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The Impact of Patient Capital on Agricultural Supply Chain Resilience: Evidence from Chinese Agricultural Listed Enterprises

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Abstract

Against the backdrop of rising global economic uncertainty and growing risks in agricultural supply chains, strengthening supply chain resilience has become essential for safeguarding national food security and advancing high-quality agricultural development. As a governance-optimizing force, the role of patient capital (e.g., through long-term credit and institutional investor participation) in shaping agricultural supply chain resilience merits systematic investigation. Drawing on panel data from 895 Chinese listed agricultural enterprises (2010–2024), this paper examines the association between patient capital and agricultural supply chain resilience and explores variables consistent with potential mechanisms. The results show that patient capital is positively associated with agricultural supply chain resilience, with evidence consistent with three possible mechanisms: improving internal management efficiency, advancing digital-intelligent transformation, and strengthening collaboration capabilities. Heterogeneity analyses reveal that this positive association is more pronounced among non-chain-leader enterprises, firms with low supply chain transparency, and those exhibiting a strong bullwhip effect. Further analysis indicates that strong ESG performance and high green total factor productivity strengthen the positive association between patient capital and agricultural supply chain resilience. This study provides enterprise-level evidence regarding the potential role of patient capital in promoting more efficient, modern, and sustainable agricultural supply chains.

Keywords: patient capital; agricultural supply chain resilience; internal management efficiency; digital-intelligent transformation; collaboration capabilities

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1. Introduction

Agriculture plays a fundamental role in economic development. Agricultural enterprises are not only the core actors ensuring food security and a stable supply of agricultural products but also key contributors to economic and social development [1]. Yet agricultural production is characterized by long investment cycles, high exposure to uncertainty, and a strong reliance on continuity and reliability, rendering agricultural supply chains particularly vulnerable to external shocks [2].

In recent years, Sustainable Supply Chain Management (SSCM) has gradually evolved into an important theoretical paradigm for understanding the long-term sustainability of supply chains. Rather than focusing solely on operational efficiency or environmental performance, SSCM emphasizes the integrated achievement of economic, environmental, and social objectives throughout the supply chain [3]. Within this perspective, supply chain resilience is widely regarded as a critical capability for achieving long-term sustainability because it enables supply chains to absorb external disruptions, adapt to dynamic environments, and maintain sustainable performance over time [4]. Furthermore, Pagell and Shevchenko (2014) [5] argue that truly sustainable supply chains require not only continuous improvements in operational processes but also the development of long-term adaptive capabilities. Therefore, enhancing agricultural supply chain resilience is not merely an operational necessity but also an essential pathway to implementing sustainable supply chain management. It is also closely aligned with Sustainable Development Goal 2 (Zero Hunger) and Sustainable Development Goal 9 (Industry, Innovation and Infrastructure). Against this background, strengthening agricultural supply chain resilience has become a key priority for promoting the sustainable development of agricultural enterprises.

Compared with general industrial manufacturers, agricultural enterprises require far greater infrastructure investment to maintain and strengthen supply chain resilience, given the mounting pressures from climate change, natural disasters, public-health emergencies, geopolitical tensions, and trade frictions faced by agricultural supply chains [6]. Furthermore, traditional financial capital often prioritizes short-term returns and tends to divest assets rapidly during sudden crises. This leads to severe financial fluctuations and disruptions in the capital chain of agricultural enterprises, forcing them to cut key investments, including those needed to build supply chain resilience.

To more effectively channel long-term financial resources into the agricultural real economy while addressing the cross-cycle funding gaps in building supply chain resilience, the April 2024 meeting of the Political Bureau of the Central Committee of the Communist Party of China first proposed the policy initiative of developing patient capital [7]. Patient capital is a form of capital oriented toward long-term investment. Unlike conventional investments that pursue high short-term returns, it emphasizes the long-term value and growth potential of enterprises, creating sustainable value through continuous engagement and long-term support. From the perspective of long-term capital provision, patient capital is more inclined to invest in non-traditional sectors and support hybrid financing arrangements than other forms of investment [8,9]. It requires not only an extended investment horizon but also a high tolerance for risk and a willingness to maintain commitments under adverse short-term business conditions [10]. Importantly, patient capital is defined not by the nature of the investment target but by the behavioral characteristics of the investor [11]. Compared with capital subject to predetermined exit horizons and short-term liquidation pressures, patient capital can accompany enterprises throughout multiple business cycles, providing continuous and stable financial support. Through deep capital empowerment and strategic synergies, patient capital is increasingly regarded as an important force for optimizing corporate governance and improving capital allocation efficiency at the firm level [12]. From the perspective of Supply Chain Finance (SCF), stable and long-term financial resources are increasingly recognized as important enablers of Sustainable Supply Chain Management (SSCM). Rather than merely improving firms' short-term liquidity, SCF emphasizes long-term financial relationships, working capital optimization, and collaborative value creation among supply chain partners [13]. These characteristics are broadly consistent with those of patient capital. By providing stable financial support, alleviating short-term performance pressures, and fostering long-term collaborative relationships among firms and their stakeholders, patient capital offers a financial foundation conducive to supply chain resilience. Accordingly, the SCF perspective provides a useful theoret-

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ical lens for understanding how patient capital may enhance agricultural supply chain resilience through long-term financial support and inter-organizational collaboration.

