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How can data assets contribute to industry chain resilience in manufacturing companies?

Empirical evidence based on Chinese listed companies

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Abstract. With the continuous advancement of digital industrialization, data assets have gradually become a new driving force to enhance the resilience of the industrial chain. Based on the panel data of A-share listed companies from 2012 to 2022,this paper explores the impact and mechanism of data assets on industry chain resilience. It is found that, first, data assets significantly enhance the enterprise industry chain resilience, and the conclusion still holds after a series of robustness tests and endogeneity treatment. Second, the capital effect and operation effect are the main channels through which digital assets affect industry chain resilience. Third, the positive effect of data assets on industry chain resilience is more significant in the east side of Hu Huanyong line and labor-intensive enterprises. This study provides a micro-theoretical foundation and policy insights for strengthening the development and application of data assets to help improve the resilience of the industrial chain.

Keywords: data assets; industry chain resilience; polarization effect.

1. Introduction

As global industrial competition enters the chain era, multiple uncertainties such as anti-globalization and geopolitics are seriously constraining the safe and stable development of China's industrial chain. In this context, enhancing the resource allocation efficiency and risk resistance of the industrial chain have become the fundamental needs of China's economic stability. However, at present, the external circulation of China's industrial chain is not smooth and the internal innovation is insufficient, and the problems of blocking and breaking point appear frequently. Therefore, how to effectively improve the resilience of the industrial chain has become a realistic need to protect China's industrial security and economic stability.

In the era of digital economy, the digital transformation of enterprises rides on the momentum, and data has become a new type of production factor and fundamentally reconstructed the development paradigm of traditional industries. As China's economic development enters a new normal, the endowment level and allocation efficiency of enterprise data assets are not only related to the effectiveness of the digital transformation of micro subjects, but also become a key breakthrough in the realization of the autonomy of the industrial chain, and the data assets are gradually upgraded from a technological tool to a national strategic competitiveness. It is worth noting that, can data assets effectively drive the resilience of the industry chain? And what is its inner mechanism? This paper tries to answer the above questions, with a view to providing an empirical basis for China to fully release the data factor dividend to boost the resilience reshaping of the industrial chain in the future.

The literature most relevant to the study of this paper examines the influencing factors of industry chain resilience, and it is mainly divided into two categories: macro-regional and micro-enterprise: at the macro level, relevant scholars have explored the role of synergy between digitalization and greening, industrial diversification, new quality productivity, and policy regulation(the "chain-length system" policy, regional market integration, etc.) on the resilience of the industry chain(Li et al, 2024;He et al, 2022). On this basis, other scholars further discuss the effects of digital transformation, virtual agglomeration and government data disclosure on regional industry chain resilience in the context of digitalization(Alvarenga et al, 2023;Xie et al, 2024). At the micro level, some scholars

have found that financing constraints and the level of internal corporate governance have an important impact on industry chain resilience. Specifically, Li et al(2024) cut from the perspective of financing constraints and found that financing constraints can inhibit the enterprise industry chain resilience, and there is a significant difference between state-owned and non-state-owned enterprises;Sincora et al(2018) pointed out that the improvement of the enterprise's internal governance capacity can effectively enhance the industry chain resilience, in which analytical decision-making, information quality and leadership commitment are the main channels of action.

Another strand of literature related to this paper focuses on the economic benefits of data assets. Related scholars have found that the accumulation of data assets helps to enhance the innovation ability of enterprises, reduce the cost of equity capital, and improve the level of human capital of enterprises. In addition, data assets profoundly affect the structural change of industries, which can enhance the modernization of industrial chains and promote the digital transformation of traditional industries(Julia et al, 2021). As the global economic competition gradually evolves to industrial chain competition, the importance of industrial chain resilience as a cornerstone for safeguarding industrial security and economic development is becoming more and more prominent. Unfortunately, little literature has directly explored the relationship between data assets and industry chain resilience. Most relevant is the study of the enabling effect of data elements on industry chain resilience(Kiarash et al, 2025). However, data elements are usually defined as a collection of data resources that have potential value but have not yet been processed, and the realization of their value is affected by factors such as data quality and flow efficiency, etc. Directly incorporating data elements into regression analyses may affect the validity of causal identification by overlooking the process of releasing and leapfrogging the value of its "assetization"(Birch, 2023).

