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Instrumental analysis of the impact of economic factors on the level of a country's economic innovativeness

Mykhailo Bril*, Iryna Pyvavar

Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauka Ave., Kharkiv, Ukraine

Abstract. The rapid development of innovative activity in Ukraine and the instability of the economic and political environment determine the relevance of studying the problems of innovative development in close connection with global and local factors of economic growth. The purpose of the research is to study the budgetary policy factors that have a dominant influence on the level of national innovative development, and their impact on the level of economic growth in order to form directions for innovation policy development based on instrumental analysis methods. The paper uses methods of econometric modeling and adaptive methods of forecasting. The constructed conceptual model includes three aggregated stages of research. The study addressed the problem of assessing the level of a country's economic innovativeness and determining the factors affecting it; it was found that this level grows with an increase in the share of private investment, a decrease in the rate of GDP growth, an increase in the share of taxes in the budget structure, a decrease in the money supply, an increase in education and public security expenditures. The impact of the state budgetary policy was analyzed and the value of the indicator of economic growth and the level of the country's economic innovativeness was forecasted. The practical significance of the results is that a gradual reduction in the level of the country's economic innovativeness is possible in periods of long-term economic growth. To avoid such negative consequences, European governments should pay more attention to internal problems and external trends of innovation activity

Keywords: innovative development, innovative activity, modeling, economic growth, time series model, correlation

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INTRODUCTION

Global research on innovation shows that innovation is a key driver of economic development. Each country has its peculiarities of innovative development, and therefore its innovation policy. Being a state with a strong innovation potential, Ukraine should take into account the world trends in innovation development and find favorable mechanisms and tools to address the related challenges. Monitoring the effectiveness of innovation policies is necessary to understand whether policies work and how they can be improved. To do this, the authorities must have reliable and up-to-date statistical information, since the effectiveness of managerial decisions depends on its quality. As innovation and economic development are interrelated, it is necessary to constantly monitor the impact of economic factors on the level of innovative development of the country's economy.

At the same time, the role of the state in the economy is being reassessed in the modern world. The 21st-century crises, the 2008 crisis, and the 2020-2022 pandemic have again brought the issue of the role of the state to the forefront of public and academic discussions. The world is rethinking the impact of state intervention in economic development. With state support, the innovative type of economic development is increasingly becoming the foundation that determines the economic strength of a country and its prospects in the world market. Innovation in the world economy is a key factor to boosting the competitiveness of EU countries and is essential in the context of globalization. Therefore, one of the most important tasks of Ukraine's national innovation policy is to ensure dynamic growth based on advanced technologies and innovations.

Rational and balanced strengthening of the role of the state in the implementation of innovation policy should provide for the importance and relevance of the formation of Ukraine's development budget, the provision of state guarantees and investment insurance to reduce innovation

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*Corresponding author

risks, reasonable support for domestic producers, the implementation of a balanced foreign policy and economic policy, which should be combined with a plan for the technological transformation of domestic industry.

In the Global Innovation Index (GII) country ranking, Ukraine ranks 45th among the 131 world economies by the level of innovation activities (80 indicators in seven areas). Switzerland, Sweden and the USA top the list of leading innovative countries. Ukraine ranks 30th among the countries of the European region and 2nd in the group of lower middle-income countries [1].

The strengths of Ukraine are university-industry collaboration in scientific research (50th place), the share of employed females with advanced degrees (3rd place), the share of information and communication technologies (ICT) exports in foreign trade (9th place), mobile app creation (15th place), intangible assets (23rd place), trademarks and patents (5th and 20th places, respectively). The weaknesses of Ukraine are the share of higher education graduates in science and engineering (82nd place) and creative goods exports as a percentage of total trade (111th place). In terms of infrastructure development, Ukraine rose from 97th place in 2019 to 94th place in 2020. At the same time, the value of the ecological sustainability indicator increased to 99th from 120th in 2019. Market sophistication led Ukraine to the 99th position in the ranking (90th in 2019) (86th in terms of credit, 79th by microfinance loans as a percentage of GDP, 121st by investment, and 45th by the level of trade and competition) [2].

As can be seen, today the innovative competitiveness of Ukraine is accompanied by a number of the aforementioned problems, so it is considered expedient to analyze the dynamics of national development in the innovation dimension and study the peculiarities of developed countries in terms of innovation activity regulation.

It is important to note that the topic of innovation is often addressed by scholars, yet innovation is more often explored at the micro level, i.e., in the context of corporate competitiveness. In modern scientific research, there are numerous works devoted to the problem of innovative development. However, due to the rapid development of innovations and the constant instability of economic and political processes observed in Ukraine, further studies of the innovative development dynamics in close connection with economic growth factors are still relevant.

Therefore, the purpose of the study is to determine the factors of budgetary policy that have a dominant influence on the level of a country's innovative development, as well as to study the scale of their impact on the level of economic growth in order to justify the priority directions of innovation policy at the national level.

The scientific novelty of the study consists in the proposed conceptual model, which includes the following research stages: assessing the level of innovativeness of a country's economy and determining the factors influencing it; modeling the level of a country's economic growth as one of the most important factors in the development of innovation activity, as well as analyzing the impact of state budgetary policy on it; forecasting resultant indicators based on the built forecasting models.

