

# The impact of China's digital economy development on changes in the labor structure

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**Abstract.** The digital economy has become a key force reshaping industrial structure and patterns of labor allocation. Against this backdrop, whether the digital economy has accelerated the trends of deindustrialization and servicization in the labor structure has emerged as an important issue requiring urgent clarification. Based on China's provincial panel data from 2013 to 2024, this study systematically examines the impact of the digital economy on changes in the labor structure from two dimensions: digital industrialization and industrial digitalization. The findings are as follows. First, the development of the digital economy generally promotes the servicization and deindustrialization of the labor structure, with the driving effect of industrial digitalization being stronger than that of digital industrialization. Second, the elevation of the "digital economy" to a national strategy in 2017 constituted a critical turning point. Thereafter, digital industrialization shifted toward promoting industrialization and restraining servicization, whereas industrial digitalization continued to strengthen servicization while suppressing industrialization. Third, the heterogeneity analysis shows that the urban digital economy exerts a stronger effect than the rural digital economy in promoting servicization and inhibiting industrialization. In addition, the impact of household-side digital economy applications is significantly greater than that of government and enterprise-side applications.

**Keywords:** digital industrialization, industrial digitalization, labor structure, deindustrialization, servicization

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## 1. Introduction

With the deep integration of next-generation information technologies such as big data, artificial intelligence, and cloud computing, the digital economy has evolved from a form of technological innovation into a core engine transforming production methods and driving industrial restructuring. At the same time, the digital economy has profoundly affected the allocation of labor across the three major sectors of agriculture, industry, and services. On the one hand, the application of digital technologies has fostered new business models such as the platform economy and the sharing economy, creating a large number of employment opportunities in the service sector. On the other hand, the advancement of intelligent manufacturing and industrial automation may replace certain traditional industrial jobs, leading to labor outflows from the industrial sector.

These developments raise several critical questions. Is the digital economy driving changes in China's labor structure? Has it accelerated the trends of "deindustrialization" and "servicization" in the labor structure? More importantly, as the two core pathways of the digital economy, do digital industrialization—centered on the

industrialization of digital technologies themselves—and industrial digitalization—centered on the digital transformation of traditional industries—differ in their effects on labor structure transformation? Furthermore, do these effects exhibit heterogeneity between urban and rural areas, as well as between household applications and government-enterprise application scenarios?

In light of these issues, this study, based on the two dimensions of digital industrialization and industrial digitalization, employs provincial-level data from China spanning 2013 to 2024 to investigate the impact of the digital economy on the servicization and industrialization of the labor structure.

## 2. Literature review

The literature related to this study primarily focuses on the impact of the digital economy on the labor market and has generated extensive findings across three dimensions: labor market scale, labor quality, and labor governance.

Regarding the impact of the digital economy on the scale of the labor market, existing studies generally fall into three categories. The first is the creation effect. Digital inclusive finance not only enhances the income stability of employed groups, but also expands employment in the financial sector and non-agricultural industries, thereby increasing overall social employment levels [1, 2]. In addition, corporate digital transformation can expand labor demand by improving production efficiency, with particularly significant employment inclusiveness for vulnerable groups such as low-skilled migrant workers [3]. The second is the substitution effect. Technologies such as artificial intelligence may shorten job life cycles and raise labor costs, thereby squeezing traditional labor-intensive and low-skilled positions. In the absence of appropriate regulation, such developments may aggravate unemployment risks [4]. The third is the heterogeneity effect. The employment effects of digital technologies have not reached a unified conclusion, as the relative strength of the creation and substitution effects varies according to differences in regions, industries, and urban labor structures [5].

Regarding the impact of the digital economy on labor quality, the quantitative contradictions in China's labor market have gradually eased, while qualitative contradictions have become increasingly prominent. As a result, employment quality has become a major focus of academic research. Early studies clearly defined employment quality as encompassing core dimensions such as job characteristics, employment conditions, and labor relations, thereby laying the foundation for the construction of evaluation index systems [6]. Subsequent studies gradually developed two major measurement frameworks. At the macro level, indicators such as the employment environment, labor compensation, and employment structure are mainly adopted to assess the employment effects of policies and economic conditions. At the micro level, measurement frameworks are divided into subjective indicators, such as job satisfaction, and objective indicators, such as wage income and work intensity, in order to analyze the differentiated logic of employment quality among different groups [7].