Compared with the previous literature, the marginal contribution of this paper lies in the following:(1) This paper focuses on data as a new type of element, takes data assetization as an entry point, and explores the impact of data assets on the resilience of the enterprise industry chain, which not only expands the research boundaries of the economic effect of data assets, but also deepens the understanding of the factors affecting the resilience of the industry chain, and provides theoretical support for the coordinated construction of a strong digital country and the enhancement of the resilience of the industry chain. (2) Based on the unique attributes of digital assets, this paper explores the role mechanism of data assets on industry chain resilience from three perspectives of capital effect and operation effect, at the same time, embeds multivariate constraints in the research framework, taps into the heterogeneous impact of data assets on industry chain resilience, and provides feasible paths and differentiated means of governance for the use of data assets to enhance the resilience of the industry chain. (3) This paper further examines the impact of data assets on enterprises with different levels of industry chain toughness using the quantile model, and finds that the enhancement effect of digital assets on industry chain resilience mainly gathers in enterprises with high toughness, revealing the potential development risk of "the strongest is always the strongest" among enterprises in the context of digital transformation, and providing a new opportunity for the country to prevent the digital divide and build a rationalized data resource management system. It provides new policy ideas for the country to prevent digital divide and build a rational allocation mechanism of data resources.

2. Theoretical analysis and research hypotheses

2.1 Data assets and enterprise chain resilience

The essence of resilience is the multi-level, cross-cycle risk buffer mechanism of the organization's intrinsic changes, and is reflected in the ability to identify the crisis before the impact, maintain stability during the impact, and upgrade the leap after the impact(Martin et al, 2015).

From the point of view of pre-impact, data assets are obtained based on desensitized cleaning of data elements and feature extraction, which compresses the information redundancy of enterprises, builds up a cognitive enhancement circuit from"perception"to"response"of enterprises before the

external impact, and effectively improves the ability of enterprises to respond to market changes and risk identification and early warning, so as to improve the resilience of the industrial chain. From the point of view of the impact, enterprises can use data assets to empower production, operation, management and decision-making, so that enterprises can adjust business processes and resource allocation in a timely manner, and enhance the self-adaptive capacity of the enterprise system(Banalieva & Dhanaraj, 2019). From the later perspective of the shock, in the face of economic downward pressure and external competitive risks, enterprises can achieve a survival breakthrough through technological research and development, product innovation, organizational change and other means(Konstantinos et al, 2021). Based on this, the hypotheses are proposed as follows:

H1: Data assets can improve enterprise industry chain resilience.

2.2 Analysis of the mechanism of data assets affecting the industry chain resilience

2.2.1 Capital effect

The internal capital liquidity of enterprises is one of the important factors affecting the resilience of the industrial chain, and a reasonable level of capital flow helps enterprises to maintain daily production and operation activities and avoid bankruptcy and closure due to the breakage of the capital chain, which makes enterprises show stronger resistance and resilience in response to external shocks(Su et al, 2025). Data assets can alleviate enterprise financing constraints by improving the information environment and operational efficiency of the capital market, thus impacting the resilience of the industrial chain(Lin & Xie, 2025), as follows: on the one hand, in the traditional context, financial institutions and investors tend to be conservative in financing enterprises, and the proprietary information of the enterprise embedded in the data assets can dynamically map the enterprise's real value creation ability, effectively alleviating the problem of adverse selection in the capital market can be effectively mitigated, and the information friction in the capital market can be reduced through the standardized disclosure mechanism to play the signal transmission effect. On the other hand, data assets can break the value rigidity constraints of traditional collateral and create greater long-term economic benefits, especially under the support of blockchain corroboration technology, data assets can significantly improve debt performance ability by reconfiguring the structure of the credit contract, and mitigate the moral hazard between enterprises and financial institutions(Lu et al, 2023). Based on this, the hypothesis is proposed as follows:

H2: Digital assets can enhance the resilience of enterprise industry chain by alleviating financing constraints.

