Digital Economy, Employment Quality and Capital Allocation Efficiencies

——Evidence from Intelligent Manufacturing Listed Companies

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Abstract. Taking intelligent manufacturing listed companies during 2015-2021 as a sample, the paper incordorated capital allocation efficiencies of enterprises, digital economy, and employment quality into a research framework. It was empirically tested the influence of digital economy on capital allocation efficiencies of intelligent manufacturing enterprises and the mediating transmission mechanism of employment quality. The results show that digital economy can promote positively capital allocation efficiencies of intelligent manufacturing enterprises, and improves their capital allocation efficiencies by improving employment quality. After the robustness test, the conclusions are still valid. Through heterogeneity analysis, digital economic has a more significant promoting on capital allocation efficiencies of state-owned enterprises. The improvement effect of the digital economy development on capital allocation efficiencies of intelligent manufacturing enterprises in the eastern region is weaker than that in other regions.

Keywords: Capital Allocation Efficiency; Employment Quality; Digital Economy

1 Introduction

The high-quality development of manufacturing industry is the top priority for the growth of China's real economy. Since the reform and opening up, manufacturing industry has developed rapidly in China, and its added value has consistently ranked first since 2012. With the continuous rise of international competitive pressure and the increasingly tightening constraints on domestic factor supply, the development speed of China's manufacturing industry is gradually slowing down, and it is facing problems such as being large but not strong, not excellent, and weak key core technologies, which restrict its high-quality development seriously. The digital economy has become a key engine for restructuring industrial factor resources. Promoting the deep integration of industrialization and industrialization is a strategic choice and necessary path to accelerate China's manufacturing power. With the promotion and application of new formats such as mobile payment, manufacturing has become the main battlefield of the digital

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economy. In this context, the 14th Five Year Plan for digital economy points out the need to adhere to the direction of digital development, and requires the implementation of deepening the integration of information technology and manufacturing industry development, and promoting industrial digital transformation. The 20th National Congress of the Communist Party of China proposed to accelerate the construction of a strong manufacturing country and a digital China.

Digital economy is a new economic form generated by digital or information technology and a new driving force for economic growth [1]. It has a promoting effect on economic growth [2], high-quality economic development [3], and manufacturing development [4] at the macro level. At the micro level, the digital economy also has a significant impact on enterprises' technological innovation [5-6], risk taking [7], and total factor productivity [8]. As a new paradigm and form, digital economy has also spawned new demand for employment and new industries, which have a certain creative effect on labor employment. However, industrial digitization will also have a certain impact effect on labor employment [9]. In the context of the digital economy, the application of intelligent technology can enable the manufacturing industry to produce more efficiently, and the improvement of employment quality can optimize the accumulation of human capital elements and promote the improvement of enterprise capital allocation efficiency. Although scholars hold that the digital economy can promote high-quality development of manufacturing industry [4,10], there is little in-depth research in existing literature on the mechanisms through which digital economy affects enterprises' capital allocation efficiencies, and lack of different characteristics of the impact of digital economy on enterprises' capital allocation efficiencies sunder different conditions.

Based on this, the paper systematically examines the influence of digital economy on capital allocation efficiency of intelligent manufacturing enterprises, the mediating transmission mechanism of employment quality, and heterogeneity. The possible innovations mainly lie in the following. Firstly, the research provides new micro data support for intelligent manufacturing industry. Secondly, an in-depth analysis of the influence mechanism of the digital economy on enterprise capital allocation efficiency was conducted, and a theoretical interpretation was provided from the perspective of employment quality, enriching empirical evidence on how the digital economy affects enterprise factor allocation. At the same time, it helps to improve the causal relationship between digital economy and capital allocation efficiencies. Thirdly, the heterogeneity influence of the digital economy on the micro level of enterprises has been further explored, providing new paths and empirical support for improving capital allocation efficiency in intelligent manufacturing enterprises.

2 Theoretical analysis

2.1 Digital Economy and Capital Allocation Efficiency

The digital economy is a new digital economic form formed through three major industries, with data as the production factor and network communication technology as the core driving force [11]. It is also a unique economic phenomenon that appears in the process of industrialization and marketization of the digital revolution [12]. Most scholars in the academic community mainly study the economic consequences caused by enterprises in the context of digital economy, reflecting the value-effect of digital economy [13].

