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The Impact of Digital Economy Development on Labor Employment Transformation

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Abstract:
The rapid development of the digital economy has profoundly reshaped the landscape of labor employment markets. Based on Chinese provincial panel data, this study investigates the mechanisms and empirical impacts of digital economy on labor transformation from skill structure and industrial dimensions. The research reveals three key findings: First, digital technologies have significantly increased demand for high-skilled labor through a "polarization effect," while reducing the proportion of medium- to low-skilled jobs. Second, the digital economy has driven industrial upgrading toward service-oriented and high-end sectors, with the tertiary industry's employment share continuously rising. Third, regional economic development levels, human capital accumulation, and urbanization processes play regulatory roles in digital-economy-driven employment transitions. Policy implications include strengthening digital infrastructure construction, improving multi-level education systems to cultivate new talent, and accelerating the digital transformation of traditional industries. This study provides theoretical foundations and practical pathways for implementing an employment-prioritizing strategy in the digital economy era.

Keywords: Digital economy, Labor employment transformation, Skill structure polarization, Industrial structural upgrading, Digital inclusive finance index

1. Introduction

The rapid advancement of key digital technologies — including big data, cloud computing, and blockchain — has positioned the digital economy as a central engine for sustaining innovation and enhancing productivity across society. These technologies have not only accelerated industrial transformation but also profoundly influenced employment markets. Within the digital landscape, data now serves as a critical production element. The Fifth Plenary Session of the 19th Central Committee explicitly emphasized deepening market-oriented reforms in data factor allocation and highlighted the strategic role of the digital economy in high-quality development. The 19th National Congress of the Communist Party of China called for implementing an employment-prioritizing strategy, with digital economy expansion offering new momentum—according to the China Digital Economy Development Report, China's digital economy reached 45.5 trillion yuan in 2021 (accounting for 39.8% of GDP), growing at 16.2%. During the COVID-19 pandemic, the digital economy served as a "stabilizer," particularly in safeguarding labor employment.

However, technological innovation in the digital era has triggered structural shifts in labor markets: On one hand, artificial intelligence and automation technologies have replaced low-skilled positions (e.g., food delivery, taxi driving), leading to contraction in traditional occupations. On the other hand, they have created new job categories and incremental employment opportunities. This "substitution-creation" effect has profoundly reshaped employment structures. Research on the evolution, quality changes, and structural optimization paths of employment under digital economy conditions holds significant practical value for policy formulation[1].

2.Literature Review

Regarding the relationship between the digital economy and employment structure, existing studies indicate that while digital economy promotes employment growth, it also alters employment patterns. B J Nalebuff and A M Brandenburger [2] argue that technological progress creates new jobs while profoundly impacting traditional employment. Hu, AG.et al. [3] demonstrate that the popularization and application of Internet has become a critical channel for job creation, with digital technologies generating substantial employment opportunities and positively influencing industrial restructuring. Li, XH.[4] highlights how China's large population base provides advantages for digital economy development, enabling "dandelion effects" where high-growth digital economy expands opportunities for SMEs and creates more jobs. Shi, XY.[5] identifies foreign investment, innovation entrepreneurship, and economic agglomeration as mediating factors in the impact of digital economy on employment, furthermore, digital government development can suppress the positive effect of digital economy on employment scale but stimulate structural upgrades.

3.Analysis of the influence mechanism of digital economy on labor transformation

Digital technology represents a production model characterized by a high degree of dependence on both human capital and physical capital. While replacing low-level, repetitive labor, this model simultaneously gives rise to more complex labor demands. During this transformation, only high-skilled labor with advanced technical capabilities—such as research, design, and innovation—can rapidly adapt to the changes brought about by digital technologies in industrial development and successfully integrate into this process. For example, professionals with specialized technical skills (e.g., cybersecurity assessors, AI system administrators) are increasingly favored by employers, reflecting the growing market demand for high-skilled talent in the digital economy[6]. The introduction of 19 new digital occupations in China in 2024 (including cybersecurity evaluators and AI system administrators) underscores the urgent need for skilled professionals in this field. What these positions have in common is that they require a high degree of specialized technical competence, reflecting the urgent need for a highly skilled workforce in the context of the digital economy.

