

Research on the Marketization of Data Elements Empowering the Digital Development of Industrial Economy

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Abstract: As an important part of market-oriented allocation of factors, the construction of data element market is an important way to empower the digital development of industries. Scientific evaluation of its policy effects is of great significance for promoting the construction of "Digital China". This article is based on a sample of 280 prefecture level cities from 2010 to 2021, and considers the establishment of data trading platforms as an exogenous shock. A multi period double difference model is used to deeply examine the impact of market-oriented allocation of data factors on the digitalization of industrial economy. Research has found that in terms of impact, the construction of data element markets has effectively improved the level of industrial digitalization development. However, due to differences in economic development and innovation levels in different regions, the impact varies. Therefore, it is necessary to continuously leverage the role of data element market construction in enhancing the level of industrial digitalization development, improve the construction level of data trading platforms, promote the free flow of data elements, fully utilize the multiple spillover effects of data element market construction, and promote the coordinated development of industrial digitalization between regions.

Keywords: Multi period double difference; Data element market; Digitalization of industrial economy.

1. Introduction

In June 2022, the 26th meeting of the Central Committee for Comprehensively Deepening Reform approved the "Opinions on Building a More Complete Market based Allocation System and Mechanism for Factors" (hereinafter referred to as the "Opinions"), which identified data as a new type of production factor that is on par with traditional production factors such as land, labor, technology, and capital that can participate in distribution. In the information age, data elements have become important means of production. With the explosive growth of global data resources, the market size of data elements is rapidly expanding, driving the rapid development of the data industry.

Historical development experience has proven that every factor marketization has promoted social innovation, and different factors of production marketization have different impacts on innovation capability. Promoting the marketization of land factors can help to continuously unleash urban innovation vitality; The advancement and marketization of labor factors are important mechanisms for promoting urban innovation; The diffusion and flow of technological elements can enhance regional innovation efficiency; The market distortion of capital factors will positively inhibit technological development and regional innovation, and have a sustained negative impact on innovation mechanisms. Compared with traditional factor marketization, data factor marketization has new characteristics such as non-competitiveness, value differentiation, strong externalities, and rapid flow across time and space. These characteristics make the impact of data factor marketization on innovation capability show different patterns.

Data elements play a decisive role in directly creating value, changing labor allocation, and improving the quality of

industrial transformation. Establishing a data element market, promoting government data openness and sharing, increasing the value of social data resources, strengthening data resource integration and protection, and opening up a new pattern of innovation driven development have become inevitable requirements for enhancing urban innovation strength and promoting national economic development.

Data empowerment has become the main path to promote the high-end, intelligent, and green construction of traditional industries. However, in the process of digital construction, due to the existence of data silos and institutional barriers, data elements, as a key factor driving the digital transformation and development of industries, still face problems such as low integration of data resources with the real economy, unreasonable allocation of digital resources between industries, and low utilization rate of data element value. These problems are precisely the key factors that constrain the inability of digital elements to empower the digital transformation of the real economy.

In summary, current research on data elements mainly focuses on defining the characteristics of data elements and analyzing the role of market-oriented allocation of data elements in economic growth. Starting from further exploring the role of data element market construction, this article explores its impact on the digital development of industries and analyzes its path of action. The marginal contribution of this article may lie in analyzing and sorting out the mechanism of the role of data factor market construction in the digital development of industries, setting up quasi natural experiments using data trading platforms, constructing a counterfactual framework of multi period double difference models, accurately identifying the promotion effect of data factor market construction on the digital development of industries from the perspective of post analysis, and addressing the practical problem of difficult definition of data

factors [1].

2. Theoretical Mechanisms and Research Hypotheses

Firstly, the marketization of data elements can enhance the discoverability, usability, and real-time sharing of data resources, improve the quality of data resources, and effectively promote the deep integration of data and real economy. As Zhang Yeqing et al. (2021) found in their research, the construction of data trading platforms helps to expand data scale, enrich data types, expand the scope of data search and access, fully tap the value of data and unleash its potential, providing core driving force for the deep integration of digital economy and real economy [2].