By effectively leveraging the potential value of patient capital, agricultural enterprises can enhance resilience and expand their capacity for resource deployment, thereby supporting more stable supply chain operations. First, patient capital is associated with greater shareholder activism [14] and improved internal governance. These governance-related characteristics can help alleviate managerial short-termism and guide enterprises toward more refined operational systems, thereby boosting internal efficiency, strengthening resource coordination [15], and facilitating agile decision-making in response to external crises. Second, patient capital can provide relatively stable financial support for long-cycle foundational technological upgrading, enabling enterprises to undertake high-cost intelligent transformation [16]. This is associated with the deeper integration of digital technologies into enterprise operations and supply chain management, supporting more flexible scheduling and precise supply–demand matching. Third, patient capital may generate reputation-related benefits, which signal to external stakeholders that the enterprise is operating soundly [17]. Such signals can help reduce external transaction costs and mitigate information asymmetry, making agricultural enterprises more likely to establish trust-based cooperative relationships with upstream and downstream farmers and distributors [18], forming a risk-sharing coalition [19]. These factors provide external network support for the supply chain's rapid recovery during crises.

Existing studies on patient capital have largely focused on its conceptual definition, formation mechanisms, and macroeconomic effects, while empirical work has primarily examined its role in housing supply [20], social equity and sustainable development [21], and infrastructure investment [22]. Research on agricultural supply chain resilience has centered on digital technology innovation [16] and government economic subsidies [23]. Although research on patient capital and supply chain resilience has progressed, several gaps remain. First, empirical studies have focused almost exclusively on the manufacturing sector [24,25], leaving agricultural enterprises largely unexamined. Second, the limited financial perspective within agricultural supply chain resilience research has focused predominantly on short-term credit instruments [26], while the role of long-term, stable, and strategically oriented capital remains largely unexplored. Third, the potential mechanisms linking patient capital and supply chain resilience remain insufficiently understood, and the boundary conditions warrant further investigation.

To overcome these gaps in the academic literature, this paper aims to analyze the effect of patient capital on agricultural supply chain resilience, as well as explore variables consistent with the potential roles of internal management efficiency, digital-intelligent transformation, and collaboration capabilities. This study is anchored in Dynamic Capabilities Theory, which posits that an enterprise's ability to integrate, build, and reconfigure internal and external resources in response to rapidly changing environments is essential for sustaining competitive advantage. Within this framework, patient capital is conceptualized as a strategic resource relevant to three interrelated dynamic capabilities: sensing, seizing, and transforming. Specifically, the long-term and governance-oriented nature of patient capital is reflected in sensing capabilities through improved internal management efficiency and capital allocation quality; in seizing capabilities through digital-intelligent transformation that enhances information processing and operational agility; and in transforming capabilities through corporate collaboration that facilitates continuous resource reconfiguration along the supply chain.

The marginal contributions of this paper are as follows. First, it extends research on patient capital and supply chain resilience to the agricultural sector, providing new evidence on the relationship between long-term capital and resilience under climatic uncertainty, biological production cycles, and high asset specificity. Second, grounded in Dynamic Capabilities Theory, it shifts the theoretical understanding of patient capital from a static financial input to a dynamic factor relevant to resilience building, constructing an integrated framework that links financial factors with organizational capabilities and provides a conceptual perspective on the relationship between capital attributes and supply chain resilience—an advancement with direct implications for sustainable agricultural development. Third, it reveals a compensatory function of patient capital in disadvantaged enterprises, offering testable propositions for boundary conditions and informing differentiated policy design. Finally, this study contributes to both the sustainable supply chain management (SSCM) and supply chain finance literatures by highlighting patient capital as a strategic governance resource that complements traditional short-term financing mechanisms. China's agricultural challenges—characterized by fragmented smallholders and severe post-production losses—are widely shared among developing countries; thus, the findings provide a useful reference for similar economies and lay the foundation for cross-country comparative research. In conclusion, this study contributes to SDG 2 (Zero Hunger) and SDG 9 (Industry, Innovation, and Infrastructure).

2. Theoretical Analysis and Research Hypotheses

2.1. The Direct Impact of Patient Capital on Agricultural Supply Chain Resilience

In recent years, external uncertainty has increased, and economic pressures have mounted downward. Meanwhile, industrial structures have continued to shift. Against this backdrop, ensuring the security and stability of industrial and supply chains has become a key priority for high-quality national economic development [16]. Patient capital differs markedly from hot money, which pursues short-term financial returns. Patient capital is long-term in nature and highly stable [15]. It provides a foundation for enterprises to withstand external systemic shocks.

