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Can Data Elements Improve Business Competitiveness? -- Evidence from SRDI Enterprises

Chuangzuo Xue

Hefei Huiling Auto Parts Co., Ltd., Hefei, Anhui, China

283071213@qq.com

Abstract

With the advent of the digital economy, data, as a critical production element, has become a new engine for driving enterprise competitiveness. This paper takes China's SRDI enterprises from 2013 to 2024as the research object to empirically test the impact of data elements on the competitiveness of SRDI enterprises. The study finds that data elements improve the competitiveness of SRDI enterprises, and the conclusions continue to hold after a series of robustness tests. This paper expands the research related to the influence of data elements on the competitiveness of SRDI enterprises and provides experience for promoting their competitiveness.

Keywords

Data Elements; SRDI; Enterprise Competitiveness; Technological Innovation.

1. Introduction

The value of data as a new element of production is becoming more and more prominent and will drive the formation of new quality productivity. It is also for this reason that in recent years, the State has attached increasing importance to data elements and issued a series of policy documents. In December 2022, the Central Committee of the Communist Party of China and the State Council issued the Opinions on Building a Data-Based System to Give Better Play to the Role of Data Element (from now on referred to as the "Twenty Articles on Data"), which is China's first national-level policy document that systematically deploys the release of the value of data element from the height of elements of production. In March 2023, the Party and State Institutional Reform Programme recommended the establishment of a National Data Agency, which will be responsible for coordinating and promoting the construction of a data foundation system, as well as the integration, sharing, and development and utilisation of data resour ces, to comprehensively realise the planning and construction of a digital China, a digital economy, and a digital society. In January 2024, the National Data Bureau and other departments jointly issued the "Data Element x" Three-Year Action Plan (2024-2026) (from now on referred to as the "Action Plan"), emphasizing the strengthening of scenario demand, the promotion of synergistic optimization, reuse and efficiency enhancement, integration and innovation of data element, and the selection of 12 industries and fields such as industrial manufacturing, to promote the multiplier effect of data element, to further promote the development and utilization of data element, advance the construction of a multi-level market for the data element, and promote the deep integration of data element, the digital economy and the real economy. As the main body of the development of the real economy, enterprises are an essential medium for releasing the value of data elements and play a vital role in integrating the digital economy and the real economy. "SRDI" enterprises have become an essential source of new economic growth points and are particularly important to developing the digital economy.

'SRDI' is an acronym for specialized, refined, differentiated, and innovative characteristics, which plays a crucial role in the development of new quality productivity. In July 2011, China's

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Ministry of Industry and Information Technology proposed SRDI for the first time and pointed out that it would vigorously promote the development of SRDI for small and medium-sized enterprises (SMEs). Ten years later, in July 2021, the Political Bureau of the Central Committee of the Communist Party of Chinaelevated the 'development of SRDI SMEs' to the national level. In 2022, the Ministry of Industry and Information Technology issued the Interim Measures for the Management of the Gradient Cultivation of High-Quality Small and Medium-sized Enterprises, which classifies SRDI enterprises into innovative small and medium-sized enterprises, 'SRDI' small and medium-sized enterprises, and SRDI 'small giants' enterprises. Among them, innovative SMEs have gained a certain level of specialisation, innovative capacity and development potential and are the foundation of high-quality SMEs; however, 'SRDI' SMEs and 'small giants' have achieved specialisation, refinement and features and have innovative solid capacity, and are the backbone and core force of quality SMEs. The Government Work Report of March 2024 mentions 'promoting the development of SRDI for small and medium-sized enterprises'. SRDI enterprises are not only the "leaders" of small and medium-sized enterprisesbut also the driving force of future industry leaders. The high-quality development of SRDI enterprises is essential to achieving China's goal of becoming a manufacturing, science, and technology power. Especially in the context of the new development pattern, the State stressed the need to cultivate and develop SRDI enterprises, implement special projects to strengthen the chain and accelerate the cracking of the 'neck' problem. On 5 July 2024, at a series of press conferences on the theme of 'Promoting High-Quality Development' held by the State Council Information Office, Minister of Industry and Information Technology Jin Zhuanglong introduced that as of the end of June 2024, more than 140,000 small and medium-sized enterprises with SRDI had been cultivated and developed nationwide. However, it should not be overlooked that the initial resource endowment, the market competitive environment, the reality of policy conditions and other elements, to promote the competitiveness of SRDI enterprises at this stage of the pain and difficulty, need to be resolved! Emerging data elements are driving a shift in production methods and becoming a 'cure' for SRDI enterprises to improve their core competitiveness. However, the existing research on the competitiveness of SRDI enterprises has seen theoretical research lagging seriously behind practice. Only a few studies have put forward corresponding suggestions from a theoretical perspective, whereas the mechanism and driving paths of data elements in enhancing the competitiveness of SRDI enterprises still need to be further explored, and relevant research remains to be improved. Based on this, this paper attempts to examine the role played by data elements in enhancing the competitiveness of SRDI enterprises. This not only helps to clarify the internal logic of data elements affecting their competitiveness but also provides empirical and practical references for formulating and optimizing policies to enhance their competitiveness.

Based on the above analysis, this paper takes 2013-2024 China's SRDI enterprises as the research object and deeply probes the mechanism of the role of data elements on the competitiveness of SRDI enterprises through technological innovation. The possible contributions to this paper are: First, the existing literature is increasingly rich in studies addressing data elements. Still, empirical studies of the impact of data elements on the competitiveness of SRDI enterprises are not deep enough. This paper takes the SRDI enterprise, a market subject with the distinctive significance of the development of the times, as the research object and systematically explores the influence of data elements on the competitiveness of the SRDI enterprise as well as the mechanism, effectively enriching the economic consequences of the data elements. Secondly, the existing literature on SRDI enterprises mainly adopts case studies or empirical summaries, focusing on a few or a single case. In contrast, this paper takes the identified SRDI-listed enterprises as the object of study to provide empirical support for assessing the effect of data elements of SRDI enterprises in promoting their competitiveness enhancement.

