

## Ensuring the effectiveness increase of regional competitiveness management based on the usage of innovation and investment activities indexes

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### ABSTRACT

The research has revealed connection and the influence degree of innovative and investment activities on the efficiency of competitiveness management in the region. In this article, for the first time, economic and statistical methods are used to study the interaction between innovation and investment activity and competitiveness at the regional level. The Granger test and the correlation and regression analysis are applied for the comprehensive study of individual and joint impact on the region's competitiveness and its innovation and investment activity. The Granger test provides an opportunity to identify cause-effect relationships between the indicators of innovation and investment activity in the region. Accordingly, pairs of indicators of innovation and investment regional activity are identified and grouped together in accordance with the presence of connection, strength and direction of impact. Correlation and regression analysis are used to determine the regional impact of innovation and investment activity and competitiveness. Accordingly, the nature, the correlation ratio and the degree of impact of certain innovation and investment indicators on the gross regional product are determined. A three-year forecast for regional competitiveness management is carried out on the basis of the actual data of the obtained dependency models of the indicators under study.

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## 1. Introduction

The modern development of world countries, especially the ones that are economically developed, is based on the ensuring and enhancing of their regions' competitiveness. Thus, it increases the management role of such processes. In most world's countries, public and local authorities as well as scientists and practitioners believe that competitiveness is the key part of particular regions development and their economic growth security. In addition, it helps to improve the operations of the social sector efficiency (Krželj-Čolović, 2015; Martin, 2003). Besides, scientific works pay special attention for finding and estimation of particular factors (domestic and external) that influence regional competitiveness. It allows

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to increase management efficiency of both regions in general and their competitiveness in particular (Kmet & Mayzner, 2017; Ručinská & Ručinský, 2007). In conditions of national economic systems transformation, modern development of regional economies has led to the increased focus on investment and innovation activities in regions to impact on management efficiency of their competitiveness (Borozan, 2008; Huggins et al., 2013; Natário, 2014; Sadeghi & Rad, 2018; Yusr et al., 2018; Ghaffari et al., 2017; Basheer et al., 2019). In many countries, developing economic systems cannot provide effective competitiveness management of the country's regions. It does not allow them to realize fully the potential of social and economic system increase and Ukraine is one of these countries.

The current stage of development of a regional economy in Ukraine requires the use of scientifically grounded management decisions that increase the efficiency of regional competitiveness management. It is possible to estimate the impact of various factors on the final result using economic and statistical methods. A large number of operating factors stipulates the necessity of multiple correlation and regression analysis for quantitative evaluation of the interdependences between statistical features. They characterize the competitiveness of the region and its innovation and investment activity. During the analysis, it is necessary to establish the theoretical form of connection between factor and performance characteristics (regression analysis) and determine the correlation ratio of this connection (correlation analysis), i.e. quantitatively measure and evaluate the mechanism of interaction of factor characteristics. Parameters of correlation analysis are used for purposeful regulation of the levels of effective attributes.

The mathematical reflection of the competitiveness study of the region is an economic and mathematical model that determines its functioning and assessment of the change of its effectiveness with possible changes in the characteristics of innovation and investment activities. The parameters of economic models are evaluated with the help of mathematical statistics methods, using real statistical information. The task of correlation and regression analysis is the construction and analysis of the economic and mathematical model of the regression equation (correlation communication equation), which reflects the dependence of the resultant feature on several factor characteristics and gives an estimate of the degree of correlation ratio. According to Kravets (2008), the correlation relationships are established on the average for a large set of data from the information base, which has rather typical and reliable statistical characteristics, as well as qualitative homogeneity (the proximity of the conditions for the formation of productive and factor characteristics) and quantitative homogeneity (the absence of a unit of observation, which, according to numerical characteristics, significantly differs from the bulk of data). These features require the solution of two problems: finding the form of functional communication and determining the degree of approximation of the correlation communication behind it.

Accordingly, the gross regional product indicator is considered to be the necessary indicator, correlating the region's competitiveness (effectiveness of its management) along with the other indicators that characterize innovation and investment activity in the region. The statistical data from the western regions of Ukraine are used, since in the case our hypothesis is confirmed, this model will hold for the whole territory of Ukraine. It is necessary to understand that research on ensuring the effectiveness increase of Ukrainian regions competitiveness management by using innovation and investment activities indexes and the formation of a particular mathematic model is based on the estimation of scientific researches by both foreign and Ukrainian scholars.

