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Research Article

UTILIZING DYNAMIC MODELS IN ANALYZING INVESTMENT ACTIVITIES IN REGIONS

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ABSTRACT

This article presents an analysis of the Almon lag model using statistical data from the Fergana Region. The Almon lag model allows for the examination of the relationship between variables over time, considering the distributed lag effects. By utilizing the available statistical data, this study investigates the dynamics of key factors in the Fergana Region and explores the optimal lag structure. The findings contribute to a better understanding of the economic dynamics in the region and offer insights for policymakers and researchers.

KEYWORDS

Dynamic model, Almon lag model, Ordinary Least Squares.

INTRODUCTION

In Presidential Degree 158, issued on September 11, 2023, Uzbekistan unveils its comprehensive vision for progress, emphasizing the importance of key sectors in driving sustainable development. The decree highlights the nation's commitment to increasing investment in the digital economy, research, education, infrastructure, and green economy. This article delves into the strategies and initiatives outlined in the decree, exploring how Uzbekistan aims to harness the potential of these sectors to propel economic growth, foster innovation, empower its workforce, enhance connectivity, and safeguard the environment. With a strong focus on both social and economic fronts, the country aims to foster growth, prosperity, and improved well-being for its citizens. As nations strive for sustainable growth, understanding the relationship between investment in fixed assets and its outcomes on GDP becomes crucial. This article delves into the intricacies of this connection, examining how investment in fixed assets influences

GDP and exploring the potential mechanisms through which it drives economic expansion.

METHODOLOGY

1) The analysis and synthesis method used to analyze investment outcomes and their correlation with GDP developing Uzbekistan's digital economy.

2) Scientific abstraction, induction, and deduction are utilized in research to compare similarities and analyze research outcomes from scientists.

3) The abstract-logical approach is utilized to theoretically generalize the research findings and formulate conclusions.

4) Mathematical and statistical processing of research results involves analyzing the collected data through various techniques such as ranking, scaling, registration, systematization, differentiation, grouping, and graphical representation.

Literature Review and Meta-Analysis:

First of all, let's clarify what an investment is. Here are a few definitions of investment by famous economists:

- "Investment is the sacrifice of current consumption in order to secure future benefits." - John Maynard Keynes. [1]
- "Investment is the process of committing resources in a strategic manner to achieve long-term goals with an expectation of generating positive returns." - Benjamin Graham.[2]
- "Investment is an activity that involves sacrificing current consumption to achieve greater future consumption." - Paul Samuelson and William Nordhaus.[3]
- "Investment is the process of creating and expanding assets that will generate returns in the future." - Robert D. Hagstrom. [4]
- "Investment is the commitment of resources to a project or venture in the expectation of gaining an additional income or profit." - N. Gregory Mankiw.[5]
- "Investment refers to the purchase of financial assets such as stocks, bonds, or real estate, with the expectation of earning a positive return over time." - Burton G. Malkiel.[6]

Some prominent Russian economists who have made significant contributions to the field of investment include Nikolai Kondratiev, Leonid Abalkin, and Evsey Domar, among others. Their works often touch upon investment theory and its role in economic development.

These definitions provide different perspectives on investment, emphasizing concepts such as sacrificing present consumption, strategic resource allocation, generating returns, creating wealth, and seeking financial advantage.

RESEARCH AND RESULTS

The recent presidential decree of the Republic of Uzbekistan, issued on September 11, 2023, outlines an ambitious objective to achieve a twofold increase in the GDP by the end of 2030. The decree includes several goals, such as poverty reduction, doubling the GDP by 2030, increasing investments in research, technology, education, health, and attracting more investors to the economy.[7] However, the question arises: How does the current situation unfold? By utilizing dynamic econometric models, it is feasible to analyze both present and future outcomes based on the data collected over the past decades.

Dynamic models in econometrics take into account the values of variables not only at the current moment but also at previous moments in time. They capture the temporal dynamics of the variables and allow for analyzing how past values impact present and future outcomes.

Not all models constructed using time series data are considered dynamic in econometrics. The term "dynamic" in this context characterizes each moment in time, denoted as t, individually rather than the entire period for which the model is built. An econometric model is deemed dynamic if, at a given moment in time t, it takes into account the values of the variables included in the model that are relevant to both the current and previous moments in time. In other words, a dynamic model reflects the dynamics of the variables under study at each moment in time.[8]

$$y_t = a + b_0 \cdot x_t + b_1 \cdot x_{t-1} + \ldots + b_p \cdot x_{t-p} + \varepsilon_t. \quad (1)$$

Using the method of Ordinary Least Squares (OLS) is not not efficient. And sometimes it's even useless, or moreover meaningless.

Building distributed lag models and autoregressive models has its own specific characteristics. Firstly, estimating the parameters of autoregressive models and, in most cases, distributed lag models cannot be done using ordinary least squares (OLS) due to the violation of its assumptions, requiring special statistical methods. Secondly, researchers have to address issues such as choosing the optimal lag length and determining its structure. Lastly, there is a certain relationship between distributed lag models and autoregressive models, and in some cases, it is necessary to transition from one type of model to another.[8]

Lags whose structure can be described using polynomials are also referred to as Almon lags, named after Shirley Almon, who first drew attention to such lag representation.

