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EVALUATION OF STRATEGY EFFECTIVENESS IN THE CONTEXT OF HARMONIOUS DEVELOPMENT

In today's world, where sustainable growth and harmonious development have become key priorities for society, evaluating strategy effectiveness is gaining particular relevance. It is due to the increasing scarcity of natural, financial, and other resources, as well as the intensifying modern challenges shaped by climate change, digital transformation, demographic shifts, and social inequality. Businesses, governments, and communities face the challenge of balancing economic, social, and environmental development, aiming to increase the flow of aggregate Hicks-Lindahl income. Determining optimal strategic approaches in harmonious development requires a comprehensive analysis that considers short-term benefits and long-term consequences for societal well-being and the environment. This article aims to explore the essence and characteristics of evaluating the effectiveness of strategies in the context of harmonious development.

Keywords: *harmonious development, Hicks-Lindahl aggregate income flow, Bellman function, investment allocation, strategy.*

ОЦІНКА ЕФЕКТИВНОСТІ СТРАТЕГІЙ В КОНТЕКСТІ ГАРМОНІЙНОГО РОЗВИТКУ

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У сучасному світі, де стале зростання та гармонійний розвиток стають пріоритетами суспільства, оцінка ефективності стратегій набуває особливої важливості. Це зумовлено зростаючим дефіцитом природних, фінансових та інших ресурсів, а також загостренням сучасних викликів, зокрема кліматичних змін, цифрової трансформації, демографічних змін і соціальної нерівності. Підприємства, держава (у особі органів державної влади) та громади змушені шукати баланс між економічним, соціальним та екологічним аспектами розвитку. Тому визначення оптимальних стратегічних підходів до гармонійного розвитку потребує комплексного аналізу, що враховує не лише короткострокові вигоди, а й довгострокові наслідки для добробуту суспільства та довкілля. Відтак, метою статті є дослідження змісту та особливостей оцінки ефективності стратегій у контексті гармонійного розвитку. У межах цього дослідження акцентується увага на важливості оцінювання ефективності стратегічних рішень із використанням методів динамічного програмування, зокрема через максимізацію потоку доходу Хікса–Ліндаля. Доведено, що застосування методу динамічного програмування як інструмента оцінки ефективності стратегій гармонійного розвитку дає змогу визначити оптимальний розподіл обмежених ресурсів і максимізувати дохід Хікса–Ліндаля. Це сприяє раціональному використанню фінансових і природних ресурсів, забезпечуючи довгострокові економічні та соціальні вигоди. Доведено, що ключовим завданням оцінки ефективності стратегій гармонійного розвитку є визначення можливостей досягнення балансу між трьома основними аспектами розвитку. Основна увага зосереджується на економічних вигодах (зростання доходів підприємств), соціальних перевагах (покращення якості життя громад, створення робочих місць) та екологічних аспектах (збереження природних ресурсів, зменшення негативного впливу на довкілля), а також на їх взаємозв'язку. Констатовано, що оптимальний розподіл інвестицій між підприємствами, громадами та економікою держави сприяє не лише економічному зростанню, а й забезпеченню справедливого розподілу вигод серед усіх учасників процесу. Зокрема, методи динамічного програмування дозволяють оцінити, як поточні вкладення впливають на майбутній розвиток та як забезпечити стабільний добробут для всіх учасників.

Ключові слова: *гармонійний розвиток, потік сукупного доходу Хікса-Ліндаля, функція Беллмана, вкладення коштів, стратегія.*

Statement of the problem. In today's world, where sustainable growth and harmonious development are priorities for society, assessing the effectiveness of strategies has become increasingly relevant. It is due to the increasing scarcity of natural, financial, and other resources along with the growing contemporary challenges shaped by climate change, digital transformation, demographic shifts, and social inequality. For example, strategies for the electrification of transport or support for sustainable agriculture should be measured through the cost benefits of reducing CO2 emissions, economic feasibility, and social benefits. The implementation of strategies for minimum wage regulation or expanding access to higher education should be evaluated in terms of their impact on reducing social inequalities.

