



Article

The Effect of the Digital Economy on the Employment Structure in Uzbekistan

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Abstract: This study assesses the impact of the development of the digital economy on regional employment and economic activity in Uzbekistan using panel data. The analysis is based on a dataset compiled for 14 regions between 2010 and 2024. To determine the level of the digital economy, the indicators of internet subscribers (per 100 inhabitants), the number of mobile base stations and mobile cellular subscriptions (per 100 inhabitants) are combined and a composite Digital_Index is created through principal component analysis (PCA). This index is used as a generalized measure of the level of digital infrastructure and digital connectivity.

The empirical assessment uses a regional fixed effects model (FE) and year effects, with standard errors clustered by region. The model includes the level of urbanization and GDP per capita (log form) as control variables. The results show that the Digital_Index has a positive and statistically significant relationship with the level of employment. Digital development also has a significant positive impact on the size of the construction sector, while the results in the agricultural sector are relatively mixed, with GDP per capita in some cases being negative and significant.

The study findings highlight that expanding digital infrastructure across regions can be an important factor in increasing employment and real sector activity. The results have practical implications for defining regional digital policy and investment priorities in Uzbekistan.

Keywords: Digital Economy, Employment, Employment Structure

1. Introduction

In recent years, digital technologies have become an integral part of economic processes, directly affecting not only the production and service delivery system, but also the formation of the labor market [1]. In particular, the expansion of Internet infrastructure, mobile communication coverage, and access to digital services can change the level of economic activity and employment across regions. In the context of Uzbekistan, this issue is even more relevant, because although the process of digital transformation is accelerating in the country, the level of digital development is not the same between regions.

This study aims to empirically assess the impact of digital economy development on employment and economic activity based on panel data for 14 regions of Uzbekistan for the period 2010–2024. In order to measure the digital economy, the study forms a composite Digital_Index using the PCA method based on the number of Internet subscribers, the density of mobile base stations, and mobile subscriptions [2], [3]. This index is considered a holistic measure of regional digital development.

The main method of the empirical analysis is the fixed effects model. This approach allows controlling for unobservable regional factors and captures common shocks over

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time through dummy variables of years. The model includes the level of urbanization and GDP per capita (log form) as control variables [4]. The results may indicate that digital development has a significant impact on employment and the performance of certain sectors, which provides practical conclusions for the formulation of regional digital policies.

2. Literature Review

In recent years, digital transformation and the development of the digital economy have been considered as important factors explaining changes in the labor market, employment structure, and economic structure [5]. The scientific literature emphasizes that the impact of digitalization on employment is not one-sided: it can reduce jobs in some sectors, while increasing the demand for new professions and roles in others. Therefore, when analyzing the impact of digital development on employment, the level of information (firm, region, or individual), the method of measuring the digital index, and the strategy for solving the endogeneity problem are important. One of the firm-level studies is Qiao et al, which examines the impact of digital transformation on employment in Chinese A-share listed companies in 2013–2023 [6]. The study uses a panel fixed effects model and examines endogeneity using instrumental variables and Propensity Score Matching (PSM). The results show that digitalization increases the demand for labor in technical, financial, and sales departments, while reducing production positions [7]. However, there is a net positive impact on total employment. However, since these results are limited to listed firms, the generalizability to other firms is somewhat limited. At the regional level, Zhao et al. estimated the employment impact of the digital economy by industry in 31 regions of China from 2013 to 2020. The Hausman test justifies the choice of the FE model. According to the results, the primary sector (agriculture, forestry, fisheries, and mining) is almost unchanged [8]. The secondary sector (manufacturing and construction) employment is significantly negatively affected. The tertiary sector (services) benefits significantly from digital development. This suggests that digitalization can accelerate the process of “tertiaryization” in the economy. However, the limited time frame of 8 years and the analysis conducted at the macro level may not fully reveal individual or firm-specific mechanisms [9]. In the case of European countries, Evangelista et al. used pooled GLS and Arellano–Bond GMM dynamic panel methods for the EU-27 countries for the period 2004–2008. Their main conclusion is that the economic impact of digitalization is only significant when the transition from basic ICT infrastructure to a higher level is achieved [10], [11]. Regarding the inclusive impact of the digital economy on employment, Lu et al. show that urban-level digital development in China increases female employment. Using an IV approach and strong fixed effects controls, they find that the probability of female employment increases by 2.59 percentage points when digital development increases by 1 standard deviation. However, long-term job quality (wage trajectory, career growth) is not well explored [12].

Overall, the literature suggests that digital development redistributes employment, strengthens the service sector, and that outcomes vary by region and sector. However, there is a lack of empirical studies assessing the impact of digital development on employment and sector performance across regions of Uzbekistan.

3. Methodology

3.1. Data and variables

This study used a balanced panel data set (N=210) formed for 14 regions of Uzbekistan between 2010 and 2024. The main dependent variable was the employment

rate (per 1,000 population), and in additional analysis, the production volume of the construction and agricultural sectors was also used as outcome variables. The main independent variable was the Digital_Index, constructed based on PCA, which combines indicators of internet subscribers, mobile base stations and mobile subscriptions. The level of urbanization and the logarithmic form of GDP per capita were included as control variables.

