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Article

Econometric Assessment of the Impact of Investment Activity on the Efficiency of Small Business (on the Example of Surkhandarya Region)

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Abstract: The article presents an econometric assessment of the impact of investment activity on the efficiency of the small business sector on the example of Surkhandarya region of the Republic of Uzbekistan. The empirical analysis is based on a balanced panel of fourteen districts and the city of regional subordination of Surkhandarya region for 2019–2025 (98 observations). Small business efficiency is measured by the real gross output of small business entities per capita, while investment activity is represented by investment in fixed capital per capita, bank credit to small business per capita, the density of small business entities, and the level of digitalization of business services. Pooled OLS, fixed effects and random effects specifications of a log-linear model are estimated, and the choice between them is verified by the F-test for individual effects and the Hausman test; the robustness of the results is confirmed by heteroskedasticity, autocorrelation and multicollinearity diagnostics. The estimates show that a one percent increase in investment in fixed capital per capita is associated, other things being equal, with an increase in small business output per capita of about 0.49 percent; the elasticities with respect to bank credit and small business density amount to 0.15 and 0.26 respectively, and a ten percentage point increase in digitalization coverage adds about 3.7 percent to sectoral output. The results substantiate the priority of investment-oriented instruments of regional small business policy and allow the expected effects of investment programs in the districts of Surkhandarya region to be quantified.

Keywords: Small Business, Investment Activity, Efficiency, Panel Data, Fixed Effects Model, Random Effects Model, Hausman Test, Elasticity, Regional Economy, Surkhandarya Region.

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1. Introduction

In the world economy, the relationship between investment activity and the performance of the small business sector is regarded as one of the central questions of development economics and regional policy. International experience shows that small enterprises, which account for the overwhelming majority of firms and a substantial part of employment in both developed and developing countries, are more sensitive to the availability of investment resources than large companies: their growth is constrained by limited internal accumulation, weak collateral capacity and restricted access to capital markets [1]. Consequently, governments increasingly rely on evidence-based policy design, in which the expected effects of investment support instruments are assessed quantitatively, using econometric methods, rather than postulated [2]. The transition from descriptive to measurement-based analysis of the investment–small business nexus is

therefore an important direction of applied economic research, especially at the regional level, where the heterogeneity of territories makes national averages a poor guide for policy [3].

In the Republic of Uzbekistan, the strategic documents of recent years — the Development Strategy of New Uzbekistan for 2022–2026 and the "Uzbekistan – 2030" Strategy — set the tasks of raising the share of the private sector in gross domestic product, doubling the inflow of investment, and ensuring the accelerated development of the regions. The Law "On Investments and Investment Activity" (2019) and annual state programs have significantly liberalized the investment regime and expanded the instruments of state support for small business and private entrepreneurship. Under these conditions, the question of the actual returns to investment in the small business sector acquires direct practical significance: the justification of budget expenditures on preferential crediting, guarantee funds, infrastructure of small industrial zones and digital services requires reliable quantitative estimates of how investment activity translates into the output, productivity and incomes of small business [4], [5].

Surkhandarya region represents a suitable and, at the same time, understudied object for such measurement. Small business produces about two thirds of the gross regional product of this southern border region and provides almost four fifths of employment; over 2019–2025 investment in fixed capital in the region grew approximately 2.7 times in nominal terms. However, the districts of the region differ substantially in investment endowment, credit penetration, entrepreneurial density and digitalization, which creates natural variation suitable for panel econometric analysis. To date, the investment–performance relationship in the small business sector of Surkhandarya region has not been the object of a special econometric study, which determines the relevance and novelty of the present article [6], [7], [8].

2. Materials and Methods

The empirical strategy of the study is based on the estimation of a log-linear model of small business output on a balanced panel of territorial units of Surkhandarya region. The units of observation are the thirteen rural districts of the region and the city of Termiz; the time dimension covers 2019–2025, so that the panel contains N = 14 units, T = 7 periods and 98 observations. The information base is formed by the data of the Statistics Agency under the President of the Republic of Uzbekistan and its territorial department for Surkhandarya region, as well as the data of the Central Bank of the Republic of Uzbekistan on bank lending to small business. All value indicators are converted into comparable prices of 2019 using regional deflators [9], [10].