By relaxing constraints on internal and external resources, patient capital can contribute to enterprises' initial risk resistance and facilitate faster recovery following disruptions. From the viewpoint of internal financing constraints, the long-term nature of patient capital is linked to greater earnings retention and stronger financial reserves [24], which are conducive to coping with sudden natural disasters or cyclical fluctuations in agricultural markets [27] and reducing the risk of supply chain disruptions arising from financial constraints during the early stages of a crisis. As far as external supply chain network optimization is concerned, patient capital can provide stronger financial buffers in the event of supply chain disruptions, thereby facilitating the diversification of supply chain nodes [28], the identification of alternative suppliers, and the reconstruction of distribution channels.

Through influencing the governance structure and factor allocation patterns of agricultural enterprises, patient capital can help maintain a dynamic balance between supply and demand across the supply chain. The operation of the agricultural supply chain is accompanied by high sunk costs, which make enterprises vulnerable to management's short-sighted behavior driven by short-term profitability targets. Capital providers with a long-term investment horizon tend to intervene more deeply in day-to-day enterprise governance and, through shareholder activism [29], help alleviate agency problems and discourage short-sighted behavior within the enterprise. This governance optimization can encourage enterprises to allocate more resources to resilience-building activities and improve the allocation efficiency of internal factors and funds [30]. When the supply chain faces external shocks, this optimized organizational collaboration can help enterprises identify risk signals more promptly and maintain supply–demand coordination at lower costs [25], thereby contributing to stronger supply chain resilience.

Patient capital can provide sufficient trial-and-error space for agricultural enterprises to leapfrog the underlying technology and fundamentally activate the restructuring potential of the supply chain by broadening the information dimension and operational flexibility. Supply chain resilience in the agricultural sector is often accompanied by high uncertainty, and its smooth progress requires deep and stable financial resources [1]. The long-term presence of patient capital helps bridge this resource gap, enabling enterprises to actively engage in digital technology innovation activities while being free from the interference of short-term financial goals [18]. As digital infrastructure improves, information barriers between nodes in the supply chain network begin to fall, and the information transparency across the supply chain increases [31], helping reduce information asymmetry in the flow of agricultural products. This digital technology-based innovation helps enterprises better understand market demand and local climatic variations, thereby enhancing operational flexibility [32]. Once the local supply chain is disrupted, enterprises can quickly mobilize the surrounding resources to restore operational flexibility, which can contribute to stronger agricultural supply chain resilience in the face of complex crises.

Deep mutual trust with upstream and downstream partners, fostered by patient capital, can help agricultural enterprises build a more resilient foundation for supply chain security. When an agricultural enterprise secures patient capital, it sends a positive signal of sound business operation and strong risk resistance to external stakeholders. This can facilitate the development of trust-based collaborative relationships with upstream and downstream farmers and business partners [33]. In this process, cross-organizational synergy and collaboration can be strengthened, and the originally loose supply chain nodes may evolve into a benefit-sharing and risk-sharing community [34]. In the face of external turbulence, this robust trust relationship can encourage participants to cooperate in responding to risks and support stronger agricultural supply chain resilience.

As a result, this paper proposes the following hypothesis:

Hypothesis 1. *Patient capital positively affects agricultural supply chain resilience.*

2.2. The Mechanism of Internal Management Efficiency

In the face of external shocks, the ability of enterprises to recover from crises is not only limited by existing resource endowments but also depends on the internal management efficiency of enterprises in dynamically configuring and revitalizing these elemental resources [35]. Therefore, an efficient internal management and resource allocation system is an important foundation for agricultural enterprises to cope with the impact of external uncertainty and ensure the security and stability of the industrial supply chain [2].

As an external governance force with strategic vision, patient capital can help improve the internal management efficiency of agricultural enterprises by mitigating agency conflicts and optimizing strategic decisions, thus enhancing their resilience to supply chain fluctuations. On the one hand, based on the principal-agent theory, the long-term nature of patient capital makes investors more likely to engage in shareholder activism [14], effectively inhibiting the short-sighted tendency and opportunistic behavior of management for short-term financial indicators. By improving incentives, monitoring, and constraining mechanisms, patient capital can encourage management to focus greater attention on optimizing internal operating processes and establishing risk control systems. On the other hand, patient capital is often accompanied by the introduction of advanced management practices. This supports agricultural enterprises in promoting the refinement of organizational structure and operating system reform, which can contribute to higher efficiency in internal capital flow and inventory turnover [36]. Higher efficiency in internal capital allocation [37] can support stronger organizational responsiveness. In case of sudden supply chain disruptions, this efficient and optimized management hub is able to quickly identify risk exposures and coordinate resources for flexibility with high execution, thus exerting strong buffering and repair capacity in external shocks.

