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MODELS FOR ATTRACTING INVESTMENT TO THE INDUSTRIAL SECTOR AND ENSURING ITS EFFICIENT USE

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Abstract: This article examines the economic substance of attracting investment to the industrial sector and ensuring its efficient use, as well as the functional relationships between these processes. The transformation of investment resources from their initial formation into fixed capital, technological renewal, production capacity, industrial output, and value added is considered as an integrated system. Based on statistical indicators describing industrial development and investment activity in Surkhandarya Region for 2010-2025, quantitative and structural changes in the regional industrial sector are assessed. As a result of the study, a dynamic simulation model is proposed that integrates investment sources, the production process, investment efficiency, the reinvestment mechanism, and external environmental factors. A distinctive feature of the model is that it does not limit the relationship between investment and industrial outcomes to a direct connection; rather, it takes into account the intermediate stages through which investment is transformed into real production results, time lags, and both positive and negative feedback effects. The findings substantiate the need to focus not only on increasing the volume of investment attracted to industry but also on its technological orientation, absorption level, and economic return.

Keywords: industry, investment, fixed capital, investment efficiency, technological level, production capacity, value added, investment flow, reinvestment, dynamic simulation model.

Аннотация: В статье исследуется экономическая сущность привлечения инвестиций в промышленный сектор и обеспечения их эффективного использования, а также функциональные взаимосвязи между данными процессами. Трансформация инвестиционных ресурсов от их первоначального формирования в основной капитал, технологическое обновление, производственные мощности, промышленный выпуск и добавленную стоимость рассматривается как интегрированная система. На основе статистических показателей, характеризующих развитие промышленности и инвестиционную активность в Сурхандарьинской области за 2010–2025 годы, проведена оценка количественных и структурных изменений в региональном промышленном секторе. В результате исследования предложена динамическая имитационная модель, интегрирующая источники инвестиций, производственный процесс, эффективность инвестиций, механизм реинвестирования и факторы внешней среды. Отличительной особенностью модели является то, что взаимосвязь между инвестициями и промышленными результатами не ограничивается прямой зависимостью, а учитывает промежуточные этапы трансформации инвестиций в реальные производственные результаты, временные лаги, а также положительные и отрицательные эффекты обратной связи. Полученные результаты обосновывают необходимость сосредоточения внимания не только на увеличении объема инвестиций, привлекаемых в промышленность, но и на их технологической направленности, уровне освоения и экономической отдаче.

Ключевые слова: промышленность, инвестиции, основной капитал, эффективность инвестиций, технологический уровень, производственная мощность, добавленная стоимость, инвестиционный поток, реинвестирование, динамическая имитационная модель.

INTRODUCTION

Expanding the productive capacity of the economy, renewing existing fixed assets, introducing new technologies, and increasing labor productivity are directly related to investment processes. In the industrial sector in particular, investment differs from other financial resources because it creates the material basis for long-term economic growth. Investment directed to industry is first transformed into fixed capital and technological assets, then into production capacity, output, and ultimately value added.

However, growth in the volume of investment cannot automatically be equated with industrial development. A region may absorb a large amount of investment, while its economic return may remain below expectations due to incomplete utilization of production capacity, insufficient technological equipment, prolonged project implementation periods, or limited market demand. Therefore, investment performance depends not on the amount of funds alone, but on the effectiveness of the entire economic mechanism that transforms these funds into production outcomes.

In economic growth theory, capital accumulation is regarded as one of the main determinants of output. R. Solow identified capital, labor, and technological progress as the principal factors of long-term production dynamics [1]. In later studies, technological progress itself began to be interpreted as an endogenous process associated with investment decisions and human capital. P. Romer demonstrated that technological change is shaped by deliberate investment decisions made by economic agents [2].

The composition of investment is no less important than its total volume. J. B. De Long and L. Summers empirically showed that investment in machinery and equipment has a stronger relationship with economic growth than some other components of investment [3]. This implies that, when assessing industrial investment, attention should be paid not only to the total amount of investment but also to its technological composition.