The main effects of digital economy on enterprises' capital allocation efficiencies include the following three aspects. Firstly, it is the innovation effect. The digital economy is not only the foundation of digital transformation, but also the prerequisite for digital transformation. The deep integration of traditional manufacturing and new generation information technology promotes enterprises' digital transformation. After the digital empowerment of the manufacturing industry, advanced technologies have been transformed into intelligent manufacturing, driving technological innovation in enterprises [14]. And digital transformation shortens the distance between enterprises and consumers, facilitating consumers to have a deeper understanding of products. Enterprises use intelligent devices and digital technology to obtain consumer data and innovate their business models. Therefore, the digital dividend generated by the digital economy helps to reduce enterprise costs, and can promote innovation in production processes, improve product quality, and enhance capital allocation efficiencies.

Secondly, it is the value-added effect. The high-tech and highly integrated characteristics of the digital economy have added data elements to the input of enterprise resource factors. The manufacturing industry is gradually shifting from factor driven to data driven, and from value reshaping to value creation. Accurately mastering digital technology and improving big data analysis capabilities will change the business operations and processes of enterprises [15]. Through enterprise digital transformation, the level of professional division of labor can be improved [16], thereby optimizing enterprise decision-making and enhancing total factor productivity [17]. It brings new opportunities for manufacturing enterprises to create value and also provides a new path for high-quality development of manufacturing industry.

In addition, it is to alleviate-mismatch effects. The high liquidity and permeability characteristics of the digital economy help to achieve rapid and reasonable flow of resources such as material, capital, talent, and technology in the manufacturing industry in the market. The Internet development has provided information channels and technological support for the free transfer and flow of labor, capital, and other production factors, effectively alleviating the degree of distortion in factor allocation, and providing a solid material guarantee for narrowing regional economic disparities.

Therefore, we propose Hypothesis 1:

Hypothesis 1: The digital economy can directly have a significant and positive influence on capital allocation efficiency of intelligent manufacturing enterprises.

2.2 Mediation Mechanism of Employment Quality

The 14th Five Year Plan emphasizes more comprehensive and high-quality employment. High-quality employment has been a new requirement for the job market in the context of digital economy. Most scholars hold that digital economy affect positively employment quality [18]. The digital economy, as an economic activity characterized by new models and formats, aims to optimize employment structure, promote innovation and entrepreneurship, cultivate new employment, and open up new employment spaces to promote employment quality.

Supported by big data, cloud computing, and other technologies, the innovation of digital economy led to the emergence of new forms of employment such as online employment [19], promoting the upgrading and transformation of employment structure [20], and improving of employment quality. Secondly, digital economic development can not only enhance the absorption capacity of the job market by creating new professions and adding new job opportunities, but also improve employment quality by changing the gender structure of employment [21]. Once again, for the labor participation rate of young elderly people, the digital economy can improve the labor participation rate of this group of people by opening up new employment spaces, effectively utilizing human resources, and thereby improving employment quality in China [22]. Therefore, we propose Hypothesis 2:

Hypothesis 2: Digital economy affects employment quality positively and significantly.

Accelerating employment structure transformation can promote the reallocation of labor in various industries and improve the total factor productivity of manufacturing enterprises [23]. In the process of climbing the enterprise value chain, digital economy promotes enterprises' digital transformation. Intelligent technology can replace traditional labor, and the demand for low skilled labor is decreasing. Low skilled labor can enter the new industry of e-commerce through the employment opportunities provided by the platform. The requirements for labor skills in intelligent manufacturing enterprises are gradually increasing, and the demand for highly skilled labor is increasing. On the contrary, the intelligentization of enterprises will lead to the replacement of low-skilled labor by machines [24]. This process inevitably puts forward higher requirements for the skills and qualities of enterprise employees. By improving the skills and quality of labor force, optimizing employment structure, and other means, we can improve the efficiency of enterprise production management, optimize capital allocation, and thereby enhance capital allocation efficiencies, promoting its high-quality development. Therefore, we propose:

Hypothesis 3: Digital economy can promote enterprises' capital allocation efficiencies by improving employment quality.