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2. Literature Review

Enterprise competitiveness is not only the potential of enterprise development but also the comprehensive reflection of enterprise value and the wealth that enterprises can obtain from the market. According to previous literature, the elements affecting the competitiveness of enterprises mainly cover three dimensions: managers, enterprise level, and external environment.

Upper Echelons Theory states that different traits of managers affect the company's strategy, which in turn affects the enterprise's competitiveness to varying degrees. It has been found that a higher level of education means that managers have a more transparent, more scientific, and systematic knowledge network structure. This allows them to make more accurate predictions of the company's future business risks and uncertainties and thus make rational decisions that are more conducive to improving the company's competitiveness [1]. In addition, female executives within the organization are more concerned about the social responsibility that the organization fulfills, which helps the organization to be more responsible and bold, which in turn creates a competitive advantage [2].

From the perspective of the enterprise, the Resource-Based View proposes that the enterprise is a collection of various resources. Due to the heterogeneity of the resources owned by the firms, the heterogeneity of the resources determines the differences in the competitiveness of the enterprises. For example, as an essential economic subject, the quantity and quality of knowledge held by an enterprise are fundamental elements determining its competitiveness [3]; the brand value of an enterprise significantly enhances its overall value and market competitiveness [4]; cash is the "blood" of an enterprise's survival and development, and the level of cash holding is also a key element affecting its competitiveness [5].

Considering the external environment of enterprises, the elements affecting the competitiveness of enterprises mainly come from policies and regulations, market environment, etc., such as the difference in the impact of environmental regulations on enterprise competitiveness under partial equilibrium and general equilibrium [6], the policy of intellectual property demonstration cities increases the protection of intellectual property rights, which, by optimizing the behavioral pattern of the government and encouraging R&D of manufacturing enterprises, provides a better opportunity for manufacturing enterprises to competitiveness by picking up firewood [7]. A high-quality business environment can bring lower tax burdens, better financing channels, and fairer and more efficient market competition, which is more helpful in enhancing the competitiveness of enterprises [8].

Against the backdrop of a new generation of information technology and the emergence of digital technology, data elements have become the basis of enterprise competitiveness in the digital economy. The extensive use of data elements also drives economic development and social change, with positive economic consequences. Scholars have explored the positive role played by data elements from the micro, meso, and macro levels.

At the micro level, the data element is mainly manifested in promoting the digital transformation of enterprises [9], improving the innovation capability of enterprises [10], and the quality of innovation of manufacturing enterprises [11]. At the meso level, a data element can promote manufacturing productivity [12], the high-quality development of China's manufacturing industry from the three levels of market matching effect, production synergy effect, and R&D and innovation effect [13], and industrial structural adjustment [14]. At the macro level, scholars mainly study the impact of data elements on economic growth. Liu Zhengchi and other scholars [15] (2023) found that data elements can promote sustainable economic growth through the progress of intelligent technology. Other scholars believe that data elements have a "two-dimensional driving" effect on China's economic growth; on the one hand, data elements directly drive economic growth through their economic growth effect, and

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on the other hand, they indirectly drive economic growth through the promotion of technological progress [16].

In summary, the research on the elements influencing the competitiveness of enterprises has achieved rich research results, which has laid a better preliminary foundation for the subsequent study of this paper. In the context of a booming digital economy, the positive economic consequences of data elements are also widely recognized. However, more research needs to be done on how data elements can improve enterprises' competitiveness. A few studies have explored the impact of digital transformationand big dataon enterprise competitiveness. Very few studies have explored the relationship between data elements and enterprise competitiveness based on the perspective of SRDI enterprises, which are microeconomic subjects. This paper reveals the mechanism and effect of data elements on the competitiveness of SRDI enterprises in the context of the development of digital economy, and deepens the relevant research on data elements from the theoretical level; on the practical level, this paper identifies the path of enterprise competitiveness influence from the national strategy, and provides experience for further improving the competitiveness of SRDI enterprises.

3. Theoretical Analysis and Research Hypothesis

As the main body of innovation in the economic field, SRDI enterprises are the backbone of high-quality economic development. Data, as a new production element, has become the "oil" of the digital economy era, and data-driven innovation and entrepreneurship are becoming a new engine to improve the competitiveness of enterprises in the latest development stage. The non-competitive, non-exclusive, easily replicable, externality, immediacy, and learning effectof data element are other characteristics, can effectively reorganize element resources, inject fresh vitality into the development of SRDI enterprises, and reshape the competitive landscape of enterprises.

First of all, according to the resource-based theory, the competitiveness of SRDI enterprises is affected by the resources they hold, and data, as an indispensable production resource of the enterprise, can help SRDI enterprises to integrate and make use of internal and external resources, help them to quickly identify market changes, grasp the direction of enterprise specialization, dynamically adjust their innovation strategies and goals, and give full play to the ‘multiplier’ creation effect, so that they can stand out from the competition in the market. Secondly, from the supply chain analysis, the use of data element resources can help to open up the ‘information islands’ between enterprises so that they can better communicate with suppliers and partners, achieve upstream and downstream information synchronization in the supply chain, and collaborative decision-making, and optimize the interface between supply and demand, thus reducing transaction costs, saving management resources, promoting production cooperation, accelerating information sharing, and therefore shaping the competitive advantage of enterprises. Again, according to the signaling and reputation theories, SRDI enterprises can use data element resources to send good signals to stakeholders, build up their image, enhance external trust, improve their reputation, and enhance their competitiveness. Finally, in terms of human capital theory, the utilization of data element resources both reduces the demand for low-skilled labor and creates the demand for high-skilled labor, which in turn motivates SRDI enterprises to improve their human capital structure. At the same time, highly skilled laborers synergize with data element resources, thus giving full play to the technological research and development, market transformation, and branding capabilities of highly skilled laborers, which in turn enhances the competitiveness of enterprises. In summary, this paper proposes the following hypotheses:

H1: Data element development helps to improve the competitiveness of SRDI enterprises.

