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ANALYZING INVESTMENT IN FIXED ASSETS UTILYSING DYNAMIC MODELS IN FERGANA REGION

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Abstract. *This article provides an analysis of the Almon lag model based on statistical data from the Fergana Region. The model facilitates the study of relationships between variables over time by accounting for distributed lag effects. Using the available data, the research examines the dynamics of key factors in the Fergana Region and identifies the optimal lag structure. The results enhance the understanding of the region's economic dynamics and offer valuable insights for policymakers and researchers alike.*

Keywords: *dynamic model, Almon lag model, ordinary least squares, auto regression model.*

FARG‘ONA VILOYATIDA ASOSIY VOSITALARGA INVESTITSIYALARNI DINAMIK MODELLARDAN FOYDALANIB TAHLIL QILISH

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Annotatsiya. *Ushbu maqola Farg‘ona viloyatining statistik ma’lumotlari asosida Almon lag modeli tahlilini taqdim etadi. Model vaqtli qatorlar bilan o‘zgaruvchilar o‘rtasidagi bog‘lanishlarni o‘rganishga imkon beradi, bu esa taqsimlangan lag ta’sirlarini hisobga oladi. Mavjud ma’lumotlardan foydalangan holda, tadqiqot Farg‘ona viloyatidagi asosiy omillarning dinamikasini tahlil qiladi va optimal lag strukturasini aniqlaydi. Tadqiqot natijalari viloyatning iqtisodiy dinamikasini yaxshiroq tushunishga yordam beradi va investorlar hamda tadqiqotchilar uchun qimmatli fikr-mulohazalar bilan o‘rtoqlashadi.*

Kalit so‘zlar: *dinamik model, Almon lag modeli, oddiy eng kichik kvadratlar, avtomatik regressiya modeli.*

АНАЛИЗ ИНВЕСТИЦИЙ В ОСНОВНЫЕ СРЕДСТВА С ИСПОЛЬЗОВАНИЕМ ДИНАМИЧЕСКИХ МОДЕЛЕЙ В ФЕРГАНСКОМ ВИЛОЯТЕ

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Аннотации. *Эта статья представляет анализ модели Алмона на основе статистических данных Ферганской области. Модель позволяет изучать взаимосвязи между переменными во времени, учитывая эффекты распределенных лагов. Используя доступные данные, исследование анализирует динамику ключевых факторов в Ферганской области и определяет оптимальную структуру лагов. Результаты способствуют лучшему пониманию экономической динамики региона и предоставляют ценные рекомендации для инвесторов и исследователей.*

Ключевые слова: *динамическая модель, модель лага Алмона, метод наименьших квадратов, модель авторегрессии.*

Introduction.

Presidential Decree 158, issued on September 11, 2023, outlines Uzbekistan's ambitious vision for sustainable development, prioritizing key sectors as drivers of progress. The decree underscores the nation's dedication to boosting investment in the digital economy, research, education, infrastructure, and green initiatives (Decree, 2023). This article examines the strategies and initiatives proposed in the decree, highlighting how Uzbekistan plans to leverage these sectors to stimulate economic growth, promote innovation, empower its workforce, improve connectivity, and protect the environment. By addressing both social and economic dimensions, the country aims to achieve growth, prosperity, and enhanced well-being for its citizens. Additionally, as nations worldwide seek sustainable development, understanding the link between fixed asset investment and GDP becomes essential. This article explores the complex relationship between these factors, analyzing how investment in fixed assets impacts GDP and identifying the mechanisms that drive economic growth.

Literature review.

Let’s begin by defining what investment is. Below are several definitions of investment provided by renowned economists:

- "Investment is an activity that involves sacrificing current consumption to achieve greater future consumption." - Samuelson and Nordhaus(2009).
- "Investment is the sacrifice of current consumption in order to secure future benefits." - Keynes(1936).
- "Investment is the commitment of resources to a project or venture in the expectation of gaining an additional income or profit." – Mankiw (2021).
- "Investment is the process of committing resources in a strategic manner to achieve long-term goals with an expectation of generating positive returns." – Graham (2005).

Several notable Russian economists, including Kondratiev, Abalkin, and Domar, have made important contributions to the study of investment. Their works frequently explore investment theory and its impact on economic development. These definitions offer various viewpoints on investment, highlighting ideas such as forgoing current consumption, strategic allocation of resources, generating returns, creating wealth, and pursuing financial gain.

Let’s define the meaning of fixed assets:

- **fixed assets** under **IAS 16** are physical assets with long-term use in business operations. They are initially recognized at cost, and over time, they are depreciated (except for land) and periodically reviewed for impairment. Their measurement can either follow the **cost model** or the **revaluation model**, offering businesses flexibility in how they report these long-term assets on their financial statements (MyBib Contributors, 2019).

Research methodology.

1) The method of analysis and synthesis is applied to evaluate investment outcomes and their correlation with GDP in the context of developing Uzbekistan's digital economy.