Table 1. Indicator system of the digital economy (Uzbekistan regions)

First Dimension	Secondary Dimension	Specific Indicators
Digital economy development	Internet infrastructure	Internet subscribers per 100 population
	Mobile network infrastructure	Mobile base stations (radiostations)
	Mobile connectivity and usage	Mobile cellular subscriptions per 100 population

Based on the availability of data at the regional level, the digital economy is confirmed by indicators reflecting digital infrastructure and connectivity. Internet penetration, mobile base station density, and mobile subscription intensity reflect the key conditions for digital development. These indicators are then aggregated into a composite digital index using principal component analysis (PCA).

Table 2. Summary of variable descriptions and data sources

Symbol	Variable	Proxy / Definition	Data Source
Employment	Employment	Number of employed persons per 1000 population	State Statistics Committee of Uzbekistan
Construction	Construction activity	Volume of construction works (billion UZS)	State Statistics Committee of Uzbekistan
Agriculture	Agriculture, forestry and fisheries	Gross output of agriculture, forestry and fisheries (billion UZS)	State Statistics Committee of Uzbekistan
ICTservice	ICT services	Volume of communication and information services	State Statistics Committee of Uzbekistan
Digital_index	Digital economy	Composite digital index (PCA-based)	State Statistics Committee of Uzbekistan
Urbanization	Urbanization	Share of urban population (%)	State Statistics Committee of Uzbekistan
lnGDPpc	logGDP per capita/Economic development	Log of GDP per capita	State Statistics Committee of Uzbekistan
In_access	Internet access per 100	Internet subscribers per 100 population	State Statistics Committee of Uzbekistan
MobBS	Mobile infrastructure	Number of mobile base stations (radiostations)	State Statistics Committee of Uzbekistan

MobSub	Mobile connectivity	Mobile cellular subscriptions per 100 population	State Committee of Uzbekistan	Statistics of
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4. Result and Discussion

4.1. Benchmark Regression Analysis

Table 3 shows the statistical description of variables, including the names of variables, number of variables, mean value, standard deviation, minimum value, and maximum value.

Table 3. Descriptive statistics of variables

Variable	Obs	Mean	Std. dev.	Min	Max
Employment	N=210 n=14 T=15	935.9924	367.7622	319.9	1563.9
Construction	N=210 n=14 T=15	4731.618	7685.528	134.9	69012.3
Agriculture	N=210 n=14 T=15	13919.69	12432.83	0	56830.8
ICTserv	N=210 n=14 T=15	995.2471	3642.625	26.7	40909.8
In_access	N=210 n=14 T=15	44.75759	34.83708	4.02057	209.2359
MobBS	N=210 n=14 T=15	1790.266	1722.557	305.6	15590
MobSub	N=210 n=14 T=15	76.95195	65.41506	15.42138	688.1787
Urbanization	N=210 n=14 T=15	49.91787	16.21555	32.22274	100
LnGDPpc	N=210 n=14 T=15	9.182626	.8947923	7.360168	11.6971

Employment levels differ sharply across different types of regions. In oasis and valley regions, economic activity relies more heavily on the “real sector,” which is associated with relatively higher employment [13], [14]. In contrast, Tashkent city is dominated by services and higher productivity activities, where employment is “lower, but more efficient.” This result provides strong justification for using the fixed effects (FE) model and highlights the need to analyse regional heterogeneity separately.

Table 4 Pearson correlation matrix giving good signal for doing PCA test: The indicators are sufficiently correlated ($r \sim 0.63-0.92$), this means that they measure a “single latent factor” (digital development). It is scientifically justified to derive a single Digital_Index through PCA

Table 4. Pearson correlation matrix

	In_access	MobBS	MobSub
In_access	1.0000		
MobBS	0.6573***	1.0000	
MobSub	0.6313***	0.9177***	1.0000

***, ** and * are significant at the 1%, 5% and 10% levels, respectively.

Table 5 the result of PCA test. A component with an Eigenvalue > 1 is accepted. Comp1 measures – Internet coverage (In_access), Mobile infrastructure (MobBS) and Mobile usage (MobSub). The combined growth of all three – Digital_Index increases. It has been accepted as a holistic measure of the concept of digital economy development.

