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Research on the Impact of AI Application on Capital Chain Resilience

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Unfavorable external factors such as COVID-19 and economy recession have affected the abilities of enterprises to continue operating. Among them, capital chain resilience has become a key issue for enterprises. In the new era, artificial intelligence (AI) technology can provide new solutions for avoiding the breakage of the capital chain. Using data from listed companies in China, we find that AI technology can improve capital chain resilience. The main impact mechanism is to reduce the level of corporate financial constraints and improve internal control efficiency, and when corporate governance efficiency and resource acquisition capability are lower, such as poor levels of executive supervision and incentive, governance, executive resource acquisition ability, financial statement tone, business and financing environment, the effect of AI technology on improving capital chain resilience is more obvious. We enrich the research on AI and capital chain resilience, provide references for enterprises to use AI technology to help enterprises obtain more funds, warn of risks, and make correct decisions quickly in a crisis to help enterprises survive the crisis smoothly.

Keywords: *Artificial Intelligence; Capital Chain Resilience; Corporate Governance; Financial Efficiency; Resource Acquisition Capability.*

Introduction

With the impact of unfavorable external environments such as COVID-19 and economy recession, the production and operation of enterprises may face forced interruption at any time, resulting in the risk of capital chain breakage, and the sustainability of enterprises is challenged. The market environment is changing rapidly, and various short-term and long-term risks are superimposed and transmitted rapidly. The business model and development path that companies rely on to survive have been destroyed, not only small and medium-sized enterprises facing resource constraints have closed down, but even many industry leaders are on the verge of bankruptcy, and companies need to improve their resilience in dealing with adversity. Why are some organizations able to cope with adverse environmental conditions and better survive in the face of crisis? The main reason is the difference in resilience. For companies, communities and countries, resilience can help organizations survive and find alternative ways to bounce back and develop at the same time, ultimately "turning crisis into opportunity".

Current research on resilience focuses on the perspectives of organizational resilience, supply chain resilience, economic resilience, and financial resilience (Essuman *et al*., 2020; Wong *et al*., 2020; Martin & Gardiner, 2019; Cantu *et al*., 2022). There are factors that can improve the resilience of organizations and supply chains, such as innovation capabilities, R&D innovation, resource acquisition capabilities, organizational flexibility, and social responsibility (Chen *et al.*, 2022; Golgeci & Kuivalainen, 2020; Tan *et al.*, 2022). Employee resilience, executive ability, and transformational leadership characteristics can also enhance organizational resilience (Mangundjaya & Amir, 2021; Saad & Elshaer, 2020).

Resilience improvement can increase corporate performance, improve corporate sustainable development capabilities, reduce risks and increase employee satisfaction (Golgeci & Kuivalainen, 2020; Beuren *et al*., 2022). However, few studies have been conducted from the perspective of capital chain resilience. Capital chain resilience is an essential factor affecting whether a company can survive or recover from a crisis. Therefore, it is necessary to conduct independent research on capital chain resilience. Enterprises with solid capital chain resilience can reduce the possibility of capital chain breaks through financing, coping with risks, and making quick decisions. Capital chain resilience is an integral part of organizational resilience, but capital chain resilience is different from organizational resilience: capital chain resilience emphasizes the flexibility of funds, while organizational resilience emphasizes the ability of the organization as a whole to respond to crises. When the capital chain breaks, enterprises can still continue to operate by obtaining external fixed assets, inventory, donations, etc., waiting for the opportunity to reverse, while the capital chain resilience only focuses on whether the capital flow in the operation process can be recovered to avoid fracture when facing difficulties, the requirements will be more stringent.

Research on capital chain resilience is extremely vital and needs to be perfected. First, under the influence of unfavorable external environments such as COVID-19 and economy recession, enterprises may encounter external shocks at any time, which bring the risk of capital shortage or even the risk of capital chain breakage. Enterprises need to be prepared for danger in times of peace and consider how to improve their capital chain resilience to quickly extricate themselves from the crisis and recover as soon as possible. Second, under the background of anti-globalization, the domestic supply chain is closely connected. Once the capital

chain of some core enterprises is broken, it will affect the capital flow of the entire supply chain and then affect the development of the entire industry. Therefore, improving capital chain resilience can guarantee the stable development of industry and economy. Developing new technologies has brought new opportunities to improve capital chain resilience. In the era of comprehensive application of digital intelligence technologies such as big data, AI, blockchain, and the Internet of Things, the speed and efficiency of information acquisition have been improved greatly, trust relationships among organizations can be established easily, and the problem of information asymmetry is alleviated. Through massive data analysis and processing, enterprises can identify risks promptly and access external resources from supply chains, banks, governments, and other organizations quickly, their governance efficiency can be improved significantly, bringing new opportunities to enhance capital chain resilience. In China, AI is an important part of the national strategy, it is the focus of economic development in the future. In order to lay out the artificial intelligence industry, the government provides financial and tax subsidies to promote the development of AI technology. In 2017, there were only 409 enterprises using AI technology in listed companies, and the number has reached to 1013 by 2021. AI has also become an important driving technology for the future development of enterprises, affecting their operation and efficiency.

We examine the impact of COVID-19 on enterprises using data from Chinese listed companies and find that AI application can improve capital chain resilience by reducing the level of corporate financial constraints and improving the efficiency of internal control. The worse the corporate governance efficiency and resource acquisition ability, such as the worse the level of executive supervision and incentive, corporate governance, executive resource acquisition ability, financial statement tone, business and financing environment, the better the effect of AI technology on capital chain resilience, mainly because AI technology can reduce the information asymmetry between enterprises and external institutions through intelligent data analysis and shared data platforms. It can make enterprises have better supervision and restraint, reduce the irrational behaviors of executives, enable enterprises to respond quickly and make correct decisions in times of crisis, help enterprises obtain more external resources, and reduce the risk of capital chain interruption.

We have the following innovations. First, previous research on resilience has mainly focused on organizational resilience, supply chain resilience, and financial resilience. Few studies have been conducted on capital chain resilience. We investigate methods to improve capital chain resilience, thereby enhancing the resilience research. Second, previous AI research has primarily centered on enhancing the precision of predictions, the capacity for innovation, and the level of performance, governance, audit, and risk management. There needs to be more about the impact and mechanism of AI on capital chain resilience. We discover that AI can enhance capital chain resiliency by reducing financial constraints and enhancing governance effectiveness, thereby enhancing AI-related research. Thirdly, we can provide a reference for enterprises to avoid capital chain rupture in a crisis. Enterprises can introduce AI technology to help them identify risks, make quick decisions, and expand financing channels. At the same time, AI technology can improve the effectiveness of internal control, strengthen the supervision of executives and employees, and boost work productivity, thereby enhancing the capacity of enterprises to cope with the crisis.

We choose Chinese enterprises as the research object for the following reasons. First, China has proposed a national strategy to realize intelligence, and there are a large number of enterprises using AI technology. Large empirical samples can be used to test the impact of AI technology on capital chain resilience. Second, Chinese companies have been greatly affected by COVID-19, which has lasted for a long time. When an epidemic occurs in an area, companies in this area cannot operate normally under strict containment measures, which will affect the company's capital flow. The use of Chinese data can be a good test of whether AI technology is more advantageous in this particular situation. Third, China has different provinces, which have different business environments and financing policies. Using Chinese data, it is possible to compare the effects of AI technology in different external environments.

This paper is organized as follows: Part II is a review of the fields related to resilience and AI, Part III is the research hypothesis, Part IV is the data and model, Part V is the empirical test results, and Part VI is the conclusion and discussion.