Secondly, market-oriented allocation of data elements can provide institutional guarantees for the deep integration of data and real economy from two aspects: data sharing and trading mechanisms. On the one hand, maximizing the value of data benefits from efficient connectivity and sharing of data, which is also the cornerstone of enterprise digital transformation. The marketization of data helps to break down data segmentation and monopoly, accelerate the circulation and sharing of data resources, alleviate the phenomenon of "data islands" and "data chimneys", and unleash the vitality of data production factors [3]. On the other hand, data possesses replicability, non-competitiveness, and incomplete contractual properties [4]. With the widespread application of new technologies such as blockchain and privacy computing in data trading platforms, the process of data generation, transmission, and utilization can be accurately and detailedly recorded, and the characteristics of "no ownership", "controllable and quantifiable", and "reliable and traceable" of data can be achieved.

Finally, market-oriented allocation of data elements is an inevitable choice for enterprises to break through the monopoly dilemma. The market-oriented allocation of data elements can strengthen the network effect, user dependence effect, and positive feedback effect of data, stimulate the competitive awareness and learning willingness of enterprises, and provide core competitiveness for the deep integration of digital economy and real economy. In regions with a high degree of marketization of data elements, the atmosphere of absorption and application of digital technology is often more intense. The "synergy effect" and "competition effect" caused by big data can stimulate the willingness of management to rely on big data for management. Through the deep integration of digital and real economy, the value of data elements can be maximized.

Based on the above analysis, the following research hypothesis is proposed: market-oriented allocation of data elements can effectively promote the development of industrial digital economy.

3. Model Construction and Data Selection

As the data element market is based on the establishment of data trading platforms, verifying the impact of data element market construction on the digital development of industries is to verify the effect of the establishment of data trading platforms on the digital development of industries and analyze their internal mechanisms.

Firstly, objectively measure the level of digital

development of regional industries, referring to relevant research, comprehensively measure the level of digital development of industries from four aspects: digital foundation, digital capability, digital talent, and digital investment. Use the global entropy method to assign weights to various indicators of digital development of regional industries, and analyze them from three dimensions: time, region, and indicators. Measure using reference related data methods.

Afterwards, based on the calculation, the comprehensive score of the digital development level of industries in each region was obtained, and the multi period double difference method was used to verify the impact of the establishment of data trading platforms on the digital development of industries in the region.

Therefore, a multi period double difference model is selected to estimate the impact of establishing a data trading platform on the level of digital development of regional industries. Based on controlling for other factors, the multi period double difference model can test whether there is a significant difference in the level of industrial digitalization development between platform regions and non-platform regions before and after the establishment of the data trading platform. The specific settings of the multi period double difference model are as follows:

$$D \& R_{it} = \beta_0 + \beta_1 DMA_{it} + \sum \beta X_{it} + \mu_i + \gamma_t + \varepsilon_{it}$$

3.1. Explained Variable: Level of Integration Between Digital Economy and Real Economy

Drawing on the research, the degree of integration between the digital economy and the real economy in various regions is measured using the following formula [5-6]:

$$D = \sqrt{C \times (\partial \cdot DE + \beta \cdot RE)}$$

$$C = \sqrt{\frac{DE \times RRE}{\left(\frac{DE + RE}{2}\right)^2}}$$

In the formula: represents the integration level of the digital economy with the real economy, ranging from 0 to 1, where a higher value indicates a higher level of integration; represents the digital economy; represents the real economy; and represent the weights of the digital economy and the real economy, respectively. Based on the research by Liu Yaobin and Song Xuefeng, $0 < D \leq 0.4$ indicates low integration, $0.4 < D \leq 0.5$ indicates moderate integration, $0.5 < D \leq 0.8$ indicates high integration, and $0.8 < D \leq 1$ indicates extreme integration. C represents the coupling degree, with a range of 0 to 1. The closer C is to 1, the higher the coupling degree between systems; the closer C is to 0, the lower the coupling degree between systems. The development levels of the digital economy and the real economy are measured using the entropy value method. Specifically, Zhao Tao et al. used data on Internet penetration rate, Internet-related output, mobile Internet user numbers, Internet-related employment, and digital finance to comprehensively measure the development level of the digital economy. Zhang Shuai et al. used data on the scale, structure, and potential of the real economy to comprehensively measure the development level of the real economy (see the table below).

