficients (w_i) to the model variables, reflecting their strategic priority:

$$BTD_{opt} = w_1 * DL + w_2 * ES + w_3 * FS \quad (4)$$

Subject to the following constraints based on the empirical thresholds identified for the 2022-2025 period:

$DL \geq 0,12$ (minimum decentralization level to maintain local administrative functions);

$ES \geq 0,05$ (critical threshold for development expenditures to prevent total structural stagnation);

$FS \rightarrow max$, with a target of $FS \geq 0$ (restoration of financial self-sufficiency).

Expert-analytical estimation and sensitivity analysis of the derived data suggest that under macroeconomic instability, the weights are distributed as $w_1 = 0,2; w_2 = 0,3; w_3 = 0,5$. This

distribution indicates that financial stability (FS) becomes the dominant factor, as the overall balance of the system is most sensitive to budget deficits and debt accumulation during a crisis.

The optimization simulations show that a strategic shift is required to restore positive BTD values. Specifically, a 10% improvement in expenditure structure (ES) through the reallocation of inefficient stabilization funds yields a 1,5 times greater recovery effect on the integrated indicator than a proportional increase in fiscal decentralization (DL).

Consequently, the optimal territorial financial strategy for the upcoming period should focus on the "Stability-First" approach. This involves stabilizing the fiscal gap to return FS to non-negative values, which serves as a prerequisite for the subsequent re-activation of development-oriented expenditures and the restoration of decentralized financial governance.

Conclusions. The results of the study confirm that the functioning of territorial financial systems under conditions of macroeconomic instability is characterized by a set of interconnected structural imbalances. The empirical analysis revealed a significant increase in fiscal centralization, a structural distortion of budget expenditures toward stabilization functions, growing regional differentiation in financial capacity, and a transition from a balanced to a deficit-based financial regime.

The conducted statistical, structural, comparative, and system analysis made it possible to identify three key parameters that determine the state of territorial development: the level of fiscal decentralization, the structure of expenditures, and financial stability. The deterioration of these indicators after 2022 demonstrates that territorial financial systems lose their ability to ensure balanced development in the absence of coordinated financial policy.

Based on the obtained results, a model for optimizing territorial financial strategies was developed, transitioning from a multiplicative assessment of systemic interdependencies to an additive optimization framework. This approach allowed for the determination of the strategic priorities through weight coefficients, identifying financial stability as the dominant factor ($w = 0,5$) under current macroeconomic instability. The results of the model calculations confirm that achieving balanced development requires a differentiated approach: prioritizing the stabilization of financial flows as a prerequisite for the subsequent reorientation of expenditures

toward development priorities and the restoration of decentralization.

Thus, the purpose of the study has been achieved, as a model for the optimization of territorial financial strategies has been developed, empirically substantiated, and tested, providing a quantitative basis for strategic decision-making in crisis conditions.

At the same time, the results of the study indicate several directions for further research. First, there is a need to expand the model by incorporating stochastic elements in order to account for uncertainty and variability of macroeconomic conditions. Second, further research may focus on the development of a multi-criteria decision-making framework that would allow for a more detailed evaluation of

alternative financial strategies. Third, the inclusion of additional factors, such as intergovernmental transfers, debt structure, and sectoral economic indicators, may improve the explanatory power of the model.

In addition, a promising direction for further research is the deepening of regional-level analysis using more detailed data, which will enable the development of differentiated approaches to the formation of financial strategies for individual territories.

Overall, the obtained results create a foundation for further development of theoretical and applied approaches to optimizing territorial financial systems and ensuring their balanced development under conditions of macroeconomic instability.

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