Literature Review

Review of Resilience Research

Scholars have studied the influencing factors and economic consequences of resilience. Scholars have analyzed the influencing factors of innovation, personnel, resources, and corporate governance.

From the perspective of innovation, supply chain resilience is affected by supplier innovation, top management support, and strategic sourcing (Mandal, 2021). Chen *et al*. (2022) found that entrepreneurial orientation, innovation capabilities, and supplier learning from disruptions can enhance firm resilience in supply chains. R&D and innovation capabilities can enhance the resilience of enterprises, mobilizing their resources and capabilities to deal with adversity (Bergami *et al*., 2022). Organizational learning positively impacts resilience (Orth & Schuldis, 2021). Organizations can improve resilience by fostering innovation proactively and consistently (Cruickshank, 2020).

From the perspective of personnel characteristics, supply chain managers' social capital, human capital, and perceptions help improve supply chain visibility, responsiveness, and flexibility, thereby strengthening supply chain resilience (Nikookar & Yanadori, 2022). Organizations can develop and improve supply chain resilience by creating a risk management culture through increasing employee risk awareness and conducting regular risk assessment exercises (Kumar & Anbanandam, 2020). Female executives can achieve change, facilitate new initiatives, solidify and manage formal relationships, and promote resilience (Cosentino & Paoloni, 2021). Executive competencies promote resilience by dealing with uncertainty and building relationships, such

as entrepreneurial ability, charismatic leadership, transformational leadership, and employee self-efficacy can help companies get out of trouble as soon as possible, adaptive culture is positively correlated with corporate resilience (Branicki *et al*., 2018; Mangundjaya & Amir, 2021; Wang *et al*., 2022; Madi Odeh *et al*., 2021). Individual and group resilience can lead to organizational resilience. For example, employee resilience manifested as tenacity, resourcefulness, and optimism can increase business continuity (Saad & Elshaer, 2020). Top executives' flexibility and cross-functional coordination ability can improve organizational resilience (Anwar *et al*., 2021). Group behavior can affect organizational resilience, such as herd behavior, endowment effects, and altruism can enhance corporate resilience (Huang *et al*., 2022). Groups influence organizational resilience processes through mechanisms of consciousness allocation, emotional separation, and attention coordination (Wang *et al*., 2021).

From the perspective of resources, supply chain networks and relationships can improve supply chain resilience, in which communication and cooperation are the main influencing factors (Spieske *et al*., 2022; Mandal & Sarathy, 2018). The social capital obtained from inter-organizational relationships can improve supply chain resilience, which is affected by absorptive ability (Golgeci & Kuivalainen, 2020). Inter-organizational relationships and intangible resources contribute to supply chain resilience (Fayezi & Ghaderi, 2022). Relationships build resilience, such as the relationships between purchasing and supplying firms, open cooperation relationships with partners outside the company's supply chain, as well as social capital and dynamic capabilities, which can help companies obtain more resources to improve resilience (Durach & Machuca, 2018; Ahn *et al*., 2018; Ozanne *et al*., 2022). Companies can improve resilience by obtaining direct capital, such as family capital, cross-organizational appropriation, and intellectual capital (Mzid *et al*., 2019; Mandal & Dubey, 2021; Mubarik *et al*., 2022). The matching degree between internal capabilities and external resources in the supply chain network will also increase resilience (Li *et al*., 2022).

From the perspective of corporate governance, supply chain risk management and business continuity plans can respond to supply chain disruptions and help the supply chain recover (El Baz & Ruel, 2021; Shashi *et al*., 2020). Enterprises can enhance supply chain resilience by promoting information sharing, developing dynamic capabilities, and improving organizational flexibility (Tan *et al*., 2022). Quality management systems affect internal transparency and thus organizational resilience (Al Balushi, 2021). The specialization of family business management will help enterprises survive better in the environment, and the early warning of weak signals will reduce the possibility of danger (Ingram & Glod, 2018). Corporate social responsibility plays an important role in improving organizational resilience. Corporate social responsibility related to shareholders, employees, enterprises, society and the environment has significantly improved companies' long-term growth and reduced their financial volatility (Berger-Douce, 2021). The design of multiple governances based on stakeholders will improve organizational resilience by promoting dynamic distribution and helping stakeholders participate in preparation, response and recovery from unexpected events (Yang *et al*., 2022). The interplay between relationships, technology, and organizational structure promotes supply chain resilience, and cooperation between supply chain partners will become a key factor (Kueffner *et al*., 2022).

Considering the economic consequences of resilience, scholars have found that resilience can improve performance (Golgeci & Kuivalainen, 2020). Resilience impacts business performance in terms of finances, customers, processes, learning, it can also improve employees' job satisfaction and enterprise sustainability (Beuren *et al*., 2022; Xie *et al*., 2022). Resilience can promote innovation and can be used as the main method of risk management (Rampa & Agogue, 2021; Hsu *et al*., 2019). Furthermore, resilience can create pathways for positive emotions and improve life satisfaction (Paul *et al*., 2019). Dexterous organizational resilience is positively associated with the competitive advantage in family firms (Ingram & Bratnicka-Mysliwiec, 2019).

Review of AI Research

AI can improve the accuracy of prediction. The application of digital technology in enterprise management can use machine learning to improve the accuracy of enterprise bankruptcy prediction (Wang *et al*., 2014). We can make full use of nonfinancial data to predict information in the analysis, for example, we can use AI to predict financial distress by adding emotional and textual information, test a company's competitive advantage and predict corporate performance from large media data by using social network technology, as well as predict stock price trends effectively by using news, online blogs and financial reports (Wang *et al*., 2018; Chang *et al*., 2018; Kim *et al*., 2018). In addition, AI technology can also help enterprises make forecasts of profit, sales, financial sustainability, tax default, and customer mood (Zhang *et al*., 2015; Yucesan *et al*., 2017; Kim *et al*., 2019; Abedin *et al*., 2021; Mushtaq *et al*., 2022).

AI technology can be used for audit work. We can use specific characteristics of financial information and management comments in company annual reports to find financial fraud and improve audit quality (Hajek & Henriques, 2017; Manita *et al*., 2020). AI technology can be used in asset appraisal activities, such as bond rating prediction, credit rating evaluation, intangible asset evaluation, and classification of online business reputation (Ben Jabeur *et al*., 2020; Wang & Ku, 2021; Tsai *et al*., 2016; Rantanen *et al*., 2020). AI technology can help companies make more accurate financial decisions, make investment portfolio choices, and promote more informed investment decisions (Adosoglou *et al*., 2021).

AI technology can improve the level of risk management. Behl *et al.* (2022) found that digital technology can improve supply chain coordination, establish rapid trust among enterprises, and reduce supply chain risks. AI-based data acquisition, processing and self-training capabilities, as well as information system infrastructure, can help organizations reduce the impact of supply chain disruptions while adjusting transportation networks and ensuring supply chain security (Behl *et al*., 2022). AI technology can improve the

prediction accuracy of system risk and help enterprises carry out an early warning of financial risks (Yuan & Lee, 2015; Zhu *et al*., 2022).

AI can enhance the innovation ability of enterprises. AI technology can help companies discover emerging themes and trends to improve innovation capabilities (Muhlroth & Grottke, 2022). The digital transformations of manufacturing enterprises have effectively improved the innovation capabilities of enterprises, while the mechanisms of innovation input, cost control, and profit protection play intermediary roles (Zhao *et al*., 2022). Multinational companies in emerging markets also use cross-border mergers and acquisitions to improve the quality of innovation in the digital economy era (Li *et al*., 2019).