In Surkhandarya Region, the scale of industrial production has expanded considerably in recent years. Industrial output increased from UZS 756.4 billion in 2010 to UZS 18,833.2 billion in 2025. Over the same period, manufacturing output rose from UZS 669.2 billion to UZS 17,015.7 billion.

At the same time, the physical volume indices of output did not follow a uniform growth trajectory. In particular, the industrial production index fell to 97.9 percent in 2017, while it amounted to 106.3 percent in 2023, 106.6 percent in 2024, and 109.3 percent in 2025.

This indicates that the relationship between investment and industrial output is affected by time lags, depreciation of capital, the degree of technological renewal, utilization of production capacity, and other factors. Therefore, this article aims to examine the attraction and efficient use of investment in industry not as a set of isolated indicators, but as an interconnected dynamic process.

REVIEW OF LITERATURE ON THE SUBJECT

The relationship between investment and economic growth has long been one of the major areas of economic theory. In the neoclassical framework, changes in output are explained by capital, labor, and technological progress. The model proposed by R. Solow laid an important methodological foundation for determining the role of capital accumulation in economic growth [1].

The endogenous growth concept developed by P. Romer deepened the analysis of the relationship between investment and technology. In his approach, technology is not treated as an independent external factor, but rather as an outcome of investment in knowledge, research, and innovation by economic agents [2].

The impact of investment composition on economic outcomes occupies a special place in the work of J. B. De Long and L. Summers. Their study showed a strong relationship between investment in machinery and equipment and economic growth [3]. This conclusion is particularly important for industry, because the productivity of production capacity is largely determined by the active component of investment – machinery, equipment, and technological assets.

R. Barro examined the relationship of economic growth with public policy, human capital, and investment activity using cross-country data [4]. His approach suggests that the effect of investment cannot be evaluated independently of macroeconomic and institutional conditions.

Hall and Jones demonstrated that differences in economic performance across countries and territories cannot be fully explained by capital alone, drawing attention to productivity and economic institutions [5]. This theoretical position reinforces the view that identical volumes of investment may generate different returns under different institutional and production conditions.

The existence of time delays between causes and results in dynamic economic systems is widely emphasized in the systems approach [6]. This perspective makes it possible to regard investment not as a one-time expenditure, but as a recurring process that creates future production results and, in turn, influences the formation of new investment resources [7].

On the basis of these approaches, efficient use of investment in industry may be defined as an economic process that transforms attracted investment resources into fixed capital and technological capacity over a certain period of time, ensures the rational utilization of existing production capacities, generates higher value added, and returns part of the resulting economic effect to a new investment cycle [8,9].

Under this definition, efficiency is not limited to the ratio between investment and output. It is determined by the degree of investment absorption, its transformation into capital, its contribution to technological renewal, its effect on capacity utilization, and its ability to generate resources for repeated investment.

RESEARCH METHODOLOGY

The study employs systems analysis, statistical grouping, time-series analysis, index methods, structural comparison, economic and logical generalization, and dynamic simulation modeling.

The empirical base of the research consists of data on gross regional product, industrial output, the structure of manufacturing, fixed capital investment, and industrial indicators by territory in Surkhandarya Region for 2010-2025.

The share of industry in the gross regional product of Surkhandarya Region was 6.7 percent in 2010 and increased to 9.9 percent in 2025. When industry and construction are considered together, their combined share rose from 11.7 percent to 19.2 percent.

In developing the dynamic model, the relationship between investment and final output is expressed through the following logic:

$$RI_t \rightarrow I_t \rightarrow IA_t \rightarrow K_t \rightarrow T_t \rightarrow C_t \rightarrow CU_t \rightarrow Y_t \rightarrow VA_t$$

where R_t available investment resources, I_t investment flow, AI_t absorbed investment, K_t fixed capital, T_t technological level of production, C_t production capacity, CU_t capacity utilization rate, Y_t industrial output, VA_t value added.

This sequence makes it possible to assess investment not as a factor that affects final output instantly, but as a dynamic resource whose impact is transmitted through several economic stages.

ANALYSIS AND RESULTS

The industrial development of Surkhandarya Region during 2010-2025 demonstrates a substantial expansion of regional production capacity. Industrial output increased from UZS 756.4 billion to UZS 18,833.2 billion, which corresponds to:

$$K_Y = \frac{18833,2}{756,4} = 24,9$$

times growth.

