



IQTISODIYOT & TARAQQIYOT

Ijtimoiy, iqtisodiy, texnologik, ilmiy, ommabop jurnal

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THE DIGITAL ECONOMY AND ITS IMPACT ON THE LABOUR MARKET AND EMPLOYMENT IN THE REGIONS OF UZBEKISTAN: PANEL DATA ANALYSIS

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Abstract. This paper presents an econometric analysis of the impact of the digital economy on the labour market and employment across the regions of the Republic of Uzbekistan for the period 2018–2025 using panel data. Based on the Fixed Effects model, the results show that a one-point increase in the digitalization index is associated with an average increase of 0.478 percentage points in regional employment, after controlling for GRP per capita, urbanization, and education. The study covers 14 regions and confirms the statistically significant positive effect of digital transformation on job creation, particularly in the services sector and among young people. Regional heterogeneity is also identified, with a stronger effect observed in highly urbanized regions such as Tashkent and Samarkand.

Keywords: digital economy, labour market, employment, panel data, Fixed Effects, Uzbekistan, Digital Index, regional development, IT sector, Digital Uzbekistan 2030 Strategy.

Аннотация. В данной статье представлен эконометрический анализ влияния цифровой экономики на рынок труда и занятость населения в регионах Республики Узбекистан за период 2018–2025 годов на основе панельных данных. С использованием модели фиксированных эффектов (Fixed Effects Model) установлено, что увеличение индекса цифровизации на один пункт связано в среднем с ростом уровня занятости в регионе на 0,478 процентного пункта после учета таких контрольных переменных, как валовой региональный продукт на душу населения, уровень урбанизации и уровень образования. Исследование охватывает 14 регионов страны и подтверждает статистически значимое положительное влияние цифровой трансформации на создание рабочих мест, особенно в сфере услуг и среди молодежи. Также выявлена региональная неоднородность: наиболее выраженный эффект наблюдается в высокоурбанизированных регионах, таких как Ташкент и Самарканд.

Ключевые слова: цифровая экономика, рынок труда, занятость, панельные данные, модель фиксированных эффектов (Fixed Effects), Узбекистан, индекс цифровизации (Digital Index), региональное развитие, ИТ-сектор, Стратегия «Цифровой Узбекистан – 2030».

Annotatsiya. Ushbu maqolada 2018–2025-yillar oralig'ida O'zbekiston Respublikasi hududlarida raqamli iqtisodiyotning mehnat bozori va bandlikka ta'siri panel ma'lumotlari asosida ekonometrik tahlil qilingan. Belgilangan effektlar modeli asosida olingan natijalar raqamlashtirish indeksining 1 punktga oshishi, aholi jon boshiga YaHM, urbanizatsiya va ta'lim darajasi kabi nazorat o'zgaruvchilari hisobga olingan holda, hududiy bandlik darajasining o'rtacha 0,478 foiz punktga oshishi bilan bog'liqligini ko'rsatadi. Tadqiqot mamlakatning 14 ta hududini qamrab oladi hamda raqamli transformatsiyaning ish o'rinlarini yaratishga, ayniqsa xizmat ko'rsatish sohasi va yoshlar bandligiga statistik jihatdan sezilarli ijobiy ta'sir ko'rsatishini tasdiqlaydi. Shuningdek, hududlar kesimida farqlanish mavjudligi aniqlanib, eng kuchli ta'sir Toshkent va Samarqand kabi yuqori darajada urbanizatsiyalashgan hududlarda kuzatilgani qayd etilgan.

Kalit so'zlar: raqamli iqtisodiyot, mehnat bozori, bandlik, panel ma'lumotlari, belgilangan effektlar modeli, O'zbekiston, raqamlashtirish indeksi, hududiy rivojlanish, IT sektori, "Raqamli O'zbekiston – 2030" strategiyasi.

INTRODUCTION

In today's world, digitalization is one of the key drivers of economic development. The digital economy, built upon the widespread use of information and communication technologies (ICT), artificial intelligence, big data, and the Internet of Things, is fundamentally transforming the structure of production, consumption,



and employment [3][4]. In the context of global competition, the transition to a digital economic model creates opportunities to increase labour productivity, generate new jobs, and strengthen national competitiveness [1] [2].

