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THE IMPACT OF INVESTMENT FLOWS ON REGIONAL ECONOMIC DEVELOPMENT: AN ECONOMETRIC ASSESSMENT OF UZBEKISTAN

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Abstract: This article develops an empirical and econometric approach to assessing the impact of investment flows on the economic development of Uzbekistan's regions. The study focuses on the relationship between investment in fixed capital and gross regional product (GRP). Furthermore, it takes into account that investment effectiveness varies depending on a region's production structure, infrastructure, human capital, and capacity to absorb investment.

Key words: investment flows, regional development, gross regional product, fixed capital formation, panel data, fixed effects, Uzbekistan, regional inequality.

Аннотация: В статье разрабатывается эмпирический и эконометрический подход к оценке влияния инвестиционных потоков на экономическое развитие регионов Узбекистана. Основное внимание уделяется взаимосвязи между инвестициями в основной капитал и валовым региональным продуктом (ВРП). При этом учитывается, что эффективность инвестиций варьируется в зависимости от производственной структуры регионов, состояния инфраструктуры, уровня развития человеческого капитала и способности регионов осваивать инвестиции.

Ключевые слова: инвестиционные потоки, региональное развитие, валовой региональный продукт, инвестиции в основной капитал, панельные данные, фиксированные эффекты, Узбекистан, региональные различия.

INTRODUCTION

Investment is a central mechanism through which economies expand productive capacity, renew capital stock, introduce new technologies, and improve infrastructure. At the regional level, however, the relationship between investment and economic development is not automatic. Similar amounts of capital may generate different outcomes depending on the quality of project selection, local labour skills, market access, institutional capacity, and the structure of regional production. Consequently, the relevant policy question is not only how much investment a region attracts but also how effectively that investment is converted into additional value added, productivity, and employment.

This issue is particularly important for Uzbekistan, where regional economies differ in industrial specialisation, demographic scale, infrastructure, and access to domestic and external markets. Official statistical data indicate that investment in fixed capital increased from UZS 16,463.7 billion in 2010 to UZS 603,558.8 billion in 2025. Over the same period, gross domestic (regional) product at current prices increased from UZS 88,102.4 billion to UZS 1,849,650.0 billion [1-2]. These figures indicate a substantial expansion in the nominal scale of investment and output.

Nevertheless, a direct comparison of nominal series is insufficient to measure the contribution of investment to real regional growth. Inflation, changes in relative prices, population growth, and differences in regional economic size may affect the observed relationship. Furthermore, investment may respond to expected growth, as economically stronger regions can attract more capital, creating a potential issue of reverse causality. A reliable empirical assessment therefore requires a panel-data framework, price adjustments, and controls for other determinants of regional output.

The article makes three main contributions. First, it considers investment intensity, rather than nominal investment volume alone, as the central explanatory concept. Second, it proposes a panel-data specification that accounts for unobserved regional heterogeneity and common annual shocks. Third, it links the econometric framework to differentiated regional policies, emphasising investment quality and absorptive capacity rather than focusing exclusively on investment volume targets.

LITERATURE REVIEW

The theoretical relationship between capital formation and economic growth is rooted in the neoclassical growth framework. Solow [6] demonstrates that capital accumulation can increase output per worker during the transition to a steady state, while long-run growth depends on technological progress. This distinction is important for regional policy: increased investment may raise output, but sustained productivity gains require technology adoption, skills development, and favourable institutional conditions.

Endogenous growth approaches place greater emphasis on knowledge, innovation, and human capital. Romer [5] argues that investment in knowledge and technological change can generate effects beyond the accumulation of physical capital. In regional contexts, this suggests that the composition of investment matters: projects that enhance technological capabilities, workforce skills, and inter-firm linkages may generate stronger spillover effects than projects that primarily expand physical capacity.

Empirical studies examining the relationship between investment and economic growth commonly address issues of endogeneity, omitted-variable bias, and measurement accuracy. Regional output can attract investment, while investment can also stimulate output. Fixed-effects models help control for time-invariant regional characteristics and common time shocks, although they do not automatically resolve reverse causality. For this reason, the interpretation of estimated coefficients requires caution, while stronger causal conclusions require an appropriate instrumental-variable strategy or another suitable identification approach.

For Uzbekistan, official regional statistics provide a basis for constructing a panel dataset comprising GRP, investment, population, and other socioeconomic indicators. The present study builds on this statistical foundation and proposes a transparent econometric model that can be replicated and extended as a complete region-year dataset is assembled.

RESEARCH METHODOLOGY

The study employs a quantitative regional panel-data design. The intended unit of observation is the administrative region-year. The core sample should cover the Republic of Karakalpakstan, the regions of Uzbekistan, and Tashkent city for the longest period during which statistical definitions and regional boundaries remain comparable. A balanced panel is preferable; however, if some observations are unavailable, an unbalanced panel may be employed, provided that missing-data patterns are explicitly reported.