Table 1. Variable Meaning

Primary indicators	Secondary indicators	Indicators of achievement
Digital economy development level (DE)	Internet penetration rate	Number of Internet broadband users per 100 people (households)
	Internet-related outputs	Per capita total telecom business (100 million yuan/person)
	Number of mobile Internet users	Mobile phone users per 100 people (households)
	Internet-related practitioners	The proportion of employees in computer services and software industry in urban units (%)
	Digital finance	China's Digital Inclusive Finance Index
Level of real economic development (RE)	The scale of the real economy	The proportion of secondary industry in GDP (%)
	The structure of the real economy	Total profits of industrial enterprises above designated size (100 million yuan)
	The potential of the real economy	Number of industrial enterprises above designated size (no.)
	Secondary indicators	Per capita retail sales of consumer goods (ten thousand yuan/person)
	Internet penetration rate	The proportion of employees in the real economy (except financial and real estate industries) (%)
	Internet-related outputs	Industrial R&D expenditure above designated size (ten thousand yuan)

3.2. Core Explanatory Variable: Market-Oriented Allocation of Data Elements

The establishment of a data trading platform is taken as a proxy variable. If a city sets up a data trading platform in a certain year, the value of the city in that year and subsequent years will be 1, otherwise it will be 0.

3.3. Control Variables

Drawing on the practices, the following control variables are selected: economic development level (GDP), government intervention degree (GOV), fixed asset investment (INV), industrial structure (IND), science and education level (TEC), financial level (FIN), urbanization level (URB) and trade openness (FDI). Regions with higher levels of economic development typically have more advanced digital economy infrastructure and industrial chains, which facilitate the integration of the digital and real economies. The degree of government intervention affects the market allocation of data elements, impacting the speed of

digital-real integration [7-8]. Fixed asset investment promotes digital-real integration; higher fixed asset investment means more resources are allocated to both sectors, fostering their integration. Optimizing the industrial structure enhances resource allocation efficiency, promoting the integration of the digital and real economies. The level of science and education reflects a region's innovation capabilities and human resource quality; a higher level of science and education helps enhance the innovation and competitiveness of both sectors, promoting their integration. A higher financial level provides financing support and financial innovation, facilitating the integration of the digital and real economies. A higher level of urbanization provides more market demand and human resources, promoting the integration of the digital and real economies. A better level of trade openness increases opportunities to introduce advanced foreign technologies, promotes talent exchange, strengthens cooperation between enterprises and foreign entities, and fosters a positive innovation environment, thereby driving digital-real integration. The specific variables and their descriptive statistical results are shown in the table below.

Table 2. Descriptive Statistics

Variable	Definition	Sample Capacity	Mean Value	SD	Min	Max
DS	The level of integration between the digital economy and the real economy	3 080	0.229	0.071	0.095	0.856
DFM	Market-based allocation of data elements	3 080	0.402	0.49	0	1
GDP	Log of GDP per capita	3 080	9.532	0.702	7.66	12.406
GOV	The proportion of fiscal expenditure	3 080	0.155	0.088	0.008	1.185
INV	Investment in fixed assets as a percentage of GDP	3 080	0.638	0.28	0.034	4.98
IND	Output value ratio of secondary and tertiary industries	3 080	2.245	0.147	1.821	2.78
TEC	The proportion of spending on science, technology and education	3 080	0.031	0.02	0.001	0.332
FIN	The proportion of outstanding loans from financial institutions at the end of the year	3 080	0.832	0.509	0.075	7.45
URB	Urban population/total population at the end of the year	3 080	0.482	0.161	0.185	1
FDI	The proportion of actually utilized foreign capital	3 080	11.127	2.677	0	15.968

