

Modeling of Investment Processes by Methods of Regression Analysis

Olena Ovchynnikova
Department of Automated Systems
and Modeling in Economics
Khmelnytskyi National University
Khmelnytskyi, Ukraine
veleslavaovch@gmail.com

Tetiana Zavhorodnia
Department of Automated Systems
and Modeling in Economics
Khmelnytskyi National University
Khmelnytskyi, Ukraine
igumnovaolga@ukr.net

Maria Ignatyshyn
Department of Finance
Mukachevo State University
Mukachevo, Ukraine
ignatishin.m.v@gmail.com

Abstract — the article presents developed models of the influence of indicators of economic, separately construction and tourism spheres on the total amount of capital investments in Khmelnytsky region. For each group of indicators, from 5 to 9 single- and multi-factor models that reflect the degree of influence of certain variables on capital investments in the region. The developed models made it possible to conclude that the investment sphere depends on the economic, construction and tourism indicators of the region. Some models have shown a low level of correlation, other built models of investment processes are qualitative, adequate and reflect the real impact of the selected factors on the resulting indicator and can be used for further forecasting.

Keywords — investments, economic indicators, modeling, regression

I. INTRODUCTION

One of the main tasks of the reform of the national economy of Ukraine is the intensification of investment activity and the formation of its new organizational and legal economic mechanism, which must meet the requirements of overcoming the crisis and improving the economy, liberalizing the conditions of the enterprises in the market conditions. The topic of attracting foreign investments is extremely relevant for Ukraine and its regions.

In order to make balanced, timely, effective and correct management decisions on investment projects, state authorities need to have accurate and reliable information on the state of development of economic indicators and their impact on investment processes. Therefore, the use of economic and mathematical modeling in the study of investment processes is relevant.

In the economic literature, issues related to investing are widely discussed. Well-known scientists like I. Blank, O. L. M. Borshch, Vorobiova, Yu. Vorobiov, T. Ye. Voronkova, N. M. Hulciaeva, N. Hordopolova, M. Denysenko, S. A. Yerokhin, I. Ihoshyn, A.Kasych, O. M. Kyrychenko, T. V. Maiorova, A. Muzychenko, S. V. Palytsia, A. Peresada, V. Stasiuk, A. Sukhorukov, I.Spil'nyk, N. V. Tkalenko, V. Fedorenko, M. Chebotarov and other. Studies of domestic and foreign experts have shown a deep enough study of the issues related to the investment process.

The purpose of the study is to develop models of the impact of economic indicators on investment processes in the region by methods of economic and mathematical modeling.

II. THE MAIN MATERIAL

Investments represent a set of expenditures that are realized in the form of long-term capital investments in various sectors of the economy. The purpose of the investment is to obtain a business profit, a percentage. According to the norms of the current legislation of Ukraine, investments are monetary, property, intellectual property, which are invested in objects of entrepreneurial activity and other activities in order to profit or achieve a social effect [1]. Under investment decisions are decisions on investing in economic entities in order to obtain returns in the future. The process of making investment decisions can be described by simulating the stages of the investment project [2]. The adoption of investment decisions is very complicated in the conditions of instability and uncertainty inherent in the real situation of the economy in Ukraine. It is also important to minimize investment risks.

To analyze the current state of investment activity in Ukraine and the region, it is important to focus on the indicators that characterize it. The volume of investments into fixed assets (capital investments) includes expenses for new construction, reconstruction, expansion and technical re-equipment of operating industrial, agricultural, transport, trade and other enterprises, expenses for construction of residential and civilian objects [3].

In 2017, the Khmelnytskyi region witnesses a positive process of increasing investment volumes (Fig. 1). Thus, 10499,875 million UAH were directed to the economy of the region. of capital investments, the bulk of them (84.8%) were investment in fixed assets.

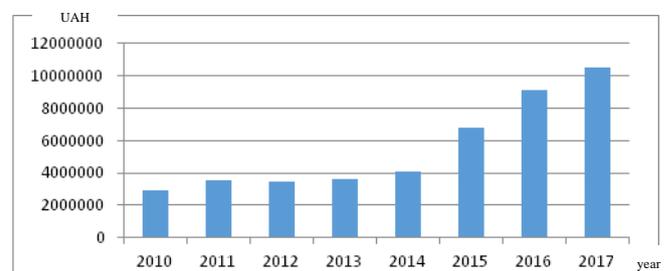


Fig. 1. Dynamics of capital investments in Khmelnytskyi region

The main source of investment in fixed capital remains the own funds of enterprises and funds of the population. The banks' loans in 2017 increased almost twice (Fig. 1).