The analytical framework diagram for this paper is shown in Figure 1.

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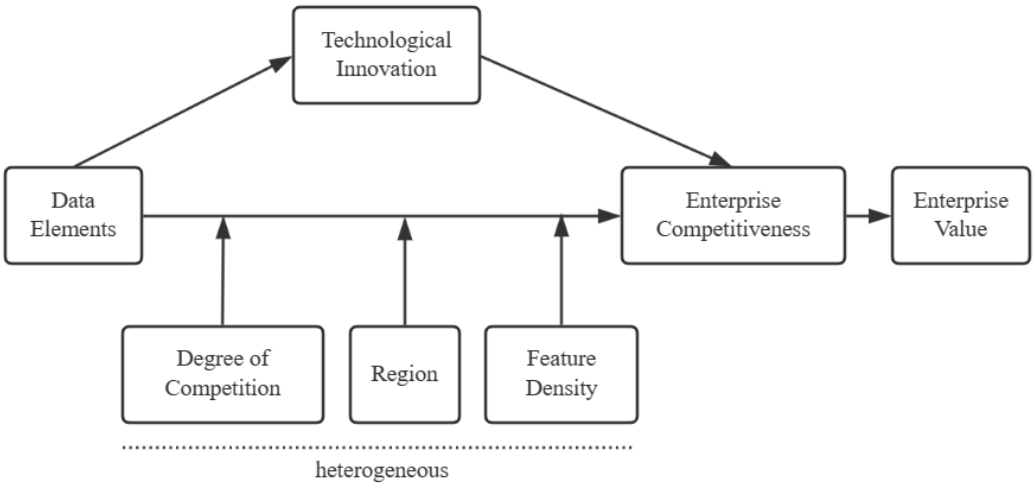

Figure 1. Diagram of the analytical framework

4. Research Design

4.1. Sample Selection and Data Sources

This paper takes the data of China's SRDI-listed enterprises from 2013-2024 as the research object for empirical analysis. The selected data are mainly from the China Statistical Yearbook, the CEI database, and CSMAR. The Digital Inclusive Finance Index is jointly compiled by the Digital Finance Research Centre of Peking University and Ant Financial Services. In this paper, the raw data are screened as follows: due to the missing severe data related to the Tibet region, enterprises whose registered place is Tibet are excluded; data in the category of abnormal trading (ST, *ST) are excluded; and data with missing key variables are excluded. On this basis, the continuous variables are indented by 5% up and down to reduce the impact of extreme outliers. The software used in this paper is Stata17.

4.2. Variable Definition and Description

4.2.1. Explained Variable: Enterprise Competitiveness

Referring to the research method of Pan Yi and Zhang Jinchang [17] (2023), the cash received from the operating activities account in the cash flow statement is income on a cash basis, which reflects the actual receipt of funds by the enterprise. The data in the cash flow statement is associated with third-party payment institutions, such as banks, and can be calibrated against each other, which can truly reflect the enterprise's actual income level. Therefore, this paper uses cash flow statement data to calculate enterprise competitiveness. In addition, Sheng Anqi et al. use the entropy value method to determine the weight size of each sub-indicator of enterprise competitiveness; the model is shown in Table 1.

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Table 1. Data description of the competitiveness model for cash flow caliber enterprises

Element	Index	Weight	Data source
Scale sub-element	Cash income	20	Subtotal cash inflows from operating activities
	Net assets	11	Net assets
	Net profit	16	Net profit
Growth sub-elements	The growth rate of funds	17	(Current year's cash receipts - last year's cash receipts)/last year's receipts
	Net profit growth rate	14	(Current year's net profit - last year's net profit)/last year's net profit
Efficiency sub-element	Return on equity	8	Net profit/net assets
	Asset contribution ratio	8	Net profit/total assets
	All labourproductivity	6	Cash receipts/number of employees
Composite indicators	Enterprise Competitiveness	100	Weighted summary of the above indicators

4.2.2. Explanatory Variable: Data Element

The National Institute of Information and Communications Technology authoritatively defines a data element as a data resource that participates in production and business activities, is recorded electronically, and generates benefits for users and owners. In view of this, this paper refers to the study of Shi Qingchunet al. [18] (2023), which used Python technology to conduct text analysis and word frequency statistics on the data element resources in the annual report information of SRDI-listed enterprises from 2013 to 2024. Among them, data elements = 'smart technology level' disclosure times + 'blockchain technology level' disclosure times + 'cloud computing technology level' disclosure times + The number of disclosures of 'big data technology level' + the number of disclosures of 'high data technology application level.'

4.2.3. Intermediate Variables: Technological Innovation

In this paper, we refer to the studies of scholars Jiang Xiaoguo et al. [19] (2019) to take R&D personnel input and patent output capacity as proxy variables for technological innovation and use the ratio of the number of R&D personnel to the total number of employees in the enterprise to measure the R&D personnel's input capacity and use the number of patent applications in the enterprise as a proxy for the patent output capacity.

4.2.4. Control Variables

This paper draws on existing related studies to select enterprise age, financial leverage, profitability, percentage of independent directors, cash flow, and equity concentration as control variables. In addition, year (Year) and industry (Industry) fixed effects are also controlled. The representation and definition of each variable is detailed in Table 2.