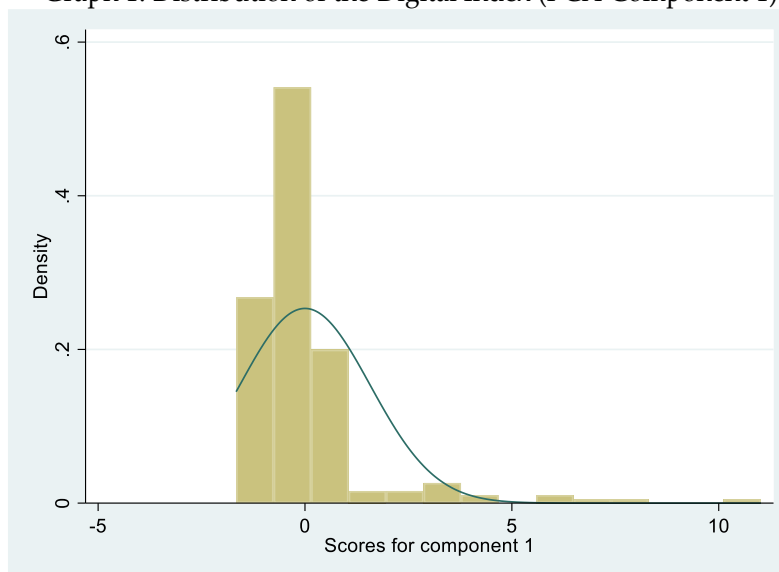
Table 5. PCA test result. Principal components (eigenvectors)

Variable	Comp1	Comp2	Comp3
In_access	0.5245	0.8505	0.0394
MobBS	0.6049	-0.3397	-0.7202

MobSub	0.5992	-0.4016	0.6926
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$$\text{Digital_Index} = 0.525 \cdot \text{In_access} + 0.605 \cdot \text{MobBS} + 0.599 \cdot \text{MobSub}$$

Graph 1. Distribution of the Digital Index (PCA Component 1)



Digital_Index varies significantly across regions, which methodologically justifies panel FE analysis and heterogeneity studies.

Table 6 Pearson correlation matrix shows that digital development is positively and significantly associated with employment. Urbanization also shows a positive association with employment, while GDP per capita does not show a significant direct correlation. The correlations between the independent variables remain below the traditional multicollinearity thresholds, indicating that the underlying regression model is well specified.

Table 6. Pearson correlation matrix with main variables.

	Employment	Digital_index	Urbanization	lnGDPpc
Employment	1.0000			
Digital_index	0.2691***	1.0000		
Urbanization	0.2886***	0.7365***	1.0000	
lnGDPpc	0.0445	0.4828***	0.2128**	1.0000

***, ** and * are significant at the 1%, 5% and 10% levels, respectively.

Basic regression result

VarName	(1) Employment	(2) Construction	(3) Agriculture
Digital_Index	13.325***	614.623***	664.103
	(4.32)	(3.52)	(1.41)
Urbanization (%)	3.300	649.638	-1762.220
	(0.16)	(0.76)	(-1.52)
ln(GDP per capita)	-84.744	11017.340	-17413.880**
	(-1.57)	(0.92)	(-2.54)
_cons	1333.198	-118152.600	227555.900**
	(1.16)	(-1.06)	(2.50)
N	210	210	210
R ² (within)	0.6392	0.6055	0.8811
Region FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

SE	Clustered	Clustered	Clustered
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Discussion

Previous studies have explored the relationships among the financial opening, wages, and employment structure at the sector level. However, few scholars have systematically researched the link between digital transformation and the labour structure of China. This study set out to examine the relationship between the digital economy and the change in the sectoral composition of employment in China. These results corroborate the ideas of Frolov and Lavrentyeva, Akaev et al, and Zhao who suggested that the digital economy is one driver of the tertiarization process. The development of the digital economy has reduced the employment proportion in the primary sectors while increasing the employment proportion in the tertiary sector and optimising the industrial structure [15]. A limitation of this study is that the research time is relatively short; only eight years of data are available. A further study could assess the long-term effects of the digital economy on the labour structure.

5. Conclusion

This study empirically assessed the impact of digital economy development on regional employment and economic activity in Uzbekistan based on panel data for 14 regions over the period 2010–2024. The main achievement of the study is that digital development was measured not by a single indicator, but by a PCA-based composite Digital_Index that combines indicators of internet subscribers, mobile base stations, and mobile subscriptions. This approach allowed for a more holistic representation of the level of digital infrastructure and digital connectivity in regions. The results obtained based on the fixed effects model and year effects showed that the Digital_Index has a positive and statistically significant relationship with the level of employment. This result means that the expansion of digital infrastructure can activate the labor market in regions and create additional conditions for job creation. However, it is also observed that the impact of digital development is not the same in all regions. For example, while employment in oasis and valley regions is more dependent on the real sector, in Tashkent city, employment is formed relatively less, but more efficiently, due to the dominance of services and high productivity. It is these strong regional differences that methodologically justify the choice of the FE model.

The results by sector also provide important conclusions. The digital index has a significant positive impact on the volume of the construction sector, which means that digital development can stimulate investment processes, infrastructure projects, and segments of economic activity related to the real sector. In the agricultural sector, the results are relatively mixed, with the level of economic development (Ln_GDPpc) being negative and significant in some cases. This can be explained by the structural change of the economy, i.e., a decrease in the share of agriculture in high-income regions.

Overall, the results of the study show that the development of digital infrastructure across regions can be an important factor in increasing employment and strengthening the activity of the real sector. However, it is recommended that future research further investigate the issue of endogeneity, use alternative indices and lag models, and include separate regressions for the services sector. This work will serve as an empirical basis for formulating regional digital policies and determining investment priorities in Uzbekistan.

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