3 Variable design and model construction

3.1 Variable design

(1) Explained Variable

Capital allocation efficiencies (CAE). The random frontier method [25] is the most widely applied in practice. The Cobb-Douglas production function is taken as the stochastic frontier production function. Monetary capital(MC), physical capital (PC),human capital (HC), knowledge capital (KC), and technological capital (TC) are selected as inputs, and enterprise operating income as the output of the production function. A stochastic frontier model is constructed to calculate capital allocation efficiencies of enterprise, as shown in Eq. (1).

$$\ln y_{it} = \alpha_0 + \alpha_1 \ln MC_{it} + \alpha_1 \ln PC_{it} + \alpha_2 \ln HC_{it} + \alpha_3 \ln KC_{it} + \alpha_4 \ln TC_{it} + v_{it} - u_{it} \tag{1}$$

Where y represents the business revenue of the enterprise. PC represents the physical capital elements, measured by the total net value of inventory, fixed assets, and investment real estate; MC represents the monetary capital element, measured by monetary cash. HC represents the human capital element of the enterprise, measured by the employee compensation payable by the enterprise. KC represents the intellectual capital elements of a company, measured by the sum of its goodwill, intangible assets, and consulting service fees. TC represents the technological capital element of a company, measured by the sum of the company's research and development expenses and the funds for purchasing and introducing technology. The bilateral error term v_{it} represents the random disturbance term, which follows a distribution $N(0,\sigma_v^2)$. The unilateral error term u_{it} follows a normal distribution $N^+(u,\sigma_u^2)$ and is independent of v_{it}, with $exp(-u_{it})$ representing the capital allocation efficiency.

(2) Explanatory Variables

Digital economy (*DE*). Drawing on Wei et al. (2022) [26], a digital economy evaluation index system is constructed from digital foundation, digital application, digital innovation, as well as digital industry. The digital foundation is measured by the penetration rate of mobile phones, the capacity of mobile phone switches, internet broadband access ports, the number of web pages, and the number of domain names. The digital application is measured by the number of digital television users, the actual proportion of cable radio and television users The number of websites owned by each hundred enterprises and the proportion of e-commerce trading activities among enterprises are measured. Digital innovation is measured by the full-time equivalent R&D personnel of industrial enterprises above designated size, R&D expenses of industrial enterprises above designated size, the number of invention patents of industrial enterprises above designated size, and technology market transactions. The digital industry is measured by software business revenue, electronic morning sales, e-commerce procurement volume, new product development funds, and new product sales revenue. The entropy weight method is used to comprehensively evaluate digital economy development.

(3) Mediating variable

Employment Quality (*EQ*). Drawing on Qi et al. (2020) [27] and Si et al. (2022) [28], a system of employment quality evaluation indicators is constructed from six dimensions: employment environment, employment ability, employment status, labor remuneration, employment protection, and labor relations. The employment environment is measured by economic development, employment services, and labor resources. Employment ability is measured by labor quality and labor training ratio, and employment status is measured by employment opportunities, employment structure and job safety. Labor remuneration is measured through wage income and income distribution. Employment protection is measured through social security and social insurance. Labor relations are measured through union participation rate and labor capital relations. The entropy-weight method is selected to evaluate employment quality.

(4) Control variables

Drawing on Huang et al. (2022) [8] and Li et al. (2023) [13], enterprise size ($Size$), enterprise age (Age), and capital structure ($Level$) are selected as control variables, and measured respectively by the natural logarithm of the total assets, the number of years the enterprise was established, and the asset liability ratio of the enterprise.

3.2 Model Contructing

To verify the impact of digital economy development on the capital allocation efficiency of intelligent manufacturing enterprises, the benchmark regression model is constructed by the following.

$$CAE_{it} = \alpha_0 + \alpha_1 DE_{it} + \alpha_2 DE_{it}^2 + \alpha_3 Size + \alpha_4 Age + \alpha_5 Level + u_i + v_t + \varepsilon_{it} \tag{2}$$

Where the explained variable is capital allocation efficiencies (CAE). The explanatory variables are digital economy (DE) and its square term (DE^2), mainly considering the nonlinear impact of digital economy on capital allocation efficiencies. The control variables are enterprise size ($Size$), enterprise age (Age), and enterprise capital structure ($Level$). u_i represents the random error term of the cross-section. λ_t represents the time random error term. ε_{it} represents the individual time random error term.