Regarding the impact of the digital economy on labor governance, transformations in employment forms under the digital economy have raised new requirements for labor market governance. Existing studies mainly focus on three key groups. For rural laborers, efforts should be made from three dimensions—expanding demand, enhancing supply-side capabilities, and improving institutional guarantees—to establish a comprehensive employment support system and ensure stable employment for low-income groups [8, 9]. For university graduates, coordinated efforts among governments, enterprises, and universities are needed to deepen industry–education integration, achieve precise matching between talent supply and industrial demand, and promote the upgrading of workers' professional value [10].

Based on the existing literature, this study may contribute in the following three respects. First, in terms of research topic, there has been little research examining the impact of the digital economy on labor structure transformation. This paper explores how the digital economy influences the industrialization and servicization of the labor structure from the two dimensions of digital industrialization and industrial digitalization, thereby enriching research on the relationship between the digital economy and the labor market. Second, in terms of research methodology, this study conducts heterogeneity analyses based on the point in time when China first incorporated the development of the digital economy into the *Government Work Report*, as well as across the urban–rural dual social structure and the two application scenarios of households and government-enterprise sectors, thereby providing a deeper examination of how China's digital economy affects labor structure transformation. Third, in terms of research samples, this paper employs comprehensive and novel data covering a long time span and encompassing 31 provinces, municipalities, and autonomous regions in China.

### 3. Empirical analysis

#### 3.1. Research design

##### 3.1.1 Variable selection

Dependent variable: labor structure. Drawing on the approach of Simon Kuznets [11], this study measures changes in the labor structure from two dimensions: industrialization and servicization of the labor structure. Specifically, the industrialization of the labor structure is measured by the ratio of employment in the secondary industry to total employment, while the servicization of the labor structure is measured by the ratio of employment in the tertiary industry to total employment.

Independent variable: digital economy development. Following the approach of Du Chuanzhong and Guan Haifeng [12], this study measures digital economy development from two dimensions: digital industrialization and industrial digitalization. Among them, the level of digital industrialization is measured by the total volume of telecommunications business, while the level of industrial digitalization is measured by e-commerce sales.

In addition, for the robustness tests, the proportion of employees engaged in information transmission, software, and information technology services is used as an alternative measure of digital industrialization, while the number of computers used per 100 persons is adopted as an alternative measure of industrial digitalization. For the heterogeneity analysis, urban broadband access users and rural broadband access users are employed to examine urban–rural heterogeneity, while household broadband access users and government-enterprise broadband access users are used to analyze scenario-based heterogeneity.

##### 3.1.2. Data sources

The data used in this study are primarily derived from official statistical data released by China's National Bureau of Statistics, the EPS Global Statistical Data Analysis Platform, the CEInet Statistics Database, and the China Labor Economics Database. Missing data for certain variables were supplemented through the *China Statistical Yearbook* and statistical yearbooks of various provinces, municipalities, and autonomous regions. Except for ratio variables and dummy variables, all continuous variables were logarithmically transformed. Considering data availability and completeness, the sample period was set from 2013 to 2024, covering 31 provinces, autonomous regions, and municipalities across China. The descriptive statistics of the variables are reported in Table 1.

**Table 1.** Descriptive statistics

Variable Definition	Observations	Mean	Standard Deviation	Minimum	Maximum
Total telecommunications business volume (RMB 100 million)	372	1,289	1,785	32.95	15,025
E-commerce sales (RMB 100 million)	372	6,068	9,183	31.40	53,707
Industrialization of labor structure	372	0.376	0.123	0.0909	0.682
Servicization of labor structure	372	0.608	0.118	0.314	0.909
Proportion of employees engaged in informatization-related work	341	0.0225	0.0196	0.00874	0.137
Number of computers used per 100 persons (units)	372	30.92	12.36	11.63	80.74
Urban broadband access users (10,000 households)	372	972.6	757.8	19.06	3,894
Rural broadband access users (10,000 households)	366	395.7	394.4	0.0100	1,653
Household broadband access users (10,000 households)	341	1,194	934.7	16.22	3,916
Government and enterprise broadband access users (10,000 households)	341	199.5	171.6	5.84	713.1

### 3.1.3. Model specification

To examine the impact of China's digital economy development on changes in the labor structure, this study establishes the following econometric model (Equation 1):

$$Y_{i,t} = \alpha + \beta X_{i,t} + \mu_i + \lambda_t + \varepsilon_i \quad (1)$$