When assessing the benefits for businesses, the state, and communities, the challenge arises of balancing the economic, social, and environmental aspects of development. This can be achieved by considering the Hicks-Lindahl aggregate income. Determining optimal strategic approaches for evaluating the effectiveness of harmonious development requires a comprehensive analysis that takes into account not only short-term benefits but also long-term impacts on societal well-being and environmental conditions.

Analysis of recent research and publications. Modern scientific research often analyzes the effectiveness of implementing development strategies at different levels: enterprises (micro-strategies), communities (meso-strategies), and the state (macro-strategies). Theoretical and methodological aspects of forming these strategies have been studied by many renowned economists, including P. Kotler, R. Berger, and N. Bickhoff [4]. The issues of strategic macro-, meso-, and microplanning have also been explored by O.Ye. Kuzmin, N.I. Horbal [5], A.S. Zaverbnyi, and I.D. Chukaieva [1].

At the same time, the specifics of evaluating the effectiveness of strategies in the context of the harmonious development of the state, community, or enterprise remain insufficiently studied, highlighting the need for further scientific research in this area.

Setting the task. This article aims to explore the essence and characteristics of evaluating the effectiveness of strategies in the context of harmonious development.

Summary of the main research material. Within the study, the author emphasizes that harmonious development entails interconnected and balanced growth of economic, social, and environmental systems. This requires effective resource management at all levels – enterprises (micro-strategies), communities (meso-strategies), and the state (macro-strategies) – ensuring their interaction and long-term sustainability [2; 4].

Given this specificity, the evaluation of strategy effectiveness in this context should be conducted using dynamic programming methods, particularly through the identification and detailed analysis of the Hicks-Lindahl income flow.

This approach enables the optimization of investment distribution, promoting long-term stability and fair access to benefits for different social groups. The outlined specificity does not emerge automatically but rather through particular features in the measurement of effectiveness, efficiency, or compliance of potential or actual actions and decisions with established criteria, as illustrated in Figure 1.

The above-mentioned features of evaluating the effectiveness of strategies in the context of harmonious development are determined by their focus on solving the task of optimal investment distribution, provided that it allows for accounting for the change in the triune effect through the optimization of resource distribution, which shapes this income over time.

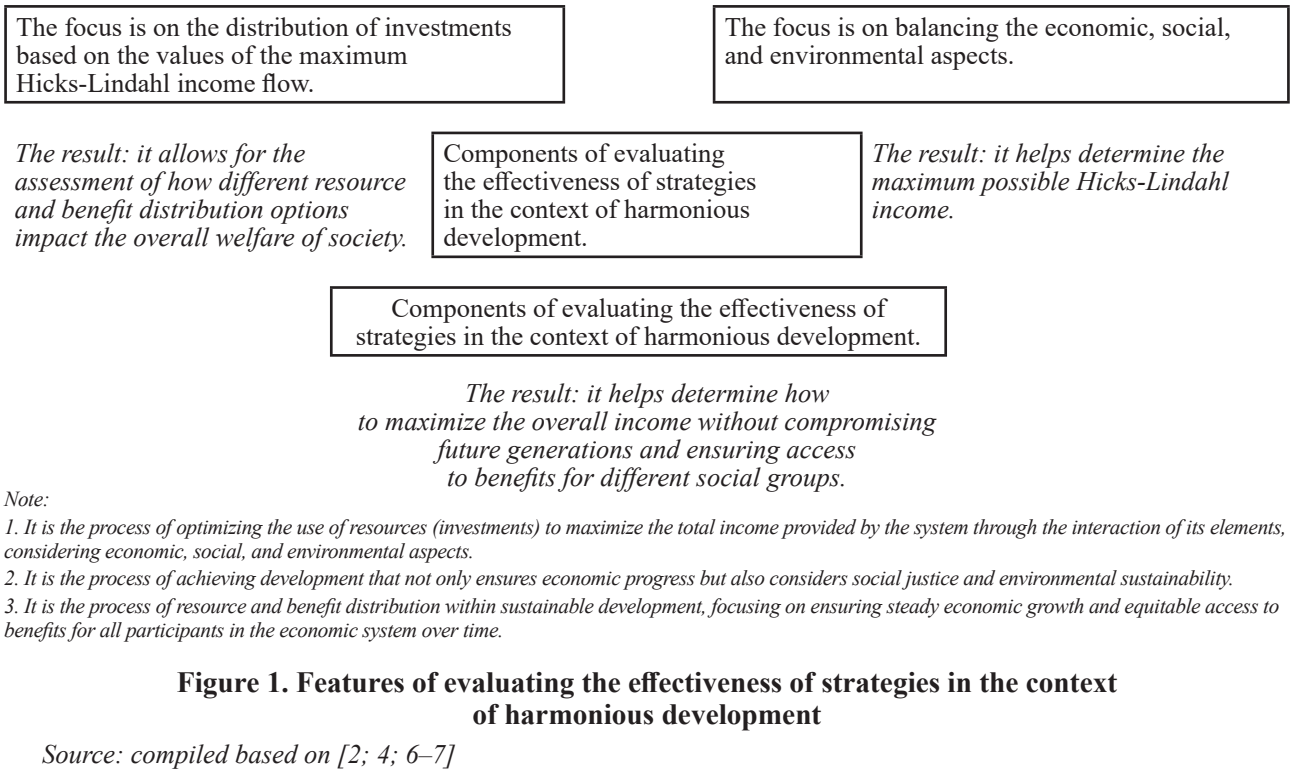
At the same time, it should be noted that the Hicks-Lindahl income flow itself is based on the idea of intertemporal triune equilibrium regarding the return on resources, which assumes a stable level of well-being for different generations. It is the key principle of harmonious development [2; 7].