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Table 2. Variable definitions

Type of variable	Name of variable	Variable symbol	Definition of variables
Explained variables	Enterprise Competitiveness	Compete	Measured by enterprise competitiveness indicators, as detailed in Table 1
Explanatory variables	Data Element	Data	Number of times the relevant indicator for the data element appears in the financial report.
Intermediate variables	Investment in R&D staff	Staff	The ratio of the number of R&D personnel to the total number of employees in the enterprise
	Patent output capacity	Patents	Ln (1+Number of corporate patent applications)
Control variables	Age of Enterprise	Age	Ln (Current year - year of incorporation +1)
	financial leverage	Lev	Debt to asset ratio
	profitability	Profit	Corporate return on net assets
	Percentage of independent directors	Indep	Number of independent directors/total number of board members
	cash flow	Cf	The ratio of cash flow (subtotal of cash inflow from operating activities) to total assets
	shareholding concentration	Share	The shareholding ratio of the largest shareholder
	Industry dummy variables	Industry	dummy variable
	Annual dummy variables	Year	dummy variable

4.3. Model Design

This paper applies empirical research methods to explore in depth the influence of data elements on the competitiveness of SRDI enterprises and constructs a benchmark regression model as shown below:

$$Compete_{i,t} = \alpha_0 + \alpha_1 Data_{i,t} + \alpha_2 \Sigma Controls_{i,t} + \alpha_3 \Sigma Year + \alpha_4 \Sigma Industry + \varepsilon_{i,t} \quad (1)$$

Where, $Compete_{i,t}$ responds to the competitiveness of enterprise i in period t, $Data_{i,t}$ represents the data element of enterprise i in period t, $Controls_{i,t}$ is the relevant control variable, and Year and Industry are the year fixed effects and industry fixed effects.

5. Empirical Analysis

5.1. Descriptive Statistics

Table 3 shows descriptive statistics. The median competitiveness (Compete) of SRDI enterprises is 3.219, and the mean is 4.643, indicating that more than half of the enterprises are less competitive than the average. Therefore, the use of data elements to enhance the competitiveness of SRDI enterprises is imminent. The maximum and minimum values are 15.691 and 1.122, respectively, indicating that competitiveness varies widely across SRDI enterprises. As can be seen from the enterprise data element (Data) indicator, the maximum and minimum values are 90 and 0, respectively, and the median is 3. This indicates that there are also significant differences in the utilization of data elements by different enterprises.

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Therefore, there is ample room for developing data elements, and this study has important practical value.

Table3. Descriptive statistics for key variables

Variable	N	Mean	p50	SD	Min	Max
Compete	5948	4.643	3.219	3.835	1.122	15.691
Data	5948	14.693	3.000	24.343	0.000	90.000
Age	5948	2.898	2.890	0.260	2.398	3.332
Lev	5948	0.320	0.299	0.163	0.085	0.641
Profit	5948	0.061	0.067	0.076	-0.147	0.184
Indep	5948	0.382	0.375	0.051	0.333	0.500
Cf	5948	0.500	0.456	0.225	0.195	1.043
Share	5948	0.307	0.291	0.121	0.127	0.564
Costs	5948	0.068	0.051	0.047	0.015	0.196
Staff	5948	0.182	0.155	0.125	0.000	0.477
Patents	5948	0.629	0.000	0.950	0.000	2.944
Products	5948	0.794	0.519	0.528	0.181	1.736

5.2. Benchmark Regression Analysis

Table 4. Benchmark regression results

	(1)	(2)	(3)	(4)
	Compete	Compete	Compete	Compete
Data	0.004*	0.004**	0.019***	0.016***
	(0.002)	(0.002)	(0.002)	(0.002)
Age		0.698***		0.057
		(0.180)		(0.193)
Lev		5.496***		4.879***
		(0.309)		(0.313)
Profit		9.490***		8.661***
		(0.662)		(0.645)
Indep		-2.040**		-1.845**
		(0.871)		(0.835)
Cf		4.397***		3.906***
		(0.243)		(0.257)
Share		-2.217***		-1.762***
		(0.380)		(0.371)
_cons	4.588***	-0.519	0.629**	-1.528**
	(0.058)	(0.658)	(0.275)	(0.687)
Industry	No	No	Yes	Yes
Year	No	No	Yes	Yes
N	5948	5948	5948	5948
Adj. R^2	0.000	0.193	0.159	0.290

Note: Values in brackets are standarderrors; ***, **, * denote significant levels at 1%, 5%, and 10%.

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Table 4 reports the results of theregressions of the data elements on the competitiveness of SRDI enterprises. Columns (1) to (4) show the results of regressions without control variables and fixed effects, with control variables only, with fixed effects only, and with both control variables and fixed effects, respectively. The regression results in columns (1) to (4) demonstrate that the coefficients of Data are significantly positive regardless of the inclusion of control variables and fixed effects, indicating that the data elements substantially enhance the level of competitiveness of SRDI enterprises. The regression coefficient of Data in column (4) is 0.016, indicating that for every 1 percent improvement in the data element, the level of competitiveness of SRDI enterprises can increase by 1.6 percentage points, and hypothesis H1 of this paper is valid.

5.3. Robustness Test

5.3.1. Replacement of Explanatory Variable Measures

This paper refers to the research ofTao Changqi, and Ding Yu [11] (2022). It constructs a data element indicator system from three dimensions, namely, data element source, application and sharing, and data element benefit, in accordance with the flow of data elements from inputs to benefits. Refer to Table 5. Using this as a replacement variable for the explanatory variables, the baseline regression model is re-estimated, and the regression results are presented in column (1) of Table 6. The regression coefficients remain significantly positive at the 1 percent level after changing the data element measure, indicating that the regression results do not change as a result of the change in the measure. This once again validates the data element's positive impact on the competitiveness of SRDI enterprises.