The dependent variable is the natural logarithm of real GRP per capita. The main explanatory variable is the natural logarithm of real investment in fixed capital per capita. Per capita measures reduce, although do not entirely eliminate, the influence of differences in regional population size. Both nominal series should be converted into comparable prices using appropriate regional or national investment and GRP deflators. If regional deflators are unavailable, this limitation should be explicitly acknowledged, and robustness checks using official real growth indices should be conducted.

The baseline two-way fixed-effects specification is:

$$\ln(GRPpc_it) = \alpha + \beta \ln(INVpc_it) + \boldsymbol{\gamma}\boldsymbol{X}_\boldsymbol{it} + \boldsymbol{\mu}_\boldsymbol{i} + \boldsymbol{\lambda}_\boldsymbol{t} + \boldsymbol{\varepsilon}_\boldsymbol{it}$$

where GRPpc_it denotes real gross regional product per capita in region I and year t; INVpc_it represents real investment in fixed capital per capita; X_it is a vector of control variables; **μ_i** captures time-invariant regional characteristics; **λ_t** captures common year-specific shocks; and **ε_it** is the idiosyncratic error term. The coefficient β measures the conditional elasticity of real GRP per capita with respect to real investment per capita.

Subject to data availability, the vector of control variables should include employment or labour force participation, average years of schooling or an appropriate education proxy, the share of industry in GRP, infrastructure access, and population growth. Control variables should be selected on theoretical grounds and assessed for multicollinearity. Variables that are direct consequences of investment should be included with caution, as their inclusion may account for part of the total investment effect.

Three estimation stages are recommended. First, pooled ordinary least squares (OLS), region fixed-effects, and random-effects models should be estimated as benchmarks. Second, the Hausman specification test should be employed to inform the choice between fixed-effects and random-effects models, while recognising that the underlying research design and the correlation between regional effects and explanatory variables

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remain decisive. Third, the two-way fixed-effects model should be estimated using standard errors clustered at the regional level. Given the relatively small number of regional clusters, wild-cluster bootstrap methods or other small-sample robust inference procedures should be considered.

To examine delayed effects, an alternative model should incorporate a one-year lag of investment: $\ln(GRPpc_{it}) = \alpha + \beta_0 \ln(INVpc_{it}) + \beta_1 \ln(INVpc_{i,t-1}) + \boldsymbol{\gamma} \boldsymbol{X}_{it} + \mu_i + \lambda_t + \varepsilon_{it}$. The sum $\beta_0 + \beta_1$ captures the contemporaneous and one-period lagged association, subject to the model's assumptions. A dynamic panel estimator may be considered only if the time dimension, instrument count, and specification diagnostics justify its application.

The main research hypotheses are as follows:

H1: Real investment intensity is positively associated with real GRP per capita.

H2: The estimated association varies across regions depending on their productive and institutional capacities.

H3: The relationship is stronger in regions with more developed human capital and infrastructure.

Hypotheses H2 and H3 can be tested using interaction terms, such as the interaction between investment and an infrastructure or human capital indicator.

Artificial intelligence (AI) tools were used to a limited extent, accounting for approximately 10% of the overall research preparation process. Their use was primarily confined to language refinement, technical editing, and structural support. The selection of research methods, analysis and interpretation of findings, and formulation of scientific conclusions and recommendations were carried out independently by the author.

ANALYSIS AND RESULTS

The official SIAT database provides annual data series on investment in fixed capital and gross domestic (regional) product. Table 1 summarises the national totals at current prices for selected years. These data are useful for describing the scale of capital formation; however, they should not be interpreted as indicators of real growth because they are expressed in nominal Uzbek soums (Table 1).

Table 1. Dynamics of Investment in Fixed Capital and Gross Domestic Product (GDP) at Current Prices in Uzbekistan, 2010–2025[1]

Year	Investment in fixed capital (UZS bn)	GRP/GDP aggregate at current prices (UZS bn)
2010	16,463.7	88,102.4
2015	44,810.4	250,544.6
2020	210,195.1	705,076.5
2023	356,071.4	1,261,806.0
2024	507,490.2	1,535,431.7
2025	603,558.8	1,849,650.0

Between 2010 and 2025, nominal investment in fixed capital increased substantially. Aggregate output also expanded over the same period. This parallel movement is consistent with the proposition that capital formation and economic activity are interconnected. However, both series exhibit a strong time trend and are influenced by price changes. Consequently, a regression of one nominal aggregate on the other could produce an artificially high estimated association. The regional panel model should therefore employ real values, per capita transformations, and year fixed effects to improve the reliability of the estimates.

The 2025 GRP data illustrate substantial differences in the economic scale of Uzbekistan's regions. Tashkent city recorded a GRP of UZS 367,222.3 billion, while Tashkent region and Navoi region recorded UZS 180,177.4 billion and UZS 167,964.6 billion, respectively. Jizzakh region recorded UZS 52,956.7 billion, while the Republic of Karakalpakstan recorded UZS 54,076.9 billion [2]. These figures reflect differences in the overall scale of regional economic activity rather than direct measures of welfare or productivity. Therefore, population size and industrial structure should also be considered when assessing regional economic development (Table 2).