LITERARY REVIEW

Among modern Ukrainian and foreign scholars who study approaches to assessing the level of innovative development and economic growth, it should be noted the study of O. Ugolkova, N. Reverenda and T. Lisovych [3], which investigates the state of innovation activity development in the world, analyzes the change dynamics in international innovation rankings and identifies key features of regulating innovation at the state level in leading countries.

The team of scholars – T. Pysarenko, T. Kuranda, T. Kvasha, *et al*. – conducted a research study on the state of scientific and innovative activity in Ukraine in 2020, which is based on the official data of the State Statistics Service of Ukraine, world rankings, international scientometric databases. Particular attention should be paid to the presented analysis of the impact of scientific and innovative activities on the economy of Ukraine [2].

In the context of the problem raised, it is also worth noting the research by W. Gajda, A. Kuznetsov and S. Kuznetsova [4], in which the state of innovative development of Poland and Ukraine is compared; the countries are respectively classified as a moderate innovator and a modest innovator. The authors analyzed 27 indicators of the countries' economic and innovative development in comparison with the achievements of the European Union using comparative analysis methods.

The issues of state regulation of innovative development are raised in the papers of N. Vetsepura [5] and V. Gornyk [6], which address the strategies for the development of Ukraine's innovative economy and recognize the key role of state regulation in ensuring economic and innovative development.

The problem of analyzing the relationship between the innovative level of the economy and economic growth is also covered by foreign researchers. The study [7] determines the impact of the level of innovative development indicators (human capital development, technological development, trade openness, government expenditure and financial system development, etc.) on the economic growth of Albania.

N. Chaabane in his work [8] analyzes and proves the impact of the level of intellectual capital on firms' performance and the level of economic development of a country as a whole. Studying the impact of the level of intellectual capital on the efficiency of a country's economic development, the author used data from 260 companies. The effectiveness of intellectual capital was measured using the smart value added ratio (VAIC) method developed by A. Pulic [9]. As a result of the research method used – multiple linear regression analysis – the author substantiates the fundamental role of intellectual capital components in ensuring economic development.

Researchers W. Al Salamat and K. Batayneh [10] prove the interrelation of the financial market with economic growth on the example of the MENA countries group (MENA stands for Middle East and North Africa – a region consisting of the Middle East and North Africa) during the period 2000-2019. At the same time, the state is recognized as a key participant in the financial market.

Having analyzed the methodology used by modern Ukrainian and foreign scholars to assess the level of

innovative development and economic growth and their interrelation, it should be noted the following:

The authors [7] used empirical analysis to assess the impact of the level of innovative development indicators on economic growth in Albania based on a modification of the model created by E. Borensztein, J. De Gregorio and J.W. Lee [11]. The authors used a multidimensional vector autoregression (VAR) model and an error correction vector model (VECM) to analyze the cause-effect relationships between variables.

The study [12] considers the individual and interacting impact of foreign direct investment, the domestic structure of production, and the share of innovative production on the level of exports and economic development. The econometric estimate is based on an analysis of the general method of dynamic system moments analysis using panel data from 44 countries in sub-Saharan Africa.

Based on the review of the current coverage of the problem of the impact of the level of a country's innovativeness on its economic development in the scientific literature, it can be concluded that there is an insufficient level of analysis of the impact of factors of government expenditure on innovative development on the level of a country's economic growth, which requires the use of modern mathematical tools.

MATERIALS AND METHODS

Having analyzed and considered the existing approaches to assessing the level of innovative development and economic growth, it can be said that econometric models occupy an important role in the methodology of studying the indicators of innovative development and their impact on the level of economic growth since they are used for in-depth analysis of a certain set of data and the identification of statistically significant relationships and dependencies of the indicators under study.

Graphically, the scheme of the study using the "black box" principle is shown in Figure 1. To attain the purpose of research and build the models, the United Kingdom was chosen as a country that is among the leading innovative countries according to the data [13]. According to the statistical data given in [14], the United Kingdom is described as a strong innovator, and over time, the indicators of the innovative level of this country's economy relative to the EU remain unchanged.