Manufacturing output increased from UZS 669.2 billion to UZS 17,015.7 billion. These results reflect a considerable quantitative expansion of industrialization in the region. However, because nominal values also incorporate the price factor, investment efficiency cannot be assessed solely on the basis of this growth.

Structural changes within manufacturing are also important. In 2010, food production accounted for 31.2 percent of manufacturing, while by 2025 its share had fallen to 18.7 percent. The share of textile production changed from 37.7 percent to 35.2 percent over the same period, although it reached 49.0 percent in 2023.

The share of other non-metallic mineral products increased from 5.6 percent in 2010 to 11.3 percent in 2025. The share of fabricated metal products rose from 2.2 percent to 9.7 percent. These changes indicate that the regional industrial structure is gradually diversifying through the development of new production segments.

Nevertheless, the scale of high-technology production continues to demonstrate significant potential for further development. In 2025, the production of computers, electronic and optical products amounted to UZS 3.9 billion, electrical equipment production to UZS 12.4 billion, and the production of machinery and equipment not elsewhere classified to UZS 18.5 billion.

This result indicates that, alongside increasing the volume of investment, there are also opportunities to further strengthen its technological orientation. Investment should support not only the creation of new buildings and infrastructure but also the introduction of modern machinery and equipment, automated production, energy-efficient technologies, and the production of higher value-added goods.

Territorial industrial indicators also show that the economic return on investment is not uniform across space. Per capita industrial output in the region increased from UZS 355.9 thousand in 2010 to UZS 6,323.6 thousand in 2025. In the city of Termez, this indicator reached UZS 10,032.8 thousand in 2025.

The shares of districts in total regional industrial output also changed significantly over time. For example, the share of Jarkurgan declined from 17.5 percent in 2010 to 7.6 percent in 2025, while the share of Termez city changed from 12.2 percent to 11.2 percent. These changes indicate the emergence of new spatial centers of production.

Therefore, the return on industrial investment depends directly on the location of the project, the industrial branch to which it is directed, and the technological characteristics of the invested asset. To represent the impact of investment on industrial outcomes in an integrated form, a dynamic simulation model was developed by the author (Figure 1).