It has been mentioned that in the economic literature of recent years much attention is devoted to the issues of innovation and investment activity and management in this field both at the national and regional level. Many foreign and domestic economists took a scientific interest in this field. Among foreign scientists we should mention the achievements of Isard (1965), who applied mathematical and statistical methods of analysis of the region's activities and offered to carry out such analysis regularly at the level of the State. Malecki (1997) argued about the relationship of regional competitiveness with the regional economy condition and proposed a system of economic regional indicators for the analysis, dynamics and control of changes in the economy of the region. Friedmann and Alonso (1964) devoted their research

to the regional level of planning the economic and social sphere at the strategic and tactical level, arguing about the peculiarities of the economic relationships of certain economic activities at the regional level rather than at the national level. Webster and Muller (2000) conducted researches on cities' competitiveness estimation in countries, which were developing at that moment, emphasizing the preparation of scenarios for such territories development based on four estimation categories (economic structure, human resources, territorial peculiarities, institutional environment). Mihaela (2016) within the personal research of competitiveness management of Romanian regions paid special attention on the connection of such management with management, investments and innovations to human capital in these territories. Uzlov and Li-chun (2017), as well as Arrillaga et al. (2013) emphasized innovation activity within the efficiency increase of regional competitiveness management based on economic and mathematic modeling. Bellù et al. (2011) offered to conduct the estimation of regions competitiveness taking into consideration the territorial competitiveness index designed by them and based on the sizes of territorial assets and economic flows. Békés (2015) suggested to manage regional competitiveness by estimating the level of such competitiveness and taking into regard foreign direct investments (FDI) to the region and the efficiency of local authorities functioning. Kariyawasam and Shanaka (2015) revealed the connection of regional development, competitiveness, the level of infrastructure provision and investments in the case study of Sri Lanka. Hladovsky et al. (2018) examined the relationships of research activities with economic indexes of European Union regions and their competitiveness management.

Meshko (2008) is among domestic economists who found some achievements in the study of the innovation and investment activities at the regional level. He devoted his research for the determination of the level of innovation and investment potential of Ukraine's regions, and also the features of the innovation and investment activity as a key factor of the accelerated economic development of the country. Zhykhor (2009) revealed the essence for the application of the indicators system of an existing and applied potential of the regions innovation and investment development and their acquisition by the regions. Gliznutsa (2016) emphasized the inter-connection of regional innovative potential parts and its competitiveness management. Bobrovska et al. (2013) stressed the importance within the efficiency increase of regional competitiveness management, provision of effective financial resources management of these regions, including investments and optimization of local authorities' activities.

Skubitskiy (2009) analyzed the existing mechanisms in the State and made suggestions for their improvement. There have been tremendous efforts for the development of a methodology for evaluation the economic, innovation and investment (e.g. Shkurupiy & Flegantova, 2014; Spodina, 2013). Onisenko (2014) and Ocheredko (2011) suggested the formation of strategies for socio-economic development of the Ukraine's regions with regard to innovative factors and Stoyka (2015) emphasized on the investment factor, as a key economic factor of improving the welfare of the regional economy. Kosach (2007) offered the improvement of management system for the investment and innovation development of regions based on management of the innovation and investment potential of the region. The mutual innovation and investment activity were studied in the works of Fedulova (2012) who concluded that an effective innovation policy influences the investment attractiveness of the regions and Ukraine in general.

Despite rather significant amount of works by scientists, the research has detected the presence of substantial debates on trends for efficiency increase provision of regions competitiveness management and the place of regional innovation and investment activities in this process. Therefore, the objective of the article is to carry out the correlation and regression analysis of the impact of the region's innovation and investment activity on its economic activity, and efficiency of competitiveness, and to forecast the further impact for a short term. The task of the correlation and regression analysis is to identify possible variants for the management of the region's economy and competitiveness, as well as to assess all possible ways of achieving the desired result.

Using in our work the study of interconnections between innovation and investment indicators of the region and their joint impact on regional competitiveness allows solving of the following main tasks:

- 1) to establish the characteristics and the correlation ratios between the innovation - investment activities of the region and its competitiveness;
- 2) to determine and quantify the impact of certain innovation and investment indicators and their complex on the level of competitiveness of the region;
- 3) and to make a forecast of dependencies of indicators and give them an objective assessment in management on the basis of the actual data of the dependence models of the investigative economic indicators.

## 2. Methods

Correlation and regression analysis provide determination of the influence of factors for which it is impossible to construct a rigid deterministic factor model. Correlation and regression analysis require a number of conditions to be implemented:

- to construct the regression equation, a certain set of objects is needed: in our study it should be spatial-temporal, since regional indicators for the period from 2013 till 2017 are used
- a sufficient amount of observations is needed, according to experts' estimates, the number of observations should be at least 3-4 times the number of factors (we carried out 30 observations).