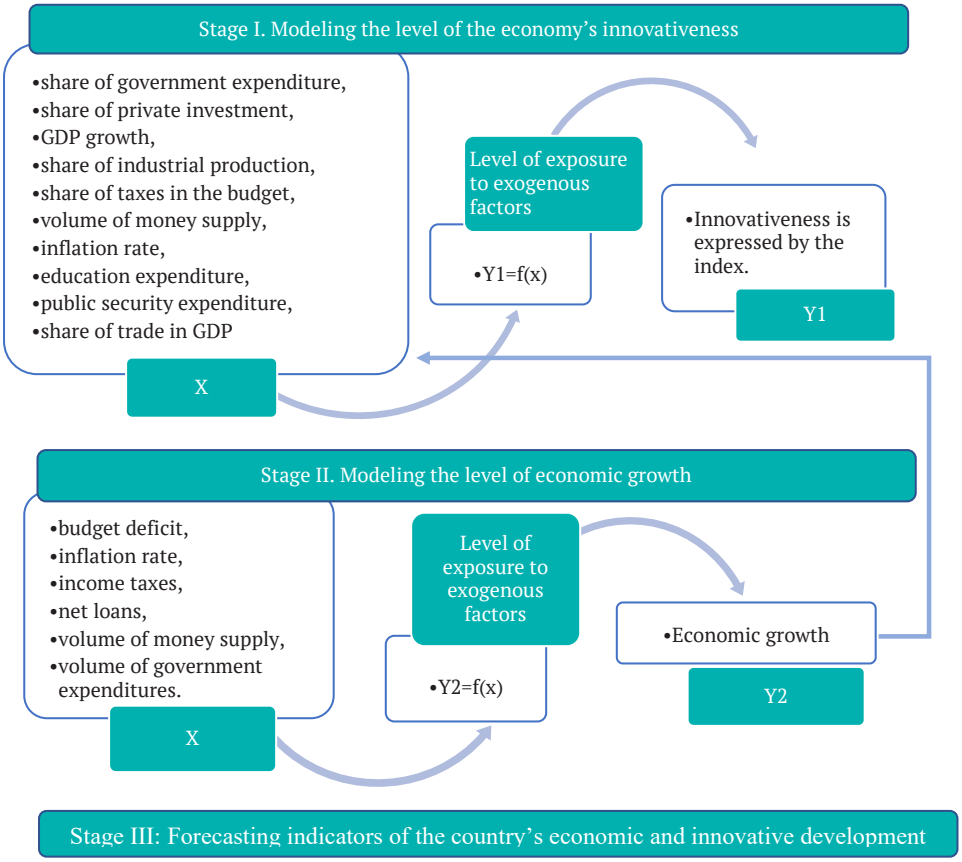

Figure 1. Investigation of factors influencing the level of innovativeness of the country's economy using the "black box" system

Having carried out a detailed analysis of literature sources [3; 5; 6] on the topic of research, in order to implement the tasks of Stage I, it was decided to include in the model ten factors that can affect the innovativeness index Y_1 and will further help to assess the impact of significant economic factors on the change in the index. The factors selected for the analysis are given in Table 1.

Table 1. Factors affecting the level of innovativeness of developed countries' economies

Indication of the influencing factor	Name of the influencing factor	Scope of influence on the level of innovative development
x_1	share of government expenditure as a percentage of GDP	the indicator demonstrates government investment in the economy, including in the field of innovation
x_2	share of private investment as a percentage of GDP	private investment is usually attracted to areas with high innovation potential, where it is possible to obtain greater added value.
x_3	GDP growth	generally, there is an increase in the share of innovative products in countries where where the production of goods and services increases.
x_4	share of industry in the economy structure	this indicator is included to investigate how the level of industrial production affects innovation, and whether industry is one of those areas where innovation is observed most often.
x_5	share of taxes in GDP	the indicator demonstrates the relation between the revenue side of the budget and the level of innovativeness
x_6	volume of money supply	research on the impact of money supply on the level of innovation
x_7	inflation growth	research on the impact of price increases on the economy's innovativeness
x_8	share of education expenditure in GDP	the development of a country's intellectual potential is a key factor in innovative development
x_9	share of public security expenditure in GDP	the factor of economic security is an important engine for the development of innovation
x_{10}	share of international trade in GDP	the involvement of a country in the world trade exchange has a positive impact on the growth of product competitiveness, and hence will further the development of innovation activities.

The construction of econometric models of dependency of the selected indicators will allow to conduct a more detailed analysis of the level of the economy's innovativeness and the impact of the budgetary policy of the leading countries on it, as well as to borrow subsequently the most optimal directions for development regarding the state innovation policy, which should be applied in Ukraine.

The construction of the econometric model is done in several main stages:

Stage 1. Qualitative analysis (defining the purpose of the analysis, determining the aggregate, determining effective and factor features, choosing the period for which the analysis is conducted, choosing the method of analysis).

Stage 2. Preliminary analysis of the modeled aggregate (testing the uniformity of the aggregate, excluding inconsistent observations, specifying the required volume of properties, defining properties distribution laws).

Stage 3. Construction of an econometric model (establishing a list of factors, calculating estimates of the parameters of regression equations, sorting through competing model variants).

Stage 4. Assessment of the model adequacy (testing the statistical significance of the dependence equation as a whole and its parameters separately; verification of the compliance of formal properties of the assessment with the objectives of the study).

Stage 5. Economic interpretation and practical use of the model.

Let's build a linear multi-factor econometric model and determine all its characteristics. Let's test the statistical significance of the model parameters and the model adequacy using the Fisher criterion. The modeling stages are implemented using the Python programming language.

When constructing an econometric model, the "black box" method of modeling is implemented, i.e. when the researcher is not aware of the mechanism of processes occurring in the system; this mechanism can be examined by the input and output characteristics of the system. Input and output characteristics of the system are often identified with exogenous and endogenous variables; alternatively, in the correlation and regression analysis such terms as independent (factor) variables, or features, and dependent (outcome) variables, or features, are used.

Modeling the level of economic growth as a result of the implementation of the second stage of the research it will allow to analyze the impact of the most significant indicators of the country's budgetary policy on the main indicator of economic development, which is the growth of the GDP rate (Y_2), as suggested by the present study.

Having carried out a detailed analysis of the linear relationships between the influencing factors on innovative development, it was built a correlation matrix (Fig. 2) and analyzed the variance in the initial data in order to identify factors that have a significant impact on the resulting indicator.