While the digital economy offers opportunities, it also poses significant challenges to China's employment landscape. Its substitution effects include:

1.Total Factor Productivity (TFP) Enhancement: Digital integration boosts TFP, leading to contraction of traditional jobs and rising labor costs for enterprises.

2.Automation-Driven Job Displacement: Iterative upgrades in automation equipment lower marginal labor costs, accelerating the replacement of low-skilled positions (e.g., food delivery drivers, taxi operators).

3.Skill Mismatch: Structural digitization causes coexistence of vanishing traditional occupations and expanding new-sector roles, exacerbating mismatches between labor supply and demand[7].

The emergence of new business models is expected to guide China's three major industries toward technology-intensive reforms and development. However, as a traditionally labor-intensive economy, China risks misallocation of resources and inefficiencies if it overly pursues emerging employment opportunities amid the rapid development of the digital economy. Simultaneously, new employment models may be constrained by outdated institutional frameworks that fail to adapt to evolving trends, potentially hindering the positive impacts of the digital economy on industrial upgrading and slowing the pace of sectoral digitalization.

At the industrial transformation level, the three industries face distinct challenges:

ž Agriculture: Mechanization has freed 30 million workers, yet many lack digital literacy to transition into new roles.

ž Manufacturing: Intelligent upgrades have displaced 20 million low-skilled positions, while creating new roles in industrial robot maintenance.

ž Services: Digitization adoption has reached 40%, giv-

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ing rise to professions such as user operations specialists. However, resource imbalances persist: intense competition for high-end talent clashes with lagging skill-training systems, risking stagnation in industrial digitization.

While emerging formats expand employment opportunities, they also expose risks of resource misallocation—a stark contrast between fierce competition for premium talent and outdated training mechanisms. Institutional rigidity could further constrain the integration of new employment models with industrial digitalization, undermining the transformative potential of the digital economy across sectors.

Based on this, puts forward the hypothesis:

H: the development of the digital economy structure of labor skills one-way "polarization" effect, increase the demand for skilled Labour, and reduce the demand for medium and low skill labor. The development of the digital economy makes the rising proportion of the tertiary industry employment, the first and second industry in China.

3. Empirical analysis

3.1 Model specification

To examine the impact of digital economy levels on labor structure, we employ the following panel regression model:

$Labor_{it}=\alpha_0+\alpha_i Digital_{it}+j\sum\beta_j CV_{ijt}+\epsilon_{it}$

where i denotes provinces, t years, *Labor* represents employment structure, *Digital* measures digital economy development (using the Digital Inclusive Finance Index), *CV* includes control variables (urbanization rate, GDP per capita, education attainment, etc.), and ϵit represents erros.

3.2 Data source and index design

Data spans 31 provinces from 2011–2020, sourced from China Labor Statistics Yearbook, China High-tech Statistics Yearbook, China Statistical Yearbook, National Bureau of Statistics, and provincial statistical Yearbook, etc. Indicators and variables are described as follows.

3.2.1 Explanatory Variable

Digital Economy Measurement (DEI):

Quantifying China's digital economy remains challenging due to fragmented metrics. However, the "Peking University Digital Inclusion Financial Index" (DEI), developed by the Peking University Digital Finance Research Center and Ant Group, serves as a robust proxy for digital economic development. This index comprehensively measures three dimensions: Coverage Breadth (geographic reach of financial services), Usage Depth (intensity of service utilization), and Digital Support Services (availability of complementary infrastructure). Empirical validation confirms its strong correlation with other regional digital economy indices ($r > 0.8$). Given its alignment with technological advancement and national economic integration, this study adopts DEI (constructed by Guo Feng et al. [9]) as the core explanatory variable.