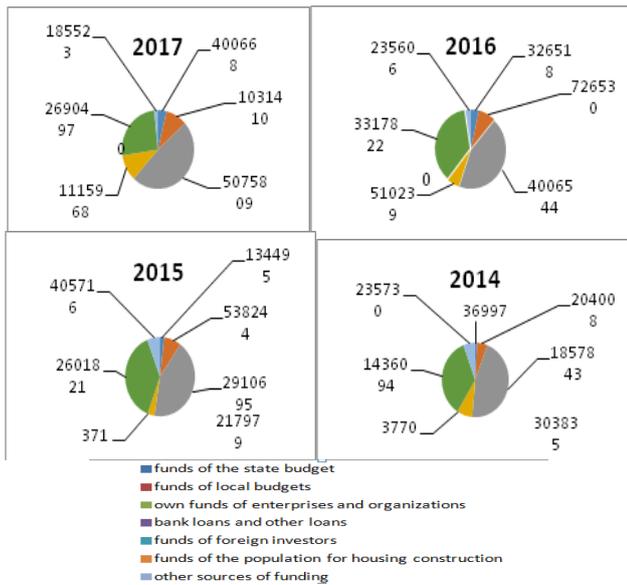


Fig. 2. Structure of investments into fixed capital by sources of financing

During 2014-2017, changes in the structure of fixed capital investment by types of economic activity took place. At technical re-equipment of agriculture directed almost one third of the volume of investment in fixed assets, developed in the branches of Khmelnytskyi [5].

Investment in housing objects is one of the most important indicators that characterizes the economic development of the region and affects the standard of living of the population, the demographic situation and many other economic factors. In recent years, there has been a positive tendency in the oblast to increase the volume of investment in housing construction. However, in 2017, less land capital investments were made in the oblast compared to 2016, compared with a decrease of 18.9% in investment in fixed assets in housing construction (Fig.3).

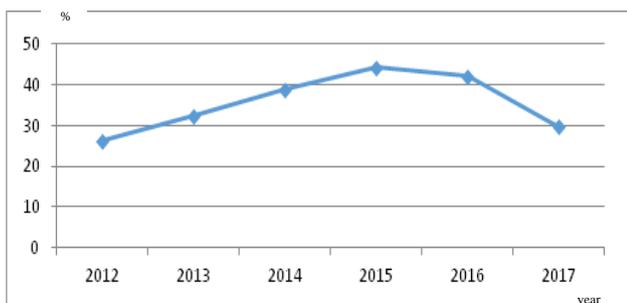


Fig. 3. Indices of investment in fixed assets in housing construction,% to the previous year

The benefits of investing are not automatically and equally expressed in different regions and sectors of the economy. Determining the impact of investment on economic development usually boils down to an econometric analysis of the relationship between investment inflows and different indicators of economic development.

Khmelnytsky Region belongs to the attractive regions of Ukraine for investment due to its favorable geographical location and economic potential. As can be seen from the chart below (Fig. 4), the volume of direct investments in the

Khmelnytsky region has been increasing rapidly over the past few years.

Although the overall investment climate in Ukraine is not currently favorable for foreign investors. Because there are a number of unresolved issues that impede the raising of funds. In addition, the unstable situation in the East is a major cause of the deteriorating investment climate.