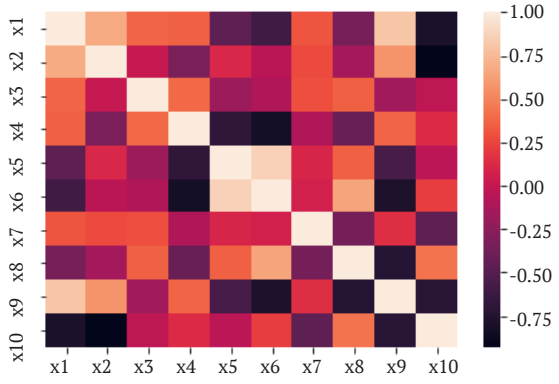

Figure 2. Building a matrix of correlations of factors influencing the level of GDP

As a result of the steps of the analysis, the set of independent variables of the model has been reduced to six factors that can influence the growth of the GDP rate (Y_2), and will further help to assess the impact of significant economic factors on the outcome indicator. The factors selected for the analysis are given in Table 2 [15; 16].

Table 2. Factors influencing the level of economic growth of developed countries

Indication of the influencing factor	Name of the influencing factor	Scope of influence on the level of economic growth
x_1	budget deficit/surplus	shows the ratio of public sector expenditures and revenues, and reflects the level of government demand stimulation.
x_2	net loans	indicates the level of fundraising to cover government expenditure
x_3	share of government expenditure in GDP	shows the share in GDP of state-manufactured goods
x_4	income tax	reflects the revenue side of the budget
x_5	volume of money supply	research on the impact of money supply on the level of economic growth
x_6	inflation	research on the impact of the price level and its regulation by the state on the level of economic growth

In Stage III, the forecasting of the studied indicators (economic and innovative development of the country) is carried out. The level of economic development is considered the input predictor of influence, and the result is obtaining forecast estimates of the level of innovativeness of the country's economy. The obtained model results for the dependencies and confirm their high quality and allow to confidently use the built models for forecasting.

However, due to the limited statistical information on the forecast values of the factors influencing the indicator of economic growth , it is impossible to make a forecast.

Upon considering the dynamics of the Economic Growth Indicator (EGI), it was decided to use a time series model, namely the ARIMA model, for forecasting. This tool provides a simple yet powerful method for generating quality time series forecasts. For building the model, the following parameters should be set: the order of the lag, the degree of difference, and the order of the moving average. In the modeling process, a linear dependence is built, which allows to exclude trend and seasonal components that negatively affect the regression quality.

RESULTS AND DISCUSSION

To implement the first stage of the study, namely modeling the level of the economy's innovativeness, it was tested the linear relationships between the selected factors and constructed a correlation matrix (Fig. 3a), which revealed possible multicollinearity. From the matrix, it can be seen that the factors x_1 and x_9 have a linear relationship, thus it will be excluded them from further data analysis. After excluding these two factors, it can be seen that the multicollinearity in the array of studied variables was eliminated (Fig. 3b).

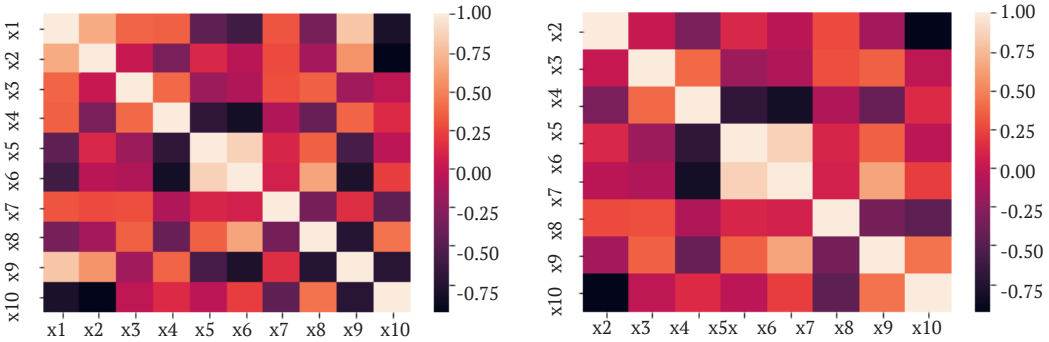

Figure 3. Correlation Matrix: a – building a correlation matrix with the initial set of factors; b – Correlation matrix excluding the factors x_1 and x_9

Further, the indicators of partial correlation between independent factors and the dependent variable are analyzed, for which it is constructed visualizations that evidently demonstrate which variables explain the variance in the data (Fig. 4).