To further explore whether the influence of the digital economy on capital allocation efficiencies can be transmitted through employment quality, employment quality is introduced as a mediating variable based on the above model. The following model is constructed to test the mediating effect.

$$EQ_{it} = \beta_0 + \beta_1 DE_{it} + \beta_2 DE_{it}^2 + \beta_3 Size + \beta_4 Age + \beta_5 Level + u_i + v_t + \varepsilon_{it} \tag{3}$$

$$CAE_{it} = \gamma_0 + \gamma_1 DE_{it} + \gamma_2 DE_{it}^2 + \gamma_3 EQ_{it} + \gamma_4 EQ_{it}^2 + \gamma_5 Size + \gamma_6 Age + \gamma_7 Level + u_i + v_t + \varepsilon_{it} \tag{4}$$

3.3 Data source

The paper selects intelligent manufacturing listed companies in China from 2015 to 2021 as the initial sample, excluding all * ST, ST listed companies, and missing data samples, and finally obtains 2146 sets of sample data. To eliminate the impact of extreme data values, the sample data is subjected to 1% Winsorize tail reduction processing. All enterprise related data comes from the Wind database; The indicator data about digital economy are all from the National Bureau of Statistics. The indicator data related to employment quality are from China Labor Statistics Yearbook and China Statistical Yearbook.

4 Empirical Result Analysis

4.1 Descriptive statistics

Table 1 provides descriptive statistics for variables in the models. The maximum of enterprise capital allocation efficiency CAE is 0.9830, the minimum is 0.0180, and the standard deviation is 0.0810. It indicates significant differences in capital allocation efficiency among manufacturing enterprises in China. The maximum and minimum of digital economy DE are 0.7935 and 0.0485, respectively, with a standard deviation of 0.1905, indicating that China's digital economy has a good trend of development. The maximum and minimum of employment quality EQ are respectively 0.1200 and 0.5400, with a standard deviation of 0.0990. There is regional heterogeneity in provincial digital economy and employment quality. The distribution of control variables is relatively reasonable.

Table 1. Distribution of main variables

Variables	N	Mean	Std	Minimum	Maximum
CAE	2146	0.8701	0.0810	0.0180	0.9830
DE	2146	0.3725	0.1905	0.0485	0.7935
EQ	2146	0.3470	0.0990	0.1200	0.5400
Size	2146	21.9400	1.2290	18.9400	26.6800
Age	2146	22.2300	5.5990	7.0000	47.0000
Level	2146	39.6500	18.0100	4.1140	187.6000

4.2 Analysis of benchmark regression

According to the Huasman test, the sample data did not reject the original hypothesis of random effects. To eliminate heteroscedasticity, the GLS random effects model was ultimately chosen to estimate the influence of the digital economy on capital allocation efficiencies. The specific results are in Table 2.

Table 2. Results of benchmark and mediate-effect regressions

Variables	Benchmark regression			Mediate-effect regression		
	CAE	*CAE*	*CAE*	*EQ*	*EQ*	*CAE*
DE		0.0332^{***}	0.0997^{***}	0.4855^{***}	0.8383^{***}	0.0184^{***}
		(0.0007)	(0.0021)	(0.0058)	(0.0183)	(0.0009)
DE^2			-0.0597^{***}		-0.4025^{***}	
			(0.0018)		(0.0201)	
EQ						0.0351^{***}
						(0.0014)
Size	0.0064^{***}	0.0032^{***}	0.0020^{***}	0.0049^{***}	0.0037^{***}	0.0020^{***}
	(0.0002)	(0.0001)	(0.0001)	(0.0011)	(0.0009)	(0.0002)
Age	0.0015^{**}	0.0019^{***}	0.0020^{***}	−0.0003	−0.0003	0.0020^{***}

	(0.0007)	(0.0007)	(0.0007)	(0.0002)	(0.0002)	(0.0009)
Level	0.0053***	0.0019***	0.0011***	−0.0038	−0.0002	0.0016**
	(0.0007)	(0.0005)	(0.0004)	(0.0063)	0.0055)	(0.0006)
_cons	0.6921***	0.7445***	0.7527***	0.0680***	0.0300	0.7611***
	(0.0167)	(0.0164)	(0.0163)	(0.0225)	(0.0189)	(0.0170)
Chi^2	1616.54	6134.71	10982.02	7193.30	10935.26	3669.73
P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	2146	2146	2146	2146	2146	2146

Note: Standard error is in parentheses, and $^{*}p<0.10,^{**}p<0.05,^{***}p<0.01$.