For example, in the process of optimal investment distribution between the economic, social, and environmental sectors, not only short-term benefits are considered, but also long-term consequences. If the state or an enterprise invests funds primarily in industry without considering environmental and social aspects, it may lead to economic growth in the short term and, at the same time, cause environmental degradation and social instability [2; 3].

On the other hand, the application of dynamic programming methods and the concept of the Hicks-Lindahl income flow allows for determining the level of investment in each sector that will ensure a balance between economic efficiency, social well-being, and environmental sustainability. For example, the optimization model may show that to maintain intertemporal equilibrium, a certain share of investments should be directed toward renewable energy sources and social initiatives, ensuring economic profitability and environmental and social responsibility.

Thus, the analysis of optimal investment distribution within the framework of the Hicks-Lindahl income flow for an organization, the state, and a community allows for determining and adopting the most effective strategic decisions that will most contribute to harmonious development and ensure a stable level of well-being for both current and future generations.

In particular, at the level of an individual community or state, it is important to identify key organizations that, through the allocation of city or preferential credit assistance, implement harmonious development, as well as to identify effective investment options based on the values of the Hicks-Lindahl income flow. In the decision-making process regarding the distribution of such funds, it is recommended to rely on dynamic programming methods based on the Bellman function (which is essentially synonymous with an optimal solution).



Note:

1. It is the process of optimizing the use of resources (investments) to maximize the total income provided by the system through the interaction of its elements, considering economic, social, and environmental aspects.

2. It is the process of achieving development that not only ensures economic progress but also considers social justice and environmental sustainability.

3. It is the process of resource and benefit distribution within sustainable development, focusing on ensuring steady economic growth and equitable access to benefits for all participants in the economic system over time.

Figure 1. Features of evaluating the effectiveness of strategies in the context of harmonious development

Source: compiled based on [2; 4; 6–7]

Formally, the Bellman function can be written as:

$$V(x) = \max_{a \in A(x)} [R(x,a) + \beta \cdot V(f(x,a))], \quad (1)$$

Where:

- V(x) – the optimal value for state x,
- a – possible actions in state x,
- A(x) – the set of possible actions in state x,
- R(x,a) – the reward (or income) from performing action aa in state x,
- β – the discount factor (to account for future benefits, if necessary),
- f(x,a) – the transition function that gives the new state after performing action aa in state x.

In particular, when considering the Bellman function, we are referring to the method of backward recursion, as it allows for incrementally weighing the consequences of current investment decisions by focusing on the possible value of the Hicks-Lindahl income flow, which at each point in time influences the future outcomes of harmonious development.