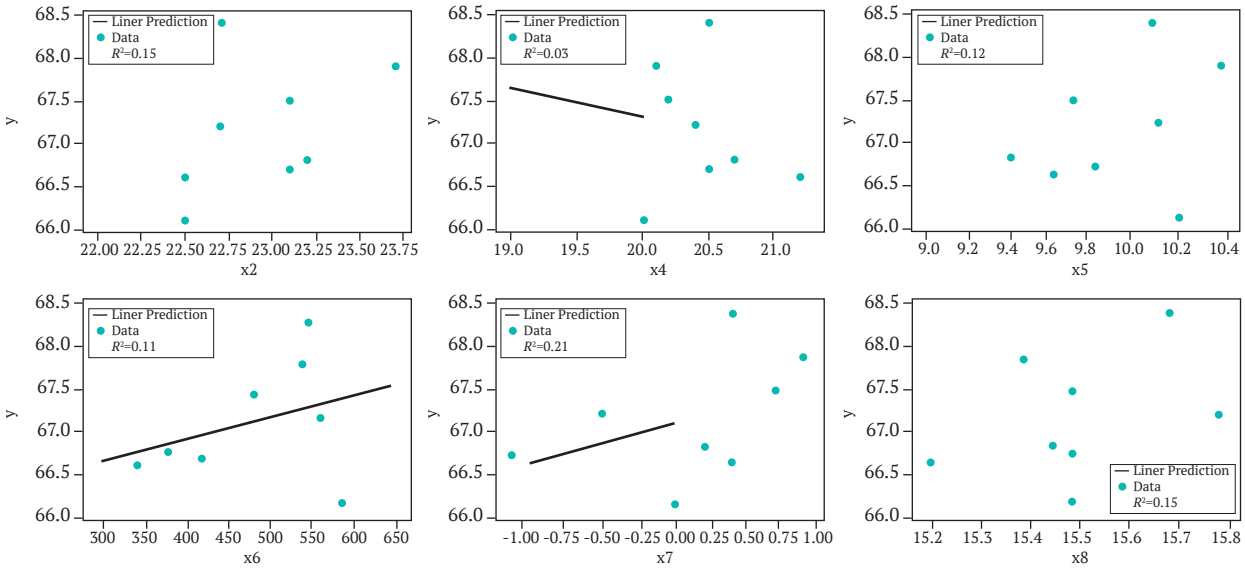

Figure 4. Dependency graphs demonstrating the influence of factors

Taking into account the conducted analysis of variance, it was constructed a multi-factor regression model with factors that significantly affect the level of innovativeness of the country's economy Y_1. The model results are shown in Figure 5.

```
X = sm.add_constant(df1.loc[:, ['x2', 'x3', 'x5', 'x6', 'x7', 'x8']])
```

OLS Regression Results

Dep. Variable:	y	R-squared:	0.878
Model:	OLS	Adj. R-squared:	0.148
Method:	Least Squares	F-statistic:	1.202
Date:	Wed, 11 Nov 2021	Prob (F-statistic):	0.603
Time:	00:52:36	Log-Likelihood:	-0.13541
No. Observations:	8	AIC:	14.27
Df Residuals:	1	BIC:	14.83
Df Model:	6		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	-101.9820	168.908	-0.604	0.654	-2248.158	2044.194
x2	0.1038	0.873	0.119	0.925	-10.988	11.196
x3	-0.6020	1.762	-0.342	0.790	-22.994	21.789
x5	3.5448	3.689	0.961	0.513	-43.327	50.417
x6	-0.0214	0.026	-0.812	0.566	-0.356	0.313
x7	1.5832	1.679	0.943	0.519	-19.755	22.922
x8	9.2148	10.504	0.877	0.542	-124.249	142.679

Omnibus:	0.028	Durbin-Watson:	2.849
Prob(Omnibus):	0.986	Jarque-Bera (JB):	0.187
Skew:	0.087	Prob(JB):	0.911
Kurtosis:	2.271	Cond. No.	3.38e+05

Figure 5. Results of building a multi-factor regression model for the impact of factors on the level of innovativeness

As shown in Figure 6, the coefficient of determination is 87%, which means that the selected factors explain 87% of the patterns and the changes in the innovativeness index, and other factors explain only 13% of the patterns. Let's test the hypothesis against model errors and verify that the measurement error is random and has a constant variance.

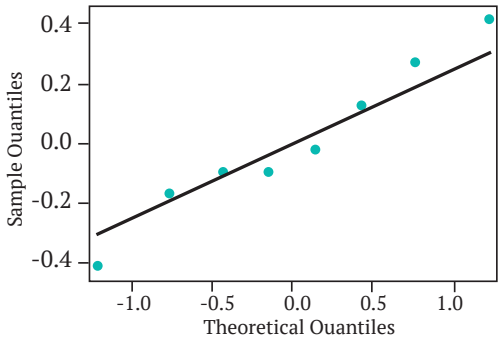

Figure 6. Error distribution graph

Based on the conducted regression analysis, it was obtained a regression equation for the impact of the factors on innovativeness: $Y_1 = 0{,}1038 \cdot x_2 - 0{,}602 \cdot x_3 + 3{,}54 \cdot x_5 - - 0{,}02 \cdot x_6 + 1{,}5 \cdot x_7 + 9{,}2 \cdot x_8$.

Based on the constructed dependency and indicators of its quality, it can be predicted that the innovativeness index of the economy increases if there is an increase in the share of private investment, a decrease in the rate of GDP growth, an increase in the share of taxes in the budget structure, a decrease in the money supply, an increase in education and public security expenditure.

For the implementation of the second stage of the research (Fig. 1) to assess the impact of budgetary policies on the growth of the countries' economies, it was studied the indicator of the growth rate of GDP (GDP).

We constructed a linear multi-factor econometric model and determined all its characteristics. The statistical significance of the model parameters and the adequacy of the model were tested by the Fisher criterion. To test the linear relationships between the factors, it was constructed a correlation matrix and studied the model for multicollinearity (Fig. 7). The findings proved that there was no multicollinearity detected in the data.