As a result, this paper proposes the following hypothesis:

Hypothesis 2. *Patient capital is positively associated with internal management efficiency*.

2.3. The Mechanism of Digital-Intelligent Transformation

By promoting digital-intelligent transformation, enterprises can help alleviate information asymmetry with upstream and downstream stakeholders and more accurately gain insight into end-market demand and natural changes. At the same time, digital-intelligent transformation optimizes the production and operation process, helps reduce cost stickiness [38], and enables enterprises to flexibly manage the cost structure and resource allocation when facing sudden external shocks. The improvement of the level of digital-intelligent transformation provides technical support for the safety, stability, and rapid recovery of the agricultural supply chain.

As a strategically oriented external governance force, patient capital can help promote the digital-intelligent transformation of agricultural enterprises. By optimizing innovation decision-making and expanding technology networks, it can contribute to stronger agricultural supply chain resilience. On the one hand, the strategic orientation of patient capital can alleviate enterprises' concerns about short-term risks, enhance enterprises' tolerance for potential losses during digital transformation [30], and help curb short-sighted management behaviors through improved supervision and incentive mechanisms. This approach can increase enterprises' willingness to assume risks in highly uncertain digital innovation projects [14], thereby directing more strategic resources toward data-driven initiatives and intelligent technology applications. On the other hand, the innovation network effect formed by patient capital [39] can help agricultural enterprises gain access to broader digital innovation resources. Through its investment network and resource integration capabilities, enterprises can more conveniently access technology collaboration and cross-border collaboration opportunities. This can facilitate the introduction, absorption, and iteration of digital intelligence technologies. This technological integration supported by capital helps enterprises use digital tools more flexibly to identify supply chain risks and optimize scheduling decisions, thereby supporting stronger adaptation and recovery capabilities under complex shocks.

As a result, this paper proposes the following hypothesis:

Hypothesis 3. *Patient capital is positively associated with digital-intelligent transformation*.

2.4. The Mechanism of Enterprise Collaboration Capabilities

In-depth collaboration among enterprises can not only promote cross-organizational information sharing and factor flow but also cultivate a cooperative culture of benefit sharing and risk sharing in the supply chain network [18]. This kind of collaboration based on deep trust can help break down the transaction barriers and reduce the incompleteness and contracting costs of external contracts. When faced with unpredictable supply chain disruption risks, a high level of enterprise collaboration can help upstream and downstream supply chain actors reach a consensus on action more quickly [34], relying on established collaboration networks for resource coordination and recovery efforts.

As an external partner with both value recognition and stability, patient capital can strengthen the collaboration ability of agricultural enterprises through signaling and relationship commitment, thereby contributing to supply chain resilience. On the one hand, the investment of patient capital sends positive signals to the market about enterprise governance, potential, and social responsibility, which enhances the credibility of the enterprise in the eyes of stakeholders. Greater credibility may enhance the attractiveness of agricultural enterprises in strategic collaboration and facilitate the expansion of their supply chain collaboration networks. On the other hand, the stability of patient capital fundamentally shapes an enterprise's strategic determination to focus on long-term value creation. This determination can support enterprises in making the specialized investments necessary for deep supply chain synergy and in bearing the initial adjustment costs associated with inter-enterprise collaboration, thereby encouraging the development of long-term partnerships grounded in mutual trust and shared risk exposure. This stable collaboration network and mutual trust founded by patient capital provide a basis for supply chain stakeholders to collaboratively mitigate risks [40] and strengthen the capacity of the agricultural supply chain to withstand and recover from disruptions.

As a result, this paper proposes the following hypothesis:

Hypothesis 4. *Patient capital is positively associated with collaboration capabilities*.

3. Research Design

3.1. Sample Selection and Data Sources

The enterprise-level data employed in this paper were sourced from the China Stock Market and Accounting Research (CSMAR) Database. Using the CSRC 2012 [41] Industry Classification scheme, this paper initially screened samples of China A-share-listed agricultural enterprises operating across various segments of the agricultural supply chain. Concurrently, this paper manually reviewed the business scopes of enterprises to identify agricultural enterprises as the preliminary sample. Given that most extant studies concentrate on resilience levels following the 2008 financial crisis, this paper adopted a research period spanning from 2010 to 2024. In order to ensure the reliability of the conclusions, this paper also carried out the following processing on the samples: ① Exclude the financial and insurance industry samples. ② Exclude the samples of ST enterprises and *ST enterprises. ③ Exclude enterprises listed in the current year. ④ Exclude samples with missing values in the data. Finally, a sample of 895 enterprises was obtained, with a total of 9232 observations.