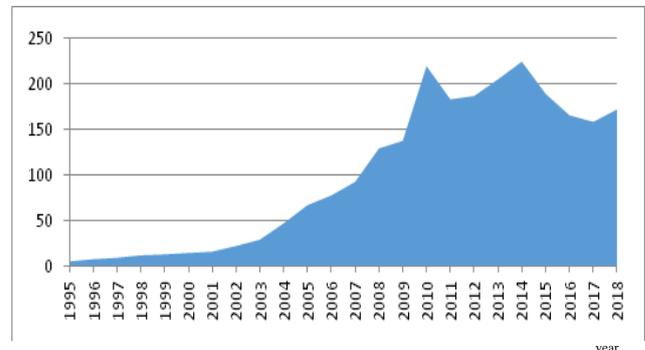


Fig. 4. Direct investment in the economy of Khmelnytsky region

The economy of our region was invested by capital from 28 countries of the world (as of 01.01.2019 there were 29 countries-investors). The largest investors in the region's economy were Liechtenstein - \$ 25.6 million, Cyprus - \$ 6.3 million, Virgin Islands - \$ 6.3 million. These three countries account for 57.3% of the total volume of direct foreign investments in the economy of Khmelnytskyi [6].

Creating a favorable investment climate allows you to rapidly increase the volume of attracted foreign investment, and vice versa, foreign investment is very responsive to events and circumstances that lead to a deterioration of the investment climate.

An important stage in solving the problem of development of the investment potential of the region is the economic and mathematical justification of the relevant factors that influence its state and dynamics. Thus, the final decision regarding the selection of a better investment project can help experts make a more accurate analysis, using methods of economic and mathematical modeling [7].

Table 1 presents the factors we selected for modeling the impact of construction sector indicators on the total volume of capital investments in the oblast.

TABLE I. INITIAL INFORMATION FOR MODELING THE INFLUENCE OF BUILDING SPHERE INDICATORS

Years	Capital investment, thousand UAH	Acceptance of residential buildings, (m2 of total area)	Construction product indices (% to the previous year)	Volume of executed construction works by types of construction products, (thousand UAH)
	Y	X_1	X_2	X_3
2010	2947584	361491	100	600798
2011	3546804	297983	113,9	821132
2012	3489339	358844	90,7	816803
2013	3637605	290210	111,5	956433
2014	4078277	351114	91,2	964443
2015	6809321	468658	108,9	1336140
2016	9123259	404822	107,6	1571072
2017	10499875	361069	127,2	2293412

According to the selected data, the correlation coefficient was equal to 0.987151, which suggests the existence of a strong correlation connection.

The regression model of the impact of construction sector indicators on capital investment will look like:

$$Y = -5265200 + 13298,82 X_1 + 11538,03 X_2 + 4,564037 X_3 \quad (1)$$

A sign near a partial coefficient indicates a positive or negative impact - as can be seen, the growth of the selected factors leads to an increase in the resultant index, with the first two factors having more influence than the third. It can be concluded that the growth of the construction industry will help improve the investment climate and increase investment attraction in the region.

Fig. 5 shows the real and calculated model of the value of the effective indicator. The simulated data is practically no different from the actual data, which suggests that the resulting model is qualitative and can be used for further prediction.

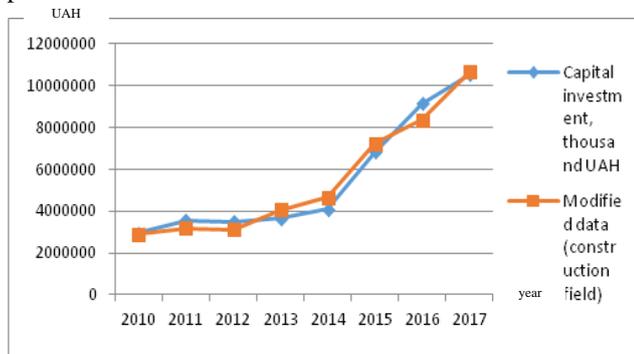


Fig. 5. Actual and simulated values of the capital investment index based on the model of the impact of construction industry indicators on investment processes

Substituting in the above equation the value of the predicted indexes of factor X attributes, we obtain the smoothed values of the resultant sign \hat{Y} , which indicate what the average capital investment should be, depending on the determined indicators of the construction sector (in other equal terms).

According to the same scheme, the following models are calculated (table 2).

The obtained models are adequate and show the influence of the selected factors on the resulting indicator (capital investment). In conditions of market relations, it is important to choose the optimal structure of sources of financing of capital investments, which is carried out at the expense of own and borrowed funds. A basic premise for determining the optimal structure of such sources may be a detailed analysis, which should determine the maximum size of capital expenditures, based on the size and relative importance of each source of funding that can be invested in investing.