The indicators of partial correlation between independent factors and the dependent variable were also analyzed, for which it was constructed visualizations showing how the variables explain the variance in the data (Fig. 8-10).

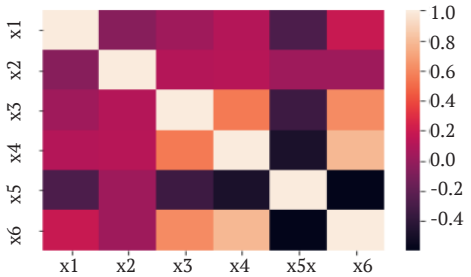

Figure 7. Building a matrix of correlations between independent factors

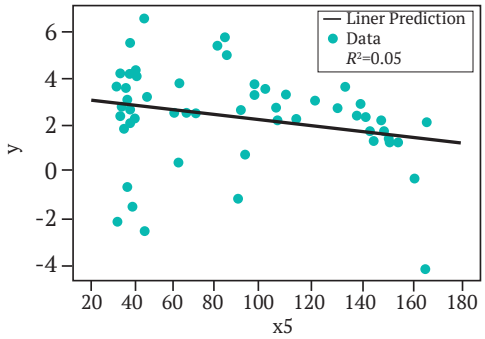

Figure 8. Visualization graph of linear distribution of variable x_5

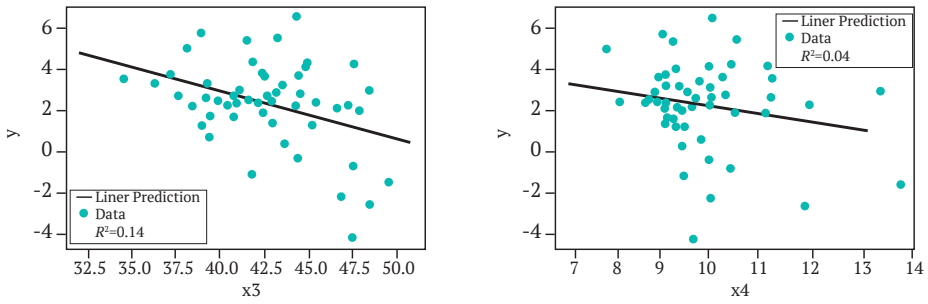

Figure 9. Visualization graph of linear distribution of variables x_3 and x_4

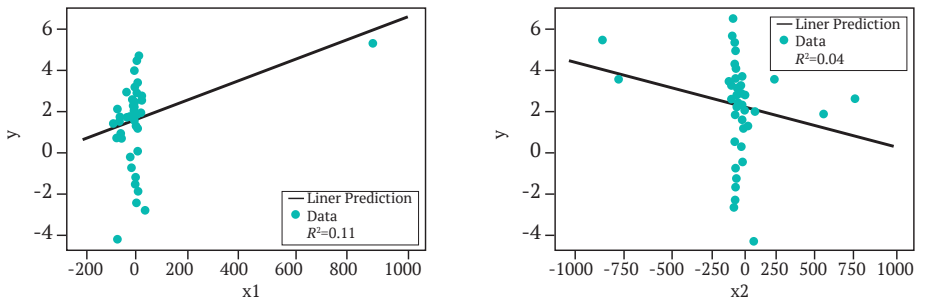

Figure 10. Visualization graph of linear distribution of variables x_1 and x_2

Then, a multi-factor regression model was constructed with the factors that affect.

```
X = sm.add_constant(df1.loc[:, ['x1', 'x2','x3','x4','x5','x6']])
```

OLS Regression Results

Dep. Variable:	y	R-squared:	0.711
Model:	OLS	Adj. R-squared:	0.548
Method:	Least Squares	F-statistic:	8.023
Date:	Mon, 30 Nov 2021	Prob (F-statistic):	5.97e-06
Time:	06:02:41	Log-Likelihood:	-94.108
No. Observations:	53	AIC:	202.2
Df Residuals:	46	BIC:	216.0
Df Model:	6		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	8.7407	3.972	2.201	0.033	0.745	16.736
x1	0.0047	0.002	2.667	0.011	0.001	0.008
x2	-0.0015	0.001	-1.408	0.166	-0.004	0.001
x3	-0.1373	0.078	-1.755	0.086	-0.295	0.020
x4	0.3085	0.312	0.989	0.328	-0.319	0.936
x5	-0.0249	0.006	-4.167	0.000	-0.037	-0.013
x6	-0.2715	0.079	-3.445	0.001	-0.430	-0.113

Omnibus:	1.632	Durbin-Watson:	1.538
Prob(Omnibus):	0.442	Jarque-Bera (JB):	1.136
Skew:	-0.356	Prob(JB):	0.567
Kurtosis:	3.089	Cond. No.	3.85e+03

Figure 11. Results of a multi-factor regression model for the impact of factors on the level of economic growth

Figure 11 shows that the coefficient of determination is 71%, which means that these factors explain 71% of the change in the level of economic growth, and other factors explain 29% of the patterns. Let's verify that the measurement error is random and has a constant variance (Fig. 12).