3.2. Definition of Variables

3.2.1. Dependent Variable

Agricultural supply chain resilience (ASCR). Supply chain resilience refers to an enterprise's ability to maintain the stable functioning of the supply chain through internal organizational mechanisms when faced with external adverse shocks [42]. Such resilience reflects an enterprise's ability to adapt and recover from disruptions, thereby supporting the sustained development of the supply chain. Supply chain resilience is not a single, isolated capability but a composite of interconnected dimensions that span multiple disruption stages (Tukamuhabwa et al., 2015) [43]. A well-established body of research identifies robustness, redundancy, agility, adaptability, and recovery speed as its core constituent elements (Wieland & Durach, 2021) [44]. Robustness refers to a system's ability to withstand disruptions without significant functional loss, while redundancy emphasizes the strategic deployment of slack resources to absorb shocks (Kamalahmadi et al., 2022) [45]. Agility and recovery speed together reflect the rapidity with which a supply chain can respond to and recover from disturbances, and adaptability captures the capacity to reconfigure structures and processes in response to changed environments (Han et al., 2020) [46]. These dimensions can be systematically aligned into two overarching phases of resilience: the pre- and during-disruption phase, where stability and buffering are paramount, and the post-disruption phase, where recovery and reconfiguration take precedence. Consistent with this logic, this paper measures ASCR along two primary dimensions—resistance capacity and recovery capacity [37]—which collectively reflect the ability of an agricultural supply chain to endure disruptions and to efficiently restore its operational functions.

Resistance capacity captures an enterprise's ability to maintain operational stability in the face of external shocks [6]. For agricultural enterprises, this capacity is reflected in whether they can maintain a stable capital flow and solid customer relationships. From a process perspective, the cyclical nature of agriculture makes it highly sensitive to downstream payment collection speed, and the maintenance of supply–demand relationships between enterprises is closely related to payment flows along the supply chain. If downstream customers tie up excessive funds owed to upstream suppliers, the suppliers face considerable accounts receivable pressure, thereby undermining the stability of supply chain operations. Therefore, referring to Cull et al. (2009) [40], this paper uses the natural logarithm of the ratio of accounts receivable to operating income to measure the degree of supply chain capital occupation. This is a negative indicator: a smaller value indicates a lower impact of capital occupation on the supply chain and a more stable supply–demand relationship between upstream and downstream partners. From an outcome perspective, the characteristics of agricultural production make a stable supplier–customer relationship particularly valuable. If a supply relationship exists between upstream and downstream partners in consecutive years, the supply chain can be considered highly stable. Moreover, supply chain stability is often accompanied by a stronger willingness of both parties to share knowledge and information, which may promote technological innovation among node enterprises [47] and, to a certain extent, reflects the supply chain's resistance capacity. Referring to Ellis (2012) [48], the proportion of non-new customers among the top five customers of an enterprise in consecutive years (i.e., the number of non-new customers divided by five) is used to characterize stable supply–demand relationships. A larger value indicates a more stable supply chain relationship.

Recovery capacity reflects an enterprise's dynamic adaptability to prevailing uncertainties [6]. For agricultural enterprises, resilience is reflected in the recovery of their product circulation efficiency and the rebound speed of operating performance. From an operational perspective, after an external disturbance, the smooth flow of products or services along the supply chain is affected, and supply chain disruptions may even lead to a complete halt in product flows. Therefore, if an enterprise can swiftly identify suitable suppliers and customers in the market, the resulting cooperative relationships may facilitate the restoration of product circulation in the supply chain. Establishing partnerships with higher-quality suppliers and a larger number of customers can further accelerate product flows and support the recovery of supply–demand coordination between upstream and downstream partners. Ivanov and Dolgui (2020) [49] note that inventory turnover efficiency is an important indicator for measuring supply chain recovery from disturbances. Following this approach, this paper uses the inventory turnover rate to capture the degree of supply–demand recovery; a larger value indicates a higher degree of supply chain recovery capacity. From an economic perspective, the deviation of an enterprise's operating performance can capture variations and fluctuations on both the supply and demand sides of the supply chain and, to a certain extent, also reflect supply chain recovery capacity. Drawing on Martin (2012) [50], this paper compares the change in enterprise performance with the overall industry performance change to construct a relative sensitivity indicator.

Finally, the entropy weight method is employed to aggregate the resistance and recovery capacity indicators into a comprehensive index of agricultural supply chain resilience (ASCR). This method assigns weights objectively according to the information entropy of each indicator, thereby avoiding the bias inherent in subjective weighting. The same procedure is used to calculate the resistance capacity, recovery capacity, and overall resilience level separately.