According to Table 2, column (1) provides the regression result of the control variable on capital allocation efficiencies. The estimated coefficients of control variables are significant and positive at the 5% level. It means that the scale, age, and capital structure of intelligent manufacturing enterprises can affect significantly and positively on capital allocation efficiencies. After the empowerment of traditional industries through digital transformation, advanced technologies enable traditional enterprises to transform towards intelligent manufacturing, driving technological innovation and enhancing their innovation capabilities. It has a promoting and enhancing effect on the full factor production of enterprises, and thus improves capital allocation efficiencies. The advanced digital technology and big data analysis capabilities brought about by digital economIC development are conducive to helping enterprises collect internal and external information to improve its effectiveness and accuracy, and facilitate accurate processing and analysis of the collected information. It can change the traditional business methods and processes of enterprises, create new vitality for their operations, and promote capital allocation efficiencies. Column (2) shows the regression results of digital economy *DE* and all control variables on capital allocation efficiencies. The coefficient of *DE* is 0.0332 and significant at the 1% level, indicating that the development of the digital economy will significantly improve capital allocation efficiencies. Column (3) further explores the nonlinear relationship between digital economy and capital allocation efficiencies. The estimated coefficients of variables DE and DE^2 are 0.0997 and − 0.0597, respectively, and both significant at the 1% level. From this, it can be preliminarily explained that digital economy has an inverted U-shaped relationship with capital allocation efficiencies. The utest test shows that the extreme point is 0.8354. Due to the fact that the maximum of digital economy in the sample data is only 0.7935, which is less than the extreme point, the inverted U-shaped relationship did not pass the utest test. Specifically, current digital economy can effectively improve capital allocation efficiencies of enterprises. When digital economy development exceeds 0.8354, the inhibitory effect of digital economy development on capital allocation efficiencies will gradually become apparent. Therefore, Hypothesis 1 holds.

4.3 Mediation effect test

The results of mediate-effect regression are in the right part of Table 2. Column (4) shows the regression results of digital economy and control variables on employment quality. The estimated coefficient of variable DE is 0.4855 and significant at the 1%

level, indicating that digital economy development helps to promote provincial employment quality. Hypothesis 2 is valid. This conclusion is consistent with Sun Jian et al. (2022) [22]. Column (5) explores the nonlinear relationship between digital economy and employment quality. The coefficient of the square term DE2 is -0.4025, significant at the 1% level. It preliminarily indicates that digital economy has an inverted U-shaped relationship with employment quality. And employment quality reaches its maximum when digital economy reaches 1.0414. The inverted U-shaped relationship failed the utest test and its square term was not introduced in subsequent regression models. Therefore, it further indicates that digital economy can promote provincial employment quality, once again verifying the validity of Hypothesis 2.

Column (6) presents the regression results of digital economy, employment quality, and control variables on capital allocation efficiencies. According to Table 2, the square terms of digital economy and employment quality are not included in column (3). It shows that the estimated coefficients for digital economy and employment quality are significantly positive at the 1% level, with values of 0.0184 and 0.0351, respectively. This indicates that the impact of the digital economy on the capital allocation efficiency of intelligent manufacturing enterprises can be transmitted through the quality of employment in the region, and there is a mediating effect. Hypothesis 3 holds. Based on the regression results of the entire sample, it can be concluded that for every unit increase in the development level of the regional digital economy, the capital allocation efficiency of intelligent manufacturing enterprises in the region will increase by 0.0332 units. Among them, digital economy directly promotes capital allocation efficiencies of intelligent manufacturing enterprises by 0.0184 units, and indirectly promotes the capital allocation efficiencies of intelligent manufacturing enterprises by 0.0148 units through the employment quality in the region, That is to say, there is a mediating effect between digital economy and the capital allocation efficiency of intelligent manufacturing enterprises, with employment quality as the indirect transmission mechanism, and this effect accounts for 44.58% of the total effect.

4.4 Heterogeneity Analysis of Enterprise Property Rights

To further investigate the heterogeneity of the relationship between digital economy with capital allocation efficiencies of enterprises with different property rights, the sample was divided into state-owned and non-state enterprises. The specific results are seen in Table 3.