AI technology can improve corporate governance, which can better evaluate the earning quality of listed companies (Chen & Howard, 2016). AI can be used as an integral part of the board to improve board diversity (Eroglu & Kaya, 2022). AI can also reduce risks, improve operational efficiency, improve corporate governance efficiency, and influence decision-making at the board level (Hilb, 2020). Big data can strengthen corporate social responsibility (CSR) awareness and make CSR disclosure more transparent to consumers (Shao *et al*., 2022). AI has a specific substitution effect on corporate social responsibility, and it can enhance corporate social responsibility (Li *et al*., 2021). AI can assess the reliability of corporate governance and improve internal control (Hernandez-Perdomo *et al*., 2019; Klius *et al*., 2020). AI has been applied to detect financial fraud in practice (Zhu *et al*., 2021).

AI technology can improve corporate performance. Digitalization brought added value to the pursuit of sustainable development goals through novel data sources, enhanced analytical capabilities and collaborative digital ecosystems (Castro *et al*., 2021). AI applications can also improve sustainability, promote high-quality development, and improve corporate social performance (Goralski & Tan, 2020; Li & Madina, 2021; Yang & Cui, 2022; Meng *et al*., 2022). In-depth integration of the digital and real economies promotes high-quality economic development and improves corporate resilience (Xia *et al*., 2022). Process, information sharing, and supply chain integration play important roles in enhancing AI's response to COVID-19 (Nayal *et al*., 2021). Applying big data technology can improve the sustainable operation abilities of enterprises (Singh & El-Kassar, 2019).

Evaluation

Research on resilience has mainly focused on economic resilience, organizational resilience, supply chain resilience, financial resilience, etc., while research on capital chain resilience is still rare. Capital flow is one of the most critical factors affecting the sustainable operation abilities of enterprises, so it is necessary to study how to improve capital chain resilience. In addition, AI application in corporate financial management mainly focuses on the activities of forecasting, auditing, and risk management, explores the impact on improving innovation capabilities, corporate governance levels, and corporate performance, while little research has been done on the impact of AI technologies on capital chain resilience. We enrich the research on capital chain resilience and AI, as well as provide references for enterprises to use intelligent technology to restore capital flow quickly and ensure sustainable operation abilities in crisis.

Research Hypothesis

Resilience is defined as the ability of an enterprise to respond quickly in the face of a crisis and return to its initial condition. Current research focuses on organizational resilience and supply chain resilience, while the capital chain is one of the most important elements in operations. Capital chain resilience requires faster response speed and higher requirements than organizational resilience, and a break in the capital chain will be the beginning of the enterprise's unsustainable operation. Therefore, it is necessary to study how AI technology can improve a company's capital chain resilience. Some studies believe that AI technology can improve organizational resilience, and enterprises can build organizational resilience through digital transformation (He *et al*., 2022). When the enterprise's digital technology level is higher, the breadth and depth of the business network have a more substantial positive impact on organizational resilience (Xie *et al*., 2022). Digital finance can help companies obtain external financing more efficiently and reduce financing costs to improve corporate resilience (Xia *et al*., 2022). Li *et al*. (2022) found that the depth of digital technology deployment has a positive impact on firm resilience, enhancing the degree of supply chain coordination. Zhou *et al*. (2022) found that IT capability was positively correlated with external supply chain resilience and that supply chain collaboration was positively correlated with internal supply chain resilience. Shi *et al*. (2022) found that the level of enterprise digitalization has no direct relationship with supply chain resilience, but the level of digitalization has a positive impact on the improvement of supply chain integration.

We believe that AI technology can improve capital chain resilience. AI technology can help enterprises make quick decisions through a visual data analysis system, can give early warning and take quick action when facing risks. AI technology can improve the information asymmetry among enterprises, external creditors, and shareholders, share more detailed and sufficient transaction data with external creditors, and help enterprises obtain more financing. AI technology can improve corporate governance's efficiency, reduce executives' irrational decision-making, and help rapid response in times of crisis. AI technology can help enterprises establish favorable relationships with suppliers and customers, strengthen the supervision of enterprises, improve the operational efficiency of enterprises, and ensure the smooth flow of supplies in times of crisis. Therefore, we propose Hypothesis 1.

Hypothesis 1: AI application can improve capital chain resilience.

AI technology can enhance an enterprise's ability to acquire resources, lessen its financial constraints, and increase its capital chain resilience.

First, enterprises that implement AI tend to disclose more positive information to the market, and specific information disclosure can reduce the information

asymmetry between enterprises, external banks, and shareholders (Cheng *et al.*, 2014). The use of AI technology must standardize and structure enterprise data, improve information utilization, provide high-quality information that is more conducive to bank credit evaluation, reduce the information asymmetry between enterprises and external creditors so that external creditors have a more complete understanding of the company, assist enterprises in obtaining more loans (Yang, 2022), and thereby strengthen capital chain resilience.

Second, companies utilizing AI technology are more likely to receive government and regulatory support because they comply with national policies. Enterprises can obtain more resources and preferential policies from the government and pertinent departments, relieving internal financial pressure, and the government can protect such enterprises in times of crisis with fiscal policies like subsidies and tax cuts. The degree of financial constraints is minimal because market investors have optimistic expectations for enterprises implementing AI technology, which will be the focus of capital pursuit on the capital market.

Third, the use of digital instruments such as Internet sales and Internet evaluation by enterprises is conducive to the visualization of soft information such as product sales and business reputation. It is advantageous for banks and other financial institutions to obtain information on the production and operation status of enterprises through fintech technology, thereby facilitating credit evaluation, as these complex and diverse large amounts of digital information can also be used as a pledged asset to help enterprises obtain more financing (Bhagat & Roderick, 2020). For instance, the incorporation of AI can assist banks in assessing credit risk better (Mai *et al.*, 2019), identifying the potential risk points of enterprises, determining whether they can provide credit loans for enterprises, enhancing the financing capabilities of enterprises, preventing the disruption of the capital chain by obtaining bank loans during a crisis, and enhancing the resilience of the capital chain.

Fourth, AI technology can alter the method of communication between enterprises, suppliers, and customers, overcome the limitations of offline cooperation effectively, establish a cross-space virtual cooperation mode, and actively contribute to achieving win-win cooperation at the supply chain level. For instance, the sharing system to make fast order decisions can enhance the collaborative relationship (Ramaswamy & Ozcan, 2016), enterprises are more likely to receive trade credit support from suppliers and customers in times of crisis, and trade credit can reduce cash flow volatility. Therefore, we propose Hypothesis 2.

Hypothesis 2: AI application improves capital chain resilience by reducing financial constraints.

AI can increase the effectiveness of enterprises' internal controls, thereby enhancing capital chain resilience.

First, enterprises can obtain immediate and massive data analysis results through the collaboration of big data, the Internet of Things, and visual data analysis systems (Bhagat & Roderick, 2020). Enterprises' information sources can be augmented by AI technology, thereby enhancing their information acquisition capabilities. Enterprises can search online for a variety of information resources, expand the scope and depth of their searches, obtain more comprehensive and valuable decision-making information, conduct risk warnings, and modify the supply and demand of the market swiftly in the event of a crisis (Yang & Wu, 2021). The machine learning algorithm of the early warning system monitors market fluctuations constantly, as well as predicts and evaluates risks. The early warning can provide relevant parties with sufficient time to minimize incident-related losses.