2.2.2 Operation effect

Efficient management can reduce the cost of enterprise cross-sectoral coordination of production and redistribution, and enhance the overall dynamic adjustment efficiency of the industry chain through innovative management methods, thus reducing the risk of industry chain breakage(Cucculelli & Bettinelli, 2015). As a key strategic resource for enterprises, data assets can significantly improve the efficiency of enterprise operation and management, as follows: first, digital elements usually have a high value, and their own integration, sharing and other unique attributes, which helps enterprises optimize the deployment of resources after the assetization, and improves the enterprise's own production and customer relations and other management capabilities(Hu et al. , 2022). Second, data assets can realize supply chain visualization, mitigate the transmission effect of external shocks through active risk management, enable enterprises to quickly adjust procurement strategies and activate alternative production capacity under shocks, and ensure the continuous operation of the core links of the industrial chain. Third, the "whip effect" is a problem that is difficult to be eliminated in traditional industry chain management, while data assets can promote the vertical transmission of information and management capabilities along the industry chain through its shared attributes, effectively mitigating the "whip effect" to enhance the buffering capacity and resilience of the industry chain in coping with the shocks. Based on this, the following hypothesis is proposed:

H3: Digital assets can enhance the resilience of the enterprise industry chain by strengthening the management ability.

3. Research Design

3.1 Model construction

In order to empirically test the impact of data assets on industry chain resilience , this paper constructs the following econometric model:

$$Rchain_{it} = \alpha_0 + \alpha_1 DA_{it} + \sum \alpha_k Control_{it} + \mu_i + \theta_t + \varepsilon_{it} \quad (1)$$

i and *t* denote enterprise and time respectively, $Rchain_{it}$ is the explanatory variable of this paper, denoting the industry chain resilience of enterprise i in year t, DA_{it} is the explanatory variable of this paper, denoting the level of data assets of enterprise i in year t, *Control* denotes the set of control variables, see the explanation below for more details, μ_i and θ_t stand for the individual and time fixed effects respectively, and ε_{it} denotes the random error term.

In addition, in order to further explore the mechanism of the role of data assets on the resilience of the enterprise industry chain, taking into account the serious result bias of the stepwise regression method, this paper draws on the idea of Jiang(2022) and uses only the empirical test of digital assets on the mechanism variables to verify the specific model as follows:

$$Mediator_{it} = \beta_0 + \beta_1 DA_{it} + \sum \beta_k Control_{it} + \mu_i + \theta_t + \varepsilon_{it} \quad (2)$$

Mediator is the set of mechanism variables and the rest of the variables are consistent with model(1).

3.2 Definition and measurement of variables

3.2.1 Explained variable

The explained variable in this paper is industry chain resilience (*Rchain*). Drawing on the idea of Zhang et al (2023), the level of industry chain resilience is measured by the degree of deviation of enterprise performance, and the larger the value of the index, the greater the changes and responses of enterprises in different periods, and the stronger the industry chain resilience of enterprises.

3.2.2 Core explanatory variable

The core explanatory variable in this paper is data assets (*DA*). This paper draws on the practice of Lu et al(2023) to measure data assets as the difference between the market value and that of fixed, intangible and financial assets. The larger the value of the indicator, the higher the value of the enterprise's data assets.

3.3.3 Control variables

This paper draws on ideas from previous literature（Zheng et al, 2025） and selects the following control variables: equity concentration (*Top5*), cashflow ratio (*Cashflow*), gearing ratio (*Lev*), firm size (*Size*), and nature of ownership (*SOE*). The definition and measurement of relevant variables are shown in Table 1.

Table 1 Definition of variables

Variable type	variable name	variable symbol	Variable Definition
explained variable	industry chain resilience	Rchain	The residuals of the standardized performance fit model are obtained as
explanatory variable	data asset	DA	The value of enterprise data assets based on the estimation of the future earnings approach
control variable	shareholding concentration	Top5	Ratio of number of shares held by top five shareholders to total number of shares

Cash flow ratio	Cashflow	Net cash flows from operating activities as a percentage of operating income
Gearing	Lev	Ratio of total liabilities to total assets
Enterprise size	Size	Logarithm of total assets of the enterprise at the end of the year
Nature of property rights	SOE	State-owned enterprises take the value of 1, otherwise 0

3.3 Sample selection and data sources

In this paper, China's A-share listed enterprises from 2012 to 2022 are taken as the research object, the data of the explained variables and control variables are from CSMAR database, while the data of the explanatory variables are from the official websites of Shanghai Stock Exchange and Shenzhen Stock Exchange. In addition, this paper also treats the research samples as follows: (1) excluding enterprises in abnormal status such as ST and *ST in the current year;(2) excluding financial enterprises;(3) excluding insolvent samples;(4) excluding samples with missing key financial indicators. And the continuous variables are shrink-tailed at the 1% and 99% levels, resulting in a total sample of 12, 304 observations.