Thus, the results of the correlation and regression analysis can be used to substantiate managerial decisions on forecasting and planning of the region's competitiveness. This will be the basis for the impact on the capacity of innovation and investment activity in the short-term future. Correlation analysis of factor characteristics was performed using Excel analysis package correlation tool. As a productive feature, we used the indicator of gross regional product and, accordingly and we obtained a correlation matrix of influencing regional innovation and investment factors (Table 1).

According to Cohen et al. (2003), one of the simplest and most widespread models is linear regression, but it usually cannot provide the required accuracy of prediction. Multifactor models (multiple correlation) are used to increase prediction accuracy and reduce the variability of the indicator. When choosing independent variables (factors) in such models, it is necessary to consider the existence of a connection with the dependent variable (indicator) and the absence of close connection with any other independent variable, that is, mutual correlation. Factors should reflect different aspects of the process being studied. To analyze the correlation ratios in multifactor correlation and regression model, a matrix of pair correlation coefficients, which measure correlation ratio of linear connection of each factor (correlation matrix) is setup. By the form of connection, correlation connections are direct and inverse, linear and nonlinear, one and multifactor. Direct and inverse bonds are distinguished depending on the direction of change of the effective character when changing the factor characteristic. If the directions match, they are direct, if not, they are inverse. Depending on the nature of the change in the index  $Y$ , when the factor  $X$  changes, linear and nonlinear connections are distinguished.

In order to determine the interconnection between independent variables, it is necessary to consider the factors of the influence of innovation and investment activity in the region on their multicollinearity. Multicollinearity, as a rule, manifests itself in a stochastic (hidden) form as stated by Golovach et al. (2005). Its presence leads to a serious decrease in the accuracy of the estimates of regression parameters, curvature of the residuals variance estimate, the variance of regression coefficients and variations between them. Regression coefficients become unreliable and they cannot be interpreted as a measure of the influence of the corresponding factor on an independent variable. Estimates become very sensitive to sample data, that is, a small increase in sample size may lead to significant changes in the values of estimates. Therefore, it is necessary to perform an appropriate check, because the resulting regression will be characterized by high variability and certain redundancy (calculated values are larger than expected). When checking for multicollinearity, as stated by Ulku and Rand (2004), the statistical significance of the  $X_i$  factor characteristics is first replaced by standardized (normalized) data, and then a correlation matrix is constructed, which consists of correlation coefficients, calculated for each possible pair

of variables. The analysis of the obtained dependences lets us estimate the degree and direction of the interconnection between factors. Then the determinant of the correlation matrix is calculated, which indicates the possible correlation between the factors (if the value is close to zero).

**Table 1**

Output data to assess the tightness of the link between the GRP and the innovation and investment indicators of the region\*

Regions of Western Ukraine	Years	Y, GRP (mln.UAH)	X <sub>1</sub> , Capital investment (mln.UAH)	X <sub>2</sub> , Direct foreign investment (equity) (millions of US dollars)	X <sub>3</sub> , Number of organizations performing scientific and scientific - technical works (units)	X <sub>4</sub> , Number of specialists performing scientific and scientific work (thousand)	X <sub>5</sub> , Number of Innovative Enterprises in Industry (units)	X <sub>6</sub> , Volume of innovative products (mln.UAH)	X <sub>7</sub> , Implementation of innovative technological processes in industry (processes)	X <sub>8</sub> , Introduction of innovative types of products in industry (units)	X <sub>9</sub> , Distribution of total expenditures by directions of innovation activity (UAH thousand)
Volyn	2012	19249	3255	291,4	12	248	29	105,8	18	8	104640,7
	2013	19817	3327	380,5	11	224	23	15,4	25	25	196348,8
	2014	23218	3390	341,3	10	145	30	9,4	17	60	192506,3
	2015	30387	6167	271,2	10	166	32	10,9	13	8	190999,8
	2016	31003	7400	270,3	10	170	32	11,0	15	20	190024,8
Zakarpattia	2012	17088	2736	348,5	14	493	18	19,5	4	11	32769,1
	2013	17044	2646	406,4	13	416	15	608,5	6	20	25026,7
	2014	19170	2639	437,5	11	363	16	568,9	3	8	16576,1
	2015	22989	3778	334,2	10	316	18	568,9	7	9	22530,6
	2016	24080	3899	350,5	10	340	20	605,5	7	9	23564,8
Ivano Frankivsk	2012	23379	5167	624	21	690	89	1451,1	24	156	203824,1
	2013	24022	4797	642,7	15	316	87	474,8	17	151	488571,3
	2014	27232	6837	813,8	16	311	99	393,9	20	130	95785,1
	2015	33170	9609	925,9	18	310	101	400,9	50	117	99189
	2016	34528	9898	986,5	22	350	121	480,9	55	120	100213,4
Lviv	2012	24387	11173	1387,8	75	3627	101	512,8	46	115	280614,4
	2013	24937	9817	1637,8	76	3422	116	123,7	47	111	257053,9
	2014	28731	9555	1701,4	72	3239	129	213,3	60	132	219754,3
	2015	37338	13387	1374,6	68	2967	130	416,8	49	251	277796,2
	2016	38925	15689	1548,6	72	3024	131	423,6	59	270	302455,2
Rivne	2012	18860	2771	280,4	12	202	36	34,1	18	19	47873,5
	2013	19003	2837	298,8	12	203	39	12,1	19	18	21130,8
	2014	24762	2805	313,4	13	172	45	13,3	8	6	11404,5
	2015	30350	4334	263,4	12	147	46	18,0	9	7	11865,9
	2016	32055	5001	286,5	15	150	50	18,7	15	10	12356,9
Khmelnyskyi	2012	26237	3489	186,8	20	780	78	1931,4	32	36	225196,2
	2013	26426	3638	205,1	19	690	58	1269,3	24	27	113120,1
	2014	32162	4078	224,5	23	650	38	1895,6	11	23	133121,2
	2015	31660	6809	189,1	25	708	18	2090,6	9	11	133121,2
	2016	32585	9123	165,5	25	713	22	2512,3	13	24	66659,4
max value		38925	15689	1701	76	3627	131	1451	60	270	488571,3
min value		17044	2639	263	10	145	15	9	3	6	11404,5
average value		25828,96	6116,56	660,70	24,73	851,73	62,12	300,47	23,33	63,733	136995,05
deviation (standard)		6306,12	3728,14	491,43	22,27	1115,05	42,49	335,20	17,70	73,99	123697,44
swing variation		21881	13050	1438	66	3482	116	1441,68	57	264	477166,8