Second, AI technology enables the collection, analysis, and processing of multichannel big data information, providing the foundation for the enterprise's efficient and smooth information flow. AI contributes to the formation of a digital governance system based on data extraction and analysis, promoting the scientific and precise nature of enterprise supervision and governance mechanisms. With the support of data, every aspect of enterprise production and operation can be restored, and business processes can be made more transparent, thereby reducing the space for managers' opportunistic behaviors (Hammami & Zadeh, 2022). AI can reduce the irrational behaviors of executives, reduce excessive investment and debt, obtain more valuable information during a crisis, provide a basis for decision-making, abbreviate response time, and assist businesses in making correct decisions swiftly to prevent greater losses (Coombes *et al.*, 2020). Using the company's digital information platform, shareholders, project partners, and other stakeholders can efficiently obtain decision-making information, monitor the development of investment projects, and reduce managers' behaviors of concealing investment information for personal gain.

Third, by transmitting more accurate information to the outside world, AI can reduce investors' pessimism towards companies and help stabilize stock prices. Through the internal information verification and comparison functions of AI, the enterprise's internal control efficiency can be enhanced, employees' laziness in times of crisis can be curbed, and the organization can work collaboratively and swiftly to achieve its goals.

Fourth, AI facilitates the flexible mobilization of personnel within an organization to address new business requirements and further enhance operational stability through internal process standardization and intelligent services. Under the influence of external factors such as epidemics and natural disasters, intelligent robots, driverless cars, unmanned automated production plants, and other AI technologies can enable enterprises to have automated production and online offices (Balog, 2020). As a result, they can reduce the likelihood of the unfavorable external environment interfering with business operations and production, ensure continuous operation, and enhance capital chain resilience.

Fifth, AI technology can efficiently connect the process of information transfer and element flow in production, distribution, exchange, and consumption in the supply chain, improve the communication convenience between enterprises, and make information sharing and communication between enterprises more convenient and smooth, thereby enhancing operational efficiency significantly (Toorajipour *et al.*, 2021). In addition, AI technology can improve demand forecasting, increase supply chain

transparency, and reduce demand variation. Several contingency plans are adopted to address potential risks and ensure the supply chain's high quality and stability (Ivanov *et al.*, 2019). Enterprises are able to respond to disruptions more rapidly and in a timely manner. Therefore, we propose hypothesis 3.

Hypothesis 3: AI application improves capital chain resilience by improving the efficiency of internal control.

Data and Sample Characteristics

Definition of Variables

Explained Variable

The explained variable is capital chain resilience. There are very few studies on the capital chain resilience. Most of the studies focus on economic resilience and organizational resilience. The research of organizational resilience mainly adopted the methods of questionnaires, and a small number of them use indicators such as stock price and financial volatility to measure (DesJardine *et al.*, 2019; Ortiz-de-Mandojana & Bansal, 2016), which cannot reflect the resilience of corporate capital chains in crises well. Therefore, we follow the measurement method of economic resilience used by Martin & Gardiner (2019) and use it to measure capital chain resilience. The details are shown in equations (1)-(3).

$$RES_i^t = (\Delta Y_i - \Delta E) \big/ |\Delta E| \tag{1}$$

$$\Delta Y_i = Y_i^t - Y_i^{t-1} \tag{2}$$

$$\Delta E = ((Y_r^t - Y_r^{t-1}) \big/ Y_r^{t-1}) Y_i^{t-1} \tag{3}$$

RES_i^t is the capital chain resilience of company *i* in year *t*, ΔY_i is the change in cash holdings of company *i* in *t*-1~*t* years, ΔE is the predicted change in cash holdings of company i in year *t*-1 to *t* based on the change in cash holdings of the company's industry in that year. Y_i^t, Y_i^{t-1} are company *i*'s cash holdings in *t* and *t*-1 years, respectively, Y_r^t, Y_r^{t-1} are the cash holdings of the company's industry in year *t*, *t*-1. Because the research object is the capital chain resilience of enterprises after encountering a crisis, only the samples with cash holdings less than the expected value are retained; thus, $RES_i^t < 0$.

Explanatory Variables

The explanatory variable is the application of AI technology. We use the annual reports of listed companies to search for keywords related to AI [1], remove negative expressions such as "no" and "never" before the keywords, and conduct full-text searches in the annual financial reports of listed companies. If the number of keywords exceeds 3, we set the AI application as 1. If the number of keywords is 0, we set the AI application as 0. If the keyword appears 1 or 2 times, we set it as the missing value.

Financial constraint. We measure the financial constraint of enterprises following Wang (2003). When enterprises face financial constraints, the investment level of enterprises is lower than the optimal investment level, and the degree of reduction depends on the level of financial constraints. Therefore, underinvestment can be used to measure the financial constraint level of an enterprise. The financial constraint index is set as *FC*, and the underinvestment index is set as *TE*. There is a positive relationship between financial constraint and underinvestment; the more significant the financial constraint of an enterprise is, the greater the underinvestment. Therefore, *FC = TE*. The underinvestment index is calculated through the stochastic frontier model. The calculation method is as follows:

The optimal investment expenditure is

$$I^* = TobinQ + v \tag{4}$$

Actual investment expenditure is

$$I = I^* - u = TobinQ + v - u \tag{5}$$

Investment expenditure can also be written as

$$I = TobinQ + \varepsilon \quad \varepsilon = v - u \tag{6}$$

v is a random interference term, which is assumed to be distributed normally and independent of each other, $v \sim N(0, \sigma^2)$

u represents the financial constraint effect. Because of its unilateral distribution, we assume that it obeys a nonnegative truncated half-normal distribution, i.e., $u \sim N^+(w, \sigma^2)$, and the factors affecting *u* include asset size, cash flow, equity financing, and debt financing, in which cash flow is internal financing, equity financing and debt financing are external financings, the investment efficiency index is the deviation degree of the actual investment below the optimal investment. We define the underinvestment index as model (7).

$$TE = 1 - \frac{e^{Xb-u}}{e^{Xb}} = 1 - e^{-u} \tag{7}$$

There is a positive relationship between the degree of financial constraints and underinvestment; the greater the financial constraints are, the greater the underinvestment. Therefore, *FC=TE* is set to calculate the financial constraint index.

The internal control efficiency is taken from the internal control index in the DIB database.

Control Variables

We choose return on total assets (*ROA*), company size (*Size*), income growth rate (*Growth*), capital structure (*Lev*), company establishment years (*Firmage*), *Tobin's Q* (*TobinQ*), the shareholding ratio of the largest shareholder (*First)*, year, and industry as control variables.

[1] *Keywords related to AI technology include: artificial intelligence, business intelligence, image understanding, investment decision assistant system, intelligent data analysis, intelligent robot, machine learning, deep learning, semantic search, biometric technology, face recognition, speech recognition, authentication, automatic driving, and natural language processing.*

Table 1

Variable Definition

Nature	Variable name	Symbol	Calculation method
Explained variables	Capital Chain Resilience	*RES*	Following the description in 4.1.1
Explanatory variables	AI Application	*AI*	1 if the company uses AI technology, 0 otherwise
	Financial Constraints	*FC*	Following the description in 4.1.2
	Internal Control Efficiency	*IC*	Internal control efficiency index
Control variables	Return on Assets	*ROA*	Net profit/total assets
	Company Size	*Size*	Natural logarithm of total assets at end of period
	Growth on Asset	*Growth*	Sales revenue growth
	Capital Structure	*Lev*	Total Liabilities/Total Assets
	Firmage	*Firmage*	The natural logarithm of years the company has been in existence
	Tobinq	*TobinQ*	(Market capitalization + book value of liabilities)/book value of total assets
	Largest Shareholder	*First*	Shares held by the largest shareholder/Total shares
	Industry	*Industry*	Industry dummy variable
	Year	*Year*	Year Dummy Variable