Table 5. Indicator system for data element

System of indicators for data element	Index	Specific calculations
	Data element generation and collection	Number of Internet broadband access subscribers
		Number of domains, number of websites, number of pages
		Percentage of enterprises with e-commerce trading activities
	Application and sharing of data element	Internet penetration
		Number of mobile Internet users
		Total telecommunication services
		Total software operations
		Total postal operations
	Benefits derived from data element	Amount of e-commerce purchases
		Amount of e-commerce sales
		China Digital Inclusive Finance Index

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Table 6. Robustness tests: Replacement of explanatory variable measures, Regression with lag term

	(1)	(2)	(3)	(4)	(5)
	Replacementof explanatory variable measures	Regression with lag term			
	Compete	Compete	Compete	Compete	Compete
Data1	0.785***				
	(0.276)				
L. Data		0.020***			
		(0.003)			
L2. Data			0.023***		
			(0.003)		
L3. Data				0.024***	
				(0.004)	
L4. Data					0.026***
					(0.004)
Age	0.064	-0.240	-0.668**	-0.909***	-1.338***
	(0.194)	(0.235)	(0.285)	(0.345)	(0.416)
Lev	4.947***	4.781***	4.545***	4.536***	4.559***
	(0.313)	(0.358)	(0.407)	(0.467)	(0.546)
Profit	8.563***	10.608***	12.598***	13.082***	13.369***
	(0.647)	(0.716)	(0.787)	(0.895)	(1.011)
Indep	-1.905**	-2.968***	-3.207***	-3.452***	-3.265**
	(0.837)	(0.956)	(1.105)	(1.259)	(1.459)
Cf	3.946***	4.296***	4.690***	4.890***	5.158***
	(0.259)	(0.294)	(0.331)	(0.377)	(0.426)
Share	-1.805***	-1.733***	-1.605***	-1.393**	-1.062
	(0.373)	(0.438)	(0.516)	(0.604)	(0.712)
_cons	-1.511**	-0.203	1.601	2.929**	4.133***
	(0.695)	(0.836)	(1.003)	(1.203)	(1.426)
Industry	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
N	5948	4697	3697	2953	2309
Adj. R^2	0.285	0.305	0.319	0.314	0.315

5.3.2. Regression With Lag Term

Considering that enterprise competitiveness enhancement is a long-term continuous dynamic process and there may be a certain lag, this paper intends to examine further the impact of the current data element on the competitiveness of enterprises in the next period, two, three, and four periods. Columns (2) to (5) of Table 6 show that the effect of data elements on the competitiveness of SRDI enterprises after lagging one period to lagging four periods is significantly positive at the 1 percent level, suggesting that the conclusion that data elements contribute to the competitiveness of SRDI enterprises is robust and that the previous hypotheses still hold.

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5.3.3. Change the Sample Interval

Force majeure elements, such as natural disasters, socially unusual events, and government policies, often impact enterprises' activities and may affect their competitiveness. 2015 was the year of the stock market crash, and 2020 was the worst year of the epidemic, which had a significant negative impact on enterprises' competitiveness; municipalities with unique economic attributes may have similarly impacted the study's results. According to the research results of Pan Yi and Zhang Jinchang [17] (2023), this paper excludes the Data of 2015 and 2020 and municipalities directly under the central government to conduct the regression. From the results in columns (1) and (2) of Table 7, the coefficients on Data are still significantly positive at the 1 percent level even when the Data for anomalous years and municipalities are excluded, suggesting that the conclusion that the data element improves the competitiveness of SRDI enterprises is valid.

Table 7. Robustness tests: Change the sample interval, Instrumental variable and PSM regression results

	(1)	(2)	(3)	(4)	(5)	(6)
	Exclusion of anomalous years	Exclusion of Municipality	Balanced panel Data	First Stage	Second Stage	PSM
	Compete	Compete	Compete	Data	Compete	Compete
Data	0.016***	0.013***	0.018***		0.022***	0.925***
	(0.002)	(0.002)	(0.003)		(0.003)	(0.079)
iv				0.904***		
				(0.007)		
Age	0.119	-0.174	-1.447***	-0.648	-0.226	0.371**
	(0.212)	(0.211)	(0.314)	(0.606)	(0.218)	(0.146)
Lev	5.116***	5.632***	3.260***	1.118	4.757***	4.731***
	(0.348)	(0.346)	(0.508)	(0.933)	(0.336)	(0.234)
Profit	8.812***	8.357***	12.097***	4.722**	10.506***	8.918***
	(0.725)	(0.738)	(1.063)	(1.865)	(0.670)	(0.485)
Indep	-1.589*	-2.397***	-7.016***	-1.240	-2.942***	-3.503***
	(0.932)	(0.922)	(1.245)	(2.687)	(0.966)	(0.671)
Cf	3.735***	3.670***	4.952***	0.319	4.289***	3.710***
	(0.283)	(0.303)	(0.389)	(0.699)	(0.251)	(0.171)
Share	-1.788***	-0.558	0.963	-0.075	-1.731***	-1.045***
	(0.407)	(0.420)	(0.620)	(1.204)	(0.433)	(0.304)
_cons	-1.799**	-1.433*	3.150***	5.506**	1.150	-2.140***
	(0.755)	(0.855)	(1.025)	(2.585)	(0.931)	(0.641)
Kleibergen-Paap rk Wald F statistic				6124.974		
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	4889	4374	2440	4,697	4,697	8712
Adj. R^2	0.288	0.315	0.428	0.868	0.313	0.297

This paper further transforms the unbalanced panel data of SRDI enterprises from 2013 to 2024 into a balanced panel data and conducts a re-test. The empirical results in column (3) of

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Table 7 show that the impact of the data element on the competitiveness of SRDI enterprises is still significantly positive at the 1% level, and Hypothesis H1 is once again verified.

5.3.4. Instrumental Variable

The results of the benchmark regression in Table 4 show that data elements significantly contribute to the competitiveness of SRDI enterprises. Although this paper tries to control for the possible influence of data elements on the competitiveness of SRDI enterprises, it may still be affected by some unobservable elements that cause estimation bias. For this reason, this paper chooses the two-stage least squares method to mitigate the possible endogeneity between data elements and enterprise competitiveness.