One of the key policy documents in this sphere is the Digital Uzbekistan 2030 Strategy, approved by Presidential Decree No. UP-6079 of 5 October 2020 [6]. The Strategy provides for the development of digital infrastructure, e-government, the national IT sector, the digitalization of economic sectors, and the improvement of digital literacy among the population. Its key priorities include the training of qualified personnel, including the One Million Uzbek Programmers programme, the establishment of IT parks across the regions, and the stimulation of investment in digital technologies.

Tax and other incentives for residents of IT Park Uzbekistan serve as an important stimulus for digital transformation [9]. Furthermore, state programmes aimed at the digitalization of healthcare, education, and public administration, including Presidential Resolution No. PP-4699 and subsequent regulatory acts, contribute to the expansion of electronic services and the development of digital competencies among the population [6].

Despite significant progress, including the growth of ICT-sector employment from 62,200 persons in 2020 to 87,800–108,800 persons in 2023–2025, as well as the development of regional IT centres [7][9], several important tasks remain relevant. These include reducing regional disparities, especially the concentration of digital activity in Tashkent, expanding the supply of skilled workers with digital competencies, and further adapting labour legislation to new forms of employment, such as freelancing, platform work, and remote employment [10].

LITERATURE REVIEW

Issues related to the impact of the digital economy on the labour market have been extensively studied by foreign researchers. According to M. Spence, digital technologies not only increase economic efficiency but also contribute to the creation of new jobs [11]. Furthermore, Brynjolfsson and McAfee emphasize that digital transformation leads to the emergence of new professions in the labour market and increases demand for highly skilled workers [12].

Uzbek scholars have also paid considerable attention to this issue. In particular, A. Vahobov notes that the digital economy has a positive impact on regional development and employment opportunities [13]. Similarly, Sh. Mustafoqulov argues that digitalization processes in Uzbekistan play an important role in promoting youth employment and expanding the service sector [14].

The development of the digital economy in Uzbekistan over the past five years, particularly in 2020–2025, has demonstrated impressive momentum, supported by the implementation of the Digital Uzbekistan 2030 Strategy [6]. According to data from UNDP and Stat.uz, ICT-sector employment increased from 62,200 persons in 2020 to 87,800 persons in 2023, reaching approximately 108,800 persons by 2025. The share of the digital economy in GDP rose from approximately 1.9–2.0% in 2020–2021 to 2.1% in 2023, while the information and communications services sector recorded one of the highest value-added growth rates, at 24.2% [8]. The number of companies operating in the ICT sector exceeded 10,500 by 2024, and ICT services exports doubled from USD 140 million in 2022 to USD 344 million in 2023 [9].

Tashkent and its surrounding regions account for a significant share of IT Park activity, hosting more than 2,500 resident companies. At the same time, in remote regions such as the Republic of Karakalpakstan, Surkhandarya, and Jizzakh, there remains considerable potential to further expand broadband internet penetration and increase the availability of digital services. According to panel data research, a composite Digital Index, constructed from the number of internet subscribers, mobile base stations, and cellular subscriptions per 100 inhabitants, demonstrates a positive correlation with employment levels across 14 regions for the period 2010–2024 [2][8].

To quantitatively assess this impact, a Fixed Effects panel data model was employed. The baseline specification takes the following form [2]:

$$\text{Employment}_{it} = \beta_0 + \beta_1 \text{DigitalIndex}_{it} + \beta_2 \ln(\text{GRP}_{it}) + \beta_3 \text{Urban}_{it} + \beta_4 \text{Edu}_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

where Employment_{it} is the employment rate, either total employment or employment in non-agricultural sectors, in region i in year t ; DigitalIndex_{it} is the digitalization index; $\ln(\text{GRP}_{it})$ is the logarithm of gross regional product per capita; Urban_{it} is the urbanization rate; Edu_{it} is the share of the population with higher education; α_i represents region fixed effects; γ_t represents time effects; and ε_{it} is the error term [8] (Table 1).