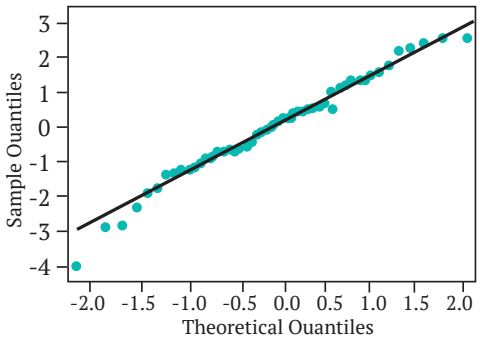

Figure 12. Error distribution graph

All points in Figure 12 are placed tightly along the straight line, which indicates a sufficiently high proximity of the real and model values of the resulting variable. Besides, the calculated coefficient of determination is sufficiently high; thus given the distribution of errors and the value of the Fisher criterion (which is equal to 8.023 and exceeds the tabulated value of 2.13), the regression equation can be used to study the effect of independent indicators on the resulting indicator.

Based on the regression analysis, it was constructed the following regression equation: $Y_2 = 8{,}74 + 0{,}0047 \cdot x_1 - 0{,}0015 \cdot x_2 - 0{,}1373 \cdot x_3 + 0{,}3075 \cdot x_4 - 0{,}0249 \cdot x_5$

The following conclusions can be drawn from the obtained equation: the higher the level of budget surplus and, accordingly, the revenue side of the budget is, the greater the level of economic growth of the economy is. An increase in the rest of the indicators, on the contrary, leads to a decrease in the rate of economic growth.

For the implementation of the third modeling stage, it was decided to use time series models for forecasting, namely the ARIMA model. Based on the value of the UK economic growth indicator from 1968 to 2021 [17; 18], it was build a forecast for the next ten years.

As can be seen from the above model results, the series under study has a normal distribution, the p-value is more than 5%, and there are single roots; therefore, the series is not stationary. Using the ARIMA model, it was obtained the following results for the forecast of the UK economic growth until 2031 (Fig. 13):

```
array([3.27224943, 3.66074349, 3.75848227, 3.79269485, 3.87928346,
       4.00558777, 4.13714742, 4.26374313, 4.39016539, 4.5208860])
```

Figure 13. Results of forecasting economic growth of the United Kingdom by 2031

Let us substitute the obtained results of forecasting the level of economic growth into the built econometric model of the formation of the level of economy innovativeness. With fixed values of the rest of influencing factors, let us calculate the forecast indicators of the level of innovativeness for the next ten years (from 2022 to 2031). The obtained results of forecasting the level of the UK economy innovativeness for the next ten years are as follows (Fig. 14):

```
array([21.80939167, 21.83749416, 21.66224222, 21.73324011, 21.58037993,
       21.61689992, 21.49776693, 21.50602646, 21.4109522 , 21.4001869 ])
```

Figure 14. Results of forecasting the level of the UK economy innovativeness by 2031

The dynamics of the indicator of economic growth and the main statistical metrics of the series are presented in Figure 15-18.

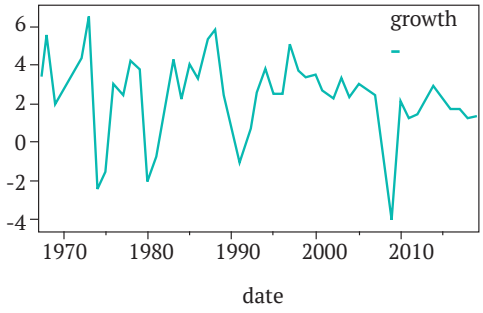

Figure 15. Dynamics distribution ofthe UK economic growth by year

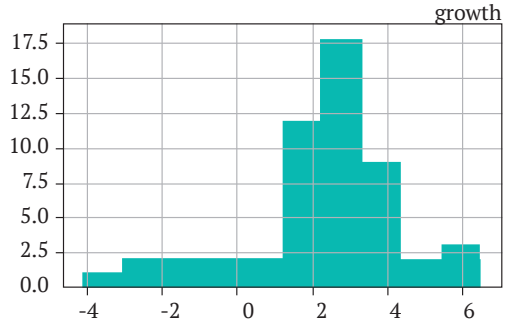

Figure 16. Building a row distribution histogram

```
V = 2.063/2.311321
print(V)
```

```
0.892563170585133
```

Figure 17. Calculation of the coefficient of variation of the row

```
test = sm.tsa.adfuller(df2)                    # как
print('adf: ', test[0])
print('p-value: ', test[1])
print('Critical values: ', test[4])
if test[0]> test[4]['5%']:
    print('есть единичные корни, ряд не стационарен')
```

```
adf:  -5.145352251315329
p-value:  1.1355422887624574e-05
Critical values:  {'1%': -3.5656240522121956, '5%': -2
```

Figure 18. Row stationarity analysis

A graphical interpretation of the obtained forecast values is shown in Figure 19.

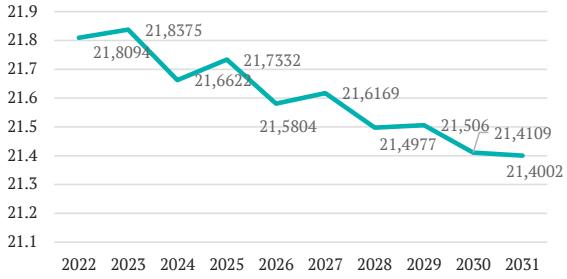

Figure 19. Results of forecasting the level of the UK economy innovativeness for 2022-2031

As can be seen, according to the forecast, the value of the innovation indicator of the UK economy will gradually decrease and may be 21.4%. in 10 years.