Formally, the model expressing the dependence of coefficients b_j on the lag magnitude *j* in polynomial form can be written as follows:

For a first-degree polynomial: $b_j = c_0 + c_1 j$;

For a second-degree polynomial: $b_j = c_0 + c_1 j + c_2 j^2$;

For a third-degree polynomial: $b_j = c_0 + c_1 j + c_2 j^2 + c_3 j^3$ and etc.

In the most general form, for a polynomial of degree *k*, we have:

$$b_j = c_0 + c_1 j + c_2 j^2 + \ldots + c_k j^k \qquad (2)$$

where b_j represents the coefficient at lag *j*, and c_0 and c_1 are the parameters to be estimated.

Each of the coefficients b_j in model (1) can be expressed as follows:

$$\begin{aligned}
&b_0 = c_0;\\
&b_1 = c_0 + c_1 + \ldots + c_k;\\
&b_2 = c_0 + 2c_1 + 4c_2 + \ldots + 2^k c_k;\\
&b_3 = c_0 + 3c_1 + 9c_2 + \ldots + 3^k c_k;\\
&\ldots\\
&b_l = c_0 + lc_1 + l^2 c_2 + \ldots + l^k c_k;
\end{aligned} \qquad (3)$$

By substituting the derived relationships for b_j into equation (1), we obtain:

$$\begin{aligned}
y_t = a + c_0 \cdot x_t + (c_0 + c_1 + \ldots + c_k) \cdot x_{t-1} + (c_0 + 2 \cdot c_1 + \ldots + 2^k \cdot c_k) \cdot x_{t-2} + \\
+ (c_0 + 3 \cdot c_1 + \ldots + 3^k \cdot c_k) \cdot x_{t-3} + \ldots + (c_0 + l \cdot c_1 + \ldots + l^k \cdot c_k) \cdot x_{t-l} + \varepsilon_t.
\end{aligned}$$

Let's rearrange the terms in equation (4):

$$\begin{aligned}
y_t = a + c_0 \cdot (x_t + x_{t-1} + x_{t-2} + \ldots + x_{t-l}) + c_1 \cdot (x_{t-1} + 2 \cdot x_{t-2} + 3 \cdot x_{t-3} \ldots + l \cdot x_{t-l}) + \\
+ c_2 \cdot (x_{t-1} + 4 \cdot x_{t-2} + 9 \cdot x_{t-3} \ldots + l^2 \cdot x_{t-l}) + c_3 \cdot (x_{t-1} + 8 \cdot x_{t-2} + 27 \cdot x_{t-3} \ldots + l^3 \cdot x_{t-l}) + \\
\ldots + c_k \cdot (x_{t-1} + 2^k \cdot x_{t-2} + 3^k \cdot x_{t-3} \ldots + l^k \cdot x_{t-l}) + \varepsilon_t.
\end{aligned} \qquad (5)$$

In this model, it is assumed that the degree of the polynomial, *k*, is less than the maximum lag value of *l*.

Let's denote the terms within parentheses as new variables, denoted by c_j:

$$\begin{aligned}
&z_0 = x_t + x_{t-1} + x_{t-2} + \ldots + x_{t-l} = \sum_{j=0}^{l} x_{t-j};\\
&z_1 = x_{t-1} + 2 \cdot x_{t-2} + 3 \cdot x_{t-3} + \ldots + l \cdot x_{t-l} = \sum_{j=0}^{l} j \cdot x_{t-j};\\
&z_2 = x_{t-1} + 4 \cdot x_{t-2} + 9 \cdot x_{t-3} + \ldots + l^2 \cdot x_{t-l} = \sum_{j=0}^{l} j^2 \cdot x_{t-j}; \qquad (6)\\
&\ldots\\
&z_k = x_{t-1} + 2^k \cdot x_{t-2} + 3^k \cdot x_{t-3} + \ldots + l^k \cdot x_{t-l} = \sum_{j=0}^{l} j^k \cdot x_{t-j};
\end{aligned}$$

Let's rewrite the model (5) taking into account the relationships (6):

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$$y_t = a + c_0 \cdot z_0 + c_1 \cdot z_1 + c_2 \cdot z_2 + \ldots + c_k \cdot z_k + \varepsilon_t. \ (7)$$

Let's analyze the efficiency of invested funds in fixed assets in the Fergana region, Uzbekistan, using the Almon lag model. To accomplish this, we will utilize the data provided in Table 1:

From Table 1, which includes GDP of Fergana Region and Investment in fixed assets in billion soums from 2000 to 2022, we can observe that there are 23 observations in total. These observations represent the values of the variables over time, allowing for analysis of their trends and potential relationships.