3.2.2. Core Independent Variable

Patient capital (Patient_Capital) is measured along two dimensions: relational debt (Debt) and stable equity (Equity). For Debt, agricultural enterprises, characterized by extended production cycles and pronounced asset specificity, typically depend on long-term credit. Following David et al. (2008) [51], Debt is proxied by the ratio of long-term liabilities to total liabilities. Equity is then expressed as the shareholding proportion of stable institutional investors. To evaluate Equity, this paper refers to the method of Gaspar (2005) [52] and Yan and Zhang (2009) [53], classifying institutional investors according to their semi-annual average turnover rates. Those with turnover rates exceeding the semi-annual mean are designated as transactional, while those below the mean are designated as stable.

A comprehensive measure of Patient_Capital is constructed as the sum of these two components. This aggregation is theoretically justified for several reasons. First, drawing on Deeg and Hardie (2016) [10], patient capital is defined by its investment behavior—a long-term horizon and tolerance for short-term underperformance—regardless of whether it takes the form of equity or debt. Relational debt and stable equity share these core attributes and thus represent two manifestations of the same underlying construct. Second, from the perspective of the Resource-Based View, the combination of stable equity and relational debt constitutes a more valuable, scarce, and difficult-to-imitate strategic resource than either dimension alone, as it requires enterprises to simultaneously cultivate long-term relationships with both institutional investors and creditor institutions. Third, the two dimensions are functionally complementary: equity provides governance “voice” through shareholder activism, while relational debt provides financial “commitment” through enduring credit relationships. Together, they allow patient capital to influence enterprise behavior through multiple channels.

3.2.3. Mechanism Variables

This paper examines the possible mechanisms of Patient_Capital on ASCR from three perspectives: internal management efficiency, digital-intelligent transformation, and collaboration capabilities.

Internal management efficiency is assessed across two dimensions: operational efficiency and investment inefficiency. Operational efficiency is measured by total asset turnover (Asset_Turnover), defined as operating revenue divided by total assets. Investment inefficiency (Ineff) is estimated following the model of Richardson (2006) [54] and is quantified as the absolute deviation between an enterprise’s actual investment and the expected investment level predicted by the model; this deviation captures the degree of capital allocation inefficiency.

The degree of digital-intelligent transformation is assessed along two dimensions: technology application and data assets. Technology application is captured by the extent of intelligent transformation (Intel_Trans). Following Yu et al. (2020) [55], this study employs a text mining method to construct the intelligent transformation indicator based on the frequency of specific keywords. The keyword list includes: intelligent manufacturing, digitalization, intelligentization, informatization, automation, cloud computing, cloud platform, Internet of Things, data visualization, cyber-physical system, network physical system, big data, sensing technology, cloud manufacturing, proactive manufacturing, smart manufacturing, intelligent enterprise, intelligent terminal, intelligent identification, robot, Industry 4.0, Industrial Internet, Internet Plus, human–computer interaction, sensor, controller, and data mining. The degree of intelligent transformation for a given enterprise in a given year is measured by the ratio of the frequency of these keywords in that enterprise's disclosures to the total frequency of the same keywords across all sample enterprises in the same industry and year. This indicator is intended to capture both the breadth and depth of technology integration undertaken by enterprises within agricultural contexts. Data assets (Data_Asset) are measured in line with prior research [56], based on financial data, by subtracting the value of other intangible assets unrelated to data assets from the total intangible assets. This measure is intended to capture the enterprise's capacity for data-driven managerial decision-making.

Enterprise collaboration capabilities are measured along two dimensions: external relational linkages and internal cultural orientation. External linkages are captured by the degree of inter-enterprise cooperation (Cooperation), which, following the approach of Lee et al. (2023) [57], is quantified as the sum of shareholding ratios held by various financial institutions. This measure is designed to reflect the equity-based institutional ties between the enterprise and entities such as banks, insurance enterprises, and investment funds. Internal cultural orientation is assessed through cooperative culture (Coop_Culture). Drawing on the text analysis approaches of Loughran and McDonald (2013) [58] and Li et al. (2021) [59], this study measures the cooperation-oriented dimension of corporate culture through keyword frequency analysis. We refer to the word list of Fiordelisi and Ricci (2014) [60], and then extract and summarize cooperation-related terms from the vision, mission, and core value statements of listed companies, and verify the identified keywords against the Dictionary of Chinese Synonyms to supplement any missing synonyms. The resulting lexicon includes the following terms: cooperation, unity, association, coordination, collaboration, synergy, joint effort, combined strength, mutual assistance, sharing, shared benefits, pulling together in times of trouble, communication, exchange, and win–win. This index measures the extent to which the enterprise espouses values of trust, collaboration, and long-term reciprocity within its organizational context.

3.2.4. Control Variables

Drawing on existing studies [61,62], this paper selects book-to-market ratio, board size, two jobs combined, fixed asset ratio, enterprise growth, debt-to-asset ratio, price-to-book ratio, return on assets, and enterprise size. Detailed definitions of all variables are provided in Table 1.