Table 1
Descriptive Statistics of Panel Data (2018–2025, 14 Regions)

Variable	Mean	Std. Dev.	Min	Max	Observations
Employment rate (%)	69.85	4.72	58.40	78.90	112
Digital Index (0–100)	48.76	18.45	22.10	92.30	112
ln(GRP per capita)	8.12	0.68	7.05	9.85	112
Urbanization (%)	51.40	12.80	32.10	78.50	112
Education, share of population with higher education (%)	18.70	5.90	9.80	32.40	112
ICT employment (thousand persons)	4.82	6.95	0.45	28.70	112

The Fixed Effects least squares estimation, based on a panel of 14 regions for the period 2018–2024/2025 and covering approximately 100–110 observations, shows that the coefficient β_1 for the Digital Index is positive and statistically significant at the 1% level. The results indicate that a one-unit increase in the digitalization index is associated with an increase in the employment rate by 0.35–0.65 percentage points, after controlling for other relevant factors. Overall, the obtained results remain robust and qualitatively consistent.

In addition, quantile regression analysis was conducted to examine effect heterogeneity across regions. The findings reveal that the impact of the digital economy is stronger in the upper quantiles of the employment distribution, particularly in more developed regions such as Tashkent, Samarkand, and Fergana. In these regions, the estimated coefficient reaches 0.8–1.0 percentage points, indicating that digital transformation has a more pronounced effect on employment in areas with stronger economic and digital infrastructure (Table 2).

Table 2
Pearson Correlation Matrix

Variable	Employment	Digital Index	ln(GRP per capita)	Urbanization	Education
Employment	1.000	0.684	0.712	0.658	0.521
Digital Index	0.684	1.000	0.793	0.824	0.679
ln(GRP per capita)	0.712	0.793	1.000	0.781	0.642
Urbanization	0.658	0.824	0.781	1.000	0.715
Education	0.521	0.679	0.642	0.715	1.000

All correlations are statistically significant at the 1% level.

The relatively high correlation between the Digital Index and urbanization confirms the importance of using the Fixed Effects model, as it allows for controlling region-specific characteristics and reducing potential bias in the estimation results.

During 2020–2025, the panel data reflect both the impact of the pandemic and the subsequent recovery period. In 2020, overall national employment temporarily declined; however, the ICT sector demonstrated positive dynamics, recording 6% growth even while the broader economy experienced contraction. By 2023–2025, total employment reached approximately 14.8–15.0 million persons, while the share of ICT-sector employment increased from below 0.5% to nearly 1% [7].

Regional disparities remain noticeable. In Tashkent, ICT employment accounts for more than 2–3% of total employment, whereas in predominantly agricultural regions such as Andijan, Namangan, and Syrdarya, this indicator remains below 0.3%. These differences are also supported by the correlation matrix: the correlation coefficient between the Digital Index and services employment ranges from 0.72 to 0.81, while its correlation with agricultural employment is negative, at –0.45 [8] (Table 3).

Table 3
Panel Regression Estimation Results
Dependent Variable: Employment Rate (%)

Variables	Pooled OLS	Fixed Effects (FE)	Random Effects (RE)	System GMM
Digital Index	0.142 (0.028)	0.478 (0.094)	0.321 (0.067)	0.392 (0.112)
ln(GRP per capita)	3.85 (0.62)	2.14 (0.89)	2.87 (0.71)	1.96 (0.95)
Urbanization	0.218 (0.045)	0.145 (0.082)	0.176 (0.068)	0.132 (0.091)
Education	0.184 (0.071)	0.267 (0.104)	0.231 (0.089)	0.204 (0.118)
Constant	18.45	—	22.76	—
R ² (within/overall)	0.682	0.574	0.631	—
Observations	112	112	112	98
Number of regions	14	14	14	14
Hausman test (p-value)	—	0.000	—	—

Robust standard errors are reported in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Interpretation of the main model, namely the Fixed Effects model, shows that a one-unit increase in the digitalization index is associated with an average increase of 0.478 percentage points in regional employment, holding other factors constant. This confirms the statistically significant positive effect of the digital economy on the labour markets of Uzbekistan’s regions over the period 2020–2025 [8].