In Equation (1),  $i$  represents the region and  $t$  denotes time.  $Y_{i,t}$  is the dependent variable, representing changes in the labor structure of region  $i$  in year  $t$ .  $\alpha$  denotes the constant term, and  $\beta$  is the core coefficient, indicating the average percentage-point change in labor structure transformation caused by the development of China's digital economy. A significantly positive  $\beta$  indicates a promoting effect, whereas a significantly negative  $\beta$  indicates an inhibiting effect.  $X_{i,t}$  represents the core explanatory variable, namely digital economy development.  $\mu_i$  denotes regional fixed effects, which control for region-specific characteristics that do not vary over time, such as geographical location and resource endowment.  $\lambda_t$  represents time fixed effects, which control for factors varying over time but affecting all regions simultaneously, such as macroeconomic fluctuations and national policies.  $\varepsilon_{i,t}$  is the random disturbance term, representing other stochastic factors not captured by the model.

### 3.2. Baseline regression results

Table 2 reports the regression results for the impact of the digital economy on the labor structure. Models (1) and (2) present the regression results for the effects of digital industrialization on the industrialization and servicization of the labor structure, respectively. The estimated coefficients are  $-0.0084$  and  $0.0099$ , both significant at the 5% level. Models (3) and (4) report the regression results for the effects of industrial digitalization on the industrialization and servicization of the labor structure, respectively. The estimated

coefficients are  $-0.0553$  and  $0.0651$ , both significant at the 1% level. As shown in Table 2, the digital economy promotes the servicization of the labor structure while reducing the level of labor structure industrialization. Moreover, the effect arising from industrial digitalization is stronger than that from digital industrialization.

**Table 2.** Baseline regression results

Variables	(1)	(2)	(3)	(4)
	Labor Structure Industrialization	Labor Structure Servicization	Labor Structure Industrialization	Labor Structure Servicization
<i>Dig</i>	$-0.0084^{**}$ (-2.2140)	$0.0099^{**}$ (2.3364)		
<i>Ind</i>			$-0.0553^{***}$ (-18.6793)	$0.0651^{***}$ (20.7500)
<i>Cons</i>	$0.4307^{***}$ (14.5647)	$0.5436^{***}$ (17.2423)	$0.8070^{***}$ (27.2075)	$0.1013^{***}$ (3.3370)
<i>N</i>	372	372	372	372
<i>R2</i>	0.4304	0.4051	0.5729	0.6276

\*Note: \*\*\*, \*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. z-values are reported in parentheses. The same notation applies below.

### 3.3. Robustness tests

To verify the robustness and reliability of the baseline regression results, this study reasonably replaces the measurement indicators of the digital economy. On the one hand, the proportion of employees engaged in information transmission, software, and information technology services is used to replace the total telecommunications business volume as the indicator of digital industrialization. On the other hand, the number of computers used per 100 persons is adopted to replace e-commerce sales as the indicator of industrial digitalization.

Table 3 presents the robustness test results for the impact of the digital economy on the labor structure. Models (1) and (2) report the regression results for the effects of digital industrialization on the industrialization and servicization of the labor structure, respectively. The estimated coefficients are  $-4.4684$  and  $4.6027$ , both significant at the 1% level. Models (3) and (4) present the regression results for the effects of industrial digitalization on the industrialization and servicization of the labor structure, respectively. The estimated coefficients are  $-0.2093$  and  $0.2373$ , both significant at the 1% level. As shown in Table 3, the findings of this section support the robustness and reliability of the baseline regression results.

**Table 3.** Robustness tests

Variables	(1)	(2)	(3)	(4)
	Labor Structure Industrialization	Labor Structure Servicization	Labor Structure Industrialization	Labor Structure Servicization
<i>Dig</i>	-4.4684*** (-11.9763)	4.6027** (10.9823)		
<i>Ind</i>			-0.2093*** (-43.2680)	0.2373*** (45.4134)
<i>Cons</i>	0.4828*** (22.1082)	0.4974*** (24.3815)	1.0792*** (46.2491)	-0.1895*** (-8.1708)
<i>N</i>	372	372	372	372
<i>R2</i>	0.3285	0.2949	0.8450	0.8573

\*Note: \*\*\*, \*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. z-values are reported in parentheses. The same notation applies below.