3.2.2 Dependent variables

Labor Structure Transformation:

The analysis focuses on two dimensions of labor structure influenced by digitization: 1.Skill Structure: Education level is an important indicator to measure human capital skills. The proportion of the workforce with different education levels is taken as the employment skills structure of the labor force, and the number of people with college degrees or above is taken as the employment structure of high-skilled labor force (high_ tec). 2. Industry Structure: serve tertiary industry employment share (tertiary_ industry) as the labor force industrial employment structure.

3.2.3 Control Variables

To isolate the effect of digital economy on labor structure, the following confounders are included:

ž Urbanization Rate (urban_rate): Urbanization drives agricultural labor migration to non-agricultural sectors, amplifying education access and sectoral reallocation.

ž Per Capita Regional GDP (dgp): Proxy for economic development. Higher GDP per capita correlates with improved employment quality and structural optimization.

ž Average Education Years per Capita (edu): Reflects regional educational investment and human capital accumulation.

ž Labor Training Participation Rate (train): Percentage of workforce engaged in formal training programs. Addresses skill mismatches by enhancing adaptability to technological changes.

Table 1 Descriptive statistics

	Quantity	Minimum	Maximum	Average value	Standard deviation
gdp	310	16024.00	190313.00	58028.54	30530.91
tertiary_ industry (%)	310	19.72	83.12	43.44	10.63

urban rate (%)	310	33.67	77.85	49.09	6.19
edu	310	4.22	12.68	9.16	1.12
high_ tec	310	2.39	50.49	14.89	7.72
train (%)	310	0.00	23.54	2.35	2.22
digital	310	16.22	431.93	216.06	96.91

3.3 Empirical analysis

3.3.1 Correlation analysis

Table 2 Correlation analysis

		digital	tertiary_ industry	high_ tec	gdp	Urban rate	train	edu
digital	Pearson correlation	1.00	542**	415**	618**	162**	0.06	270**
	significance		0.000	0.000	0.000	0.004	0.317	0.000
	N	310	310	310	310	310	310	310
tertiary_ industry	Pearson correlation	542**	1.00	853**	776**	242**	284**	645**
	significance	0.000		0.000	0.000	0.000	0.000	0.000
	N	310	310	310	310	310	310	310
high_ tec	Pearson correlation	415**	853**	1.00	839**	149**	243**	812**
	significance	0.000	0.000		0.000	0.004	0.000	0.000
	N	310	310	310	310	310	310	310
gdp	Pearson correlation	618**	776**	839**	1.00	281**	242**	671**
	significance	0.000	0.000	0.000		0.000	0.000	0.000
	N	310	310	310	310	310	310	310
Urban rate	Pearson correlation	162**	242**	149**	281**	1.00	226**	-.131*
	significance	0.004	0.000	0.004	0.000		0.000	0.012
	N	310	310	310	310	310	310	310
train	Pearson correlation	0.06	284**	243**	242**	226**	1.00	0.03
	significance	0.317	0.000	0.000	0.000	0.000		0.593
	N	310	310	310	310	310	310	310
edu	Pearson correlation	270**	645**	812**	671**	-.131*	0.03	1.00
	significance	0.000	0.000	0.000	0.000	0.012	0.593	
	N	310	310	310	310	310	310	310

3.3.2 Baseline regression

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Table 3 Baseline Regression (Dependent variable: Proportion of employees in the tertiary industry)

model		Nonnormalized coefficient		Standardized Coefficients	t	significance
		B	standard error	β		
1	(constant)	-12.022	5.704		-2.108	0.036
	digital	0.021	0.005	0.188	4.345	0.000
	Urban rate	0.220	0.063	0.135	3.494	0. 001
	Gdp	0.000	0.000	0.374	6.015	0.000
	Edu	3.279	0.474	0.344	6.912	0.000
	Train	0.676	0.168	0.140	4.024	0.000

Table 4 Baseline Regression (Dependent variable: college and above employment proportion)