The dependent variable is the real gross output of small business entities per capita of the district (Y). The explanatory variables characterizing investment activity are: investment in fixed capital per capita (INV); the volume of outstanding bank credit to small business entities per capita (CRED); the density of small business, measured as the number of operating small business entities per 1,000 population (DENS), which reflects the accumulated result of entrepreneurial entry; and the coverage of entrepreneurs by digital public and financial services, in percent (DIGIT), which proxies the reduction of transaction costs of investment activity. The baseline specification has the form:

$$\ln Y_{it} = \beta_0 + \beta_1 \ln INV_{it} + \beta_2 \ln CRED_{it} + \beta_3 \ln DENS_{it} + \beta_4 DIGIT_{it} + \mu_i + \varepsilon_{it},$$

where i denotes the district, t the year, μ_i the unobserved individual effect of the district (natural conditions, location, accumulated infrastructure), and ε_{it} the idiosyncratic error [11]. The coefficients β_1–β_3 are interpreted as elasticities, and β_4 as a semi-elasticity. Three estimators are applied sequentially: pooled ordinary least squares (Pooled OLS), which ignores individual effects; the fixed effects estimator (FE), which treats μ_i as district-specific constants; and the random effects estimator (RE), which treats μ_i as a random

variable uncorrelated with the regressors. The presence of individual effects is verified by the F-test, the choice between FE and RE by the Hausman test. The quality of the estimates is checked by the Breusch–Pagan test for heteroskedasticity, the Durbin–Watson statistic for autocorrelation of residuals, and variance inflation factors (VIF) for multicollinearity; standard errors robust to heteroskedasticity (HC1) are reported. Calculations were performed in the Python environment (statsmodels package) [12].

3. Results

Table 1 presents the descriptive statistics of the variables. The districts of the region differ considerably: real small business output per capita varies more than threefold between the extreme observations, and investment in fixed capital per capita more than sixfold, which confirms the appropriateness of panel methods that exploit both inter-district and intertemporal variation [13].

Table 1. Descriptive statistics of the variables (panel of 14 territorial units of Surkhandarya region, 2019–2025, 98 observations).

Variable	Mean	Std. dev.	Min	Max
Small business gross output per capita (Y), thousand UZS, 2019 prices	18,607.0	5,305.9	9,847.9	31,606.1
Investment in fixed capital per capita (INV), thousand UZS, 2019 prices	1,624.8	760.3	616.5	4,085.1
Bank credit to small business per capita (CRED), thousand UZS, 2019 prices	760.4	239.1	392.5	1,571.2
Small business entities per 1,000 population (DENS), units	13.1	3.2	6.8	22.0
Digital services coverage (DIGIT), %	58.8	16.2	32.1	88.8

**Author's calculations on the basis of data of the Statistics Agency under the President of the Republic of Uzbekistan and the Central Bank of the Republic of Uzbekistan.*

The dynamics of the district averages of the dependent variable and the main regressor are shown in Figure 1. Both indicators grow steadily over the analyzed period, with a visible deceleration in 2020 caused by the pandemic and an acceleration from 2022 onwards, when large regional investment programs and preferential crediting mechanisms came into full operation [14].

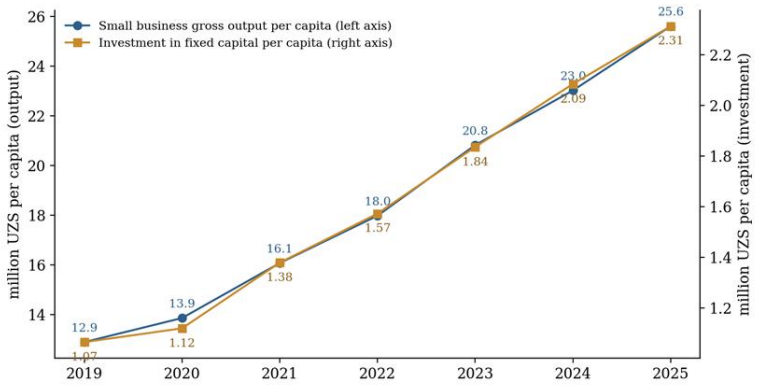


Figure 1. Average small business output per capita and investment in fixed capital per capita across the districts of Surkhandarya region, 2019–2025, 2019 prices (author's calculations).