The research findings are consistent with the results of other scholars who have studied this problematic topic in their research. Thus, for instance, N.V. Vetsepura [5] investigates a set of indicators of innovative activity as the main factor influencing the indicator of aggregate factor productivity, which assuredly forms economic development. However, the author has not proposed any specific toolkit for identifying the nature of this impact or its prediction. This is what constitutes the difference in the results obtained.

V.G. Gornyk [6] also adheres to the opinion that the provision of innovative development of the state is possible only after the formation of the development budget of Ukraine, with specific steps of the state budgetary policy taken into account. However, the author does not provide any mathematical substantiation of his conclusions.

Comparing the methodology for assessing the level of economy innovativeness and its impact on the indicator of economic development proposed in this study and by other scholars, it should be noted that similar research tools are proposed by the scholars [7] in their work. The authors conducted an analysis of the dynamic relations between foreign direct investment and economic growth, particularly stressing the importance of capital absorption variables. For their research, the authors used a model of multidimensional vector autoregression and an error correction vector model for the analysis of cause-effect relationships between variables. The obtained results proved the effectiveness of the proposed methods of analysis and substantiated the hypothesis of the impact of foreign direct investment on economic development (on the example of Albania).

The scholars [17] also assess the impact of public administration factors on economic growth, and similarly

to this study, build econometric models using panel data. However, in their study, the authors supplement the analysis by using the principal component method.

Thus, the research findings are consistent with the conclusions of other authors, thus the proposed research toolkit can be considered effective, and the results obtained – significant.

CONCLUSIONS

The study identifies the budgetary policy factors that have a dominant impact on the level of national innovation development and investigates the degree of their impact on the level of economic growth.

To achieve the research aim, this paper proposes a conceptual model that includes an assessment of the level of innovativeness of the country's economy and identification of influencing factors; modeling of the level of national economic growth as one of the most important factors in the development of innovative activity and analysis of the impact of state budgetary policy on it; forecasting of performance indicators based on the constructed forecasting model. In particular, the paper examines the factors influencing the innovation index of the United Kingdom and analyzes this indicator. The findings revealed that the changes in the selected factors explain 87% of the patterns and the changes in the innovation index, and other factors explain only 13% of them. The level of GDP growth was defined as one of the most influential factors, hence the impact of budgetary policy on economic growth was investigated. Forecasting for the UK economic growth indicator for 2022-2031 was done using the ARIMA model; the results obtained made it possible to calculate the forecast indicators of the innovativeness of the country's economy.

Calculations showed that when economic growth is observed, a gradual decrease in the economy's innovativeness should be expected at the same time. Taking this trend of economic development into account, governments of European countries should increase their attention to the problems of innovative activity, with due regard to the interaction of all levels of public-private partnership. The examined example of European countries confirms that state attention and creation of a system of mechanisms and incentives for innovation policy ensures powerful socioeconomic development.

Promising areas for further research of the problem under consideration are the development of tools and modeling of the consequences of certain scenarios of the formation of the state budgetary policy using simulation modeling, forecasting models, and decision-making methods. Qualitative development of this set of models will allow to assess the effectiveness of specific managerial decisions in advance in terms of their impact on the level of state economic and innovative development.

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Інструментальний аналіз впливу економічних факторів на рівень інноваційності економіки країни

Михайло Сергійович Бріль, Ірина Володимирівна Пивавар

Харківський національний економічний університет імені Семена Кузнеця
61166, просп. Науки, 9А, м. Харків, Україна

Анотація. Швидкий розвиток інноваційної діяльності в Україні та нестабільність економічного та політичного середовища обумовлюють актуальність дослідження проблем інноваційного розвитку у тісному зв'язку зі світовими та локальними факторами економічного зростання. Мета – дослідження факторів бюджетної політики, які мають домінуючий вплив на рівень національного інноваційного розвитку, та їх впливу на рівень економічного зростання для формування напрямів розвитку інноваційної політики на основі методів інструментального аналізу. У роботі використано методи економетричного моделювання та адаптивні методи прогнозування. Побудована концептуальна модель включає агреговані три етапи дослідження. Розглянуто проблему оцінки рівня інноваційності економіки країни та визначення чинників впливу на нього, виявлено, що рівень підвищується від зростання частки приватних інвестицій, зниження темпів зростання ВВП, підвищення частки податків у структурі бюджету, зменшення грошової маси, зростання витрат на освіту та суспільну безпеку. Здійснено аналіз впливу державної бюджетної політики та спрогнозовано значення показника економічного зростання і рівня інноваційності економіки країни. Практичне значення результатів полягає в тому, що в періоди тривалого економічного зростаннання можливо поступове зниження рівня іноваційності економіки. Для уникнення таких негативних наслідків урядам європейських країн слід посилити увагу до внутрішніх проблем та зовнішніх трендів інноваційної діяльності

Ключові слова: інноваційний розвиток, інноваційна діяльність, моделювання, економічне зростання, модель часового ряду, кореляція