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MODELING THE INFLUENCE OF INTELLECTUAL AND INNOVATIVE DETERMINANTS ON THE ECONOMIC SYSTEMS' DEVELOPMENT IN THE CONDITIONS OF THE CREATIVE ECONOMY FORMATION

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Abstract
The purpose of the article is to substantiate the theoretical and conceptual foundations of modeling the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation. It is proposed to use the approach of economic-mathematical modeling in the form of simulation modeling of the intellectual-innovative development of economic systems in the conditions of the creative economy formation. Simulation modeling involves modeling the effects of three constituent blocks: "economic system", "innovative processes", "creative potential". The calculation of the integral indicator of the development of intellectual and innovative determinants of economic systems in the conditions of the creative economy formation makes it possible to forecast indicators of the economic system' development. The proposed approach was tested in relation to the economic system of Ukraine.

Keywords: *intellectual and innovative determinants, development, economic system, creative economy, simulation modeling.*
JEL Codes: *C 19, E 20, R10.*

Introduction

The formation of a post-industrial society, which forms the trends of the transition from industrial social development to post-industrial, is determined by the rapid innovative progress of development processes. In turn, such vectors of social development increasingly focus on innovative transformations, digitalization, informatization and activation of intellectual potential and creative searches for solutions to multi-vector processes.

Such processes lead to the development of new concepts of post-industrial development in order to increase the effectiveness of the functioning of socio-economic models of social development with an emphasis on the intellectual and innovative component in the description of modern phenomena and processes of systems of different levels. One of the modern directions of post-industrial social development is the creation of a creative economy based on the use of intellectual potential, innovative development and a creative approach to heterogeneous processes and phenomena. The creative economy contributes to increasing the efficiency of the functioning of the socio-economic system at various levels, causes the emergence of new creative sectors of the economy and creates

added value. The creative economy combines the processes of scientific and innovative activity, the production of innovative products and services, the adoption of non-standard creative decisions and is impossible without the development of intellectual capital.

In the current conditions of social development, the creative economy is one of the innovative strategies for the economic systems' development at various levels, since the adoption of strategic decisions regarding the activation of intellectual and innovative determinants of development are relevant for all economic systems. At the same time, modeling the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation today is an understudied issue that requires further research in this area.

The purpose of the article is to substantiate the theoretical and conceptual foundations of modeling the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation.

Literature review

One of the current directions of post-industrial social development is the formation of a creative economy based on the use of intellectual potential, innovative development and a creative approach to diverse processes and phenomena. These aspects prove the relevance of the research of leading scientists.

Scientists such as Djakona A. et al. (2021), Dubyna M. et al. (2021), Lazarenko I. et al. (2020), Popelo O. et al. (2021), Tulchynska S. et al. (2022), Cosmulese C.G. et al. (2019) devoted their research to the innovative development of economic systems at various levels. The scientists studied modern trends in the introduction of innovative information technologies in various spheres of social life, studied the current state and predicted the level of innovative activity of regions, including due to the introduction of digitization processes.

Such scientists as: Ilič B. et al. (2016), Khrushch N. et al. (2022), Martinidis G. et al. (2021), Savin S. (2021), Yavorsky M.S. (2016) devoted their research to modern aspects of the development of intellectual potential in the context of the formation of a creative economy. In their scientific articles, it was proved that intellectual capital is the basis of rapid regional development, the peculiarities of the influence of the realization of economic potential on the development of the creative economy were investigated, and how intellectual capital contributes to the development of innovations in the EU regions.

Despite the available publications, the question of the impact of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation is insufficiently studied and requires further research.

Methodical approach

To model the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation, it is advisable to use the parameters of simulation modeling. Because in conditions of high uncertainty and limited statistical data, it is through the use of predictive models that the relevant behavioral characteristics of the studied processes can be determined. To form such an influence, it is advisable to use the approach of economic and mathematical modeling in the form of simulation modeling of the intellectual and innovative development of economic systems in the conditions of the creative economy formation.