### 3.4. Heterogeneity analysis

#### 3.4.1. Temporal heterogeneity analysis

In 2017, the Chinese government incorporated the development of the digital economy into the *Government Work Report* for the first time, marking the elevation of the digital economy to a national strategy. Accordingly, this study divides the sample period into two stages, 2013–2017 and 2017–2024, to conduct a temporal heterogeneity analysis and examine whether the impact of the digital economy on the labor structure has changed over time.

Table 4 presents the results of the temporal heterogeneity analysis regarding the impact of the digital economy on the industrialization of the labor structure. Models (1) and (2) report the regression results for the effects of digital industrialization on labor structure industrialization before and after 2017, respectively. The estimated coefficients are  $-0.0333$  and  $0.0182$ , both significant at the 1% level. Models (3) and (4) report the regression results for the effects of industrial digitalization on labor structure industrialization before and after 2017, respectively. The estimated coefficients are  $-0.0245$  and  $-0.0392$ , both significant at the 1% level.

The regression results in Table 4 indicate that the inhibiting effect of digital industrialization on labor structure industrialization existed only before 2017. After 2017, digital industrialization began to exert a promoting effect on labor structure industrialization. In contrast, industrial digitalization consistently exerted an inhibiting effect on labor structure industrialization, and this inhibitory effect became stronger after 2017.

Table 5 presents the results of the temporal heterogeneity analysis regarding the impact of the digital economy on the servicization of the labor structure. Models (1) and (2) report the regression results for the effects of digital industrialization on labor structure servicization before and after 2017, respectively. The estimated coefficients are  $0.0324$  and  $-0.0202$ , both significant at the 1% level. Models (3) and (4) report the regression results for the effects of industrial digitalization on labor structure servicization before and after 2017, respectively. The estimated coefficients are  $0.0262$  and  $0.0432$ , both significant at the 1% level.

The regression results in Table 5 indicate that the promoting effect of digital industrialization on labor structure servicization existed only before 2017. After 2017, digital industrialization began to exert an

inhibiting effect on labor structure servicization. By contrast, industrial digitalization consistently promoted the servicization of the labor structure, and this promoting effect became stronger after 2017.

**Table 4.** Temporal heterogeneity analysis of the impact of the digital economy on labor structure industrialization

Variables	(1)	(2)	(3)	(4)
	Before 2017	After 2017	Before 2017	After 2017
<i>Dig</i>	-0.0333*** (-4.7009)	0.0182*** (8.4561)		
<i>Ind</i>			-0.0245*** (-7.0382)	-0.0392*** (-9.4846)
<i>Cons</i>	0.6327*** (13.2492)	0.2146*** (10.1674)	0.6040*** (18.6196)	0.6609*** (17.2016)
<i>N</i>	155	217	155	217
<i>R2</i>	0.4480	0.4013	0.3870	0.4358

\*Note: \*\*\*, \*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. z-values are reported in parentheses. The same notation applies below.

**Table 5.** Temporal heterogeneity analysis of the impact of the digital economy on labor structure servicization

Variables	(1)	(2)	(3)	(4)
	Before 2017	After 2017	Before 2017	After 2017
<i>Dig</i>	0.0324*** (4.4308)	-0.0202*** (-8.8431)		
<i>Ind</i>			0.0262*** (7.3989)	0.0432*** (9.9394)
<i>Cons</i>	0.3483*** (7.1939)	0.7895*** (36.9076)	0.3597*** (11.2701)	0.2960*** (7.4301)
<i>N</i>	155	217	155	217
<i>R2</i>	0.4188	0.3770	0.3960	0.4623

\*Note: \*\*\*, \*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. z-values are reported in parentheses. The same notation applies below.

### 3.4.2. Urban–rural heterogeneity analysis

Based on the reality of China's urban–rural dual social structure, this study employs the number of urban broadband access users and rural broadband access users to measure the levels of digital economy development in urban and rural China, respectively. An urban–rural heterogeneity analysis is then conducted to reveal the urban–rural characteristics of the digital economy's impact on the labor structure.

Table 6 presents the results of the urban–rural heterogeneity analysis regarding the impact of the digital economy on the labor structure. Models (1) and (2) report the regression results for the effects of the urban and rural digital economy on labor structure industrialization, respectively. The estimated coefficients are  $-0.0955$  and  $-0.0352$ , both significant at the 1% level. Models (3) and (4) present the regression results for the effects

of the urban and rural digital economy on labor structure servicization, respectively. The estimated coefficients are 0.1105 and 0.0392, both significant at the 1% level.