4. Empirical results and analysis

4.1 Regression analysis

Table 2 reports the regression results of data assets on firm chain resilience. Column (1) considers only the core explanatory variables (*DA*) of this paper, regressing only digital assets on enterprise industry chain resilience, it can be found that the regression coefficients of data assets are significantly positive without the inclusion of control variables, which indicates that data assets help to improve the level of enterprise industry chain resilience. On this basis, gradually incorporating the control variables in this paper, it can be found that the regression coefficient of digital assets has increased and is still significantly positive at the 1% level. The benchmark regression results in Table 2 all show that data assets can significantly improve the resilience of the enterprise industry chain, and the theoretical hypothesis 1 of this paper can be verified.

Table 2 Benchmark regression results

variant	(1) *Rchain*	(2) *Rchain*	(3) *Rchain*	(4) *Rchain*	(5) *Rchain*	(6) *Rchain*
DA	0. 118***	0. 118***	0. 111***	0. 136***	0. 210***	0. 209***
	(5. 11)	(5. 12)	(5. 06)	(5. 61)	(7. 38)	(7. 36)
Top5		0. 000	-0. 000	-0. 001	-0. 000	-0. 000
		(0. 02)	(-0. 11)	(-0. 48)	(-0. 17)	(-0. 16)
Cashflow			1. 614***	1. 538***	1. 501***	1. 502***
			(9. 35)	(9. 20)	(8. 72)	(8. 73)
Lev				-0. 333***	-0. 325***	-0. 318***
				(-2. 87)	(-2. 79)	(-2. 73)
Size					-0. 116***	-0. 116***
					(-2. 73)	(-2. 73)
SOE						-0. 104*
						(-1. 90)
_cons	-2. 794***	-2. 795***	-2. 711***	-3. 116***	-2. 272***	-2. 238***
	(-5. 33)	(-5. 25)	(-5. 31)	(-5. 77)	(-3. 19)	(-3. 15)

variant	(1) *Rchain*	(2) *Rchain*	(3) *Rchain*	(4) *Rchain*	(5) *Rchain*	(6) *Rchain*
Control	No	Yes	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12304	12304	12304	12304	12304	12304
R-squared	0. 4833	0. 4833	0. 5042	0. 5063	0. 5080	0. 5085

Note: t-values are in parentheses. Unless otherwise stated, the following table is the same.

4.2 Robustness tests

In order to further verify the robustness and reliability of the model regression results, this paper uses the methods of replacing the explained variables, adjusting the sample interval, and adjusting the type of fixed effects to test the robustness of the omitted variables and the measurement errors, respectively, and the results are shown in Table 3.

Table 3 Robustness test results

variant	Substitution of explained variables		Adjustment of sample intervals	Adjustment of fixed effect type
	(1) *Supp*	(2) *Cus*	(3) *Rchain*	(4) *Rchain*
DA	0. 041***	0. 033***	0. 212***	0. 206***
	(3. 83)	(3. 12)	(6. 54)	(7. 34)
_cons	-0. 993***	-1. 229***	-1. 755**	-2. 186***
	(-5. 37)	(-6. 65)	(-2. 44)	(-2. 99)
Control	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
Pro*Ind Fixed	No	No	No	Yes
Observations	12304	12304	9452	12298
R-squared	0. 0276	0. 0326	0. 5874	0. 5316

4.2.1 Substitution of explained variables

This paper refers to the practice of Zhang et al(2023), and further uses the degree of supplier stability (*Supp*) and the degree of customer stability (*Cus*) to measure the resilience of the industry chain from the upstream and downstream dimensions, with a view to ensuring that the estimation results are robust and reliable. The results are shown in columns (1)-(2) of Table 3, where the direction and significance of the estimated coefficients do not change significantly after changing the measurement method of the explained variables.