The logic of conducting this simulation modeling of the impact of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation is illustrated in Fig. 1.

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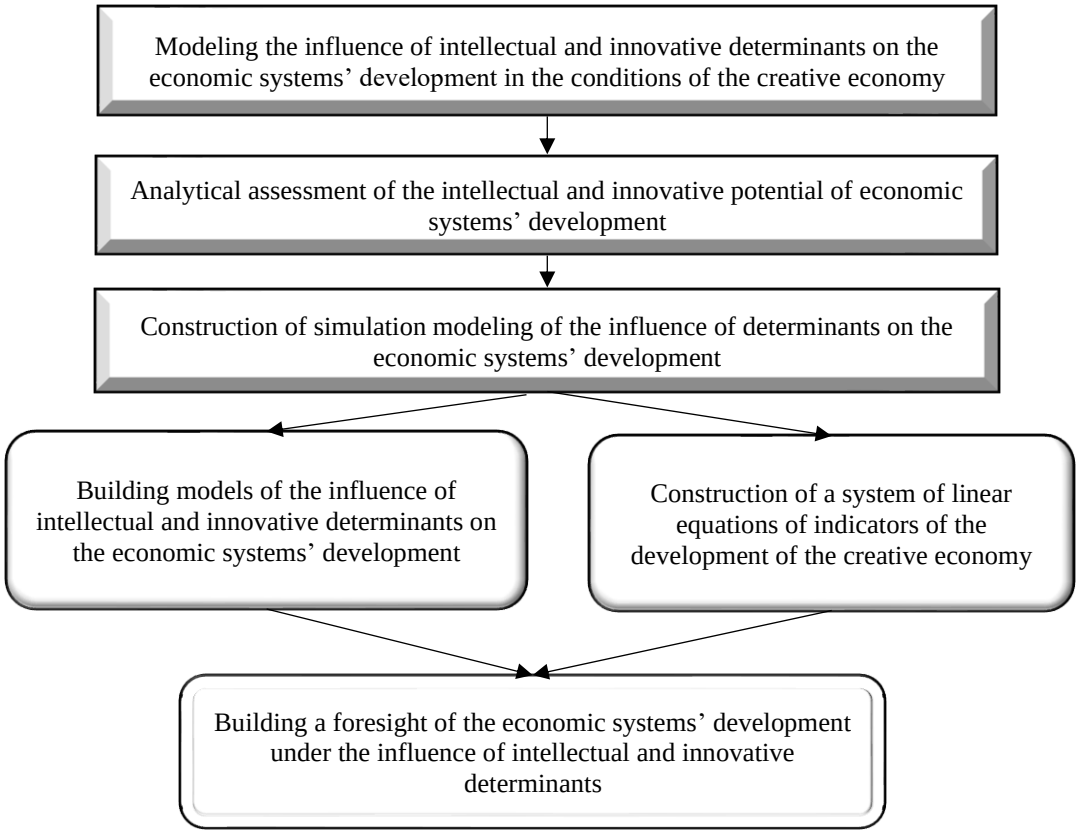

Figure 1. Research model of the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation
**Source: proposed by the authors.*

To determine the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation, it is proposed to carry out simulation modeling, which is the basis for scenario modeling of relevant economic processes in the conditions of a creative economy. At the same time, the division of indicators into three component blocks is used (Fig. 2). The first "Economic system", which is characterized by such evaluation features as the financing of scientific, technical and research work, the amount of fixed capital and the resulting indicator of economic systems represented by Gross Regional (GR) or Gross Domestic Product (GDP).