Model		Nonnormalized coefficient		Standardized Coefficients	t	significance
		B	standard error	β		
1	(constant)	-29.448	2.979		-9.886	0.000
	digital	0.035	0.002	-0.021	-0.645	0.000
	Urban rate	0.102	0.033	0.091	3.099	0.002
	Gdp	0.000	0.000	0.442	9.319	0.000
	Edu	3.483	0.248	0.533	14.057	0.000
	Train	0.324	0.088	0.098	3.696	0.000

Empirical findings from the model estimations demonstrate that digital economy advancement exerts a statistically significant positive impact (at the 1% level) on high-skilled labor's employment share, whereas concurrently suppressing the workforce participation rates of medium- and low-skilled labor groups. In the meantime, it significantly promotes the employment proportion of the tertiary industry, which verifies the hypothesis.

1. Digital technology has a significant differentiated impact on employment structure: the demand for high-skilled jobs increases the most, mid-skilled jobs suffer the most obvious impact, and the substitution effect of low-skilled jobs is weak. This indicates that the development of the digital economy is more in line with the characteristics of high-skill jobs, and its technological innovation mainly replaces repetitive skilled labor, while the replacement of pure manual labor is limited.

2. The upgrading of industrial structure presents the characteristics of 'three-industry-led and high-end focus': the digital economy promotes the accumulation of labor force to the service industry, and accelerates the high-end transformation of manufacturing and service industry. This double effect of service deepening and manufacturing upgrading has prompted the continuous concentration of the job market in high-skill areas.

3.3.3 robustness test

This study verify the robustness of measurement of the level of digital economy through the index replacement method, selects the measurement mode of Zou H. et al. [10], and combines the availability of data to construct four first-level indicators and seventeen second-level indicators, covering digital infrastructure, digital industrialization, industrial digitalization, digital development potential, etc. The entropy weight method is used for comprehensive calculation as the independent variable of digital economy alternative index digital^2. The regression model was reconstructed for analysis.

Table 5 Robustness test (Dependent variable: Proportion of employees in the tertiary industry)

model		Nonnormalized coefficient		Standardized Coefficients	t	significance
		B	standard error	β		
1	(constant)	38.467	0.729		52.798	0. 000
	digital2	46.052	4.535	0.501	10.156	0.000

Table 6 Robustness test (Dependent variable: college and above employment proportion)

model		Nonnormalized coefficient		Standardized Coefficients	t	significance
		B	standard error	β		
1	(constant)	10.925	0.527		20.712	0. 000
	digital^2	33.72	3.283	0.506	10.272	0.000

After changing the measurement method of core explanatory variables, it can be seen from table 5 and table 6 that it is consistent with the results of basic regression. This shows the significance of the model to some extent.

4. Policy suggestion

This study elucidates the multidimensional pathways through which digital economy-driven labor market transformation occurs. These findings provide directional guidance for future research by highlighting two critical domains requiring deeper exploration.

In the aspect of human capital training system, it is urgent to build a skill demand forecasting model to deal with the structural contradictions brought by technological change[11]. The existing research shows that there is a lag in the education supply system, and future research should focus on the innovation path of the integration model of industry and education, especially the connection mechanism between vocational education and industrial digital transformation. In addition, the regional disequilibrium of skill formation is worthy of in-depth exploration, and a multi-dimensional skill evaluation index system should be established to guide the allocation of educational resources.

At the level of industrial upgrading path selection, it is suggested to focus on optimize the industrial structure and driving steady employment growth. All areas must implement suitable measures to steadily expand the service sector. For regions where the primary industry dominates, advancing the modernization of conventional agriculture is essential. In regions predominantly driven by secondary industries, prioritizing the introduction of indigenous technological systems and production apparatus becomes imperative. Such strategic implementation enables the modernization of conventional industrial sectors through automated and intelligent transformation, thereby cultivating emerging technology-intensive industries[12]. Conversely, areas with tertiary sector dominance should vigorously support associated service industries while assuming responsibility for workforce absorption from primary and secondary industrial transitions.

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