\* own calculations

If a linear dependence between these factors is detected, the resulting equation system will not meet the conditions for obtaining an unambiguous connection. If at this stage of model construction we find multicollinearity, then we will be able to avoid model specification errors, because they reduce the accuracy

of indicators, on the basis of which it will not be possible to build a reliable interconnection model. The matrix of correlation coefficients is presented in Table 2.

**Table 2**  
The matrix of correlation coefficients\*

	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9
1	2	3	4	5	6	7	8	9	10	11
Y	1									
X1	<b>0,9873</b>	1								
X2	<b>0,8603</b>	0,9517	1							
X3	0,5485	0,5375	0,5543	1						
X4	0,1127	0,1553	0,1657	0,1077	1					
X5	<b>0,8840</b>	0,9131	0,8138	0,7548	0,7801	1				
X6	<b>0,8707</b>	0,7690	0,7675	0,7686	0,7683	0,7670	1			
X7	0,3816	0,4095	0,3948	0,4564	0,4390	0,3425	0,5111	1		
X8	0,5616	0,5691	0,5485	0,5375	0,5543	0,5836	0,4854	0,3255	1	
X9	0,6302	0,6382	0,6127	0,6553	0,6574	0,6108	0,6494	0,6581	0,6831	1

\* The factors of greatest influence upon the gross regional product are highlighted with color

According to Moore and Weatherford (2004), the correlation coefficient ( $r$ ) ranges from -1 to +1. If  $|r| < 0,30$ , then the interconnection between the characteristics is weak;  $0,30 \leq |r| \leq 0,70$  - moderate interconnection;  $|r| > 0,70$  - strong or dense interconnection. When  $|r| = 1$  - the interconnection is functional. Therefore, for inclusion in the regression model, we have selected indicators (factor impact) - capital investments, direct foreign investments, the volume of innovative products and the number of innovative enterprises that have the greatest impact on the result - the gross regional product. In order to avoid the multicollinearity phenomenon, all other factors with a low impact were excluded from the regression model. Then the new model is re-evaluated. For verification, several possible models are constructed and the value of determination coefficient  $R^2$  is calculated, which measures the share of the variation of the indicator, which is explained by the interconnection between the independent variable and factors and the calculated value of Fisher  $F_p$  criterion by the formulas:

$$R^2 = \frac{\sum_{i=0}^n (\hat{Y}_i - \bar{Y}_i)^2}{\sum_{i=0}^n (Y_i - \bar{Y}_i)^2}, \quad (1)$$

where  $\hat{Y}_i$  - calculated indicator value;  $Y_i$  - statistical value of the indicator for the  $i$ - observation;  $\bar{Y}_i$  - selective average indicator value.

$$F_p = \frac{R^2}{1 - R^2} \left( \frac{n - m - 1}{m} \right) \quad (2)$$

where  $n$  - number of observations;  $m$  - number of factors. The closer the value of  $R^2$  is to one, the better the statistics data correspond to the constructed regression function. The value of  $F_p$  should be several times greater than the table value, then regression will not only be significant, but also have practical value for forecasting. We conducted a regression analysis using the MS Excel tools. Output regression information and model quality analysis are presented in Table 3.