2) *Scientific abstraction,* along with the methods *of induction and deduction*, is employed in research to compare similarities and evaluate findings from various scientists.

3) The abstract-logical method is applied to theoretically synthesize the research findings and derive conclusions.

4) The mathematical, econometric and statistical, analysis of research results entails examining the collected data using various methods, including ranking, scaling, classification, systematization, differentiation, grouping, and graphical representation.

Analysis and discussion of results.

The recent presidential decree of the Republic of Uzbekistan, released on September 11, 2023, sets an ambitious target of doubling the GDP by 2030. The decree outlines various objectives, including poverty reduction, boosting investments in research, technology, education, and healthcare, as well as attracting more investors to the economy [1]. However, the question remains: What is the current situation? By applying dynamic econometric models, it becomes possible to analyze both current and future outcomes using data gathered over the past decades.

Dynamic models in econometrics consider the values of variables not just at the current point in time but also at earlier points. These models capture the time-based changes in variables and enable the analysis of how past values influence both present and future outcomes.

Not every model built with time series data is classified as dynamic in econometrics. The term "dynamic" here refers to how each individual time point, denoted as t, is considered, rather than focusing on the entire period for which the model is constructed. An econometric model is considered dynamic if, at any given time t, it incorporates the values of the variables in the model that are relevant to both the current and past time points. In essence, a dynamic model captures the evolving nature of the variables at each specific moment in time (Елисеева и др., 2003).

Using the Ordinary Least Squares (OLS) method is not always efficient and, in some cases, can be ineffective or even meaningless. Building distributed lag models and autoregressive models involves certain specific challenges. First, estimating the parameters of autoregressive models and, in most cases, distributed lag models cannot be done with OLS due to violations of its assumptions, necessitating the use of specialized statistical methods. Second, researchers must address challenges like selecting the optimal lag length and determining its structure. Finally, there is a relationship between distributed lag models and autoregressive models, and in some instances, it may be necessary to switch from one model type to another(Almon, 1965).

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

Lags that can be represented using polynomials are known as Almon lags, a term derived from Shirley Almon, who was the first to highlight this form of lag representation.

Formally, the model that represents the relationship between the coefficients b_j and the lag magnitude j in polynomial form can be expressed as follows:

For a 1st -degree polynomial: $b_j = c_0 + c_1 j$;

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

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

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

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

where b_j denotes 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:

$$b_0 = c_0;$$
$$b_1 = c_0 + c_1 + \cdots + c_k;$$
$$b_2 = c_0 + 2c_1 + 4c_2 + \cdots + 2^k c_k;$$
$$b_3 = c_0 + 3c_1 + 9c_2 + \cdots + 3^k c_k;$$
$$\ldots$$
$$b_l = c_0 + lc_1 + l^2 c_2 + \ldots + l^k c_k; \quad (3)$$

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

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

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

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

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

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

$$z_0 = x_t + x_{t-1} + x_{t-2} + \cdots + x_{t-l} = \sum_{j=0}^{l} x_{t-j} ;$$

$$z_1 = x_{t-1} + 2 \cdot x_{t-2} + 3 \cdot x_{t-3} + \cdots + l \cdot x_{t-l} = \sum_{j=0}^{l} j \cdot x_{t-j} ;$$

$$z_2 = x_{t-1} + 4 \cdot x_{t-2} + 9 \cdot x_{t-3} + \cdots + l^2 \cdot x_{t-l} = \sum_{j=0}^{l} j^2 \cdot x_{t-j} ;$$

$$\ldots$$
$$z_k = x_{t-1} + 2^k \cdot x_{t-2} + 3^k \cdot x_{t-3} + \ldots + l^k \cdot x_{t-l} = \sum_{j=0}^{l} j^k \cdot x_{t-j} ; \quad (6)$$

Let's express the model (5) again, incorporating the relationships from (6):

$y_t = a + c_0 \cdot z_0 + c_1 \cdot z_1 + c_2 \cdot z_2 + \ldots + c_k \cdot z_k + \varepsilon_t.$ (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 2023, 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 (Gujarati and Porter, 2009).

Table 1

GDP of Fergana Region (Gross Regional Product) and Investment in Fixed Assets (billion soums), 2000-2023.