In addition, a dynamic System GMM model, based on the Arellano-Bover/Blundell-Bond approach, was estimated to account for employment persistence and the potential endogeneity of the Digital Index. In this model, the Digital Index was instrumented using lagged values and external factors, including public investment in digital and transport infrastructure.

One of the important transmission channels is job creation through IT parks and training centres. By 2024–2025, more than 200 IT centres were operating in Uzbekistan, producing approximately 125,000 graduates annually, 20% of whom specialized in IT-related fields. The One Million Uzbek Programmers programme has also contributed to strengthening digital skills among young people. Econometric analysis using the Digital Index × Youth Share interaction term shows that the effect of digitalization on youth employment is 40–50% stronger than its effect on overall employment. This highlights the potential of the digital economy to support youth employment and reduce youth unemployment, which exceeded 10–12% in certain regions during 2020–2022 [9] (Table 4).

Table 4
Heterogeneity of Effects
Quantile Regression with Fixed Effects

Quantile	25th	50th (Median)	75th
Digital Index	0.291	0.465	0.812
Standard error	(0.118)	(0.097)	(0.134)

The effect is stronger in more developed regions, particularly in the upper quantiles of the employment distribution.

At the same time, certain transformation-related risks should also be considered. Automation and the digitalization of traditional sectors, including agriculture and manufacturing, may require the reskilling of low-skilled workers. The Oaxaca-Blinder decomposition, conducted on aggregated data, suggests that approximately 25–35% of employment growth in the digital sector can be explained by observable characteristics such as



education and urbanization, while the remaining share reflects the broader influence of digitalization policy. Although regional disparities are gradually narrowing, they still remain relevant: the coefficient of variation for the Digital Index across regions declined from 0.48 in 2020 to 0.35 in 2025, but continues to indicate uneven digital development [4].

Descriptive statistics from the panel dataset for 2018–2025 confirm these general trends. The mean value of employment ranges from 68% to 72% of the economically active population across regions, while the Digital Index increased by an average of 45–60% over the period. In addition, GRP per capita, expressed in logarithmic form, rose by 25–30% in real terms. The correlation matrix indicates moderate multicollinearity, with VIF values below 4 for all variables, which supports the reliability of the estimates. Potential heteroskedasticity, tested using the Breusch-Pagan test, and autocorrelation, tested using the Wooldridge test, were addressed through the application of robust standard errors [8].

Overall, the results of the empirical analysis confirm the hypothesis that the digital economy has a positive effect on regional labour markets in Uzbekistan. Digitalization serves not only as a driver of GDP growth but also as an important instrument of structural employment transformation, facilitating the transition from agriculture-based employment toward services and high-technology activities. To further strengthen these positive effects, additional policy measures may focus on reducing the digital divide, developing regional digital infrastructure, expanding retraining programmes, stimulating foreign direct investment in the IT sector beyond the capital city, and adapting labour legislation to platform-based and remote forms of employment [10].

RESEARCH METHODOLOGY

This study employs a quantitative econometric approach to analyse the impact of the digital economy on labour market development and employment across the regions of Uzbekistan. The research is based on panel data collected from 14 regions of the Republic of Uzbekistan for the period 2018–2025. The use of panel data makes it possible to examine both regional and time-specific effects, thereby providing a more comprehensive understanding of the relationship between digitalization and employment [2].

The empirical dataset was compiled using official statistical sources, including the National Statistics Committee of the Republic of Uzbekistan (Stat.uz), the Ministry of Digital Technologies, and reports from the Ministry of Employment and Labour Relations. The dataset includes annual observations on employment rates, digital infrastructure, regional economic performance, urbanization levels, and educational attainment [7].

To assess the level of digitalization, a composite indicator called the Digital Index was developed. This index is based on three main indicators: the number of internet subscribers per 100 inhabitants, the number of mobile communication base stations, and the number of cellular subscriptions per 100 inhabitants [8].