The multiple correlation coefficient is close to one, indicating a strong correlation between indicators and performance. The determination coefficient is equal to 0.98, the change in the effective indicator was 98% due to the

selected factors, and 2% due to factors not included in the model.

TABLE II. MODELS OF INFLUENCE OF BUILDING INDICATORS ON INVESTMENT PROCESSES

	Model 1	Model 2	Model 3	Model 4	Model 5
Y	<i>Indicators (X), where "+" - the model includes the indicator, "-" - does not include</i>				
Capital investment, thousand UAH	<i>Acceptance of residential buildings, (m2 of total area)</i>				
	+	+	-	-	-
	<i>Construction product indices (% to the previous year)</i>				
	-	+	+	-	+
	<i>Volume of executed construction works by types of construction products, (thousand UAH)</i>				
	-	-	-	+	+
Regression coefficients	-3644264 25,32182	-2,1E+07 27,64783 159540,7	-1,1E+07 150793,9	-487819 5,131775	1461914 -22121,4 5,476584
Correlation coefficient	0,492571	0,827306	0,629699	0,964487	0,966731
Determination coefficient	0,242626	0,684435	0,396521	0,930236	0,934569
Fisher's Criterion	1,922114	5,422292	3,942348	80,00363	35,70837

We have also developed models for the impact of economic factors on the overall indicator of total capital investment in the Khmelnytsky region. Table 3 presents the output data for calculation.

TABLE III. OUTPUT DATA FOR CALCULATION OF MODEL OF INFLUENCE OF ECONOMIC INDICATORS

Years	Capital investment, thousand UAH	Share of enterprises engaged in innovations, %	The number of the existing population, thousands of people	Unemployed population (according to the ILO methodology) of able-bodied age, thousand persons	Wholesale trade - total (excluding VAT), mln. UAH	Volume of industrial products sold, thousands UAH
	Y	X ₁	X ₂	X ₃	X ₄	X ₅
2010	2947584	16,9	1334	54,9	5009,4	11807180
2011	3546804	22,3	1326,9	55,4	5461,2	15045248
2012	3489339	22,5	1320,2	53,7	6111,7	16618937
2013	3637605	18,2	1314	49,9	6416	17552533
2014	4078277	11	1307	54	4939,9	16038246
2015	6809321	12,3	1301,2	56,6	6876,3	20050052
2016	9123259	12,8	1294,4	53	10395,3	24460817
2017	10499875	5,7	1285,3	50,2	15715,8	31747660

The regression model has the form:

$$Y = 3,5E+08 + 172833,9 X_1 - 275320 X_2 + 381537,9 X_3 + 1707,007 X_4 - 1,00438 X_5 + 3,5E+08 X_6 \quad (2)$$

The second model also showed the existence of investment dependence on a number of economic indicators. Yes, improving production and capacity-building for innovative products leads to increased investment in industries. At the same time, the model also reflected the

impact of the unemployed on the investment climate. Therefore, employment problems, such as the ability to provide new jobs, can also be seen as factors for investment growth. Investments have a direct and indirect impact on employment levels in the country. In a situation where capital is in relative scarcity and labor resources in excess of the creation of additional jobs are one of the most important consequences of attracting foreign direct investment. In addition, the effect of investment on economic development depends on the skill level of the worker forces in the region. As you know, there is a close relationship between foreign ones the investment and education level of the employed because the transfer.

Technology requires an appropriate level of local training that can effectively work with advanced technology Direct investment can have a positive impact on regions of the country through the transfer of capital, technology, and management resources that would be unavailable in the absence of investment. Such a shift in resources may stimulate the economic growth of the country and its regions.

The regression model allows you to calculate the predicted values for the actual data, as shown in Fig. 6.

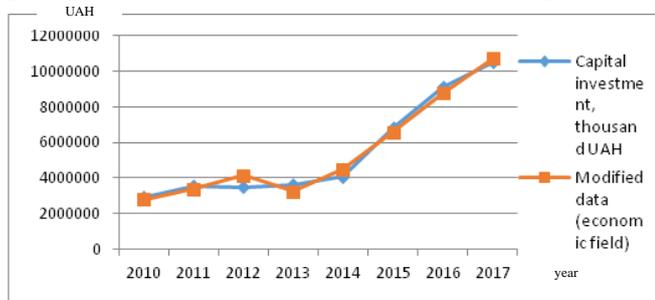


Fig. 6. Real and simulated changes in the indicator of capital investment from the influence of economic factors

It is clear that domestic markets for goods and services are characterized by high profitability of doing business and relatively cheap labor, however, institutional instability frustrates potential investors.