Table 3. Regression Results for Different Property Rights

Variables	State-owned enterprises					Non-state enterprises				
	CAE	*CAE*	*EQ*	*EQ*	*CAE*	*CAE*	*CAE*	*EQ*	*EQ*	*CAE*
DE	0.0370***	0.1171***	0.5260***	0.9204***	0.0794***	0.0327***	0.0955***	0.4714***	0.8173***	0.0192***
	(0.0019)	(0.0056)	(0.0147)	(0.0437)	(0.0061)	(0.0007)	(0.0022)	(0.0065)	(0.0205)	(0.0008)
DE^2		−0.0777***		−0. 4986***	−0.0543***		−0.0556***		−0.3856***	
		(0.0052)		(0.0525)	(0.0051)		(0.0019)		(0.0221)	
EQ					0.0305***					0.0322***

					(0.0030)					(0.0013)
Size	0.0047***	0.0021***	0.0019	0.0022	0.0018***	0.0029***	0.0019***	0.0062***	0.0038***	0.0019***
	(0.0005)	(0.0004)	(0.0027)	(0.0024)	(0.0004)	(0.0001)	(0.0001)	(0.0012)	(0.0010)	(0.0001)
Age	−0.0003	−0.0005	0.0007	0.0004	−0.0005	0.0020**	0.0021**	−0.0004	−0.0002**	0.0020**
	(0.0013)	(0.0013)	(0.0006)	(0.0005)	(0.0013)	(0.0008)	(0.0008)	(0.0003)	(0.0002)	(0.0008)
Level	0.0007	0.0039***	0.0325**	0.0528	0.0020	0.0015***	0.0006*	−0.0075	0.0059*	0.0014***
	(0.0017)	(0.0014)	(0.0166)	(0.0153)	(0.0012)	(0.0004)	(0.0004)	(0.0068)	(0.0059)	(0.0004)
_cons	0.7748***	0.8211***	0.0727	0.0044	0.8287***	0.7448***	0.7509***	0.0505**	0.0352***	0.7591***
	(0.0335)	(0.0331)	(0.0568)	(0.0525)	(0.0328)	(0.0186)	(0.0185)	(0.0246)	(0.0203)	(0.0186)
Chi^2	948.80	1770.73	1404.50	1774.26	2404.46	5552.65	9759.05	5739.13	8841.05	8452.43
P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	424	424	424	424	424	1722	1722	1722	1722	1722

Note: Standard error is in parentheses, and $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

According to column (1) of Table 3, the estimated coefficient of digital economy *DE* is significantly positive, indicating that digital economy has a significant positive impact on the capital allocation efficiency of intelligent manufacturing state-owned enterprises. To further explore the nonlinear impact of the digital economy on the capital allocation efficiency of intelligent manufacturing state-owned enterprises, the square term DE^2 for digital economy is introduced in column (2). The results indicate that before the *DE* of digital economy development reaches 0.7535, digital economy can improve capital allocation efficiencies of intelligent manufacturing state-owned enterprises. When the *DE* exceeds 0.7535, digital economy will actually suppress capital allocation efficiencies. Columns (3) and (4) provide a significant inverted U-shaped relationship between digital economy and employment quality. Furthermore, it was found that the inverted U-shaped relationship did not pass the utest test, indicating that digital economy has a significant positive impact on employment quality. The estimated coefficient of variable *EQ* in column (5) is 0.0305 and is significant at the 1% level. This indicates that digital economy can have a curve indirect effect on capital allocation efficiencies of intelligent manufacturing state-owned enterprises through employment quality.

From columns (6) and (7), it can be seen that the extreme point of the nonlinear relationship between digital economy and capital allocation efficiencies of non-state enterprises is 0.8588, which fails the utest test. It further indicates that digital economy contributes to the improvement of capital allocation efficiencies of non-state enterprises in intelligent manufacturing. According to columns (8) and (9), the digital economy can improve provincial employment quality. The square term DE^2 was not introduced in column (10), and the estimated coefficients of variable *DE* and variable *EQ* were significant at the 1% level, with values of 0.0192 and 0.0322, respectively. It indicates that for non-state enterprises in intelligent manufacturing, the indirect improvement effect of the digital economy on capital allocation efficiencies of non-state enterprises by improving employment quality is 0.0135, accounting for 41.28% of the overall improvement effect. Digital economy has a significant improvement effect on capital allocation efficiencies of different enterprises, and the improvement effect of non-state enterprises is relatively weak.