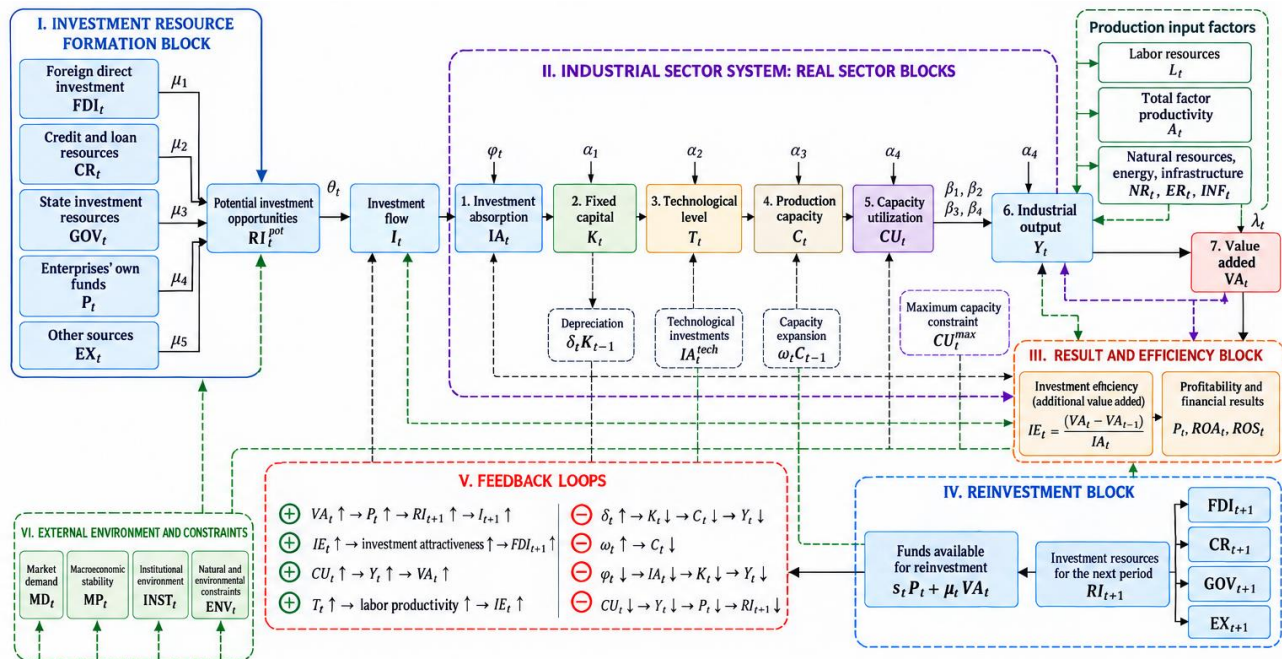


Figure 1. Dynamic simulation model for attracting investment to the industrial sector and ensuring its efficient use¹

The basic logic of the model follows the sequence “resources → absorption → capital and technology → production → outcome → reinvestment.” Investment resources are formed from various sources, transformed into actual investment, and absorbed into production. Absorbed funds expand fixed capital and technological capabilities and thereby affect production capacity. The utilization rate of this capacity determines the volume of industrial output and value added. A portion of the resulting economic outcome is then redirected to investment in the following period. Thus, the system functions not as a one-off process but as a recurring investment-production cycle.

Investment resources are formed as follows:

$$RI_t = \mu_1 FDI_t + \mu_2 CR_t + \mu_3 GOV_t + \mu_4 P_t + \mu_5 EX_t, \quad (1)$$

where FDI_t denotes foreign direct investment, CR_t credit and borrowed funds, GOV_t public investment resources, P_t enterprises' own funds, and EX_t other sources of financing.

Not all available investment opportunities are immediately transformed into actual investment. Therefore:

$$I_t = \theta_t RI_t, \quad (2)$$

where θ_t reflects the extent to which investment opportunities are converted into actual investment flows. The part of investment flow that enters the real production process is expressed as:

$$IA_t = \varphi_t I_t, \quad (3)$$

where φ_t is the investment absorption coefficient. An increase in this coefficient indicates that attracted funds are transformed into productive assets more rapidly.

The dynamics of fixed capital are expressed as:

$$K_t = (1 + \delta_t) K_{t-1} + \alpha_1 IA_t, \quad (4)$$

¹ Developed by the author.

where δ_t denotes the depreciation rate of capital and α_1 reflects the extent to which absorbed investment is transformed into fixed capital.

This relationship shows that growth in investment does not necessarily translate into an equivalent increase in capital, because a portion of investment may be used to replace depreciated assets.

Technological development is expressed as:

$$T_t = T_{t-1} + \alpha_2 I_t^{tech} \quad (5)$$

where I_t^{tech} represents investment directed toward technological modernization.

This equation shows that it is not only the total volume of investment that matters, but also the share allocated to modern technologies.

Production capacity is formed through the interaction of capital and technological level:

$$C_t = f(K_t, T_t) \quad (6)$$

The economic result of available capacity depends on its utilization:

$$Y_t = C_t \cdot CU_t \quad (7)$$

where CU_t is the capacity utilization rate.

For this reason, the utilization of existing capacity should be assessed before additional production facilities are created. If a significant portion of existing capacity remains unused, new capital investment may not generate the expected increase in efficiency.

In broader form, the production process may also be represented by a modified Cobb-Douglas function:

$$Y_t = A_t K_t^{\beta_1} L_t^{\beta_2} T_t^{\beta_3} CU_t^{\beta_4} \quad (8)$$

where A_t is total factor productivity, L_t is labor resources, and β_i are the elasticity coefficients of the corresponding factors.

The advantage of this function is that the effect of investment is not confined to capital alone. Labor, technology, and capacity utilization also jointly influence industrial output.

The economic result of industrial output is expressed through value added:

$$VA_t = \lambda_t Y_t \quad (9)$$

where λ_t is the share of value added in output.