Research Model

We build model (8) to test Hypothesis 1. If the coefficient of a_1 is significantly positive, then Hypothesis 1 is true.

$$RES = a_0 + a_1 AI + Controls + Year + Ind + \varepsilon \quad (8)$$

We build a structural equation model (9) to test Hypotheses 2 and 3. If a_1 and b_1 are significant and h_1 is smaller than c_1, then Hypotheses 2 and 3 are true.

$$\begin{cases} FC / IC = a_0 + a_1 AI + Controls + Year + Ind + \varepsilon \\ RES = b_0 + b_1 FC / IC + Controls + Year + Ind + \varepsilon \\ RES = c_0 + c_1 AI + Controls + Year + Ind + \varepsilon \\ RES = h_0 + h_1 AI + h_2 FC / IC + Controls + Year + Ind + \varepsilon \end{cases} \quad (9)$$

Data Sources

The data comes from China's A-share listed companies from 2016 to 2021, the financial and governance data are derived from the CSMAR database, and whether enterprises use AI technology is derived from the annual reports of listed companies. Following previous research, we address the data as follows: (1) remove the samples of financial industry enterprises; (2) remove the samples of ST companies; (3) remove the missing values from the main regression variables and winsorize all variables at the 1 % ~ 99 % level to reduce the bias introduced by outliers to the research results. The remaining samples are 16797. In addition, we mainly analyse the role and mechanism of AI in companies with poor capital chain resilience in the latter part, and the remaining samples are 9657.

Empirical Results

Descriptive Statistics

We calculate descriptive statistics of the samples, and the results are shown in Table 2. We perform grouping tests for positive and negative *RES* samples. When *RES* is positive, the mean value is 11.28, and when *RES* is negative, the mean value is -3.61. At the same time, we test the AI application and other control variables by *T* test. It can be seen that there are always some companies use AI technology regardless of whether the company's *RES* is positive or negative, and enterprises with higher capital chain resilience have a higher return on total assets, larger company scale, better growth, higher debt ratio, lower firm age, larger proportion of the largest shareholder, *T*-test and rank sum test are significant.

Table2

Sample Descriptive Statistics

Variable	Mean	Sd	Median	Mean	Sd	Median	*T*-Test	Rank sum Test
	RES>=0			*RES<0*				
RES	11.28	24.68	3.35	-3.61	5.35	-2.08	14.88***	110.97***
AI	0.18	0.39	0.00	0.19	0.39	0.00	-0.01**	-1.71*
ROA	0.04	0.07	0.04	0.02	0.09	0.03	0.02***	15.06***
Size	22.35	1.28	22.23	22.23	1.35	22.05	0.12***	8.17***
Growth	0.28	0.60	0.15	0.13	0.41	0.09	0.15***	20.10***
Lev	0.43	0.21	0.43	0.43	0.22	0.41	0.00*	2.73***
Firmage	3.02	0.27	3.04	3.03	0.27	3.04	-0.01**	-2.21**
TobinQ	2.51	1.96	1.88	2.50	1.96	1.89	0.01	0.129
First	0.33	0.14	0.31	0.32	0.14	0.30	0.01***	3.03***
N	7140			9657				

Results of AI's Impact on Capital Chain Resilience

We examine the impact of AI on capital chain resilience, and the results are shown in Table 3. The explained variable is capital chain resilience, and the explanatory variable is the application of AI. Column (1) is listed as the full sample test, but the results show that AI technology has no significant impact on capital chain resilience. We carry out grouping tests according to the positive and negative *RES*, and the results are shown in columns (2) and (3). When capital chain resilience is negative, AI technology can improve capital chain resilience, but when capital chain resilience is positive, the impact of AI technology on capital chain resilience is not obvious. This shows that AI technology will play a better role only under poor financial conditions. We will focus on the samples of negative capital chain resilience in the following text and explore the path and optimization countermeasures of AI technology to enhance capital chain resilience when enterprises are in adverse conditions.

Table 3

The Impact of AI Technology on Capital Chain Resilience

	(1)	(2)	(3)
	Full sample	*RES*>=0	*RES*<0
AI	0.445	0.649	0.337***
	(0.238)	(0.388)	(0.005)
ROA	16.213***	-7.065	6.800***
	(0.000)	(0.233)	(0.000)
Size	-0.435***	-1.332***	0.262***
	(0.001)	(0.000)	(0.000)
Growth	6.937***	9.056***	0.027
	(0.000)	(0.000)	(0.845)
Lev	2.081**	-1.433	-0.064
	(0.030)	(0.491)	(0.812)
Firmage	-0.157	0.172	0.059
	(0.762)	(0.875)	(0.726)
TobinQ	0.015	0.071	-0.000
	(0.845)	(0.691)	(1.000)
First	-0.889	-2.236	0.342
	(0.341)	(0.234)	(0.288)
Constant	20.954***	61.510***	-10.508***
	(0.000)	(0.000)	(0.000)
Year	Control	Control	Control
Ind	Control	Control	Control
N	16797	7140	9657
R^2	0.067	0.173	0.224
F	12.632***	18.950***	53.082***

Impact Mechanism of AI on Capital Chain Resilience

Mechanism 1: AI Improves the Capital Chain Resilience by Reducing Financial Constraints

We discuss the impact mechanism of AI technology to enhance capital chain resilience when capital chain resilience is negative. We use a structural equation model for testing, and the results are shown in Table 4. The explained variable in column (1) is corporate financial constraints, the explanatory variable is AI application, and the results show that AI technology can reduce financial constraints. The explained variable in column (2) is capital chain resilience, and the explanatory variable is corporate financial constraints. The results show that the smaller the corporate financial constraint is, the greater the capital chain resilience, and the Sobel test is significant, proving that there is a mediating effect that AI technology can enhance capital chain resilience by reducing corporate financial constraints. The explained variable in columns (3) and (4) is capital chain resilience, and the explanatory variable is AI application, we can see that after the addition of the financial constraint index, the impact of AI technology on capital chain resilience is reduced, which proves that financial constraint plays a mediating role. AI technology can reduce the information asymmetry among enterprises, external banks and investors, it can provide data support for enterprises to obtain fintech by digitizing business data, helping enterprises obtain more funds, thereby reducing the degree of corporate financial constraints. AI technology can attract the government to provide more financial support and strengthen partnerships with supply chain enterprises. When enterprises obtain more funds in crisis, they can avoid breaking the capital chain and improve capital chain resilience.