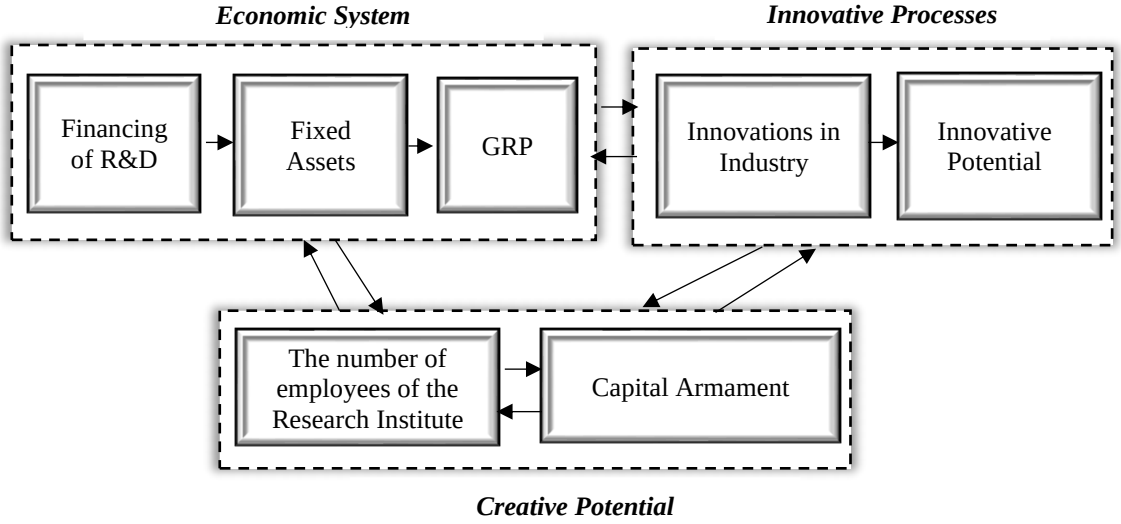

Figure 2. Structural and logical architecture of the main constituent blocks, simulation modeling of the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation

**Source: proposed by the authors.*

The next component block „Intellectual-innovative processes" acts as a determinant of the economic systems' development and characterizes the dynamics of the volumes of implemented innovative products depending on the costs of implementing innovative activities by types of economic activity in a regional or national context.

The third component block is "Creative potential". It should be noted that in the opinion of the authors, the creative potential and in general the creative development of economic systems should not and cannot be narrowed down to the development and results of the creative sector, which includes cinema, theaters, art in general, etc. The formation of a post-industrial economy in the direction of a creative one consists not only in the creation of added value in the creative sector, but also in the formation of creativity in intellectual potential and its use in all spheres of economic activity at the level of various types of economic systems. Therefore, the creative potential is characterized by such evaluation indicators as: the number of organizations carrying out R&D, the number of employees involved in the implementation of R&D, the number of higher education institutions, the number of patents for inventions.

Simulation modeling of the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation makes it possible to establish relationships between the components of the model and to reveal the dependence of the determining influence on the resulting indicator of the economic systems' development in the conditions of the creative economy formation.

For further forecasting of intellectual and innovative determinants, the integral indicator of intellectual and innovative development is calculated. Namely, the component block of the innovative processes model includes five variables that form an integral indicator of intellectual and innovative potential:

$$I_{\text{п}}=X_1 V_1 + X_2 V_2 + X_3 V_3 + X_4 V_4 + X_5 V_5 \quad (1)$$

where X_1 – share of innovatively active enterprises;

X_2 – the share of enterprises that implement innovations;

X_3 – the share of enterprises in which innovative processes have been implemented;

X_4 – volume of implementation of innovative products;

X_5 – investments in fixed capital;

V_1, V_2, V_3, V_4, V_5 – weight coefficients of innovative activity indicators.

The determination of the integral

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indicator of the intellectual and innovative determinants of economic systems' development in the conditions of the creative economy formation makes it possible to build predictive values of development taking into account the influence of intellectual and innovative determinants in the conditions of the creative economy formation.

Results

To test the proposed approach to modeling the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation, an economic system at the level of the national economy of Ukraine was taken.

In the "Economic system" block, the indicator of fixed capital was chosen as a basis, since it is one of the factors of economic growth. On the basis of which, in the modeling, the chains of movement of financial flows are formed from investment funds in fixed capital to the volumes of production of products and services, which is the initial indicator in the activities of enterprises. Also, the starting indicator when considering intellectual and innovative determinants is the export of research and development.