Investment efficiency may be determined as:

$$EA_t = \frac{VA_t - VA_{t-1}}{IA_t} \quad (10)$$

This indicator shows the amount of additional value added generated per unit of absorbed investment.

Another important element of the model is the reinvestment process:

$$RI_{t+1}^{int} = s_t P_t + \mu_t VA_t \quad (11)$$

where s_t is the share of profit reinvested and μ_t is the proportion of value added redirected to the next investment cycle.

As a result, a positive feedback loop emerges:

$$VA_t \uparrow \rightarrow P_t \uparrow \rightarrow RI_{t+1} \uparrow \rightarrow I_{t+1} \uparrow$$

Similarly:

$$E_t \uparrow \rightarrow \text{investment attractiveness} \uparrow \rightarrow FDI_{t+1} \uparrow$$

describes the mechanism through which high investment efficiency stimulates future investment inflows. However, the system also includes limiting relationships:

$$\delta_t \uparrow \rightarrow K_t \downarrow \rightarrow C_t \downarrow \rightarrow Y_t \downarrow$$

or

$$\varphi_t \downarrow \rightarrow IA_t \downarrow \rightarrow K_t \downarrow \rightarrow Y_t \downarrow$$

Therefore, the model makes it possible to identify not only the initial and final investment indicators, but also the particular stage at which efficiency losses occur.

Economic Meaning and Practical Application of the Model. Under the proposed approach, the transformation of investment into economic outcomes depends on several important conditions:

First, available financial opportunities in the region must be converted into real investment projects. If potential funds fail to become actual investment because of deficiencies in the investment climate, infrastructure, or project management, investment potential will not generate economic results;

Second, attracted investment must be absorbed in a timely manner. The longer the construction phase or equipment commissioning is delayed, the greater the time gap between investment expenditure and production outcomes;

Third, the technological composition of investment has a significant impact on production efficiency. Investment in modern technological equipment can increase productivity and improve product quality;

Fourth, the level of capacity utilization determines the return on investment. If a firm has substantial production capacity but uses only a limited part of it, the efficiency of new capital expenditure may remain low;

Fifth, reinvesting part of the profit and value added generated by industrial enterprises ensures continuity of the investment process.

Therefore, investment efficiency should not be evaluated using a simple relationship:

$$I \rightarrow K$$

but rather through the full cycle:

$$I \rightarrow IA \rightarrow K \rightarrow T \rightarrow C \rightarrow CU \rightarrow Y \rightarrow VA \rightarrow RI_{t+1}$$

Possibilities for Applying the Model in Surkhandarya Region. The changes observed in the industrial sector of Surkhandarya Region during 2010-2025 provide an economic basis for applying the proposed model at the regional level:

First, the substantial increase in industrial output indicates the formation of new production capacity. Industrial output amounted to UZS 13,819.8 billion in 2024 and increased to UZS 18,833.2 billion in 2025;

Second, manufacturing accounts for the major part of industrial output. This indicates opportunities to shift the investment policy from simple extraction of raw materials toward deeper processing, production of finished goods, and retention of a larger share of value added within the region;

Third, new industrial segments are emerging in the regional structure. In 2025, pharmaceutical production reached UZS 129.3 billion, rubber and plastic products UZS 117.2 billion, and furniture production UZS 577.4 billion. This suggests that the investment portfolio can be gradually diversified beyond traditional food and textile production toward new manufacturing segments;

Fourth, the territorial unevenness of industrial development indicates that investment location decisions should take into account the existing production base, infrastructure, and resource potential of individual districts;

Fifth, the system for monitoring investment efficiency should include not only the amount of funds allocated to a project, but also the commissioned capacity, capacity utilization, value added created, labor productivity, technological renewal, and the amount of profit reinvested.

Systematic monitoring of these indicators can help determine the stage of the investment process at which inefficiency arises.