**Table 3**  
Correlation ratio coefficients\*

<i>Regression statistics</i>	
Multiple R	0,961477481
Squared R	0,924438947
Normalized squared R	0,870466766
Standard error	0,226961
Observation	30

\* calculations with help MS Excel

The value of the coefficient of multiple correlation  $R$  characterizes the quality of the resulting model. According to the calculations, this coefficient is 0.96, which indicates the presence of a high correlation model. The value of the  $R^2$ , that is, the determination coefficient, indicates that the initial data and the regression model are consistent, since its value is as close as possible to 1 and is equal to 0.92. Thus, the linear model explains 91% of variations, which means the correct choice of factors. Only 9% is due to other factors influencing the gross regional product, but not included in the linear regression model (Table 4).

**Table 4**

Model quality indicators\*

Variance analysis	df	SS	MS	F	Significance F
Regression	10	882,295536	66229553,61	17,12806358	3,531675
Residual	14	7,2116368	5,151169		
Total	24	95,441			

\* calculations with help MS Excel

The high value of correlation coefficient and determination indicates that this dependence is sufficiently regular. Indicator Significance  $F$  demonstrates that the evaluation results are sufficiently reliable. It is worth paying attention to the variance and  $F$  statistics, their high value indicates the variation of a dependent and independent variable, so the regression equation is significant.

### 3. Results

The obtained correlation and regression analysis of indicators (Table 5) makes it possible to construct a model of influence of innovation and investment factors on gross regional product.

**Table 5**

Correlation and regression analysis of dominant indicators\*

	Coefficients
Y	55,50
X1	2,78
X2	1,95
X5	34,92
X6	10,04

\* calculations with help MS Excel

In accordance with the calculations, the model has the following form:

$$Y = 55,50 + 2,7X_1 + 1,9X_2 + 34X_5 + 10X_6, \quad (3)$$

where:  $Y$  represents gross regional product in millions of UAH;  $X_1$  denotes the capital investments in millions of USD;  $X_2$  represents the direct foreign investments in millions of UAH;  $X_5$  indicates the volume of innovation products in thousands of UAH and finally  $X_6$  shows the number of innovation enterprises, in units. On the basis of the obtained equation of gross regional product dependence on the indicators of innovation and investment activity of the regions of Ukraine, one can conclude that in case of an increase in the volume of capital investments and / or direct foreign investments by 1 million UAH, the gross regional product will grow by 2.7 million UAH and 1.9 million UAH, respectively. As a result of an increase in the number of innovative enterprises by 1%, we will have an increase in the gross regional product by 10 million UAH, and an increase in the volume of innovative products by 1 million UAH will increase the gross regional product by 34 million UAH. Using the Excel tools for regression analysis, we calculate the standard error for the coefficients and the corresponding confidence intervals for the equation coefficients at the significance level (Table 6).

**Table 6**

Table of coefficients\*

	Coefficients	Standard error	t-statistics	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Y	55,50	220,77	2,49	0,02	889,95	10115,05	889,95	10115,05
X1	2,78	0,39	6,98	1,18	1,95	3,62	1,95	3,62
X2	1,95	6,14	0,31	0,75	1,48	10,90	1,48	10,90
X5	34,92	71,29	89,85	0,62	-11,42	38,41	-11,42	38,41
X6	10,04	59,92	0,16	0,86	-115,39	135,47	-115,39	135,47

\* calculations with help MS Excel

The final results of our calculations are as follows:

1. Multiple correlation coefficient (*Multiple R*) – 0,96;
2. Determination coefficient (*Squared R*) – 0,92;
3. Fischer's criterion for the regression equation (at the intersection of the graph regression F) is 17, and tabular Fisher's F-criterion is 2.24;
4. The sum of the squares of deviation from the mean values (at the intersection of the Residual graph: SS) is 7.21;
5. Standard deviation (at the intersection of the Residual graph: *MS*) - 5,15
6. Coefficients of the regression equation  $A_0 = 55,50$  (Y- intersection),  $A_1 = 2,7$  (Variable  $X_1$ ),  $A_2 = 1,9$  (Variable  $X_2$ ),  $A_5 = 34$  (Variable  $X_5$ ),  $A_6 = 10$  (Variable  $X_6$ ).
7. Standard error for coefficients (Standard error) is accordingly 220,77, 0,39, 6,14, 71,29, 59,92.
8. Accordingly, the confidence intervals for the coefficients of the equation at the level of significance 0,05:
9. Lower boundary (lower 95%) for  $A_0$  - 889,95; for  $A_1$ -1,95;  $A_2$ -1,48;  $A_5$ -(-11,42);  $A_6$ -(-115,38).
10. Upper boundary (upper 95%) for  $A_0$  – 10115,05; for  $A_1$ -3,62;  $A_2$ -10,90;  $A_5$ -38,41;  $A_6$ -135,47.