The diagram of cause and effect relationships in the "Economic system" block is presented in Fig. 3, which was obtained as a result of simulation using the Vensim software product.

On the basis of the conducted simulation, the relationship between labor productivity and costs of innovative activity was established. It was determined that increasing the level of labor productivity of employees involved in the implementation of the R&D has an impact on the indicator of costs for innovative activity, and contributes to increasing the efficiency of innovative activity. In this block, the initial data is capital equipment, the increase of which leads to an increase in production capacity.

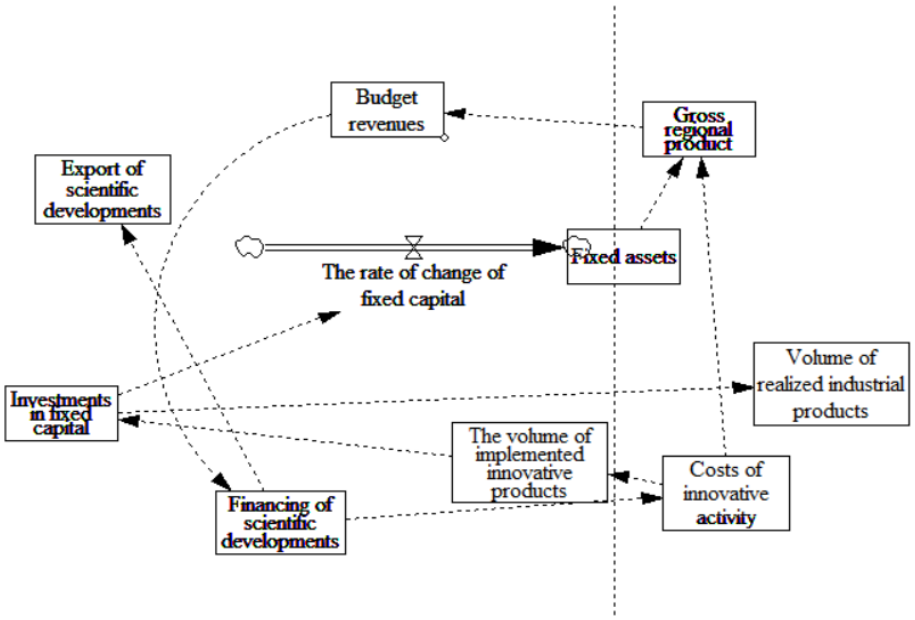

Figure 3. Diagram of cause-and-effect relationships and flows of the block "Economic system"
**Source: constructed by the authors.*

The diagram of cause and effect relationships in the "Creative potential" block is presented in Fig. 4.