Table 4

Results of Influence Mechanism: Financial Constraint

	(1)	(2)	(3)	(4)
	FC	*RES*	*RES*	*RES*
AI	-0.016***		0.337***	0.305**
	(0.000)		(0.005)	(0.013)
FC		-1.906***		-1.829***
		(0.002)		(0.003)
ROA	-0.170***	6.627***	6.800***	6.650***
	(0.000)	(0.000)	(0.000)	(0.000)
Size	-0.008***	0.251***	0.262***	0.241***

	(1)	(2)	(3)	(4)
	(0.000)	(0.000)	(0.000)	(0.000)
Growth	-0.040***	-0.071	0.027	-0.066
	(0.000)	(0.627)	(0.845)	(0.650)
Lev	-0.005	-0.077	-0.064	-0.050
	(0.456)	(0.779)	(0.812)	(0.856)
Firmage	0.048***	0.115	0.059	0.132
	(0.000)	(0.498)	(0.726)	(0.437)
TobinQ	0.001**	-0.003	-0.000	-0.007
	(0.032)	(0.904)	(1.000)	(0.780)
First	0.002	0.348	0.342	0.396
	(0.837)	(0.282)	(0.288)	(0.221)
Constant	0.334***	-9.873***	-10.508***	-9.715***
	(0.000)	(0.000)	(0.000)	(0.000)
Year	Control	Control	Control	Control
Ind	Control	Control	Control	Control
N	9580	9580	9657	9580
R^2	0.158	0.224	0.224	0.224
F	34.970***	52.665***	53.082***	51.067***
Sobel Test	2.68***			

	(1)	(2)	(3)	(4)
	(0.000)	(0.000)	(0.000)	(0.000)
Growth	18.392**	-0.011	0.027	-0.008
	(0.016)	(0.937)	(0.845)	(0.951)
Lev	-207.234***	0.282	-0.064	0.300
	(0.000)	(0.309)	(0.812)	(0.280)
Firmage	-42.076***	0.118	0.059	0.136
	(0.000)	(0.478)	(0.726)	(0.417)
TobinQ	-5.313***	0.014	-0.000	0.011
	(0.000)	(0.565)	(1.000)	(0.670)
First	88.502***	0.150	0.342	0.197
	(0.000)	(0.644)	(0.288)	(0.544)
Constant	172.081***	-10.854***	-10.508***	-10.677***
	(0.003)	(0.000)	(0.000)	(0.000)
Year	Control	Control	Control	Control
Ind	Control	Control	Control	Control
N	9540	9540	9657	9540
R^2	0.288	0.228	0.224	0.229
F	49.863***	53.162***	53.082***	51.578***
Sobel Test	3.44***			

Mechanism 2: AI Technology Improves Capital Chain resilience by Improving Corporate Governance Efficiency

We use a structural model to test whether AI technology improves capital chain resilience by improving internal control efficiency, and the results are shown in Table 5. The explained variable in column (1) is internal control efficiency, and the explanatory variable is the application of AI. The results show that AI application can improve internal control efficiency. The explained variable in column (2) is capital chain resilience, and the explanatory variable is internal control efficiency. The results show that when internal control efficiency is higher, corporate capital chain resilience is higher, and the Sobel test proves the existence of a mediating effect. The explained variable in columns (3) and (4) is capital chain resilience, and the explanatory variable is the application of AI technology. We can see after the addition of internal control efficiency, the effect of AI technology application on capital resilience decreases, which proves the existence of a mediation effect. AI technology can use intelligent decision-making systems when enterprises face a crisis, provide a basis for executives' decision-making, reduce executives' irrational behavior, strengthen supervision and governance within the company, improve operational efficiency, help enterprises make correct decisions, avoid capital chain rupture, and improve capital chain resilience. The internal control efficiency data comes from the DIB database.

Table 5

Results of Influence Mechanism: Internal Control Efficiency

	(1)	(2)	(3)	(4)
	IC	*RES*	*RES*	*RES*
AI	26.225***		0.337***	0.279**
	(0.000)		(0.005)	(0.023)
IC		0.002***		0.002***
		(0.000)		(0.000)
ROA	694.058***	5.376***	6.800***	5.398***
	(0.000)	(0.000)	(0.000)	(0.000)
Size	27.514***	0.218***	0.262***	0.209***

Heterogeneity Tests

The Impact of AI Application on Capital Chain Resilience under Different Incentive Policies

AI technology can enhance capital chain resilience by improving corporate governance efficiency, so the lower the governance efficiency of the company is, the better the effect of AI on improving capital chain resilience. Corporate incentives and supervision systems are important aspects of governance efficiency. Giving equity incentives to executives, directors, and supervisors can reduce the principal-agent problem, integrate their interests with the company, make better decisions and play their functions, so that supervisors can play a better role. If there are deficiencies in the company's incentive and supervisory system, AI technology can be used as a supplement. AI technology reduces the irrational decision-making behavior of the company's executives and directors through automated decision-making. AI technology can play a better supervisory role through data analysis and risk early warning systems; when unreasonable and irregular behavior occurs, it can be found and corrected in time. The explained variable in Table 6 is capital chain resilience, the explanatory variable is AI technology application, and the adjusting variable is incentive policy. Columns (1)-(3) are executive incentive, director incentive, and supervisor incentive, which are measured by the proportion of stocks held by each other. It can be seen that the worse the degree of incentive is, the better the effect of AI technology application on improving capital chain resilience.

Table 6

Heterogeneity Tests under Different Incentive Policies

	(1)	(2)	(3)
AI	0.830***	0.828***	0.440***
	(0.000)	(0.000)	(0.000)
Stock_manager	-0.005*		
	(0.075)		
AI×Stock_manager	-0.036***		
	(0.000)		
Stock_director		-0.005*	

	(1)	(2)	(3)
		(0.086)	
AI×Stock_director		-0.039***	
		(0.000)	
Stock_supervisor			0.069
			(0.308)
AI×Stock_supervisor			-0.470**
			(0.013)
Constant & Controls	Control	Control	Control
Year & Ind	Control	Control	Control
N	9596	9596	9596
R^2	0.228	0.228	0.225
F	49.415***	49.425***	49.206***

The Impact of AI Technology on Capital Chain Resilience under Different Executive Backgrounds

The background and resources of executives will affect the resource acquisition abilities of enterprises, thus affecting the company's overall development. When executives have a financial background (*Financeback*), they know how to obtain bank financing, and the working relationship and alums relationship brought by financial background can help enterprises obtain external financing. Overseas background (*Overseaback*) can help enterprises expand overseas business; when the domestic environment is not good, it can help companies explore external growth and financing opportunities. When executives lack the financial or overseas background, AI technology can play an alternative role and help enterprises obtain more financing by reducing the information asymmetry between enterprises and the outside world. The results are shown in Table 7, columns (1) and (2) show that the application of AI technology has a better effect on improving capital chain resilience under the worse executives' financial and overseas backgrounds.

The Impact of AI Technology on Capital Chain Resilience under Different Financial Statement Information

Financial statements can convey information to external investors, affect the external investors' expectations for enterprises, and then affect corporate financing abilities. Hope, optimism, resilience, and confidence can be used as significant signals of crowdsourcing, and entrepreneurs who convey positive psychological capital have more access to financing. When the tone of financial statements is poor and the level of risk transmitted is high, external investors have poor expectations for enterprises; they are unwilling to invest in enterprises, thus affecting corporate cash flow. While AI technology can alleviate the information asymmetry between enterprises and external investors, transmit enterprises' actual situations to external investors, and improve investors' expectations for the future of enterprises. The results are shown in Table 7. The explained variable is capital chain resilience, and the explanatory variable is AI application. The adjusting variable in column (3) is the tone of financial statements, and the results show that the worse the tone of financial statements is, the better the effect of AI technology on improving capital chain resilience. The adjusting variable in column (4) is the risk attitude reflected in financial statements, and the results show that the greater the risk attitude of the company's financial statements, the better the effect of AI technology on improving capital chain resilience. AI technology can increase the level of corporate investors' future expectations and transmit positive signals to the outside world. It can reduce the impact of negative information reflected in financial statements, and more investors will be willing to invest in the company's stock, thus improving capital chain resilience. The data comes from the WINGO database, and the data is counted by word frequency, *Tone* = (number of positive words－number of negative words)/(number of positive words + number of negative words), *Riskindex* = Number of words corresponding to risk indicator keyword set/total number of words in the report text.