Directions for Improving the Efficiency of Investment Use. Based on the analysis and the proposed dynamic model, several directions can be identified for improving investment efficiency in the industrial sector of Surkhandarya Region;

First, in selecting investment projects, additional value added generated per unit of investment should become one of the main evaluation criteria alongside total project cost. This would reduce the excessive allocation of resources to low-return projects;

Second, the technological composition of investment should be optimized. Alongside the construction of facilities, the share of investment directed toward modern machinery and equipment, digital management

systems, energy-efficient technologies, and automated production lines should be increased gradually;

Third, the placement of new investment projects should take into account the existing industrial and engineering infrastructure. Establishing new production facilities in areas with insufficient electricity, gas, water, or transport infrastructure increases project costs and delays commissioning;

Fourth, industrial enterprises should conduct an inventory of existing production capacities and assess their actual utilization. If substantial unused capacity already exists, technological modernization may be more economically efficient than the construction of new facilities;

Fifth, regional investment policy should be linked with industrial cooperation. If newly established enterprises are integrated with local suppliers, raw material producers, transport and logistics companies, and service providers, the multiplier effect of investment can be expanded;

Finally, industrial enterprises should be encouraged to allocate part of their profits to production renewal. This would reduce dependence on external financing and strengthen the internal investment capacity of the region.

Scientific Distinctiveness of the Proposed Model. The main distinction of the proposed dynamic simulation model from simple investment-output models is that it explains the effect of investment on the final result through intermediate economic stages.

A simple model:

$$Y = f(I)$$

describes only the overall relationship between investment and industrial output.

The proposed approach forms the chain::

$$I_t \rightarrow IA_t \rightarrow K_t \rightarrow T_t \rightarrow C_t \rightarrow CU_t \rightarrow Y_t \rightarrow VA_t$$

This makes it possible to identify the stage at which the main constraint arises in the transformation of investment into production results.

For example, a large amount of investment may be attracted, but if absorption is low, the economic effect will remain limited. If absorption is high but the share of technological investment is small, labor productivity may not improve substantially. If new capacity is created but its utilization remains low, capital productivity will decline.

Therefore, the objective of investment policy should not be limited to ensuring:

$$I_t \uparrow$$

but should also focus on simultaneously improving:

$$\theta_t \uparrow, \varphi_t \uparrow, T_t \uparrow, CU_t \uparrow, IE_t \uparrow$$

Another important feature of the model is that current industrial outcomes affect investment resources in the subsequent period. As a result, investment and industrial development become part of a continuous reproduction mechanism.

CONCLUSIONS AND SUGGESTIONS

The study shows that attracting investment to the industrial sector and ensuring its efficient use should be evaluated not through isolated financial indicators, but within a system of interconnected production processes.

During 2010-2025, industrial output in Surkhandarya Region increased substantially, manufacturing became an important area of economic activity, and new production segments emerged within the industrial structure. However, fluctuations in physical volume indices and significant differences across branches and territories indicate that the volume of investment alone does not fully explain industrial performance.

The dynamic simulation model proposed by the author makes it possible to represent the entire process from the formation of investment resources to their transformation into industrial output and value added within a unified framework. The sequence:

$$RI_t \rightarrow I_t \rightarrow IA_t \rightarrow K_t \rightarrow T_t \rightarrow C_t \rightarrow CU_t \rightarrow Y_t \rightarrow VA_t$$

reveals the effect of investment on final results step by step.

Based on this approach, investment management in the regional industrial sector should give priority to economic returns rather than simply increasing the amount of investment. Investment should be directed toward high value-added production, technological modernization, deeper processing, and automation projects.

When evaluating investment projects, it is advisable to use the criterion of “one unit of investment – additional value added”, monitor the timing and degree of investment absorption, identify unused industrial capacity, and align new investment decisions with the infrastructure potential of the region.

In addition, developing mechanisms that encourage industrial enterprises to reinvest part of their profits in modernization and new production capacity would ensure continuity of the investment process. This could reduce dependence on external investment and strengthen the internal financial potential of industry in the region.

In general, the efficient use of investment is not merely a matter of increasing investment funds, but of transforming them rapidly and effectively into productive capital, raising the technological level, fully utilizing available capacity, and returning part of the resulting economic outcome to a new investment cycle. By revealing the interdependence of these processes, the proposed dynamic simulation model can serve as a methodological basis for designing regional industrial investment policy and assessing the long-term consequences of investment decisions.

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