The regression results shown in Table 6 indicate that both the urban digital economy and the rural digital economy promote the servicization of the labor structure while reducing the level of labor structure industrialization. However, the urban digital economy exerts a stronger promoting effect on labor structure servicization and a stronger inhibiting effect on labor structure industrialization than the rural digital economy.

**Table 6.** Urban–rural heterogeneity analysis of the impact of the digital economy on the labor structure

Variables	(1)	(2)	(3)	(4)
	Labor Structure Industrialization		Labor Structure Servicization	
	Urban	Rural	Urban	Rural
Digital Economy	-0.0955*** (-22.1585)	-0.0352*** (-12.3898)	0.1105*** (24.1910)	0.0392*** (12.3396)
_cons	1.8794*** (26.9011)	0.8814*** (19.9178)	-1.1311*** (-15.3600)	0.0453 (0.9367)
<i>N</i>	372	366	372	366
<i>R</i> <sup>2</sup>	0.6922	0.4411	0.7433	0.4673

\*Note: \*\*\*, \*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. z-values are reported in parentheses. The same notation applies below.

### 3.4.3. Scenario-based heterogeneity analysis

Based on the two application scenarios of households and government-enterprise sectors, this study employs the number of household broadband access users and government-enterprise broadband access users to measure the level of digital economy development in household and government-enterprise application scenarios in China, respectively. A scenario-based heterogeneity analysis is then conducted to reveal the scenario-specific characteristics of the digital economy's impact on the labor structure.

Table 7 presents the results of the scenario-based heterogeneity analysis regarding the impact of the digital economy on the labor structure. Models (1) and (2) report the regression results for the effects of household and government-enterprise digital economy applications on labor structure industrialization, respectively. The estimated coefficients are  $-0.0840$  and  $-0.0741$ , both significant at the 1% level. Models (3) and (4) present the regression results for the effects of household and government-enterprise digital economy applications on labor structure servicization, respectively. The estimated coefficients are 0.0984 and 0.0828, both significant at the 1% level.

The regression results shown in Table 7 indicate that both household digital economy applications and government-enterprise digital economy applications promote the servicization of the labor structure while reducing the level of labor structure industrialization. However, household digital economy applications exert a stronger promoting effect on labor structure servicization and a stronger inhibiting effect on labor structure industrialization than government-enterprise digital economy applications.

**Table 7.** Scenario-Based heterogeneity analysis of the impact of the digital economy on the labor structure

Variables	(1)	(2)	(3)	(4)
	Labor Structure Industrialization		Labor Structure Servicization	
	Household	Government–Enterprise	Household	Government–Enterprise
Digital Economy	-0.0840*** (-17.9285)	-0.0741*** (-11.8640)	0.0984*** (19.7532)	0.0828*** (12.0942)
_cons	1.7066*** (22.3241)	1.4137*** (15.7954)	-0.9499*** (-11.7468)	-0.5510*** (-5.6379)
<i>N</i>	341	341	341	341
<i>R2</i>	0.6329	0.5698	0.6956	0.5458

\*Note: \*\*\*, \*, and \* indicate significance at the 1%, 5%, and 10% levels, respectively. z-values are reported in parentheses. The same notation applies below.

## 4. Conclusion

This study finds that the development of China's digital economy has significantly reshaped the labor structure, generally promoting the shift of labor toward the service sector while reducing its proportion in industry. Moreover, this effect is primarily driven by industrial digitalization, whose impact is stronger than that of digital industrialization. Further analysis indicates that the elevation of the "digital economy" to a national strategy in 2017 constituted a critical turning point. Thereafter, digital industrialization began to promote industrialization and inhibit servicization, whereas industrial digitalization continued to strengthen servicization and suppress industrialization, with these effects becoming even more pronounced. The heterogeneity analysis further shows that the urban digital economy exerts a stronger promoting effect on labor structure servicization and a stronger inhibiting effect on industrialization than the rural digital economy. Likewise, household digital economy applications demonstrate stronger effects than government-enterprise applications. These findings suggest that the digital economy, through different actors and regional channels, has differentially accelerated the transformation of China's labor structure toward "deindustrialization" and "servicization".

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