3.4. Data Sources

Considering the impact of data availability and administrative division adjustments on data continuity, 280 prefecture level cities from 2010 to 2021 were selected as the sample for examination. The establishment of data trading platforms was regarded as an exogenous shock, and a multi period double difference model was used to deeply examine

the impact of market-oriented allocation of data factors on industrial economic digitization. The data is sourced from the relevant years' China Urban Statistical Yearbook, China Research Data Service Platform (CNRDS), various statistical yearbooks, statistical bulletins, etc. Linear interpolation was used to fill in some missing samples, resulting in 3080 sample observations.

4. Empirical Result Analysis

4.1. Multi Period Double Difference Regression Results

The establishment of a data trading platform is a fundamental exploration in the construction of the data element market. Due to the different establishment times of data trading platforms in different regions, a multi period double difference model is established to examine the impact of data factor market construction on the level of industrial digitalization development. The first column adopts a bidirectional fixed model of region and time, and the results show that the construction of data factor markets has a significant positive impact on the level of industrial digitalization development. On this basis, control variables such as economic development level, government intervention level, and industrial structure optimization were added. As shown in column (2), the positive significant

impact of the core explanatory variables did not change. At the same time, the level of economic development and government intervention also had a positive significant impact on the level of industrial digitalization development, while the impact of industrial structure optimization on the level of industrial digitalization development was not significant. The level of economic development during the sample period helps to enhance the level of industrial digitalization development, as regional economic development provides basic support for digital technology innovation and can improve the development environment of regional industrial digitalization. It also indicates that the digital development of industries cannot be separated from infrastructure construction, and regional digital infrastructure construction cannot be separated from government policy formulation and financial support. Therefore, in the early stage of industrial digital development, the degree of government intervention has a positive impact on improving the level of industrial digital development.

Table 3. Multi period double difference regression results

	The level of industrial digitalization	
	-1	-2
Digital Image Data	0.057***	0.051***
	-6.553	-6.027
Level of economic development		0.167***
		-4.733
The degree of government intervention		0.094**
		-2.12
Optimization of industrial structure		-0.018
		(-0.612)
N	300	300
R ²	0.658	0.697
Regional fixed effects	It's under control	It's under control
Time fixed effects	It's under control	It's under control

Note: "***", "**", "*" respectively represent the significance level of 1%, 5% and 10%, and the values in parentheses are t-test values.

4.2. Parallel Trend Test After Empirical Analysis

From 2010 to 2021, the integration of the digital economy and the real economy across various regions in China has shown that the national average is 0.362, with the lowest value of 0.303 in 2010 and the highest value of 0.411 in 2021. Overall, China's integration of the digital and real economies is at a moderate level. The reasons for this include: first, the level of technological development has limited the deep integration of the digital and real economies. Although China has made significant progress in areas such as the Internet, artificial intelligence, and big data, applying these technologies to the real economy still faces technical bottlenecks and a lack of practical experience. Second, the transformation challenges faced by the real economy have slowed down the pace of digital and real economic integration. The real economy faces multiple challenges during its transformation, including industrial structure, workforce quality, and corporate business philosophies. Third, the lack of a robust regulatory mechanism for data transactions hinders the flow of vast amounts of data between the real economy and the digital economy, hindering deeper

integration. Fourth, there are issues with talent cultivation and collaboration among industry, academia, and research institutions. Collaboration between universities, research institutes, and enterprises is insufficient, and there is a disconnect between talent cultivation and market demand, which affects the effectiveness of digital and real economic integration.