This paper uses lagged one-period explanatory variables as instrumental variables.Column (4) of Table 7 reports the regression results for the first stage of the instrumental variables; the coefficient of the instrumental variable (iv) is 0.904 and is significant at the 1 percent level, indicating a significant positive correlation between the instrumental variables chosen and the data elements. The second leg of the regression in Column (5) shows that the coefficient of Data is significantly positive at the 1% level, indicating that the data element still contributes to the competitiveness of SRDI enterprises after accounting for endogeneity issues. Meanwhile, the Kleibergen-Paap rk Wald F statistic is much larger than the critical value of the Stock-Yogo weak instrumental variable test, indicating that there is no weak instrumental variable problem. Hypothesis H1 of this paper is further verified.

5.3.5. PSM Regression Results

Rosenbaum and Rubin proposed Propensity Score Matching (PSM) in 1983. It employs the estimation of treatment effects in a counterfactual simulation state, effectively eliminating the selectivity bias generated by confounding elements. In this paper, the samples of enterprises having word frequency of data elements are set as high grouping, i.e., treatment group, and the samples of enterprises without word frequency of data elements are set as low grouping, i.e., control group. The idea behind the PSM research methodology is to match an individual from the control group who is similar to the experimental group in all characteristics on the basis of the propensity score estimated by logit or probit models so as to compare the gap in competitive performance between SRDI enterprises that are similar in all other characteristics and have differences only in the data elements. In the actual matching process, the similarity distance between individuals must be considered. This paper mainly uses band caliper proximity matching to estimate the average treatment effect (ATT) of the impact of data elements on the competitiveness of SRDI enterprises, and the results are shown in Table 8. ATT is significant at a 1 percent level, indicating the validity of the treatment group's data elements on the competitiveness of SRDI enterprises compared to the control group.Meanwhile, the model was tested using the matched samples, and the regression results are shown in column (6) of Table 7, where the data element coefficients remain significantly positive.

This paper conducted a balance test on the samples after PSM to check the quality of matching, and the results are shown in Figure 2. The variability of the main control variables between the treatment group and the control group after PSM is significantly reduced, so thematching effect is more satisfactory.

Table 8. PSM model results

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Compete	Unmatched	4.85082235	4.07368909	0.777133254	0.111878571	6.95
	ATT	4.83393277	4.33627079	0.497661986	0.121488237	4.10
	ATU	4.07368909	4.58507677	0.511387683		
	ATE			0.50135808		

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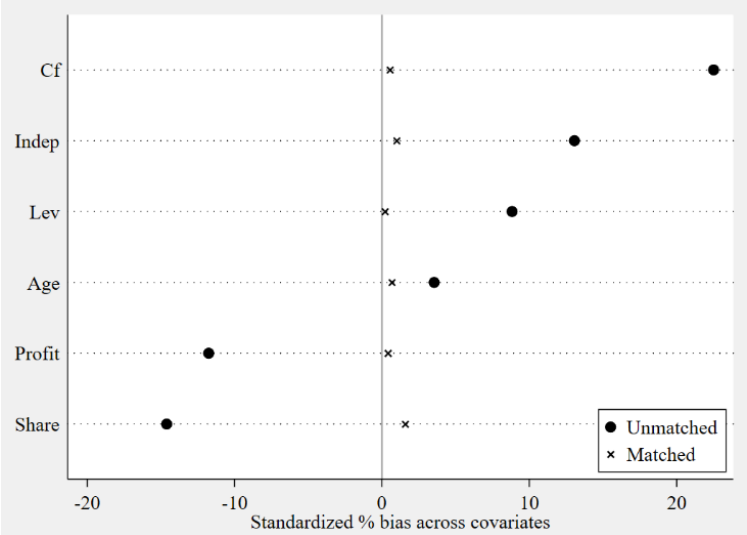

Figure 2. Balance test

5.4. Mechanism of Action Tests

While the previous section provides sufficient support for data elements to improve the Competitiveness of SRDI enterprises, it has yet to explore their mechanism of action. The following section will reveal the "dark box" in which data elements promote the Competitiveness of SRDI enterprises. Theoretically, data elements promote technological innovation and upgrading of enterprises through spillover, demonstration, and synergy effects, improving enterprise competitiveness. Firstly, the data element can help SRDI enterprises accelerate the speed of innovation resources, efficiently integrate various types of innovation information, and promote mutual technological spillovers among various subjects. Second, the data element promotes regional innovation through demonstration effects to further promote technological innovation in SRDI enterprises. Finally, the data element can enhance the linkages between existing individuals or departments in SRDI enterprises, reduce information silos within the enterprise, and enhance inter-departmental synergies. Enterprises carry out technological innovation is not only easier to obtain new product markets, technological innovation to achieve the transformation of technological advantages to product advantages, increase market share and growth rate, and further enhance the competitiveness of the enterprise, but also SRDI enterprises to carry out technological innovation can facilitate the enterprises to produce products that are differentiated from other competitors and achieve product differentiation and uniqueness, which enables them to maintain competitive advantages in the market and enhance their competitiveness.

In this paper, two proxy variables for technological innovation are selected: R&D personnel inputs (Staff) and patent output capacity (Patents). This paper verifies the mechanism of action in two steps: 1. empirically test the impact of data element on enterprise technological innovation, and initially support the theoretical logic if the empirical evidence shows that the data element promotes technological innovation of the enterprise; 2. combine with the existing literature to identify the direct and noticeable impact of technological innovation on the competitiveness of the enterprise, and further validate how the data element influence the SRDI enterprises' competitiveness. This paper constructs model (2) for the first step. In this case, the control variables and fixed effects settings are consistent with the baseline regression model, and the Mediator denotes the mediating variable.

$$Mediator_{i,t} = \alpha_0 + \alpha_1 Data_{i,t} + \alpha_2 \Sigma Controls_{i,t} + \alpha_3 \Sigma Year + \alpha_4 \Sigma Industry + \varepsilon_{i,t} \quad (2)$$

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Table 9 shows that the data element (Data) is positively significant at the 1% level for the proxy variables of technological innovation of SRDI enterprises, R&D personnel input (Staff), and patent output capacity (Patents), indicating that the data element is effective in enhancing the level of technological innovation of SRDI enterprises.