4.5 Regional heterogeneity analysis

To further investigate the heterogeneity of the impact of the digital economy on the capital allocation efficiencies of enterprises in different regions, the enterprise sample was divided into eastern and central western regions based on the China Regional Financial Operation Report. The results are seen in Table 4.

Table 4. Regression Results for Different Regions

Variables	Eastern region					Central and western regions				
	CAE	*CAE*	*EQ*	*EQ*	*CAE*	*CAE*	*CAE*	*EQ*	*EQ*	*CAE*
DE	0.0333*** (0.0007)	0.0916*** (0.0022)	0.4519*** (0.0064)	0.7994*** (0.0250)	0.0201*** (0.0008)	0.1119*** (0.0042)	0.3198*** (0.0170)	0.9273*** (0.0382)	−0.3615* (0.1919)	0.2933*** (0.0161)
*DE*²		−0.0521*** (0.0019)		−0.3661*** (0.0255)			−0.6186*** (0.0494)		4.4371*** (0.6490)	−0.6291*** (0.0456)
EQ					0.0315*** (0.0013)					0.0232*** (0.0031)
Size	0.0027*** (0.0001)	0.0019*** (0.0001)	0.0041*** (0.0011)	0.0034*** (0.0010)	0.0018*** (0.0001)	0.0019*** (0.0003)	0.0009*** (0.0003)	0.0007 (0.0021)	0.0012 (0.0020)	0.0006** (0.0003)
Age	0.0021*** (0.0008)	0.0022*** (0.0008)	−0.0003 (0.0002)	−0.0003 (0.0002)	0.0022*** (0.0008)	−0.0003 (0.0011)	−0.0001 (0.0011)	0.0005 (0.0004)	0.0003 (0.0004)	−0.0002 (0.0011)
Level	0.0010** (0.0005)	0.0007* (0.0004)	−0.0072 (0.0066)	−0.0049 (0.0060)	0.0010** (0.0004)	0.0022* (0.0011)	0.0028*** (0.0009)	0.0273** (0.0126)	0.0176 (0.0119)	0.0025*** (0.0009)
_cons	0.7422*** (0.0184)	0.7457*** (0.0183)	0.1036*** (0.0229)	0.0478*** (0.0208)	0.7553*** (0.0183)	0.8418*** (0.0245)	0.8454*** (0.0245)	0.0482*** (0.0413)	0.1285*** (0.0407)	0.8494*** (0.0246)
*Chi*²	5988.17	9912.04	5206.82	6685.08	9092.90	1949.25	3083.91	664.53	792.69	3680.15
P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	1769	1769	1769	1769	1769	377	377	377	377	377

Note: Standard error is in parentheses, and $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

For the eastern region, digital economy helps to improve enterprises' capital allocation efficiencies, and in its impact process, employment quality plays a mediating role. The indirect improvement effect of the digital economy on the capital allocation efficiency of intelligent manufacturing enterprises by improving employment quality in the eastern region is 0.0129, accounting for 38.74% of the overall improvement effect. The eastern region has a strong level of digital technology application and resources for digital technology innovation. After the digital empowerment of traditional manufacturing, it utilizes advanced technologies to transform into intelligent manufacturing, accelerate talent flow, drive enterprise technological innovation, and have a more significant optimization effect on the allocation of various capital elements for enterprises. For the central and western regions, digital economy has an inverted U-shaped relationship with capital allocation efficiencies. When digital economic development is below 0.2585, it can effectively improve capital allocation efficiencies. When digital economy exceeds 0.2585, it will have a certain inhibitory effect on capital allocation efficiencies. In the central and western regions, there is greater space for improvement in employment quality, and the digital economy has a stronger promoting effect on the improvement of employment quality, thereby promoting the improvement of capital allocation efficiency for intelligent manufacturing enterprises. Employment quality plays a curve mediating effect in the impact of digital economic on enterprises' capital allocation efficiencies in the central and western regions.