Therefore, in order to ensure a change in the structure of the economy of Ukraine in sufficient investments in the context of limited domestic resources, favorable conditions for attracting foreign investment must be created [8].

Table 4 presents our single and multi-factor models for changing the total volume of capital investment from the impact of economic indicators.

Thus, the simulation confirmed that it is expedient to develop a multi-purpose program for the development of the regional market, the creation and operation of an investment and loan system that mobilizes free cash resources of the population, regional entrepreneurial structures, foreign investors, as well as interregional cooperation for the investment of regional projects [9].

In order to ensure a change in the structure of the economy of Ukraine in sufficient investments in the context of limited domestic resources, it is necessary to create favorable conditions for attraction of foreign investments. The region should give priority to measures aimed at increasing investment attractiveness. Unlike domestic investors, foreign investors pay more attention to the conditions that shape the investment climate, in particular: legislation, fiscal policy, political situation, crime situation [10].

TABLE IV. MODELS OF GENERAL CAPITAL INVESTMENT INCOME OF ECONOMIC INDICATORS

Y	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
<i>Indicators (X), where "+" - the model includes the indicator, "-" - does not include</i>								
Capital investment, thousands UAH	<i>Share of enterprises engaged in innovations, %</i>							
	+	-	-	-	-	+	+	+
	<i>The number of the existing population, thousands of people</i>							
	-	+	-	-	-	-	+	-
	<i>Unemployed population (according to the ILO methodology) of able-bodied age, thousand persons</i>							
	-	-	+	-	-	-	+	-
	<i>Wholesale trade - total (excluding VAT), million UAH</i>							
-	-	-	+	-	-	-	-	
<i>Volume of industrial products sold, thousand UAH</i>								
-	-	-	-	+	-	-	-	
Regression coefficients	11437277 -389204	2,17E+08 -161190	27059219 -402950	11363,31 722,8679	-2965915 0,442598	2,04E+08 -34845,2 -151076	2,07E+08 -30174,8 -156559 69544,68	93867707 12801,16 -84086,3 326000,5 552,7791
Correlation coefficient	0,776522	0,914205	0,328005	0,917509	0,953569	0,915048	0,916483	0,986335
Determination coefficient	0,602986	0,835771	0,107587	0,841823	0,909295	0,837313	0,839942	0,972858
Fisher's Criterion	9,112804	30,53424	0,723347	31,93217	60,1483	12,86694	6,996978	26,88213

As there are many places in Khmelnytsky region that can attract tourists, we also developed models of impact of

tourism indicators on the indicator of total capital investment in the Khmelnytsky region. The tourism business is

confident in its pursuit of excellence in comparison to other industries. Today, the tourism industry in Ukraine is the fifth by the value of the budget replenishment component, and in the long term its specific gravity in replenishment the country's budget can grow significantly. But despite the positive dynamics regarding growth of capital investment in tourism, Ukraine has a low image level in the world investment market. In most It ranks last in terms of investment attractiveness. If you improve this situation, then perhaps the tourism industry will be able strengthen your ranking and invest in all industries.

According to the standard scheme, we have constructed a model of the influence of tourism sector indicators on the total volume of capital investments in the oblast (Table 5).

TABLE V. OUTPUT DATA FOR CALCULATION OF THE MODEL OF THE INFLUENCE OF TOURISM SPHERE

Years	Capital investment, thousand UAH s	The number of hotels and other places for temporary accommodation	Children's health and recreation facilities that worked in the summer	The number of tourists serviced by tour operators and travel agents is total	Number of places, hotels and similar facilities, units
	Y	X ₁	X ₂	X ₃	X ₄
2010	2947584	27	871	59806	30563
2011	3546804	25	869	31212	3141
2012	3489339	22	834	32437	3342
2013	3637605	22	833	24402	3665
2014	4078277	27	687	19027	3598
2015	6809321	29	267	25416	3636
2016	9123259	29	239	19885	3692
2017	10499875	31	204	26829	3746