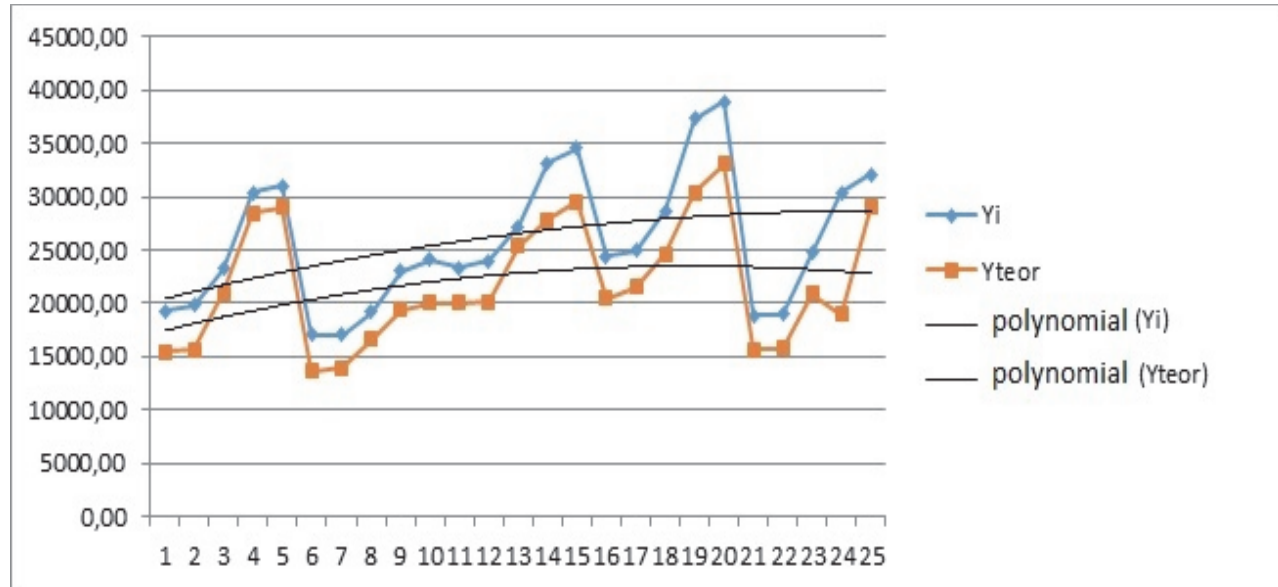
#### 4. Discussion

Thus, the constructed correlation and regression model fully corresponds to the basic statistical requirements of the significance, adequacy and stability of the solution, and the results are statistically significant. The research has shown the greatest impact on the gross regional indicator of some of the innovation and investment indicators of the region, namely: capital investments, foreign direct investments, the volume of innovation products and the number of innovative enterprises. Also, the reliability and accuracy of data have been shown to construct an adequate model for further prediction of the influence of factors on the gross regional product. It is also necessary to graphically compare the simulation results with the obtained regression equation with the values of the statistical sample (Fig. 1) in order to visualize the simulation error. Using the polynomial function, we can forecast the future. The economic goal of a correlation and regression analysis is to identify possible options for managing the competitiveness of the region, as well as assess possible ways to achieve the desired result. The developed model can be used to improve the planning of increase of competitiveness, by means of activation of innovation and investment processes in the region. The outlook for the results, albeit for the short-term, provides an opportunity to learn about the prospects of obtaining the appropriate level of competitiveness. The forecast is dynamic and adapts to changes taking into account the latest data. The suggested model can be integrated into the existing system of support for the decision to increase management efficiency the competitiveness of the region.

Moreover, the correlation and regression analysis have given an opportunity to evaluate the existing state by using the regression equation. Using data on the magnitude and direction of the factors being analyzed, it is possible to obtain data to assess the relevant impact on the current level of competitiveness of the region. That is, such an analysis is a powerful and flexible tool for studying interconnections between some indicators of innovation and investment activity and the competitiveness of the region. This method gives an opportunity to better understand the level of influence on the competitiveness of the region



(namely, the innovation and investment indicators), and accordingly learn to manage the ongoing processes, as well as more precisely forecast their further mutual influence.