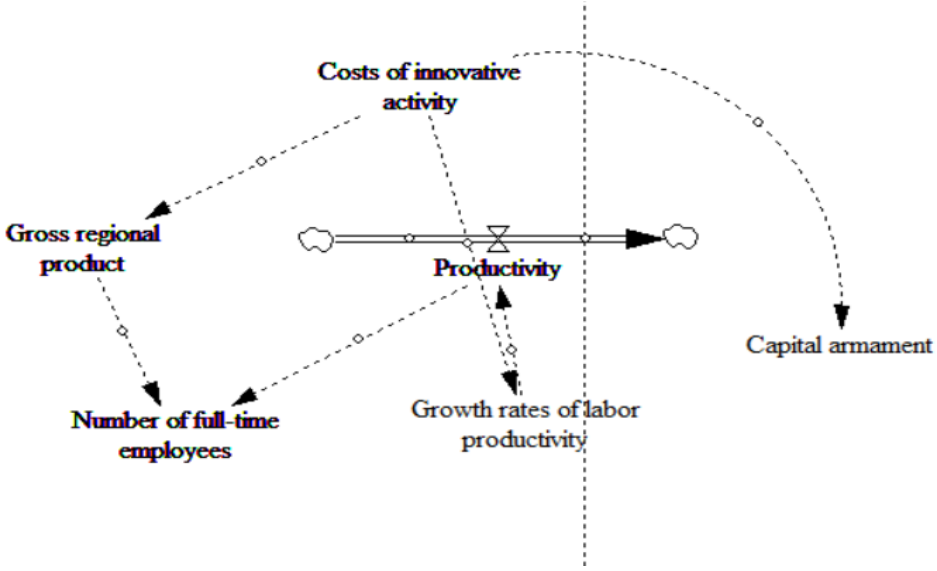

Figure 4. Diagram of causal relationships and flows of the "Creative potential" block
**Source: constructed by the authors.*

The conducted scenario modeling proved that it is the innovative component that contributes to increasing the level of the economic systems' sustainable development in the conditions of the creative economy.

To carry out simulation modeling of the influence of intellectual and innovative determinants on the economic systems' development, it was established that the key indicators are the gross domestic product and the volume of sales of innovative products. Therefore, it is appropriate to determine the forecast values of economic development based on these indicators.

Indicators whose normalized coefficients were 0.5 or higher were used in the simulation model. The calculated values of the Student's t-statistic were compared with the table values of the distribution of random variables, which are equal to the value of 0.05.

The dynamics of the values of the integral indicator and its components are shown in Table 1.

Table 1. Components and an integral indicator of the intellectual and innovative potential of the economic system

Year	The share of innovatively active enterprises in the total number of industrial enterprises, %	The share of industrial enterprises that introduced innovations in the total number of industrial enterprises, %	Share of enterprises implementing innovative processes, %	The share of implemented innovative products in the volume of industrial products, %	The share of investment in fixed capital in the total volume of investments, %	Integral indicator of intellectual and innovative potential
2012	17,4	13,6	16,09	3,8	92,6	25,71
2013	16,8	13,6	16,42	3,3	94,6	25,91
2014	16,1	12,1	13,75	0,5	95,4	24,37
2015	17,3	15,2	16,86	1,4	96,4	26,38
2016	18,9	16,6	15,65	1,1	93,3	26,09
2017	16,2	14,3	13,79	0,7	96,3	25,05
2018	16,4	15,6	13,74	0,8	96,1	25,33
2019	16,3	13,8	13,61	1,3	95,4	24,88
2020	16,9	14,9	13,5	1,1	94,6	25,03

**Source: summarized by the authors.*

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In order to determine the appropriate scenario for the economic systems' development, the influencing factor of the amount of financing of innovative activities was chosen, on the basis of which the simulation of various options for the development of events was carried out.

The basic scenario of the economic systems' development assumes the preservation of current trends in the field of intellectual and innovative shifts. An increase in development indicators is achieved when using intensive scenarios of growth in the amount of funding for innovative activities (10% or more), growth of selected components of the intellectual and innovative potential (5% or more).

However, it is important to implement such scenarios in the current conditions of scarce financing of innovative processes, especially for Ukraine. More realistic is the development of a moderately optimistic type of scenarios, in which there is a slight acceleration of financing of intellectual and innovative activities (1% - 7%), which slightly differ from the indicators of the base scenario.

Thus, with an increase in indicators of intellectual and innovative development of economic systems in a moderately optimistic scenario, an increase in the gross domestic product and the volume of realized innovative products is predicted in the period until 2025 (Fig. 5). The implementation of forecast values is carried out in the period from 2021, since in connection with the military operations on the territory of Ukraine for this period, there are no official statistical data on the necessary indicators.