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	1220.0	3606.6
2005	1419,0	162,3	654.6	1376.9	4255.7
2006	1880,8	178,2	722.7	1545.2	4897.6
2007	2638.5	272.9	838.8	2070.9	6739.5
2008	3224.6	484.5	1218.0	3275.4	11083.2
2009	3752.9	663.4	1761.3	4831.1	16244.7
2010	5417.5	930.9	2529.9	6955.7	23075.9
2011	7228.5	1261.4	3613.1	9649.6	31698.6
2012	9113.0	1505.8	4846.0	12332.6	39832.4
2013	10966.4	2130.0	6491.5	16491.1	53608.7
2014	13549.5	2295.3	8123.4	19844.2	63179.4
2015	16342.4	2542.3	9734.8	22820.9	71360.3
2016	18106.3	2643.6	11117.0	24921.9	76489.5
2017	24218.2	2954.5	12565.7	27128.7	83528.9
2018	31814	5539.1	15974.8	38849.4	128332.8
2019	38116.4	8685.4	22364.9	59911.5	203279.8
2020	43413.1	11040	30862.6	84248.9	279919.4
2021	55831.9	12625.2	40844.2	106530.7	341643.9
2022	65516.9	15419.3	53309.0	130318.2	413181.0
2023	77670.6	19955	67724.9	162368.3	519594.5

Source: *compiled by authors. (stat.uz, n.d.)*

Correlation matrix shows the following:

	Z_0	Z_1	Z_2	*GDP*
Z_0	1			
Z_1	0.99803272	1		
Z_2	0.99653181	0.99968397	1	
GDP	0.98587212	0.98778852	0.988293985	1

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

$$\tilde{y}_t = 3622.528 + 1.106 z_0 + (-1.143) z_1 + 0.458 z_2.\ R^2 = 0{,}9782$$

(1072.98) (1.08) (1.445) (0.339) - 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:

$$b_0 = 1.106$$
$$b_1 = 1.106 - 1.143 + 0.458 = 0.421$$
$$b_2 = 1.106 + 2 * (-1.143) + 4 * 0.458 = 0.652$$
$$b_3 = 1.106 + 3 * (-1.143) + 9 * 0.458 = 1.799$$
$$b_4 = 1.106 + 4 * (-1.143) + 16 * 0.458 = 3.862$$

The distributed lag model has the following form:

$$y_t = 3622.528 + 1.106 + 0.421x_{t-1} + 0.652x_{t-2} + 1.799x_{t-3} + 3.862x_{t-4};$$
$$R^2 = 0.9782$$

The analysis of this model indicates that a 1 billion sum increase in investment in fixed capital during the current period will result in an average GDP growth of 7.84 billion sum after 4 years(1.106+0.421+0.652+1.799+3.862), based on the coefficients.

Let's determine the relative coefficients:

$$\beta_0 = 1.106/7.84 = 0.140$$
$$\beta_1 = 0.421/7.84 = 0.053$$
$$\beta_2 = 0.652/7.84 = 0.084$$
$$\beta_3 = 1.799/7.84 = 0.229$$
$$\beta_4 = 3.862/7.84 = 0.494$$

Over half of the factor's effect on the outcome materializes with a 4-year lag, with 14% of the impact occurring immediately in the current period. For a more precise analysis, it is crucial to have a larger dataset. Furthermore, all analyses should be conducted under the assumption of ceteris paribus (Ahmadjonovich and Rakhmatovich, 2023) meaning that other relevant factors are held constant. This approach allows for isolating the effect of the specific variable being examined, leading to a clearer understanding of its impact.

Investment in fixed assets can be directed towards various sectors, such as education and tourism, each providing unique opportunities for growth and development. In the education sector, investments could focus on acquiring new educational equipment (Akhunova et al., 2024), upgrading classrooms, or introducing advanced technologies to enhance the learning experience. Meanwhile, in the tourism industry(Akhunova and Askarov, 2023) investments could be channeled into high-tech innovations, such as AI-driven programs (Muminova et.al., 2024), smart systems for managing tourism services, or cutting-edge infrastructure to improve visitor experiences and efficiency. These investments not only contribute to the growth of their respective sectors but also foster broader economic development. Additionally, attention to environmental sustainability is crucial, ensuring that these investments promote eco-friendly practices (Muminova et.al., 2024) alongside economic growth.

Conclusion and suggestions.

Investment in fixed assets in regions undeniably affects GDP. The high correlation coefficient of 0.98 between fixed asset investment and GDP indicates a strong positive relationship between these two variables. This suggests that investment in fixed assets plays a crucial role in driving the growth of the Gross Regional Product (GRP). Our analysis and research provide evidence supporting this finding.

In conclusion, this article presented an analysis of the Almon lag model using statistical data from the Fergana Region. If an investor puts 1 billion soums into the Fergana region, they could expect a return of 7.84 billion soums. Furthermore, the data suggests that 14% of this return (7.84 billion soums) could be realized by the end of the first year. The study aimed to explore the relationship between variables over time, factoring in distributed lag effects. While the Almon lag model provides valuable insights into the region’s economic dynamics, it also has some limitations. These include challenges in estimation and interpretation, potential violations of assumptions, limited ability to capture nonlinear relationships, difficulties in determining optimal lag length, and data requirements. Despite these limitations, the findings offer a clearer understanding of the economic conditions in the Fergana Region and present useful insights for policymakers and researchers. Future research could investigate alternative modeling approaches to further validate and complement the results derived from the Almon lag model.

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