The multiple correlation coefficient is close to one, indicating a strong correlation between indicators and performance. The determination coefficient is equal to 0.91,

TABLE VI. MODELS OF THE INFLUENCE OF THE INDICATORS OF THE TOURIST SPHERE ON INVESTMENT PROCESSES

Y	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
<i>Indicators (X), where "+" - the model includes the indicator, "-" - does not include</i>									
<i>Capital investment, thousands of hryvnias</i>	<i>The number of hotels and other places for temporary accommodation</i>								
	+	-	-	-	+	+	-	-	-
	<i>Children's health and recreation facilities that worked in the summer</i>								
		+	-	-	-	+	+	+	-
	<i>The number of tourists serviced by tour operators and travel agents is total</i>								
-	-	+	-	-	+	+	+	+	+
<i>Number of places, hotels and similar facilities, units</i>									
-	-	-	-	+	-	-	-	+	+
<i>Regression coefficients</i>	-1,3E+07 700031,1	10944006 -9038,3	8446668 -98,0749	6240797 -104,623	10431488 16110,48 -8895,77	10690126 6464,754 -9104,07 -9034,67 2,690626	10884802 -9104,07 3,303574	10065240 -9351,95 51,01878 -66,0362	10199152 -187 130,6258
<i>Correlation coefficient</i>	0,789828	0,95063	0,43617	0,342278	0,950686	0,950724	0,950719	0,953959	0,465262
<i>Determination coefficient</i>	0,623828	0,903698	0,190245	0,117154	0,903803	0,903877	0,903866	0,910039	0,216469
<i>Fisher's Criterion</i>	9,950141	56,30383	1,409645	0,796202	23,48844	12,53778	23,50529	13,48785	0,690682

Ukraine has abundant tourism and recreational resources that, if used appropriately, can contribute to the rapid and highly efficient development of the tourism industry. Despite

91% change in the effective indicator occurred due to selected factors, and 9% due to factors not included in the model.

The regression model has the form:

$$Y = 7379900 + 83029.05 X_1 - 8516.62 X_2 + 53.91974 X_3 - 80.9461 X_4 \quad (3)$$

You can see the positive impact of the growth of the number of hotels on the growth of the total value of investments, which indicates the direct interest of investors in investing in the tourism business.

The regression model allows you to calculate the predicted values for the actual data. We construct a graph of calculated indicators and actual values (Fig. 7).

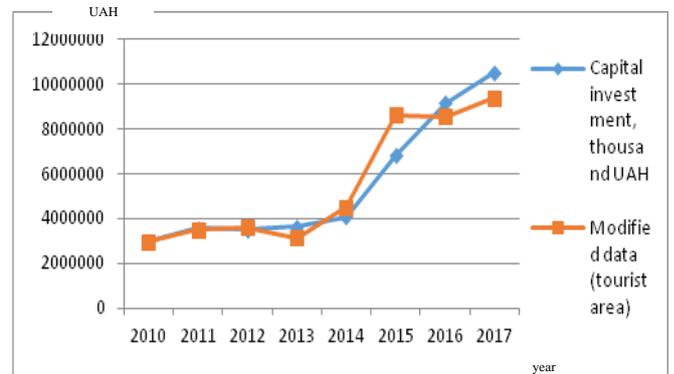


Fig. 7. Real and simulated changes in the rate of capital investment from the impact of tourism indicators

Table 6 presents the calculations of other models of influence of tourism sector indicators on investment processes.

some changes, the development of tourism is hampered by many reasons, the most important of which is the lack of

tourism infrastructure, the slow growth rate of investment in the development of the logistics base of tourism.

Thus, modeling of investment processes in Khmelnytsky region was carried out. Constructed single- and multi-factor regression models. Construction of models of investment decision making is economically profitable, since this way acquires new knowledge, information, which in turn reduces uncertainty [11]. In addition, the analysis of trends in the dynamics of foreign investment inflows and the main directions of effective attraction of foreign investments in the Khmelnytsky region.