**Fig. 1.** Graphical comparison of calculated values with statistical data in Excel and their polynomial forecast, where  $Y_i$  – gross regional product is calculated by model;  $Y_{teor}$  – actual gross regional product.

\* own research

Taking into consideration stated above, one can say that that the goal of the research put in the beginning of the scientific work has been achieved. The key value of the article is the model developed and detected unity of key innovation and investment factors of influence on regions competitiveness management in Ukraine. In this regard, some restrictions in the usage of this article results can be outlined, for example: necessity to check the model suggested during longer period with possible corrections; necessity to adapt the model designed to other countries, which are developing their own economic systems. At the same time, stated restrictions do not decrease the scientific and practical value of this article and mostly characterize perspectives of further scientific researches conduction.

## 5. Conclusion

These studies are important for the formation and the implementation of the managerial decisions to improve the competitiveness of the region. It reduces the choice of indicators with the greatest influence on the level of regional competitiveness from the innovation and investment indicators of the region. On this basis, it is possible to specify the measures of regional influence on activation of innovation and investment activity of the region with justified expectations of the maximum result. The ability to make a short-term forecast of such an impact allows us to determine the regional prospects in the context of the implemented measures.

Having determined the direction of impact on specific indicators of innovation and investment regional activity, management entities reduce resources for ineffective measures for regional competitiveness in this area. The depth of influence and its character will be carried out by the regional administration on the principles of regional economic selfishness, since they are based on subjective approaches and managerial skills. From the point of view of the national economy, the state today forms and sets the tandem in the regional management policy in a definite direction for the innovation and investment development of the regions. For the competitiveness of the region, both the regional management and the general state policy, and especially their parallel symbiosis are key factors.

Perspectives of further researches based on and with the usage of scientific results of the research conducted here are as follows: checking of data received regarding other countries, which are developing their own economic systems; developing of a set of recommendations concerning the efficiency increase of regional competitiveness management in Ukraine; designing of the strategy to secure the appropriate level of regional competitiveness in Ukraine.

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### References

- Arrillaga, H. Grand, L., & Ramírez, N. (2013). The evaluation of innovation processes from the perspective of territorial development. *Journal of Technology Management & Innovation*, 8, 118-130.
- Basheer, M., Siam, M., Awn, A., & Hassan, S. (2019). Exploring the role of TQM and supply chain practices for firm supply performance in the presence of information technology capabilities and supply chain technology adoption: A case of textile firms in Pakistan. *Uncertain Supply Chain Management*, 7(2), 275-288.
- Békés, G. (2015). *Measuring regional competitiveness: A survey of approaches, measurement and data*. Retrieved from <http://econ.core.hu/file/download/mtdp/MTDP1529.pdf>
- Bellù, L.G., Cistulli, V., Marta, S., & Timpano, F. (2011). Assessing regional competitiveness: analysis of stock indicators and flows variables. 51st Congress of the European Regional Science Association: *New Challenges for European Regions and Urban Areas in a Globalised World* (30 August - 3 September 2011), Barcelona, Spain. Retrieved from <https://www.econstor.eu/handle/10419/120100>.
- Bobrovska, O. Y., Savostenko, T. O., Polska, I. E., Popruga, V. I., Ogdansky, K. M., Shevchenko, L. G., Kakhovska, O. V., Kurinny, O. V., & Matveev, O. Yu. (2013). *Regional competitiveness provision in the context of economic development activation*. Dnipropetrovsk: DRIDU NADU.
- Borozan, D. (2008). Regional competitiveness: Some conceptual issues and policy implications. *Interdisciplinary Management Research*, 4(1), 50-63.
- Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd Ed.). Mahwah, NJ: Erlbaum.
- Ghaffari, S., Arab, A., Nafari, J., & Manteghi, M. (2017). Investigation and evaluation of key success factors in technological innovation development based on BWM. *Decision Science Letters*, 6(3), 295-306.
- Fedulova, L. (2012). Conceptual model innovation strategy Ukraine. *Economy and Forecasting*, 1, 87-100.
- Friedmann, J., & Alonso, W. (1964). Introduction, in: Friedmann, J., Alonso, W. (Eds.), *Regional development and planning*. Cambridge: MJT Press, pp. 1-13.
- Gliznutsa, M. (2016). Identification of constituents and evaluation of innovative potential of region. *Technology audit and production reserves*, 3(5(29)), 11-14.
- Golovach, A., Zahojoy, V., & Golovach, N. (2005). *Statistical provision of economic management. Applied statistics*. Kyiv: KNEU.
- Hiadlovsky, V., Hunady, J., Orviska, M., & Pisar, P. (2018). Research Activities and their Relation to Economic Performance of Regions in the European Union. *Business systems research*, 9(1), 44-54.
- Huggins, R., Izushi, H., & Thompson, P. (2013). Regional competitiveness: theories and methodologies for empirical analysis. *Journal of CENTRUM Cathedra: The Business and Economics Research Journal*, 6(2), 155-172.
- Isard, W. (1965). Metody analizy regionalnej, in: *Wprowadzenie do nauki o regionach*. Warszawa: PWN, pp. 191-202. [in Poland].