Table 9. Tests of the mechanism of action based on the mediating effects model

	(1)	(2)
	Staff	Patents
Data	0.001***	0.004***
	(0.000)	(0.001)
Age	-0.028***	0.023
	(0.005)	(0.051)
Lev	-0.103***	0.518***
	(0.008)	(0.083)
Profit	-0.030	0.248
	(0.018)	(0.178)
Indep	0.036	-0.229
	(0.024)	(0.251)
Cf	-0.046***	0.021
	(0.006)	(0.063)
Share	-0.049***	-0.350***
	(0.010)	(0.108)
_cons	0.141***	0.254
	(0.024)	(0.194)
Industry	Yes	Yes
Year	Yes	Yes
N	5948	5948
Adj. R^2	0.482	0.064

6. Further Analysis

6.1. Heterogeneity Analysis

6.1.1. Heterogeneity Analysis Based on the Degree of Competition in the Industry

The degree of competition in the industry in which it operates may affect the utility of the data elements of SRDI enterprises in enhancing their competitiveness. This paper uses operating revenues to calculate the Herfindahl-Hirschman Index (HHI), an inverse indicator; the higher the value, the closer the market is to monopoly and the lower the degree of competition.In this paper, the sample is divided into two groups, high and low competition, according to the mean of the HHI. The results in columns (1) and (2) of Table 10 show that the regression coefficients of the data elements are significantly positively correlated for both the high and low competition groups, but the data elements of the SRDI enterprises in the high degree of competition are more significant in enhancing their competitiveness. This difference may be due to the fact that enterprises in high-monopoly industries have unique advantages in terms of access to resources, market share, etc., and face less competitive pressure in the market, with less incentive to utilize data elements. In contrast, in highly competitive industries, where enterprises face higher pressure to crowd out competitors' resources due to more competitors and lower barriers to entry, enterprises are more willing to utilize data elements. The

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utilization of data element resources can promote technological innovation and upgrading and shape the competitive strength of enterprises.

Table 10. Heterogeneity test

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	low degree of competition	high degree of competitiveness	Eastern Region	Central Region	Western Region	labour-intensive	technology-intensive	capital-intensive
	Compete	Compete	Compete	Compete	Compete	Compete	Compete	Compete
Data	0.012***	0.019***	0.015***	0.027***	0.010	0.011	0.015***	0.034**
	(0.003)	(0.003)	(0.003)	(0.005)	(0.007)	(0.007)	(0.002)	(0.015)
Age	-0.014	0.105	0.229	1.022**	-0.896	2.708***	-0.234	-1.012**
	(0.303)	(0.248)	(0.221)	(0.463)	(0.556)	(0.545)	(0.223)	(0.513)
Lev	4.655***	4.968***	5.276***	2.926***	5.117***	4.126***	4.622***	7.436***
	(0.515)	(0.394)	(0.346)	(0.787)	(1.006)	(0.768)	(0.372)	(0.853)
Profit	7.928***	9.188***	8.926***	9.246***	3.539**	7.856***	9.120***	6.060***
	(1.134)	(0.783)	(0.716)	(1.518)	(1.731)	(1.819)	(0.738)	(2.029)
Indep	-5.712***	0.219	-0.552	-1.834	-9.789***	-5.982***	-0.541	-4.526**
	(1.362)	(1.061)	(0.977)	(1.676)	(2.030)	(2.290)	(0.987)	(2.222)
Cf	4.072***	3.804***	3.748***	2.203**	5.922***	3.935***	3.449***	5.220***
	(0.419)	(0.325)	(0.276)	(0.872)	(0.796)	(0.624)	(0.312)	(0.628)
Share	-1.878***	-1.623***	-2.922***	2.828**	-0.840	-1.863	-1.904***	-1.481
	(0.576)	(0.481)	(0.418)	(1.095)	(1.153)	(1.135)	(0.414)	(1.217)
_cons	0.702	-2.966***	-2.206***	-4.813***	5.078***	-2.257	-0.907	3.199*
	(1.023)	(0.910)	(0.775)	(1.687)	(1.766)	(1.627)	(0.795)	(1.935)
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2214	3734	4611	734	603	919	4158	837
Adj. R^2	0.396	0.220	0.301	0.438	0.563	0.448	0.215	0.303

6.1.2. Heterogeneity Analysis Based on Region

China is a vast country, and different regions have significant disparities in resource endowment and economic development level; this paper divides the sample into three subsamples: eastern, central, and western regions according to the location of the enterprises, to examine the regional heterogeneity of data elements on the competitiveness of SRDI enterprises. Column (3) of Table 10 shows that data elements significantly contribute to the competitiveness of SRDI enterprises in the East with a regression coefficient of 0.015 and a significance level of 1 percent.Possibly with the developed economy in the east, the internet, big data, and other developments started early, has a complete digital infrastructure related to these first-mover advantages to help enterprises use the data elements of the R&D capabilities of the more substantial, to promote their technological innovation, and thus improve the competitiveness of enterprises. Enterprises in the central region have also benefited from the development of the data element, which has led to a significant increase in their competitiveness. This may stem from the fact that a number of provinces in the central region have made the construction of a solid digital province a vital goal. Hubei, Henan, Hunan, Anhui, Jiangxi, and others are forming a new momentum for data development by consolidating the construction of digital infrastructure and promoting policy dividends, etc. The central region has ushered in a new opportunity for growth, providing an opportunity for SRDI enterprises to

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utilize the elements of data to enhance their competitiveness. The reason why data elements do not play a significant role in improving the competitiveness of SRDI enterprises in the western region may be due to the relative lag in economic development and digital infrastructure construction in the area of the west. The high cost of enterprises' utilization of data element resources restricts them from better utilizing the data elements. It makes the impact of data elements on their competitiveness not significant.