For example, using this method, the optimal plan for harmonious development in the Mukachevo consolidated territorial community for 2025–2027 can be determined. This plan would include options for providing grant assistance within the framework of the EU initiative – EU4Business and the USAID Program "Competitive Economy of Ukraine" for three small woodworking enterprises (as of 02.2025, applications have been submitted by LLC CIM, LLC UGOVA, and LLC FREZER).

In this case, the projected Hicks-Lindahl income flow for the enterprises should be calculated over the years and according to the investment options for grant funds in the projects. For the Mukachevo consolidated territorial community, these are:

1. Project 1: Development of logistics and infrastructure
2. Project 2: Modernization of production lines
3. Project 3: Implementation of renewable energy systems
4. Project 4: Development of new products using recycled wood or natural materials

Additionally, a supplementary project is possible that does not require initial investments, specifically transitioning to FSC-certified wood.

So, the list of investment options for city support, which can serve as the basis for the effectiveness of strategies in the context of harmonious development in the Mukachevo united territorial community for 2025–2027, is provided in Table 1.

All the investment options mentioned above, funded through grant support, contribute to the harmonious development of woodworking enterprises, as they combine economic benefit, social responsibility, and environmental sustainability.

However, to determine the optimal grant support option from the perspective of the development of the outlined community, a detailed analysis is necessary, which includes the assessment of initial investments, projected Hicks-Lindahl income flows, and long-term consequences for stable development.

Within this analysis, it should be clearly defined which investment option will result in the maximum Hicks-Lindahl income flow. This task will be demonstrated illustratively, taking into account the data presented in Table 2.

Table 1

Investment options for city support that can serve as the basis for the effectiveness of strategies in the context of harmonious development in the Mukachevo united territorial community

Project	Specifics of implementing harmonious development	Benefits that form the Hicks-Lindahl income flow*
Transition to FSC-certified wood	Investments in the transition to FSC-certified wood in accordance with Forest Stewardship Council (FSC) standards can ensure not only environmental sustainability but also enhance the competitiveness of the enterprise in international markets. It will also help meet environmental standards and provide additional advantages in the form of increased demand for products made from certified wood.	Improvement of the enterprise's reputation, increased customer trust. Access to new markets where certification is required. Enhancement of the environmental sustainability of production.
Modernization of production lines	The modernization of production lines will enable enterprises to improve resource efficiency, reduce energy consumption, and optimize production costs. It may include the purchase of new sawmills, automation of wood processing processes, the implementation of technologies to reduce waste, and improvements in product quality.	Reduction of operational costs. Increase in productivity and product quality. Reduction of the negative environmental impact through the optimization of energy and material usage.
Implementation of renewable energy (bioenergy, solar panels)	The implementation of renewable energy systems, such as bioenergy based on wood waste or solar panels, will significantly reduce energy resource costs and improve the environmental sustainability of production. The use of renewable energy sources will allow enterprises to become more energy-efficient and reduce carbon emissions.	Reduction of energy resource costs. Increase in the enterprise's energy independence. Reduction of the negative environmental impact, particularly CO_2 emissions.
Development of new products using recycled wood or natural materials	Investments in the development of new products using recycled wood or natural materials (eco-friendly furniture, wood panels, bio-plastics) will attract environmentally conscious consumers and align with current trends.	Expansion of product range and entry into new markets. Increase in competitiveness due to the ecological characteristics of the products. Reduction of negative environmental impact through the use of recycled raw materials.
Development of logistics and infrastructure	Investing in the improvement of logistics infrastructure, particularly in the modernization of warehouses and the optimization of raw material and finished product transportation, will reduce transportation costs and enhance supply chain efficiency. It may also include investments in improving storage conditions for wood or creating new warehouses for finished products.	Optimization of transportation and storage costs. Increase in order processing and delivery speed. Improvement of overall production efficiency.