- Kariyawasam, S., & Shanaka, S. (2015). *Infrastructure, investment and development evaluation: A Complex Stakeholder Perception Mapping approach for improving local and regional economic development outcomes*. QUT Thesis (PhD). Queensland University of Technology.
- Kmet, E. B., & Mayzner, N. A. (2017). The Methodical Approach to the Evaluation of the Competitiveness of the Border Territories. *European Research Studies*, 20(2), 182-199.
- Kosach, I. (2007). Theoretical principles of development of the strategy of innovation and investment development of the region. *Actual problems of the economy*, 6, 123-129.
- Kravets, O. (2008). *Statistics*. Odesa: Palmira.
- Krželj-Colović, Z. (2015). Regional Competitiveness. *DIEM: Dubrovnik International Economic Meeting*, 2(1), 437-445.
- Malecki, E. J. (1997). Technology Economic Development, in: *The Dynamics of Local, Regional and National Competitiveness*. London: Longman, pp. 24-185.
- Martin, R. L. (2003). *A Study on the Factors of Regional Competitiveness. A draft final report for The European Commission Directorate-General Regional Policy*. Rotterdam: Cambridge Econometrics, Ecorys-Nei.
- Meshko, N. (2008). The investment and innovation potential of the region: evaluation criteria and formation problems. *Economic space*, 10, 78-88.
- Mihaela, S. (2016). Competitiveness and economic growth in Romanian regions. *Journal of Competitiveness*, 8(4), 46-60.
- Moore, J. H., & Weatherford, L. R. (2004). *Decision modeling with Microsoft(r) Excel*. Moscow: Williams.
- Natário, M. M. S. (2014). Regional Competitiveness: Innovation, Entrepreneurship and Triple Helix. *International Journal of Economics and Management Sciences*, 3(4), 1-5.
- Ocheredko, O. O. (2011). The innovation strategy as a modern tool for managing the development of the enterprise. *Theoretical and Practical Aspects of Economics and Intellectual Property*, 1, 98-104.
- Onisenko, T. (2014). Strategies of innovation activity management and their impact on publishing competitiveness. *Economics, Finances and Law*, 1, 20-26.
- Ručinská, S., & Ručinský, R. (2007). Factors of regional competitiveness, in *2nd Central European Conference in Regional Science – CERS*. Košice: Technická univerzita Košice, pp. 902-911.
- Sadeghi, A., & Rad, F. (2018). The role of knowledge-oriented leadership in knowledge management and innovation. *Management Science Letters*, 8(3), 151-160.
- Shkurupiy, O., & Flegantova, A. (2014). Scientific approaches to the substantiation of the methodology of research of innovation and investment potential of Ukrainian economy development. *Economic Sciences*, 2, 9-17.
- Skubitskiy, O. (2009). *Innovative and investment management*. Kyiv: CUL.
- Spodina, V. O. (2013). Innovation and investment: the nature and relationship. *Electronic journal "Effective economy"*, 12. Retrieved from <http://www.economy.nayka.com.ua/?op=1&z=2640>
- Stoyka, V. (2015). Innovation as a factor in ensuring the effective social production. *Investytsiyi: praktyka ta dosvid*, 6, 28-31.
- Ulku, H. and Rand, D. (2004). Innovation, and Economic Growth: An Empirical Analysis. *International Monetary Fund*, 4, 185-200.
- Uzlov, K., & Li-chun, T. (2017). Indicator Evaluation of Regional Innovation System According to the Cluster Approach. *International Journal of Engineering Management*, 1(1), 27-30. doi:10.11648/j.ijem.20170101.14.
- Webster, D., & Muller, L. (2000). *Urban competitiveness assessment in developing country urban regions: the road forward*. Washington D.C.: The World Bank.
- Yusr, M., Mokhtar, S., Abaid, W., Perumal, S., & Fauzi, F. (2018). The antecedents' strategies and processes of product innovation performance. *Management Science Letters*, 8(11), 1183-1198.
- Zhykhor, O. (2009). The potential of innovation development of regions of Ukraine and its reserves for improving the efficiency of regional economy management. *Visnyk of the Lviv State Financial Academy*, 16, 100-110.



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