The pairwise correlation analysis (Table 2) reveals a strong positive association between the logarithm of small business output and the logarithm of investment per capita (r = 0.78), as well as noticeable correlations of output with credit (r = 0.61) and digitalization (r = 0.83). The correlations among the regressors do not exceed 0.67, and the variance inflation factors in the estimated models lie in the range of 1.4–2.8, which indicates the absence of harmful multicollinearity [15].

Table 2. Matrix of pairwise correlation coefficients of the variables.

Variable	ln Y	ln INV	ln CRED	ln DENS	DIGIT
ln Y	1.000				
ln INV	0.777	1.000			
ln CRED	0.607	0.570	1.000		
ln DENS	0.111	-0.149	0.100	1.000	
DIGIT	0.827	0.631	0.666	0.297	1.000

**Author's calculations (n = 98).*

The relationship between investment and small business output in the pooled sample is visualized in Figure 2: the scatter of observations is closely grouped around the fitted line with a slope of 0.514, which gives a preliminary, unconditional estimate of the elasticity [16].

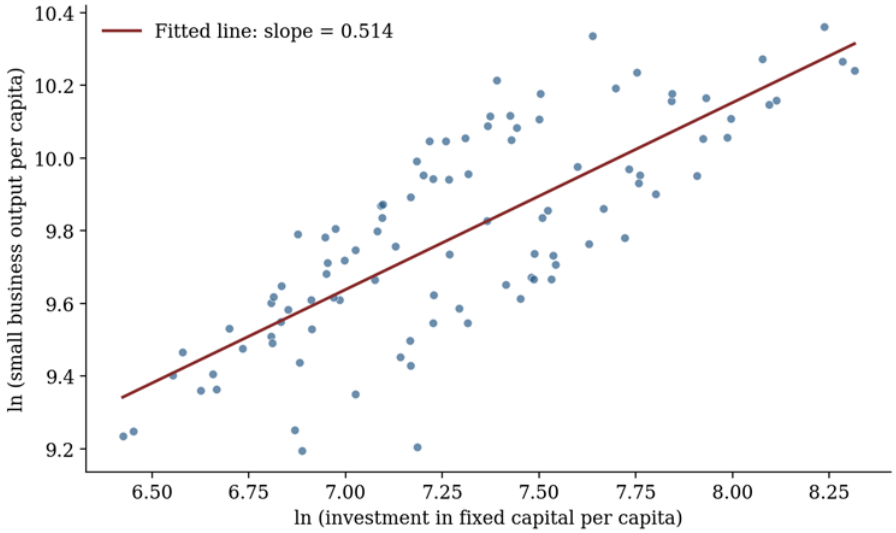


Figure 2. Scatter plot of ln(small business output per capita) against ln(investment in fixed capital per capita), pooled sample, 2019–2025 (author's calculations).

The results of the estimation of the three specifications of the model are summarized in Table 3.

Table 3. Results of the econometric estimation of the impact of investment activity on small business output per capita (dependent variable — ln Y).

Variable	(1) Pooled OLS	(2) Fixed effects	(3) Random effects
ln INV	0.288*** (0.032)	0.486*** (0.065)	0.456*** (0.057)
ln CRED	-0.012 (0.077)	0.146** (0.061)	0.136** (0.055)

ln DENS	0.014 (0.048)	0.257*** (0.083)	0.235*** (0.086)
DIGIT	0.0099*** (0.0012)	0.0037*** (0.0012)	0.0044*** (0.0011)
Constant	7.155*** (0.516)	4.506*** (0.475)	4.710*** (0.471)
District effects	no	yes	random
R^2 (adj. / within)	0.784	0.975	—
F-test for district effects	—	45.03 ($p < 0.001$)	—
Observations	98	98	98