Table 7

Heterogeneity Tests under Different Executive Background and Financial Statement Information

	(1)	(2)	(3)	(4)
AI	0.743***	0.752***	1.655***	-4.747***
	(0.000)	(0.000)	(0.003)	(0.000)
Financeback	0.087			
	(0.426)			
AI×Financeback	-0.746***			
	(0.006)			
Overseaback		0.072		
		(0.505)		
AI×Overseaback		-0.841***		
		(0.001)		
Tone			3.699***	
			(0.000)	
AI×Tone			-4.702***	
			(0.006)	
Riskindex				-180.138***
				(0.000)
AI×Riskindex				586.621***
				(0.000)
Constant & Controls	Control	Control	Control	Control
Year & Ind	Control	Control	Control	Control
N	9657	9657	9502	9502
R^2	0.224	0.225	0.227	0.232
F	49.789***	50.047***	49.638***	49.139***

The impact of AI Technology on Capital Chain Resilience under Different Governance Levels

AI technology can improve the efficiency of corporate governance and thus enhance capital chain resilience. On-the-job consumption, investment efficiency, total factor productivity, and risk-taking level can show the effect of corporate governance. When the company's on-the-job consumption is high, it shows that corporate governance has not had a very good supervisory effect. When investment efficiency and total factor productivity are low, it indicates that there are mistakes in executives' decision making. Excessive risk-taking will bring high uncertainty to the company, which will trigger financial distress easily, as well as damage future business performance and corporate value. AI technology can help executives make correct decisions through big data analysis and automated decision-making,

at the same time exert supervisory intelligence through index checking, early warning and other functions. Therefore, in the case of poor corporate governance efficiency, AI technology will play a better role in improving capital chain resilience.

Following the measurement method used by Luo *et al*. (2011), we use model (10) to estimate regular consumption, and the residual is on-the-job consumption (*Nexp*). The larger the residual is, the greater the on-the-job consumption is. *Perk* is the amount after deducting the compensation of directors, supervisors, and executives from the administrative expenses; *Asset* is the total assets; △ *Sale* is the change of sales revenue; *PPE* is the net value of fixed assets; *INV* is the total inventory; *LnEmployee* is the natural logarithm of the total number of employees, we also control the annual and industry dummy variables.

$$\frac{Perk_t}{Asset_{t-1}} = \beta_0 + \beta_1 \frac{1}{Asset_{t-1}} + \beta_2 \frac{\Delta Sale_t}{Asset_{t-1}} + \beta_3 \frac{PPE_t}{Asset_{t-1}} + \beta_4 \frac{INV_t}{Asset_{t-1}} + \beta_5 LnEmployee_t + Year + Ind + \varepsilon_t \quad (10)$$

Investment efficiency is measured following Richardson (2006). We use model (11) to estimate investment efficiency by using regression residuals. *Inv* is investment, *Growth* is the growth rate of total assets, *Lev* is the capital structure of enterprises, *Cash* is the cash holding level of the enterprise, *Size* is the natural logarithm of the asset, and *Age* is the natural logarithm of enterprises' establishment years. We also control the annual and industry dummy variables.

$$INV_{it} = \beta_0 + \beta_1 INV_{i,t-1} + \beta_2 Growth_{i,t-1} + \beta_3 Lev_{i,t-1} + \beta_4 Cash_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Age_{i,t-1} + Year + Ind + \varepsilon_t \quad (11)$$

Total Factor Productivity uses the OP model to measure following Richardson (2006). Excessive risk-taking is measured by the corporate's risk-taking level minus the industry median, where the corporate's risk-taking level is measured by the standard deviation of the industry-adjusted return on assets before interest and tax for periods from $t-2$ to t.

The results are shown in Table 8. The explained variable is capital chain resilience, the explanatory variable is AI application, and the moderating variable in column (1) is the on-the-job consumption of executives, which shows that the higher the on-the-job consumption, the better the effect of AI application on improving the capital chain resilience, indicating that AI technology can reduce the waste of capital by supervising the behavior of executives. The moderating variable in column (2) is the efficiency of corporate investment, and the results show that when the company has a large degree of overinvestment, the application of AI has a better effect on improving capital chain resilience. However, the effect of underinvestment on AI is not obvious, which shows that in times of corporate crisis, AI is more concerned with overinvestment that can lead to large outflows of corporate capital. The moderating variable in column (3) is total factor productivity, and the results show that the lower the total factor productivity is, the better the effect of AI on improving capital chain resilience. The moderating variable in column (4) is excess risk-taking, and the results show that the higher the level of excessive risk-taking, the better the effect of AI technology on improving capital chain resilience, indicating that AI can warn and respond to corporate risks and help enterprises make decisions quickly when facing risks.

Table 8

Heterogeneity Tests under Different Levels of Governance

	(1)	(2)	(3)	(4)
AI	0.133	0.227	3.039***	0.185
	(0.283)	(0.220)	(0.004)	(0.163)
Nexp	5.603**			
	(0.029)			
AI×Nexp	12.795**			
	(0.014)			
Overinvest		-5.970***		
		(0.000)		
AI×Overinvest		10.075*		
		(0.061)		
Underinvest		1.211		
		(0.561)		
AI×Underinvest		0.904		
		(0.877)		
TFP			0.081	
			(0.361)	
AI×TFP			-0.408***	
			(0.008)	
Overrisk				-4.005***
				(0.006)
AI×Overrisk				6.862**
				(0.012)
Constant & Controls	Control	Control	Control	Control
Year & Ind	Control	Control	Control	Control
N	9209	8470	9494	9657
R^2	0.218	0.233	0.227	0.225
F	53.938***	49.790***	48.137***	50.795***

The Impact of AI Technology on Capital Chain Resilience under Different Business Environments

The business environment will affect the abilities of enterprises to recover quickly in a crisis, and when enterprises use AI technology, it can alleviate the negative impact of an adverse business environment on capital chain resilience. The explained variable in Table 9 is capital chain resilience, the explanatory variable is AI application, and the moderating

variable is the business environment (*Business*). Columns (1)-(4) use the fairness of government to enterprises (*Fairness*), the relationship between government and market (*Relationship*), the development of product market (*Market*), the level of statutory tax burden (*Tax*) in different provinces to measure the business environment.

The worse the government's fairness, the worse the coordination between the government and market, the worse the product market development, and the higher the tax burden, then the harder it is for enterprises to get fair competition, financing, and market-driven pricing, the local government will also exclude non-local enterprises. At this time, the application of AI can increase information disclosure, broaden the financing channels of enterprises, send positive signals, and obtain cooperative alliances of supply chain enterprises. Getting rid of the constraints brought by the unfavorable business environment will improve the capital chain resilience greatly. The data comes from the survey reports by Wang & Fan (2020). The results show that the worse the external business environment is, the better the effect of AI technology on improving capital chain resilience, indicating that AI can be more effective in adverse external environments. Even if it is difficult for enterprises to obtain help and support from the government, they can also obtain more external resources through AI technology, improve their governance efficiency, respond quickly to the crisis, and smoothly return to their original state.