*Note: * Benefits form the Hicks-Lindahl income flow if they can be quantified in monetary terms.*

Source: compiled based on data from business entities and [1; 4–5]

Table 2

Input data for assessing investment options that may form the basis of effective strategies for harmonious development in the Mukachevo united territorial community

Hicks-Lindahl income flow, thousand UAH.			Declared resource investment volumes (xi), million.
LLC CIM (f1)	LLC UGOVA (f2)	LLC FREZE (f3)	
44	33	36	0
80	97	88	1
330	380	265	2
420	455	620	3
530	733	699	4

Source: compiled based on data from business entities

Given the provided data, it is possible to apply the procedure for finding the paths to maximize the Hicks-Lindahl income flows in enterprises that ensure the harmonious development of the Mukachevo united territorial community (or their conditional optimization).

Regarding the first step of conditional optimization (k = 3), let's assume that all funds in the amount of x3 = 4 are allocated to the development of projects 1–5 for enterprise №3 (LLC "FREZER"). In this case, the maximum Hicks-Lindahl income, as seen from the table 3, will be f3(u3) = 699, thus, F3(e3) = f3(u3).

For the second step (k = 2), we determine the optimal strategy when distributing funds between projects for enterprises №2 (LLC "UGOVA") and №3 (LLC

"FREZER"). The recurrence relation of Bellman for the Hicks-Lindahl income is as follows (table 3):

$$F2(e2) = \max(x2 \leq e2)(f2(u2) + F3(e2 - u2)), \quad (2)$$

Where:

- F2(e2) is the optimal income for enterprise № 2;
- x2 is the amount of money allocated to the projects of enterprise № 2;
- u2 is the amount of money allocated within the projects of enterprise № 2;
- f2(u2) is the income of enterprise №2 based on the allocation u2;
- F3(e2−u2) is the optimal income for enterprise №3 based on the remaining funds after allocating to enterprise №2.

For the third step, we determine the optimal strategy for distributing funds between projects for enterprises №1 (LLC "CIM"), №2 (LLC "UGOVA"), and №3 (LLC "FREZER"). The Bellman recurrence relation for Hicks-Lindahl income is as follows (Table 3):

$$F1(e1) = \max(x1 \leq e1)(f1(u1) + F2(e1 - u1)), \quad (3)$$

Where:

- F1(e1) is the optimal income for enterprise № 1;
- x1 is the amount of money allocated to the projects of enterprise № 1;
- u1 is the amount of money allocated within the projects of enterprise № 1;
- f1(u1) is the income of enterprise №1 based on the allocation u1;
- F2(e1 – u1) is the optimal income for enterprise № 2, which depends on the remaining funds after allocating to enterprise № 1.

From Table 3, specifically from the calculated 3rd step of conditional optimization, we have F*1(e0 = 4 million UAH) = 777 thousand UAH. It means that the maximum Hicks-Lindahl income for the entire system with an investment amount of e0 = 4 million UAH equals 777 thousand UAH.

From the table, we conclude that for the 1st enterprise (ТОВ ЦІМ), the allocated amount should be u*1(e0 = 4 million UAH) = 0 thousand UAH. In this case, the remaining funds will be: e1 = e0 – u1 = 4 – 0 = 4 million UAH.

From Table 3, specifically from the calculations in the second step, we have F*2(e1 = 4 million UAH) = 733 thousand UAH. It means that the maximum Hicks-Lindahl income for the entire system, with the amount of funds e1 = 4 million UAH, is 733 thousand UAH.

From Table 3, we can see that the second enterprise (TOB UHOVA) should be allocated u*2(e1 = 4 million UAH) = 4 million UAH.

Thus, the remaining funds available under the grant support will be:

e2 = e1 – u2 = 4 million UAH – 4 million UAH = 0 UAH.

Table 3

Finding paths for maximizing Hicks-Lindahl income flows in enterprises ensuring harmonious development of the Mukachevo united territorial community