4.6 Robust Test

4.6.1 Replacing explanatory variables.

To ensure the robustness and accuracy of the above results, we first use Digital Inclusive Finance (DFI) as a substitute variable for digital economic development to test the robustness. The results are in Table 5. After replacing the core explanatory variables, the coefficients of digital economy and employment quality are significant and positive at the 1% level in columns (1) to (3), basically consistent with the previous results, indicating that the regression results are robust and the conclusion is reliable. It also confirms once again that digital economy can directly promote enterprises' capital allocation efficiencies, and can indirectly promote the improvement of enterprise capital allocation efficiency through the transmission mechanism of improving employment quality.

4.6.2 Instrumental variable method.

Using instrumental variable method for robustness testing to alleviate potential endogeneity issues between variables. Selecting *Digital_industry* as an instrumental variable for digital economy, the robustness is tested by using a two-stage least squares method. The results are seen in Table 5.

Table 5. Robustness testing results

Variables	Replacing explanatory variables			Variables	Instrumental variable method	
	CAE	*EQ*	*CAE*		First-stage: DE	Second-stage: *CAE*
DE	0.0060^{***} (0.0001)	0.0680^{***} (0.0011)	0.0051^{***} (0.0001)	*DE*		0.0338^{***} (0.0007)
EQ			0.0134^{***} (0.0006)	Digital_ industry	1.7499^{***} (0.0061)	
Size	0.0009^{***} (0.0001)	0.0082 (0.0024)	0.0007^{***} (0.0001)	*Size*	−0.0007 (0.0007)	0.0031^{***} (0.0001)
Age	0.0020 (0.0007)	−0.0008 (0.0008)	0.0020^{***} (0.0005)	*Age*	−0.0004 (0.0036)	0.0019^{**} (0.0007)
Level	−0.0004 (0.0004)	−0.0001 (0.0001)	−0.0003 (0.0004)	*Level*	0.0001^{***} (0.0002)	0.0001^{***} (0.0004)
_cons	0.7839^{***} (0.0173)	−0.0382 (0.0479)	0.7857^{***} (0.0172)	_cons	0.1226 (0.0823)	0.7454^{***} (0.0164)
Chi^2	7441.4600	7135.0600	9037.9000	*Chi*^{2}	119513.0000	6147.4400
P	0.0000	0.0000	0.0000	P	0.0000	0.0000
N	2146	2146	2146	N	2146	2146

Note: Standard error is in parentheses, and $^{*}p<0.10,^{**}p<0.05,^{***}p<0.01$.

According to the results of the first stage in Table 5, the digital industry has a significant and positive influence on digital economy at the 1% level, and the F-value is 357.9400, which is much greater than 10. It confirms that the digital industry has a strong positive correlation with digital economy, and the selection of instrumental variables is reasonable. According to the results of the second stage, the instrumental variable *Digital_industry* passed the weak instrumental variable test and the over identification test at the 1% level. Therefore, selecting the digital industry as a tool variable is reasonable and effective. From the results of the second stage, the coefficient of digital economy is 0.0338, significant at the 1% level and basically consistent with the original results, indicating a significant and positive correlation between the digital economy and capital allocation efficiencies.

5 Conclusions

Intelligent manufacturing listed companies in China from 2015 to 2021 are selected as a sample to explore the relationship among the digital economy, employment quality, and capital allocation efficiencies of enterprises. It shows that the digital economy can improve capital allocation efficiencies. After robustness testing using the replacement explanatory variable method and instrumental variable method, the positive promoting effect still exists. The intermediary transmission mechanism indicates that the digital economy can promote capital allocation efficiencies by improving employment quality. The digital economy in non-eastern regions can better promote capital allocation efficiencies. Compared to non-state enterprises, the digital economy has a more significant impact on improving capital allocation efficiencies in state-owned enterprises. Therefore, local governments should actively promote the construction of new infrastructure, the digital transformation of the manufacturing industry, and fully leverage the digital dividend advantages brought by the digital economy for the development of the manufacturing industry. Emphasize the introduction and cultivation of digital labor force, effectively improve the digital skills level of employed personnel, optimize employment structure, and achieve optimal allocation of human resources. Vigorously support digital economic development in the central and western regions, actively build industrial big data platforms, continuously optimize the digital business environment, optimize industrial structure, and drive the improvement of capital allocation efficiencies.

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