From the development trends of digital and real economy integration in various regions, the averages for the eastern, central, western, and northeastern regions are 0.455, 0.363, 0.247, and 0.323, respectively. This indicates that the central region is generally at an average level, the eastern region is above the national average, while the northeastern and western regions are below the national average. This pattern shows a spatial distribution where the eastern, central, northeastern, and western regions show decreasing integration levels. The reasons for this phenomenon may include: the uneven development of digitalization across different regions in China. The eastern region is primarily characterized by advanced manufacturing and modern services, while the central and northeastern regions are traditional heavy industry bases. In contrast, the western region has a relatively low level of digitalization, with deficiencies in the development of advanced manufacturing and modern services, leading to an imbalance where the integration level is higher in the east and lower in the west.

From the parallel trend in the degree of industrial digitalization, it is evident that the estimated coefficient of the policy dummy variable was not significant before the exogenous shock, fluctuating around the 0 value. This suggests that there was no significant difference in the trend of industrial digitalization between the experimental group and the control group before and after the exogenous shock, meeting the conditions for the parallel trend hypothesis. After the exogenous shock, the estimated coefficient of the policy dummy variable gradually increased, indicating a continuous and increasing marginal effect of the establishment of data trading platforms on industrial digitalization.

4.3. Benchmark Regression

Table 4. Benchmark Regression

Variable	DS	
	-1	-2
DFM	0.018***(0.004)	0.015***(0.003)
controlled variable	deny	yes
Fixed effects for years	yes	yes
Urban fixed effects	yes	yes
constant term	0.203***(0.023)	0.198***(0.013)
R ²	0.618	0.665

Note: "** **", "** **", and "**" represent significance levels of 1%, 5%, and 10%, respectively. The values in parentheses are t-test values.

The above table reports the specific impact of market-oriented allocation of data elements on the fusion of logarithm and reality. Regression analysis controls for fixed effects by region and year, and adopts clustering standard errors at the city level. The first column only includes the core explanatory variable, and its estimated coefficient is significantly positive at the 1% level; On this basis, the second column includes macro level control variables, and the estimated coefficient of the core explanatory variable is still significantly positive at the 1% level. Regardless of whether control variables are included or not, the market-oriented allocation of data elements significantly promotes the integration of industrial digitization, which proves the hypothesis.

5. Policy Opinion

Based on the above research conclusions, the following policy recommendations are proposed:

(1) Continue to accelerate the process of improving the infrastructure for the development of data elements and continuously enhance the level of construction of data trading platforms. Analysis shows that due to differences in the level of data trading platform construction between regions, there are also differences in the level of industrial digitalization development between regions. Therefore, it is necessary to continuously pay attention to improving regional digital infrastructure construction, optimizing the layout of data element centers, comprehensively accelerating the construction of data element markets, ensuring the circulation of data element resources between regions, solving the problem of digital divide between regions, and accelerating the digital transformation and development of industries [9].

(2) It is necessary to establish and improve the operational mechanism of the data element market, and promote the digital collaborative development of industries between regions. Focusing on the differences in economic development and innovation resources between regions, by

improving the operation mechanism of the data element market, promoting the free flow of data elements, achieving coordinated digital and collaborative development of regional industries, and reasonably allocating data elements, we can fully leverage the information spillover effect, technology spillover effect, and knowledge spillover effect of the data element market construction. By improving the construction of data element trading platforms, integrating and fully utilizing existing data resources, establishing and improving data element trading markets, consolidating the technological foundation of data elements, and creating data trading models suitable for local development characteristics. Especially in the western region, it is necessary to actively participate in cross regional division of labor and cooperation of data elements, and obtain regional linkage effects with the data element aggregation areas in the eastern and central regions [10].

(3) Emphasize the role of strengthening industrial integration and technological innovation in driving digital transformation of industries, and leverage the driving effect of human capital. Taking data elements as the foundation for changing the digital transformation and development of industries, efforts should be made to improve the data foundation, network foundation, and operational development platform of industrial digital development, and enhance the role and advantages of data elements in the transformation and competition of manufacturing and service industries. Continue to increase research and development efforts in data element technology, and enhance the role of human capital in driving high-quality digital development of industries [11].

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