Table 1. Definition of Control variables.

Variable	Symbols	Variable Definition
Book-to-market ratio	BM	Book value/Total market value
Board size	Board	The natural logarithm of the number of board members
Two jobs combined	Dual	Is the general manager and the chairman the same person, 1 if yes, 0 if no.
Fixed asset ratio	Fixed	Fixed assets/Total assets
Enterprise growth	Growth	(Current period sales revenue/Previous period sales revenue) − 1
Debt-to-asset ratio	Lev	Total liabilities/Total assets
Price-to-book ratio	PB	Price per share/Book value per share
Return on assets	ROA	Net profit/Total assets
Enterprise size	Size	The natural logarithm of total assets

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3.3. Model Construction

To examine the impact of patient capital on agricultural supply chain resilience, this paper establishes the following benchmark Model 1:

$$\text{ASCR}_{\text{it}} = \alpha_0 + \alpha_1 \text{ Patient\_Capital}_{\text{it}} + \alpha_2 \text{ Controls}_{\text{it}} + \lambda_{\text{t}} + \mu_{\text{i}} + \varepsilon_{\text{it}}$$

where i and t denote the firm and year, respectively. The dependent variable is ASCR_{it}, the independent variable is $\text{Patient\_Capital}_{\text{it}}$, and $\text{Controls}_{\text{it}}$ represents the series of control variables described above. α_0 is a constant term, ε_{it} is the random error term, and λ_{t} and μ_{i} denote year and firm fixed effects, respectively.

4. Empirical Analysis

4.1. Descriptive Statistics

The descriptive statistics are presented in Table 2. The average ASCR performance of the sampled companies is 0.444, indicating a low overall level of ASCR. The maximum and minimum values are 0.736 and 0.056, respectively, reflecting variation in supply chain resilience across sample enterprises. The standard deviation of 0.138 suggests that the ASCR of most enterprises is moderately dispersed around the mean, with only a few enterprises significantly outperforming or underperforming relative to the sample average. Regarding patient capital, the minimum and maximum values are 0 and 0.956, respectively, indicating heterogeneity in the level of long-term, stable capital support across enterprises. The mean value of 0.346, which is relatively low, suggests that the majority of enterprises in the sample possess limited patient capital. The descriptive statistics for the remaining variables are generally consistent with prior studies in the literature; therefore, detailed discussion of these statistics is omitted.

Table 2. Descriptive Statistics.

Variable	Obs	Mean	SD	Min	Max	Median
ASCR	9232	0.444	0.138	0.056	0.736	0.473
Patient_Capital	9232	0.346	0.245	0.000	0.956	0.353
BM	9232	0.606	0.256	0.000	1.571	0.596
Board	9232	2.116	0.207	0.000	2.833	2.197
Dual	9232	0.280	0.449	0.000	1.000	0.000
Fixed	9232	0.219	0.168	0.000	0.860	0.187
Growth	9232	0.120	0.343	−0.673	5.076	0.066
Lev	9232	0.401	0.240	0.010	8.612	0.372
PB	9232	3.544	3.397	0.000	51.810	2.653
ROA	9232	0.037	0.206	−6.776	8.441	0.038
Size	9232	22.176	1.277	17.663	27.098	21.998

4.2. Benchmark Regression

In order to test the impact of Patient_Capital on ASCR, this paper chooses the panel data fixed effects model to estimate Model 1, and Table 3 reports the regression results. Columns (1) and (2) are regression results with Patient_Capital as an independent variable. Column (1) includes only firm and year effects. Column (2) further adds control variables. According to the regression results of Column (2) in Table 3, the coefficient of Patient_Capital remains positive and statistically significant at the 1% level after the inclusion of control variables. This result indicates a significantly positive association between Patient_Capital and ASCR. Specifically, a one-unit increase in Patient_Capital corresponds to a 0.096-unit increase in ASCR. This finding is consistent with the view that Patient_Capital, through its long-term orientation, risk-bearing capacity, and strategic synergy, may help alleviate financing constraints, support long-term capability investments, and improve decision-making quality through governance participation, factors that are associated with greater supply chain stability and responsiveness. Therefore, the empirical evidence supports Hypothesis 1.

Table 3. Benchmark Regression.

Variable	(1) ASCR	(2) ASCR
Patient_Capital	0.099 ***	0.096 ***
	(9.23)	(9.22)
BM		−0.163 ***
		(−18.24)
Board		0.001
		(0.10)
Dual		−0.012 ***
		(−3.05)
Fixed		0.142 ***
		(9.00)
Growth		0.027 ***
		(7.80)
Lev		0.046 ***
		(5.88)
PB		−0.006 ***
		(−11.50)
ROA		0.006
		(0.99)
Size		0.034 ***
		(11.31)
Constant	0.410 ***	−0.284 ***
	(105.25)	(−4.18)
N	9224	9224
R^2	0.431	0.475
Adj. R^2	0.37	0.42

Note: *t*-statistics in parentheses. *** $p < 0.01$.