6.1.3. Heterogeneity Analysis Based on Enterprises' Element Intensity

According to the differences in factor intensity of enterprises, this paper divides the sample enterprises into three subsamples: labor-intensive, technology-intensive and capital-intensive. The regression results are shown in Columns (6), (7) and (8) of Table 10.As the table shows, data elements can improve the competitiveness of both technology-intensive and capital-intensive enterprises, and the effect is more pronounced in capital-intensive enterprises.This is because, firstly, labor-intensive enterprises do not have a hard foundation for the use of data elements, may need training and technical support to use data elements, and may take longer to accept and assimilate data elements, which imposes certain limitations on their competitiveness. Secondly, technology-intensive enterprises usually have the advantages of talent and technology. The existing element resources of enterprises and data elements can be efficiently integrated to optimize the element structure, production mode, and management mode in an all-around way and promote their technological innovation, thus enhancing their competitiveness. Finally, capital-intensive enterprises often have muscular financial strength, providing an essential guarantee for enterprises to use data elements, which is more conducive to playing a positive role in technological innovation of data elements, which can play a more significant role in promoting the competitiveness of enterprises.

6.2. Enterprise Value Effect

In the following section, the further impact of data elements on SRDI enterprises will be analyzed in depth from the perspective of enterprise value to provide practical and reliable empirical evidence for the research implications of this paper.

Anenterprise's existing profitability and future investment activities determine its value. On the one hand, the improvement of the competitiveness of SRDI enterprises can send a ‘good’ signal to the outside world, effectively weakening the adverse external shocks caused by the intensification of competition in the industry, enhancing the ability to fight with competitors and the ability to adapt to the environment, and improving the profitability of enterprises, which is conducive to the enhancement of enterprise value. On the other hand, the 'hedging effect' exerted by the competitive advantage of SRDI enterprises conveys the favorable signal of good prospects for the future development of enterprises, reduces the investment risk of investors, triggers the positive response of potential investors. Investors are more optimistic about the expectations of future earnings of enterprises and are more willing to invest in enterprises, enriching the capital flow of the enterprise's future investment activities, effectively promoting enterprise investment, and thus enhancing enterprise value.

Based on this, this paper selects enterprise market capitalization as the measure of enterprise value. Where Market Capitalisation= (Capitalization- Domestically listed foreign B shares)* Current value of A shares at today's closing price+ Domestically listed foreign B shares* Current value of B shares at today's closing price(Shanghai stock market *CNY_USD, Shenzhen stock market/HKD_CNY, Conversion to RMB)+ Total liabilities Closing value for the period. The results in Table 11 indicate that data elements can indirectly increase enterprise value by improving the competitiveness of SRDI enterprises.

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Table 11. Enterprise value analysis

	(1)	(2)
	market value	market value
Data	0.003***	0.001**
	(0.000)	(0.000)
Compete		0.130***
		(0.002)
Age	-0.111***	-0.119***
	(0.034)	(0.023)
Lev	1.104***	0.471***
	(0.053)	(0.035)
Profit	2.479***	1.355***
	(0.115)	(0.084)
Indep	-0.075	0.164
	(0.149)	(0.104)
Cf	-0.272***	-0.779***
	(0.040)	(0.028)
Share	-0.302***	-0.073
	(0.067)	(0.044)
_cons	21.739***	21.937***
	(0.136)	(0.100)
Industry	Yes	Yes
Year	Yes	Yes
N	5948	5948
Adj. R^2	0.284	0.666

7. Conclusion and Suggestions

7.1. Conclusion

Along with the rapid development of digital technology and the digital economy, data has become one of the most important strategic resources in today's society. In the context of digitalization, it is crucial to understand what role data elements play in the competitiveness of SRDI enterprises. By deeply exploring the impact of data elements on the competitiveness of China's SRDI-listed enterprises from 2013 to 2024, this paper finds that data elements can significantly enhance the competitiveness of SRDI enterprises, and the conclusions still hold after a series of robustness tests. The mechanism of action suggests that data elements can contribute to the competitiveness of SRDI enterprises by enhancing their technological innovation capabilities. The heterogeneity results show that the effect of data elements on competitiveness is more significant in the high degree of competitiveness, eastern and central regions, and technology-intensive versus capital-intensive enterprises. Furthermore, the increase in the competitiveness of SRDI enterprises by data elements is conducive to the increase in their value.

7.2. Suggestions

This study has important policy implications. As an essential element of production, the positive role played by the data element in the economy is well established, and the Action Plan issued by seventeen ministries is the implementation of the "Twenty Articles on Data." This paper argues that, first, SRDI enterprises should grasp the opportunity of data element development

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and fully activate its potential. In view of the positive role of data elements in SRDI enterprises, SRDI enterprises should increase their investment in R&D and strengthen the application of data elements in all aspects of production. In particular, when SRDI enterprises carry out technological innovation, they should combine their internal and external data resources, make use of the Internet, big data, and other technologies to break down the data barriers, pull out the 'data chimney,' and infiltrate the data elements into the innovation activities of the enterprises, so as to enhance the level of technological innovation of the enterprises and ultimately improve the competitiveness of the enterprises. Second, because SRDI enterprises have different levels of industry competition, regions, and element intensities, governments should adopt differentiated policies for different types of enterprises. For example, give play to the superiority and inferiority mechanism of market competition, break down industry barriers, encourage enterprises to engage in healthy competition, and stimulate the promotion of SRDI enterprises' data elements to their competitiveness by competition. For the Western region, we should strengthen the investment in digital technology and talents, steadily and orderly promote the construction of digital infrastructure, and improve the communication and interaction mechanism for the development and utilization of inter-regional data elements so as to make the development of data elements inter-regional linkage, and to help the SRDI enterprises in the western region to make use of the data element resources to enhance their competitiveness. The government should actively enhance the level of awareness of data-element resources among labor-intensive enterprises, encourage their development and utilization of data-element resources, and promote the competitiveness of SRDI enterprises.

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