Table 1: GDP of Fergana Region (Gross Regional Product) and Investment in Fixed Assets (billion soums), 2000-2022.

year	GDP of Fergana region	Investment in fixed capital	Z0	Z1	Z2
2000	374.2	52.4			
2001	495.2	110.1			
2002	727.2	156,8			
2003	898,9	105,3			
2004	1089,4	120,1	544,7	958,8	2561,8
2005	1419,0	162,3	654,6	1241,5	3714,1
2006	1880,8	178,2	722,7	1345,6	4099,2
2007	2638.5	272.9	838.8	1284.3	3593.1
2008	3224.6	484.5	1218.0	1596.6	4368.0
2009	3752.9	663.4	1761.3	2214.1	5776.7
2010	5417.5	930.9	2529.9	3163.9	7908.7
2011	7228.5	1261.4	3613.1	4802.8	12311.4
2012	9113.0	1505.8	4846.0	7051.4	18707.6
2013	10966.4	2130.0	6491.5	9474.9	25543.9
2014	13549.5	2295.3	8123.4	12649.4	34400.2
2015	16342.4	2542.3	9734.8	16118.3	44549.9
2016	18106.3	2643.6	11117.0	19546.1	54986.3
2017	20749.2	2954.5	12565.7	23134.1	67550.5
2018	27523.9	5539.1	15974.8	25049.8	73134.4
2019	32520.8	8685.4	22364.9	29548.1	81826.3
2020	37216.2	11040.0	30862.6	39201.5	99729.9
2021	47760.5	12625.2	40844.2	56846.1	142905.5
2022	56315.9	15419.3	53309.0	82917.8	223579.3

Source: compiled by authors. [11]

Parameters of regression equation (7) after applying method of ordinary least squares (OLS):

$$\hat{y}_t = 2957{,}96 + 2{,}17 z_0 + (-2{,}85) z_1 + 0{,}8 z_2 \cdot \; R^2 = 0{,}981$$

(765.8) (0.479) (0.939) (0.256) - standard errors

Using the found regression coefficients for the variables $z_i, i = 0{,}1{,}2$ and ratios (3), it is possible to calculate the regression coefficients of the original model:

$$b_0 = 2.17$$
$$b_1 = 2.17 - 2.85 + 0.8 = 0{,}12$$
$$b_2 = 2.17 + 2*(-2.85) + 4*0.8 = -0.33$$
$$b_3 = 2.17 + 3*(-2.85) + 9*0.8 = 0.82$$
$$b_4 = 2.17 + 4*(-2.85) + 16*0.8 = 3.57$$

The distributed lag model has the following form:

$$\hat{y}_t = 2957.96 + 2.17 x_t + 0.12 x_{t-1} - 0.33 x_{t-2} + 0.82 x_{t-3} + 3.57 x_{t-4}; R^2 = 0.981$$

Analysis of this model shows that a 1 billion sum increase in investment in fixed capital in the current period will lead to an average GDP growth of 6.19 billion sum after 4 years, considering the coefficients (2.17 + 0.12 - 0.33 + 0.82 + 3.57).

Let's determine the relative coefficients:

$$\beta_0 = 2.17 / 6.19 = 0.35$$
$$\beta_1 = 0.12 / 6.19 = 0.02$$
$$\beta_2 = -0.33 / 6.19 = -0.05$$
$$\beta_3 = 0.82 / 6.19 = 0.13$$
$$\beta_4 = 3.57 / 6.19 = 0.58$$

More than half of the factor's impact on the outcome is realized with a lag of 1 year, and 35% of this impact is realized immediately in the current period.

To conduct a more accurate analysis, it is indeed necessary to have a larger number of observations. Additionally, it is important to ensure that all analyses are conducted under the assumption of ceteris paribus, meaning that all other relevant factors remain constant. This helps isolate the impact of the specific variable being studied and provides a more accurate understanding of its influence.

CONCLUSION

Investment made in fixed assets in regions certainly has an impact on GDP. The high correlation coefficient of 0.98 between investment in fixed assets and GDP suggests a strong positive relationship between the two variables. This indicates that investment in fixed

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assets is a significant factor influencing the growth of Gross Regional Product [12]. Our analysis and research provide evidence supporting this conclusion.

In conclusion, this article presented an analysis of the Almon lag model using statistical data from the Fergana Region. If an investor invests 1 billion soums in the Fergana region, they may expect to receive a return of 6.19 billion soums. Additionally, based on the given information, it suggests that 35% of the total return (6.19 billion soums) could be covered by the end of the first year.The study aimed to explore the relationship between variables over time, considering distributed lag effects. While the Almon lag model offers insights into the dynamics of key factors in the region, it is important to acknowledge its drawbacks. These include complexity in estimation and interpretation, assumptions that may be violated, limited flexibility in capturing nonlinear relationships, challenges in determining optimal lag length, and data requirements. Despite these limitations, the findings contribute to a better understanding of the economic dynamics in the Fergana Region and provide valuable insights for policymakers and researchers. Future studies could explore alternative modeling approaches to complement and validate the results obtained from the Almon lag model.

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