Table 9

Heterogeneity Tests under Different Business Environments

	(1)	(2)	(3)	(4)
	Fairness	*Relationship*	*Market*	*Tax*
AI	28.100***	3.638***	3.089***	-20.361***
	(0.000)	(0.000)	(0.000)	(0.000)
Business	1.446***	0.167***	0.140***	-0.838***
	(0.000)	(0.001)	(0.000)	(0.002)
AI×Business	-7.539***	-0.446***	-0.398***	5.456***
	(0.000)	(0.001)	(0.000)	(0.000)
Constant & Controls	Control	Control	Control	Control
Year & Ind	Control	Control	Control	Control
N	9567	9655	9655	9567
R^2	0.231	0.225	0.229	0.241
F	49.413***	50.189***	49.635***	49.981***

The Impact of AI Technology on Capital Chain Resilience under Different Financing Environments

Different regions have different bank loan policies, and enterprises in developed regions are more likely to obtain bank loans and have lower interest rates, which is more helpful for enterprises to alleviate the risk of capital chain rupture by obtaining financing in the crisis. The explained variable in Table 10 is capital chain resilience, the explanatory variable is AI application, and the adjustment variable is the financing environment of enterprises (*Finance*). The data comes from the survey reports by Wang & Fan (2020). Columns (1)-(4) are the amount of bank loans (*Bank Loans*), other financing amounts (*Other Financing*), loan interest rates ($Interest_1$), and other financing interest rates ($Interest_2$) in different provinces, which can measure the financing environment.

The higher the bank loan amount and other financing amount, the easier it is for enterprises to obtain financing, the better the financing environment. The higher the loan interest rate and other financing rate, the higher the financing cost of the enterprises, and the worse the financing environment. We can see from the results that when the financing environment is worse, AI technology has a better effect on improving capital chain resilience. AI technology can help enterprises obtain financing more easily by reducing the information asymmetry between enterprises and banks, it can provide banks with a large amount of real-time transaction data, and it can also be used as a pledge of digital assets to obtain financing. AI technology can help enterprises obtain loans quickly when facing crises and improve capital chain resilience.

Table 10

Heterogeneity Tests under Different Financing Environments

	(1)	(2)	(3)	(4)
	Bank Loans	*Other Financing*	$Interest_1$	$Interest_2$
AI	18.439***	8.202*	-7.018***	-7.773***
	(0.000)	(0.094)	(0.000)	(0.000)
Finance	0.724**	0.157	-0.158	-0.152**
	(0.013)	(0.616)	(0.100)	(0.034)
AI×Finance	-5.145***	-2.338	2.008***	2.165***
	(0.000)	(0.107)	(0.000)	(0.000)
Constant & Controls	Control	Control	Control	Control
Year & Ind	Control	Control	Control	Control
N	9567	9567	9567	9567
R^2	0.227	0.225	0.229	0.232
F	49.328***	49.759***	49.929***	49.892***

Robustness Test

(1) We change the measurement method of capital chain resilience. We use formula (12) to measure the index *RES* following the method of economic resilience adopted by Faggian *et al*. (2018). The results are shown in column (1) of Table 11 and the conclusions remain unchanged.

$$RES_i^t = \frac{\Delta Y_{it} / Y_{i,t-1}}{\Delta E_{it} / E_{i,t-1}} \tag{12}$$

RES_i^t is the capital resilience of company *i* in year *t*, Y_{it} is the cash holdings of company *i* in year *t*, and E_{it} is the cash holdings of the company's industry in that year.

(2) The research object of this paper is the enterprises during the crisis. The sample range is set as $RES < 0$ in the preceding text, and we change the sample range in the robustness test, we set *RES* below the median for samples of companies in financial crisis. The results are shown in column (2) of Table 11, and the conclusions remain unchanged.

(3) We change the measurement method of AI: ① when the words related to AI appear more than 4 times, it is defined as 1; otherwise, it is defined as 0, The results are shown in column (3) of Table 11.② when the words related to AI appear more than 2 times, it is defined as 1; otherwise, it is defined as 0, The results are shown in column (4) of Table 11. It can be seen that the conclusions remain unchanged under different AI measurement methods.

Table 11

Results of Robustness Test

	(1)	(2)	(3)	(4)
AI	0.360**	0.361***	0.356***	0.296***
	(0.038)	(0.008)	(0.008)	(0.006)
Constant & Controls	Control	Control	Control	Control
Year & Ind	Control	Control	Control	Control
N	9748	8361	9317	10325
R^2	0.195	0.225	0.221	0.223
F	42.944***	50.299***	51.253***	58.227***

Conclusions and Discussions

Previous studies on AI mainly focused on how to use AI technology to improve prediction accuracy, audit quality, asset evaluation, risk management, enterprise innovation, corporate governance and performance (Wang *et al.*, 2014; Manita *et al.*, 2020; Tsai *et al.*, 2016; Behl *et al.*, 2022; Muhlroth & Grottke, 2022; Lin & Chang, 2021; Castro *et al.*, 2021). However, there is little attention to whether AI technology can be used in capital chain management to improve capital chain resilience. The impact of the capital chain rupture on enterprises is rapid, direct and wide-ranging, so specific attention needs to be paid to how to improve the capital chain resilience. Based on the data of Chinese listed companies, we find the following conclusions:

(1) AI technology can enhance the capital chain resilience by reducing the level of financial constraints and enhancing the efficacy of internal control. By reducing the information asymmetry between enterprises, external creditors, and shareholders, AI technology can support enterprises in acquiring resources swiftly and reducing the likelihood of financial constraints in times of crisis. It can quickly warn and react to risks, improve the efficiency of corporate governance through data analysis systems and automatic decision-making systems, enable companies to make the right decisions quickly, reduce the irrational behavior of executives, and mitigate the risk of capital chain failure.

(2) When corporate governance is weaker, the application of AI has a greater impact on enhancing capital chain resilience. For instance, when executive incentive and supervision, investment efficiency, and total factor productivity are lower, and when on-the-job consumption and excessive risk-taking are greater, the role of AI in replacing human decision-making becomes more apparent. Through real-time data analysis, early risk warning systems, automatic verification, and other functions, AI technology can better supervise enterprise executives and employees, avoid incorrect decisions caused by human psychological factors during a crisis, and help enterprises recover quickly.

(3) When the enterprise's ability to acquire resources is weaker, AI technology has a greater impact on enhancing capital chain resilience. For instance, when corporate executives have limited access to resources, the business and financing environment of the company is unfavorable, and the tone of financial statements conveys negative information, AI will play a greater role by reducing the information asymmetry between companies and external creditors. By providing more real-time and detailed data analysis results, external creditors will have positive expectations for the company and be more willing to provide loans, shareholders will continue to hold the company's shares without causing significant fluctuations in stock prices, and capital flows will be stable.

In order to help enterprises make better use of AI technology to improve the capital chain resilience, we put forwards the following suggestions:

(1) Enterprises can increase the use of AI technology in strategic deployment. AI technology can provide risk warning for companies through real-time data analysis and automated decision-making, help the enterprise to make decisions quickly when a crisis occurs, reduce the irrational decision-making of executives, ensure the effective use of company capital, and help the enterprise to find new opportunities when the crisis comes to get through the difficult period smoothly.

(2) When enterprises face crises, they can use AI technology to share data to reduce the information asymmetry between enterprises and the outside world. AI technology can share information with creditors and shareholders so that stakeholders can understand the company better, thereby improving the loaning ability and reducing the loan interest rate. AI technology helps companies store and process diversified transaction data, which can be pledged as a digital asset to help enterprises obtain bank loans, improve the abilities of enterprises to obtain funds in times of crisis, and reduce the risk of capital interruption.

(3) Companies can introduce AI technology into corporate governance to improve governance efficiency and reduce the principal-agent problem between executives and shareholders. AI technology can detect corporate fraud and mistakes through automatic verification, preventing executives and employees from transferring company assets in a crisis, restraining executives' and employees' behavior, and enabling them to take actions and make decisions that are more conducive to the sustainable development of the company. (4)The realization of AI requires high-speed network and information transmission as the basis. The government should build infrastructure platforms, such as platforms of information communication and mobile Internet, to ensure the smooth implementation of AI technology.

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