1 Author's development.

Table 2. Regional Distribution of Gross Regional Product (GRP) in Uzbekistan in 2025 (at Current Prices)

Region	GRP in 2025, current prices (UZS bn)
Tashkent city	367,222.3
Tashkent region	180,177.4
Navoi region	167,964.6
Samarkand region	121,489.5
Andijan region	107,717.6
Jizzakh region	52,956.7
Republic of Karakalpakstan	54,076.9

Source: National Statistics Committee, SIAT, annual volume of gross domestic (regional) product [2].

The observed differences reinforce the need to distinguish regional economic size from regional development performance. A large region may record a high total investment volume simply because it has a larger population or production base. Conversely, a smaller region may achieve higher investment intensity per capita while still recording a lower total GRP. Accordingly, the econometric analysis should report both aggregate and per capita indicators and, where possible, investment-to-GRP ratios.

The official national time series and regional GRP figures establish the relevance of the research question but are insufficient to estimate and report a panel regression coefficient. In particular, regional investment observations for each region and year must be matched with corresponding regional GRP, population, and control variables, while nominal values must be consistently adjusted for inflation. Until the complete dataset is assembled and the model is estimated, statements suggesting that a 1% increase in investment causes a specific percentage increase in GRP would lack sufficient empirical support.

The proposed fixed-effects model is designed to identify whether within-region changes in investment intensity are associated with changes in real output after accounting for common annual shocks and time-invariant regional characteristics. If the estimated coefficient decreases substantially following the inclusion of year fixed effects, this would suggest that part of the observed relationship is attributable to nationwide trends. If lagged investment is statistically significant while contemporaneous investment exhibits a weaker association, the result would be consistent with delays associated with project implementation and productive capacity development. These interpretations represent testable hypotheses rather than empirical findings established by the present descriptive dataset.

The proposed framework suggests that regional investment policy should extend beyond investment volume targets. Project appraisal should assess expected additional value added, productivity, employment quality, local supplier linkages, technology transfer, and environmental sustainability. Regions with developing infrastructure or workforce skills may benefit from complementary public investment to enhance the effectiveness of substantial private capital inflows and support the achievement of intended economic outcomes.

A differentiated approach is also necessary. In industrially specialised regions, investment screening can prioritise technological upgrading and the development of value chains. In regions with a substantial agricultural base, investment can support processing, storage, irrigation efficiency, and logistics. In service-oriented and tourism regions, connectivity, utilities, workforce skills, and the preservation of local assets may determine the productivity of new capital. Such differentiation can improve the conversion of investment into value added retained within regional economies.

CONCLUSION AND RECOMMENDATIONS

The study examines the relationship between investment flows and regional economic development in Uzbekistan and develops a panel-data approach for its econometric assessment. Official statistics indicate a substantial increase in nominal investment in fixed capital and aggregate output between 2010 and 2025. Regional GRP data also demonstrate considerable differences in the economic scale of regions. These patterns highlight the importance of analysing investment not only in aggregate terms but also from a regional perspective.

1. Investment in fixed capital has expanded considerably in nominal terms. However, nominal growth should be distinguished from real capital accumulation and investment effectiveness. Adjustments for inflation and population size are essential for meaningful comparisons.

2. Regional differences in total GRP are substantial. Therefore, regional investment performance should be assessed using a combination of total investment volume, per capita investment, investment intensity, and real output growth.

3. A two-way fixed-effects panel model provides an appropriate baseline for estimating the conditional relationship between investment intensity and regional output, provided that the dataset is consistent and the underlying assumptions and diagnostic results are properly reported.

4. Investment effects are likely to depend on complementary regional conditions, including infrastructure, human capital, industrial structure, and institutional capacity. These interaction effects should be examined empirically rather than assumed.

5. The evidence presented in this study provides a foundation for further estimating causal elasticities and statistically significant panel coefficients. Establishing such results requires the completion of the region-year dataset, appropriate price adjustments, and the estimation of the proposed econometric model.

Based on these conclusions, the following recommendations are proposed:

− Establish an integrated annual regional dataset combining real investment in fixed capital, GRP, population, employment, education, and infrastructure indicators.

− Introduce a regional investment efficiency dashboard to monitor additional value added, labour productivity, stable employment, local procurement, and project completion rates.

− Prioritise complementary investments in transport, energy, water supply, digital connectivity, and vocational skills in regions where further development of absorptive capacity would enhance investment effectiveness.

− Evaluate public investment projects using ex post performance indicators by comparing planned outcomes with realised effects on output, productivity, and employment.

− Encourage private and foreign investment that supports technology transfer, export diversification, and stronger linkages between large investors and local small and medium-sized enterprises.

Further research should estimate the proposed model using a fully deflated regional panel dataset and assess the robustness of the results through alternative dependent variables, lag structures, and identification strategies. This would facilitate a transition from descriptive analysis of parallel trends to a more rigorous assessment of the contribution of investment to regional economic development.

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