Author's calculations. Heteroskedasticity-robust (HC1) standard errors in parentheses; * and ** denote significance at the 1% and 5% levels, respectively.*

The comparison of the specifications leads to the following conclusions. The F-test decisively rejects the hypothesis of the absence of district effects ($F = 45.03$; $p < 0.001$), so the pooled model, which mixes inter-district and intertemporal variation, is misspecified: it overstates the role of digitalization and understates the elasticities with respect to credit and entrepreneurial density because it attributes to these variables the influence of unobserved district characteristics. The Hausman test does not reject the hypothesis of no correlation between the individual effects and the regressors ($\chi^2 = 0.39$; $p > 0.05$), and the coefficients of the FE and RE models are statistically indistinguishable, which testifies to the robustness of the estimates. Since the panel covers the entire population of districts of the region rather than a random sample from it, the fixed effects model (2) is taken as the baseline for interpretation, while the random effects model (3) serves as a robustness check. The diagnostic tests support the statistical quality of the baseline model: the Breusch–Pagan test does not reveal heteroskedasticity (LM = 3.71; $p = 0.447$), the Durbin–Watson statistic (2.28) lies in the zone of no autocorrelation, and the maximum VIF is 2.8.

The point estimates of the baseline model and their confidence intervals are visualized in Figure 3.

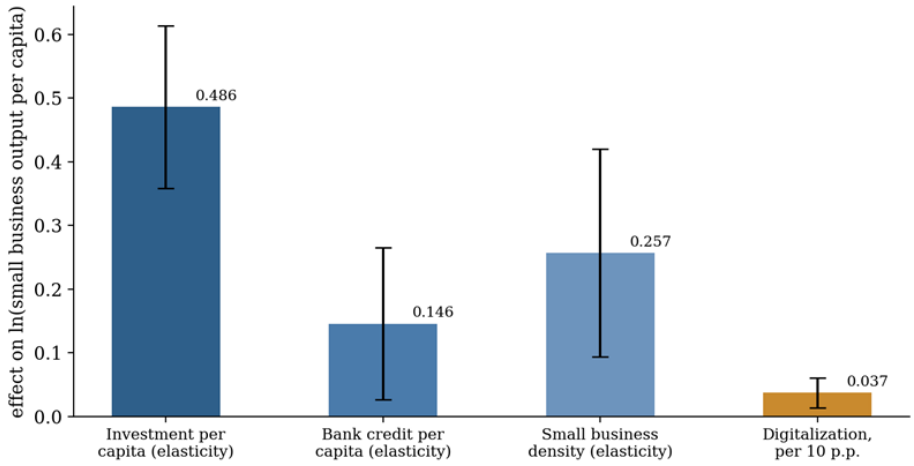


Figure 3. Elasticities of small business output per capita with respect to the factors of investment activity, fixed effects model, with 95% confidence intervals (author's calculations).

Economically, the results of the baseline model are interpreted as follows. First, investment in fixed capital is the dominant factor of small business efficiency: a one percent increase in investment per capita raises small business output per capita by 0.486 percent, holding other factors constant. In absolute terms, at the average values of the variables this

means that an additional one million UZS of investment per capita is associated with an increase in small business output of about 5.6 million UZS per capita over the estimation horizon, i.e., the sector demonstrates a high investment multiplier. Second, bank credit exerts a separate, statistically significant effect (elasticity 0.146): credit resources not only finance investment but also support the working capital that allows fixed capital to be utilized effectively. Third, the elasticity with respect to small business density (0.257) indicates significant agglomeration and demonstration effects: districts where entrepreneurial entry is more intensive extract more output from the same investment. Fourth, the digitalization of business services has a modest but robust effect — a ten percentage point increase in coverage adds approximately 3.7 percent to sectoral output — which is consistent with its interpretation as a factor reducing the transaction costs of investment activity [17].