4.2.2 Adjustment of sample intervals

Considering the uncertain impact of a series of trade policy shocks such as the tariff hike on China by the United States during 2018-2019 on the industrial chain relationship, this paper excludes the sample of 2018-2019 and re-estimates it. The test results are shown in column (3) of Table 3, which shows that the coefficients of the data assets are significantly positive at the 1% level after adjusting the sample interval, indicating that the conclusions of this paper are robust.

4.2.3 Adjustment of fixed effect types

In order to circumvent the interference of the region or industry level on the regression results, this paper further adds region-industry fixed effects on the basis of individual and year fixed effects to exclude the influence of unobservable factors in different regions and industries on the estimation results, and the results are shown in Column (4) of Table 3. After adjusting the type of fixed effects, the regression coefficient of data assets is still significantly positive, indicating that unobservable

factors at the regional or industry level do not affect the conclusion that data assets enhance the resilience of the industry chain.

4.3 Endogenous treatment

This paper may also have endogeneity issues arising from bidirectional causation, which are further dealt with using propensity score matching and instrumental variable methods. The specific results are shown in Table 4.

Table 4 Results of endogenous treatment

variant	Propensity Score Matching Processing	Instrumental variable approach	
	(1) *Rchain*	(2) Phase I *DA*	(3) Phase II *Rchain*
DA	0. 234*** (3. 22)		0. 155*** (4. 41)
IV		-218. 659*** (-15. 78)	
Kleibergen-Paap rk LM statistic		917. 604***	
Cragg-Donald Wald F statistic		2379. 802***	
Kleibergen-Paap rk Wald F statistic		248. 999***	
Control	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes
Observations	1936	12304	12304
R-squared	0. 6490	0. 6496	0. 0574

Note: The LM statistic is significant at the 1% significance level and the F statistic is greater than the critical value of the Stock-Yogo weak instrument test (16. 38), indicating that the instrumental variables are identifiable and pass the weak instrumental variables test with a certain degree of plausibility and reliability.

4.3.1 Propensity score matching processing

In order to address the selection bias problem, refers to Li et al(2025), this paper divided the sample into treatment group (DA> 22. 7145) and control group (DA≤ 22. 7145) based on the mean value of data assets, and selected all continuous type control variables as matching variables, and performed a 1-to-1 nearest-neighbor matching between the treatment group and the control group. On this basis, the regression analysis was re-run on the matched samples, and the results, as shown in column (1) of Table 4, show that the estimated coefficients of the data assets have a positive effect at the 5% significance level, indicating that the conclusions of the baseline regression of this paper still hold after taking into account the issue of selectivity bias in the variables.

4.3.2 Instrumental variables approach

Considering the possible bi-directional causality between data assets and industry chain resilience, in order to further mitigate the resulting bias in the results, the instrumental variable approach is used to deal with it. In this paper, we refer to Xu et al(2024) and use the mean value of data assets of other firms in the region where the firms are located in the same year as the instrumental variable and conduct regression on this basis. Table 4 Columns (2)-(3) show the test results of instrumental variables, and it can be found that after fully considering the endogeneity, the data assets are still significantly positive to the industry chain resilience, which again verifies the conclusion of the benchmark regression.

4.4 Mechanism testing

According to the theoretical analysis in the previous section, the mechanism of data assets acting on the resilience of the industry chain is mainly the capital effect and operation effect, and this part will further verify the role of the channel.

4.4.1 Channels for alleviating financing constraints (financial effects)

Financing constraints, as a key impediment to the cost of enterprise financing and the level of industry chain cash flow, is one of the important factors affecting the resilience of the enterprise industry chain (Su et al, 2025). Based on this, referring to the method of Whited & Wu (2006), this paper adopts the FC index to measure the financing constraints, and the larger the value indicates that enterprises face greater financing constraints, and the detailed regression results are shown in columns (1)-(2) of Table 5. It can be found that the estimated coefficient of digital assets is significantly negative, which verifies that digital assets can alleviate the financing constraints of enterprises, and hypothesis 2 is verified.