III. CONCLUSION

The results of the analysis of volumes of capital investments in Khmelnytsky region showed that the largest share belongs to investments from own funds of enterprises and organizations - they make up to 2/3 of all investments, and the remaining funds by specific weight differ little among themselves. The attraction of foreign investment is an important task for the region, because its own funds are still not enough. In order to increase the share of foreign investment, it is necessary to fundamentally change the investment climate for the better.

As you know, the existing investment process in Ukraine contributes quantitatively to the restoration of the national economic complex, but does not contribute to the renewal and improvement of its structure. Economic system investment resources should be constantly reproduced, and reproduction should not only be extended but also be accompanied by structural changes.

The development of the economy depends on the construction industry, and it still receives a very small share of investment. To improve the situation, it is necessary to create an effective system of state regulation of this branch and more favorable conditions for investors.

Although an insignificant part of the issues that arise when considering investing problems is analyzed, but the outcomes can be the basis for new research.

Khmelnytsky region belongs to a group of regions of high level of investment attractiveness. But in the Khmelnytsky region, as in Ukraine as a whole, investment conditions have recently deteriorated, primarily due to the effects of adverse factors of national significance. The main directions for improving the investment attractiveness of the region are a more efficient allocation of budget investment resources; improvement of mechanisms of investment attraction; formation and planning of investment policy, support for tourism development.

Prospects for further research are the development of a comprehensive regional program for the development of investment processes, based on a functional and integrated assessment of priority directions of development of Khmelnytsky region.

As a result, attracting more investment will contribute to faster economic growth and better living conditions for the population of the country and its regions

REFERENCES

- [1] N. V. Hordopolova, "Theory and practice of accounting for financial investments", *Effective economy*, vol.12, 2011. [Online]. Available: <http://www.economy.nayka.com.ua/?op=1&z=828>. Accessed on: May 05, 2019.
- [2] O.I. Milashov'ska, and N.M. Hoblyk-Markovych, "The methodical approach to the assessment of the effects of the formation of supply and demand in the regional tourism market". *Uzhhorod: Scientific bulletin of Uzhgorod University. Economy*, vol. 35, no. 2, pp. 213 – 219, 2012.
- [3] The Verkhovna Rada of Ukraine. The Law of Ukraine "About investment and investment activity", Available: <http://zakon2.rada.gov.ua/laws/show/1560> 12. 1991. [Online]. Accessed on: April 05, 2019.
- [4] Capital investment in Ukraine for 2017. Kyiv: State Statistics Service of Ukraine, 2018. [Online]. Available: <http://ukrstat.gov.ua>. Accessed on: May 15, 2019.
- [5] Site of the Main Department of Statistics in the Khmelnytskyi Region. [Online]. Available: <http://www.statbrd.ic.km.ua/ukr/index.htm>. Accessed on: April 20, 2019
- [6] V. S. Zdretyk, "The essence of financial investment as the object of accounting: problems and solutions". *Ukrainian Science: Past, Present, Future*, vol. 1, no. 19, pp.51-59, 2014.
- [7] V. M. Zhuk, Yu. S. Bezdushna, and O. S. Vdovenko, "Accounts technology to ensure the investment attractiveness and financial security of agricultural enterprises". *Accounting and Finance*, no. 4 (62), pp. 32-38, 2013.
- [8] V. P. Stasiuk, *Modeling of the processes of investment activity of an enterprise. Adaptive Enterprise Management Models*. Donetsk: Yuhovostok, 2003.
- [9] A. I. Sukhorukov, and O. V. Sobkevych, "Activization of investment and innovation policy in industry is a strategic priority of the national economic interests of Ukraine". *Foreign Trade: Economics, Finance, Law*, no. 3(80), pp. 193-205. 2015.
- [10] V. V. Shkirenko, "Methodical approaches to the preliminary analysis of the economic efficiency of projects at the pre-investment stage". *Investments: practice and experience*, no. 17, pp. 44-48. 2017.
- [11] I. V. Spil'nyk, "Analysis of the investment activity of the enterprise according to the data of financial reporting", *Economic analysis*, no. 2, pp. 78-87, 2013.
- [12] A. O. Kasych, "New approaches to investment analysis techniques", *Effective economy*, vol. 3, 2016. [Online]. Available: <http://www.economy.nayka.com.ua/>. Accessed on: May 22, 2019.