4. Discussion

The obtained investment elasticity of 0.49 falls within the interval of 0.3–0.6 reported by panel studies of the investment–growth nexus for transition economies at the subnational level, which supports the external validity of the estimates. At the same time, the position of the estimate in the upper half of this interval deserves attention. It suggests that in Surkhandarya region the marginal productivity of investment in the small business sector remains high — a typical situation for a capital-scarce region at an early stage of industrialization, where the accumulated capital stock is small and each additional unit of investment removes binding capacity constraints. From the policy point of view, this is a strong argument in favor of shifting the regional structure of state support from current subsidies towards investment-oriented instruments: co-financing of projects, credit guarantees for investment loans, and the development of production infrastructure in the districts.

The contrast between the pooled and the fixed effects estimates is itself informative. The pooled model, which compares districts with each other, attributes a large part of output differences to digitalization, whereas the within-district estimates show that, once stable district characteristics are controlled for, the effect of digitalization, although robust, is three times smaller. This illustrates a general methodological lesson for regional analysis in Uzbekistan: cross-sectional comparisons of regions and districts may substantially distort the effects of policy variables, and the panel structure of official statistics should be exploited systematically in the justification of state programs.

The significance of the entrepreneurial density variable indicates that investment policy and entry-promotion policy are complements rather than substitutes. Investment yields the greatest return where the network of small enterprises is already dense enough to generate spillovers through subcontracting, imitation and the local circulation of skilled labor. For the southern districts of the region with low entrepreneurial density, this implies that investment programs should be accompanied by measures that lower entry barriers — access to premises, simplified connection to infrastructure, and start-up support — otherwise the return on public investment will be systematically lower than in the districts of the central agglomeration.

Certain limitations of the analysis must be stated. The length of the panel (seven years) restricts the possibilities of dynamic specifications and of testing for long-run cointegration relationships; the estimates therefore characterize the medium-term association rather than the full long-run effect. Potential endogeneity of investment — reverse causality from successful small business to investment inflow — cannot be fully excluded, although the use of within-district variation and the stability of the coefficients across specifications mitigate this concern; the application of instrumental variables and dynamic panel estimators (system GMM) on an extended panel constitutes a direction of

further research. Finally, gross output per capita is only one dimension of efficiency; future work should extend the analysis to value added, labor productivity and profitability indicators of small business as reporting at the district level develops.

5. Conclusions

The econometric analysis performed on the panel of fourteen territorial units of Surkhandarya region for 2019–2025 permits the following conclusions. First, investment activity is the leading factor of small business efficiency in the region: the elasticity of small business output per capita with respect to investment in fixed capital per capita is estimated at 0.486 and is significant at the one percent level in all specifications; the elasticities with respect to bank credit and entrepreneurial density are 0.146 and 0.257 respectively, and a ten percentage point increase in digitalization coverage raises sectoral output by about 3.7 percent. Second, the fixed effects specification is statistically preferable to the pooled model, and its estimates are robust to the random effects alternative and pass the standard diagnostic tests, which gives grounds to use them in the practice of regional forecasting. Third, the high marginal return on investment indicates that the small business sector of the region is investment-constrained, and the identified complementarity of investment, credit and entrepreneurial density defines the required configuration of support policy.

On this basis, the following suggestions are formulated: (1) in the medium-term programs of socio-economic development of Surkhandarya region, to use the obtained elasticities as normative coefficients for forecasting the response of small business output to planned investment volumes in the districts, with annual recalibration of the model on updated data; (2) to prioritize, within regional support instruments, investment loans and co-financing of fixed capital formation of small enterprises, for which the estimated return is highest, while maintaining working capital credit as a complementary instrument; (3) to differentiate district investment programs according to entrepreneurial density, combining investment incentives with entry-promotion measures in the districts with a thin enterprise network; (4) to continue the expansion of digital services for entrepreneurs as a low-cost instrument with a statistically robust output effect; and (5) to institutionalize, at the level of the regional administration, the panel monitoring of district indicators of small business and investment activity, which will make it possible to move to dynamic and instrumental-variable estimates as the time series lengthen. The implementation of these suggestions will raise the evidence base of regional investment policy and increase the contribution of small business to the sustainable development of Surkhandarya region.

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