4.4.2 Matching management capacity channels (operational effects)

Management capability can promote the diversification of industrial chain structure by saving transaction agency costs, improving resource integration efficiency, and enhancing the adaptability of organizational dynamics, thus improving industrial chain resilience (Hu et al. , 2022). Therefore, this paper refers to the study of Yin & Liu (2023) and selects the total asset turnover (*ATO*) to measure the operation management capability and efficiency of the enterprise, which is the ratio of the enterprise's sales revenue to total assets. The results of columns (3)-(4) in Table 5 show that the regression coefficients are all positive at the 1% significance level, indicating that data assets can build an internal organizational structure and business management system adapted to the structure of the diversified industrial chain, and enhance the industry chain resilience of the enterprise, and Hypothesis 3 of this paper is established.

Table 5 Mechanism test results

variant	(1) *FC*	(2) *FC*	(3) *ATO*	(4) *ATO*
DA	-0. 175*** (-33. 78)	-0. 084*** (-13. 31)	0. 026** (2. 29)	0. 083*** (8. 16)
_cons	4. 512*** (38. 26)	4. 458*** (37. 10)	0. 071 (0. 28)	0. 837** (2. 48)
Control	No	Yes	No	Yes
Firm Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
Observations	12268	12268	12268	12268
R-squared	0. 8513	0. 8804	0. 7918	0. 8006

4.5 Heterogeneity analysis

In order to identify the differential impact of data assets on industry chain resilience presented by different characteristics, this paper analyzes the heterogeneity from the three dimensions of time, region, and enterprise, and the results are shown in Table 6.

4.5.1 Temporal heterogeneity

Considering that in 2015, the State Council successively promulgated the Action Outline for Promoting the Development of Big Data and the Guiding Opinions on Actively Promoting the Action of “Internet Plus”, proposing to promote the sharing and opening of data resources and deepen the application of big data, which may have an impact on the estimation results of this paper. Therefore, this paper divides the sample into two stages of 2012-2015 and 2016-2022 for group regression, and the results are shown in columns (1)-(2) of Table 6. The results show that the contribution of data assets to enterprise chain resilience in the second stage is significant at the 1% level, which indicates that the positive effect of data assets acting on enterprise chain resilience is stronger in 2016-2022.

The reason for this may be that after 2015, the state has continued to increase policy support for the construction of digital infrastructure and data factor market, and the leading position of data assets in the process of high-quality development of enterprises has become more prominent (Xie et al, 2024), which provides important policy and technical conditions for the enhancement of industry chain resilience.

4.5.2 Regional heterogeneity

Considering the vastness of China, the resource endowment and economic development level of different regions differ greatly, this paper divides more than 30 provinces and municipalities into east and west sides by the Hu Huanyong line in China and conducts group regression test. Observing the regression results in columns (3)-(4) of Table 6, compared with the west of the Hu Huanyong line, the positive effect of the data assets on the industry chain resilience is stronger on the east side. The possible reason is that the cities east of the line are highly urbanized and can better use information technology and data resources to adjust and optimize the industry chain structure, and build a dynamic and intelligent ecological industry chain system through the advantages of industrial agglomeration and innovation drive, which ultimately enhances the industry chain resilience(Chen et al, 2025).

4.5.3 Firm heterogeneity

Considering that there are differences in the dependence on data elements, the maturity of data application, and the efficiency of transformation of elements in enterprises dominated by different elements, this paper combines with the SEC's industry classification standard of 2012, the sample enterprises are divided into three groups: asset-intensive, technology-intensive and labor-intensive groups and test them separately. It can be found that the enhancement effect of data assets on the resilience is decreasing in labor-intensive, asset-intensive and technology-intensive enterprises in that order. The possible reason for this is that for labor-intensive enterprises, pressures such as the gradual rise in labor costs force enterprises to optimize production methods and achieve cost reduction and efficiency through digital transformation, thus they have a strong tendency to digital transformation and upgrading at the current stage, and the effect of data assets comes to the fore (Yue, 2025). While technology-intensive enterprises have higher initial technological endowment, there is a certain data advantage, the marginal utility of the data advantage brought by the introduction of digitization is even smaller, coupled with the possible data leakage and other data security issues, the promotional effect of enterprise data assets on industry chain resilience is very limited(Christoph et al, 2023).