General condition*			Step 1**			Step 2**					Step 3**				
e2	u3	e3 = e2 - u3	f3(u3)	F*3(e3)	u3(e3)	f2(u2)	F*2(e1)	F1(u2,e1)	F*2(e2)	u2(e2)	f1(u1)	F*1(e0)	F0(u1,e0)	F*1(e1)	u1(e1)
1	**2**	**3**	**4**	**5**	**6**	**4**	**5**	**6**	**7**	**8**	**4**	**5**	**6**	**7**	**8**
1	0	1	36			33	88	121	121	0	1	44	121	165	165
	1	0	88	88	1	97	0	97			0	80	0	80	
2	0	2	36			33	265	298			2	44	380	424	424
	1	1	88			97	88	185			1	80	121	201	
	2	0	265	265	2	380	0	380	380	2	0	330	0	330	
3	0	3	36			33	620	653	653	0	3	44	653	697	697
	1	2	88			97	265	362			2	80	380	460	
	2	1	265			380	88	468			1	330	121	451	
	3	0	620	620	3	455	0	455			0	420	0	420	
4	0	4	36			33	699	732			4	44	733	777	777
	1	3	88			97	620	717			3	80	653	733	
	2	2	265			380	265	645			2	330	380	710	
	3	1	620			455	88	543			1	420	121	541	
	4	0	699	699	4	733	0	733	733	4	0	530	0	530	

Note:

** Columns 1 (invested funds), 2 (project), and 3 (remaining funds) are the same for all three tables, so they are generalized.*

** Column 4 is filled based on the initial data of the Hicks–Lindahl income functions, the values in column 5 are taken from column 7 of the previous table, and column 6 is filled with the sum of the values from columns 4 and 5 (in step 3, the columns 5 and 6 are absent). Column 7 contains the maximum value of the previous column for a fixed initial state, and column 8 contains the control from column 2, which achieves the maximum in column 7.*

Source: formed based on the data from Table 2

As a result, the last enterprise (TOB FREZER) will receive 0 UAH.

For effective allocation of grant support among the woodworking enterprises of the Mukachevo United Territorial Community, it is necessary to determine the optimal investment plan that maximizes the Hicks-Lindahl income while considering limited resources. According to the data provided, the allocation of funds should be as follows:

- TOB CIM (Enterprise 1) will receive 0 UAH.
- TOB UGOVA (Enterprise 2) is to be allocated 4 million UAH.
- TOB FREZER (Enterprise 3) will receive 0 UAH.

This allocation optimizes the Hicks-Lindahl income based on the available resources.

The strategy for the harmonious development of the Mukachevo United Territorial Community, developed based on the backward induction method, is focused on maximizing the Hicks-Lindahl income stream through the efficient allocation of investments among various projects of woodworking enterprises. This approach ensures the optimal distribution of resources to foster long-term economic, social, and environmental benefits for the community.

It was determined using this method that the maximum Hicks-Lindahl income amounts to 777 thousand UAH. By allocating the grant support solely to "UGOVA" LLC, the available resources can be utilized more effectively for modernizing production lines, implementing renewable energy systems, and new products developing. It will contribute to increased productivity, reduced costs, and improved competitiveness of the united community in the market. The funds allocated to the projects of this enterprise ensure an increase in the efficiency of production processes and the most stable financial outcome.

It is essential to highlight that by employing the same method, one can ascertain the optimal investment distribution both at the individual enterprise level and by aggregating this data for the entire country.

Conclusions from the study. Within the framework of the study on harmonious development, the importance of integrating economic, social, and environmental aspects into strategic decision-making processes is emphasized. Dynamic programming methods are effectively utilized to maximize the Hicks–Lindahl income flow. In this regard, the following conclusions have been made regarding the assessment of the effectiveness of harmonious development strategies using dynamic programming methods:

1. The application of dynamic programming allows for determining how to properly allocate limited resources across different projects to maximize the Hicks–Lindahl income flow. This ensures the optimization of the use of financial and natural resources to achieve long-term economic and social benefits.

2. The key task is to ensure a harmonious balance between the three main aspects of development. Economic benefits (e.g., increased enterprise revenues), social advantages (improved community living conditions, job creation), and environmental benefits (preservation of natural resources, reduction of negative environmental impacts) must be interrelated.

3. Optimal distribution of investments fosters economic growth and ensures a fair distribution of benefits among all participants in the process. It includes businesses, the community, and the environment. Dynamic programming methods help assess how current investments impact future development and how to ensure stable well-being for all.

The application of dynamic programming methods and the maximization of the Hicks–Lindahl income flow allow for the effective distribution of limited resources to achieve harmonious development. It promotes the creation of a sustainable, balanced, and fair development strategy that includes economic growth, social responsibility, and environmental sustainability.

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