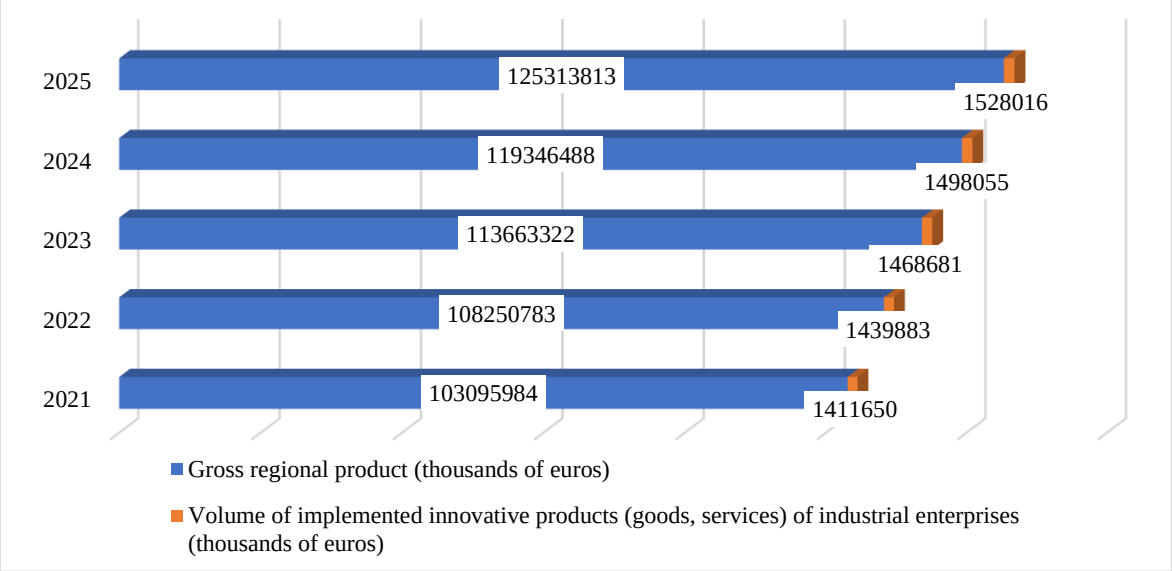

Figure 5. Forecast values of the development of economic systems' indicators
**Source: constructed by the authors.*

It should be noted that, regardless of significant risks, it is possible to finance innovative activities both with own funds and with the funds of investors. The post-war period should contribute to the intensification of investment activities in the state, especially in the restoration of priority development and reconstruction areas.

On the basis of the developed predictive values, it is possible to single out the relevant directions for the development of intellectual and innovative determinants of economic systems in the conditions of the creative economy development.

Features of the creative economy are the primary importance of creativity and a creative approach to solving socio-economic problems. Intellectual capital becomes the main driving force of economic development. The priority directions for the development of intellectual

capital and its components must take into account the relevant specific characteristics of each direction and collectively contribute to the achievement of a specific result.

Conclusions

On the basis of the conducted research, it was established that today the determinants of the intellectual and innovative development of economic systems have a significant impact in the conditions of the creative economy. Based on the creation of appropriate conditions for the promotion of intellectual development and the introduction of innovative developments, on the basis of which additional value is created, it is possible to ensure the economic systems' development. Based on the application of a methodological approach, with the use of simulation models, it is possible to forecast the development of the economy in conditions of high uncertainty.

The scientific novelty of the research consists in substantiating the theoretical and conceptual foundations of modeling the influence of intellectual and innovative determinants on the economic systems' development in the conditions of the creative economy formation, which is based on a systemic approach and involves the construction of economic simulation modeling of the influence of determinants on the development of economic systems, which includes modeling the effects of three blocks "Economic system", "Innovative processes", "Creative potential", the calculation of the integral indicator of the development of intellectual and innovative determinants of economic systems in the conditions of the creative economy formation and the construction of a forecast of the values of the integral indicator.

On the basis of the conducted modeling on the example of the national economic system of Ukraine, it was determined that the most realistic scenario for the creation of a creative economy today is a moderately optimistic scenario due to an increase in the amount of funding for intellectual and innovative activities while increasing the level of innovative activity of enterprises.

Aspects of modeling of the creative sector development of the economy in conditions of uncertainty under the influence of intellectual and innovative determinants require further research.

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