To estimate the relationship between digitalization and employment, the Fixed Effects (FE) model was applied. This method allows for controlling unobserved regional characteristics that remain constant over time, such as institutional quality, industrial specialization, and historical development patterns. The econometric model is specified as follows:

$$\text{Employment}_{it} = \beta_0 + \beta_1 \text{DigitalIndex}_{it} + \beta_2 \ln(\text{GRP}_{it}) + \beta_3 \text{Urban}_{it} + \beta_4 \text{Educ}_{it} + \alpha_i + \gamma_t + \varepsilon_{it} \quad [2].$$

In addition, quantile regression and System GMM estimation were used as robustness checks to examine the heterogeneous and dynamic effects of digitalization on employment. These methods strengthen the reliability of the empirical findings and provide a broader assessment of how digital transformation influences labour market outcomes across different regions of Uzbekistan.

ANALYSIS AND RESULTS

The empirical analysis reveals a significant positive relationship between the digital economy and regional employment in Uzbekistan. Descriptive statistics show that the average employment rate across the 14 regions during 2018–2025 was 69.85%, while the average Digital Index reached 48.76 points. At the same time, gross regional product per capita and urbanization rates demonstrated steady growth, indicating the expansion of regional economic activity and digital infrastructure.

The correlation analysis indicates a strong positive association between employment and digitalization. The Pearson correlation coefficient between employment and the Digital Index is 0.684, suggesting that higher levels of digitalization are generally associated with better labour market performance. Similarly, employment shows positive correlations with gross regional product per capita (0.712), urbanization (0.658), and education (0.521), confirming the importance of these factors in regional employment dynamics.



The Fixed Effects regression model provides the main empirical results of the study. The coefficient of the Digital Index is positive and statistically significant at the 1% level, with an estimated value of 0.478. This means that a one-point increase in the digitalization index is associated with an average increase of 0.478 percentage points in regional employment, holding other factors constant.

The Hausman test results strongly support the Fixed Effects model over the Random Effects model (p -value = 0.000), indicating the presence of significant regional heterogeneity. Additional robustness checks using System GMM estimation also confirm the positive effect of digitalization. Although the estimated coefficient is slightly lower at 0.392, it supports the view that digital transformation contributes to both short-term and long-term improvements in employment.

Quantile regression analysis reveals heterogeneous effects across regions. The impact of digitalization is stronger in the upper quantiles of the employment distribution, with coefficients increasing from 0.291 in the 25th quantile to 0.812 in the 75th quantile. This suggests that more developed and urbanized regions benefit more actively from digital transformation compared to less developed regions.

One of the main explanations for this positive effect is the rapid growth of the ICT sector in Uzbekistan during 2020–2025. Government initiatives such as the “Digital Uzbekistan 2030” Strategy, the expansion of IT parks, and the “One Million Uzbek Programmers” programme have accelerated digital transformation and expanded employment opportunities, particularly for young people and highly skilled workers [6].

Overall, the study demonstrates that digitalization is not only an important factor of economic growth but also a key mechanism for employment generation and labour market modernization in Uzbekistan. To further strengthen these positive outcomes, policymakers should focus on reducing regional digital inequality, expanding digital education, and creating favourable conditions for ICT investment across all regions of the country [10].

CONCLUSIONS AND RECOMMENDATIONS

The development of the digital economy in Uzbekistan during 2020–2025 has had a significant positive impact on regional labour markets and employment. The empirical analysis, based on panel data from 14 regions, confirms the main research hypothesis that digitalization is an important driver of employment growth. According to the Fixed Effects model estimates, the coefficient of the Digital Index is positive and statistically significant, indicating that digital transformation contributes to the creation of new jobs in the ICT sector and related industries.

During the study period, employment in the information and communications sector increased from 62,200 persons in 2020 to 108,800 persons in 2025. The composite digitalization index also increased by an average of 45–60% across regions. The strongest effects are observed in urbanized areas and among young people, as confirmed by the quantile regression results and interaction terms. At the same time, regional differences in digital development remain relevant. The concentration of digital jobs in Tashkent and surrounding regions indicates the need to expand positive spillover effects to more remote regions, including the Republic of Karakalpakstan, Surkhandarya, and Jizzakh.

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