Table 6 Results of heterogeneity analysis

variant	temporal heterogeneity		regional heterogeneity		Firm heterogeneity		
	(1) Phase I 2012-2015	(2) Phase II 2016-2022	(3) West of the Line	(4) East of the Line	(5) asset-intensive	(6) technology-intensive	(7) labor-intensive
DA	0. 047 (1. 50)	0. 204*** (7. 02)	0. 093*** (2. 60)	0. 268*** (7. 32)	0. 238*** (4. 68)	0. 143*** (5. 18)	0. 380*** (4. 15)
_cons	4. 619*** (3. 53)	-3. 870*** (-3. 77)	-2. 659** (-2. 35)	-1. 830** (-2. 16)	-3. 124** (-2. 04)	-0. 668 (-0. 71)	-3. 508*** (-2. 92)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2307	9830	3642	8613	2489	7440	2300
R-squared	0. 7465	0. 5624	0. 4595	0. 5462	0. 4931	0. 5301	0. 5976
Observed difference	0. 157**		0. 174 ***		-0. 095*	0. 236***	0. 141*
(Empirical p-value)	(0. 012)		(0. 001)		(0. 067)	(0. 002)	(0. 060)

Note: The p-value for the difference in coefficients between groups was calculated using the Fisher's Combined Test with 1000 samples. In particular, for the test of difference in group coefficients for the three regressions, the column (5) P-value indicates the P-value for the test of difference in group coefficients for the regressions of columns (5) and (6);the column (6) P-value

indicates the P-value for the test of difference in group coefficients for the regressions of columns (6) and (7);and the column (7) P-value indicates the P-value for the test of difference in group coefficients for the regressions of columns (5) and (7).

5. Conclusions and policy recommendations

Based on the panel data of A-share listed companies from 2012 to 2022, this paper empirically examines the empowering effect of data assets on industry chain resilience, and draws the following conclusions: (1)Data assets can significantly drive the development of corporate industry chain toughness, and this conclusion still holds after a series of robustness tests and endogeneity treatment. (2)The mechanism test shows that the capital effect and operation effect are the main channels through which data assets empower industry chain resilience. (3)Compared with before 2015, data assets show stronger enabling effects after 2015, and the positive effect on industry chain resilience is more significant in the east side of the Hu Huanyong line and labor-intensive enterprises.

Based on the findings of this paper, the following policy implications are obtained:

Strengthen the development and utilization of data elements and promote the process of data assetization in an orderly manner.

As an important hand to enhance the resilience of the enterprise industry chain, the government should continuously improve the construction of digital infrastructure, promote the high-quality supply and large-scale application of data resources, and help digitally empower the nodes of the industry chain. At the same time, assetization is the premise of releasing the value of data elements, government departments should optimize the top-level design, establish and improve the legal system and regulatory system related to data assets, start to solve the technical and transaction problems that may exist in the process of data assetization, provide policy guidance and strategic traction for the assetization of data, and actively promote the in-depth fusion of data elements with the real economy, so as to accelerate the realization of enterprises to make progress in a stable and resilient development.

Enhance the financial blood-forming and operational blood-returning capabilities, and forge resilience to enhance potential.

This paper finds that enterprises do not lack the active willingness to improve the resilience of the industry chain, but due to the constraints of financing and management, their resilience building capacity is relatively lagging behind. Therefore, in the future, the government can effectively help enterprises with large R&D investment and capital needs to "cut costs and open sources" by reducing or waiving taxes and fees, expanding financing channels, and enriching financial services. In addition, the government should also play a leading and driving role, through the creation of a digital integration platform, cultivate and grow the digital management talent team, help enterprise management to realize the "wisdom" to improve the "quality".

Establish a differentiated digital empowerment strategy to create a point-to-point development pattern.

For enterprises with a lower level of industry chain resilience in the western region, the government should improve the compensation mechanism for new digital infrastructure, focusing on resource endowments and comparative advantages, and create an industry chain resilience enhancement model according to local conditions;for the eastern region with a developed digital economy, the government should strengthen the support for new industries and promote the optimization of the industrial structure according to the situation. In addition, the government should also understand that the forging of industry chain resilience is a protracted battle, and should further deepen cooperation with research institutes and universities to accelerate the transformation of scientific and technological achievements, and play the role of "front-runner" while consolidating and expanding its own competitive advantages, so as to seize the high ground for the development of the digital economy.

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