4.3. Endogenous Issues

4.3.1. Propensity Score Matching (PSM)

Considering that Patient_Capital may not be random, there is a sample self-selection bias. Therefore, this paper adopts the propensity score matching (PSM) method, constructs a treatment variable based on whether Patient_Capital is higher than the median, and performs nearest-neighbor 1:1 matching. Based on the regression results of matched samples, as shown in Column (1) of Table 4, the regression coefficient of Patient_Capital is 0.045 and is significantly positive at the 1% level. This shows that after controlling for self-selection bias of the sample, the positive effect of Patient_Capital on ASCR remains significant.

Table 4. Endogenous Problems.

Variable	(1) PSM	(2) Heckman	(3) I	(3) II
Patient_Capital	0.045 ***	0.094 ***		0.106 ***
	(3.74)	(9.05)		(6.64)
imr		−0.616 ***		
		(−5.52)		
IV			0.787 ***	
			(77.98)	
Constant	−0.227 ***	0.153		
	(−2.85)	(1.46)		
Control	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	6653	9224	9224	9224
Adj. R^2	0.46	0.48	0.43	0.09

Note: *t*-statistics in parentheses. *** $p < 0.01$.

4.3.2. Heckman Two-Stage Model

To alleviate sample selection bias and test robustness, this paper employs the Heckman two-stage model to control for unobservable variables. Table 4 Column (2) shows that the regression coefficient of Patient_Capital is 0.094, and it is significantly positive at the 1% level, indicating that the benchmark regression results are robust and not driven by sample self-selection bias.

4.3.3. Instrumental Variable Tests

To address potential endogeneity concerns arising from reverse causality or omitted variables in the relationship between patient capital and agricultural supply chain resilience, this study adopts an instrumental variable approach and conducts two-stage least squares estimation. Specifically, the average level of patient capital among other agricultural enterprises in the same year, industry, and region is used as the instrumental variable. The rationale for this instrument is twofold: first, enterprises in the same industry and region face similar financing environments and policy shocks, supporting the relevance condition. Second, the patient capital level of other enterprises is not expected to directly affect the supply chain resilience of the focal enterprise. Nevertheless, this instrument may still capture common regional or industry-level financial conditions that are also related to supply chain resilience. Therefore, the IV results should be interpreted as supplementary evidence rather than definitive proof of causality. The instrumental variable regression results are reported in Table 4. Column (3) presents the first-stage results (I): the coefficient of IV is 0.787, significant at the 1% level, ruling out weak instrument concerns. Column (3) also reports the second-stage results (II): the coefficient of Patient_Capital is 0.106, remaining significant at the 1% level and consistent with the baseline findings, indicating that the positive association between patient capital and agricultural supply chain resilience remains statistically significant after applying the instrumental variable approach.

4.4. Robustness Tests

4.4.1. Alternative Independent Variables

The way an indicator is measured can influence the benchmark regression results. This paper therefore reconstructs the measure of Patient_Capital by developing an evaluation system that covers three first-level indicators of orientation, risk tolerance and strategic relationship, as well as seven second-level indicators, including the ratio of investor shareholding to its standard deviation over the preceding three years [12,30], and uses the entropy weight method to objectively weight and aggregate them. As shown in Table 5, Column (1), the positive effect of Patient_Capital on ASCR remains significant at the 1% level, consistent with the conclusions of the previous section.

Table 5. Robustness Tests.

Variable	(1) ASCR	(2) ASCR	(3) ASCR	(4) ASCR	(5) ASCR
Patient_Capital	0.106 ***			0.100 ***	0.074 ***
	(8.53)			(7.70)	(6.78)
Debt		2.213 **			
		(2.00)			
Equity			0.096 ***		
			(9.20)		
Constant	−0.242 ***	−0.289 ***	−0.286 ***	−0.381 ***	−0.266 ***
	(−3.52)	(−4.14)	(−4.20)	(−4.48)	(−3.81)
Control	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Province FE	No	No	No	No	No
Industry FE	No	No	No	No	No
N	9224	9224	9224	9224	8446
Adj. R^2	0.42	0.41	0.42	0.49	0.41
Variable	(6) Prov. × Yr FE	(7) Ind. × Yr FE	(8) High-Dim FE	(9) Pre-Policy	(10) Post-Policy
Patient_Capital	0.108 ***	0.101 ***	0.111 ***	0.088 ***	0.155 ***
	(10.00)	(9.41)	(9.95)	(4.32)	(12.06)
Constant	−0.251 ***	−0.175 **	−0.179 **	−0.205	−0.253 **
	(−3.52)	(−2.40)	(−2.35)	(−1.29)	(−2.41)
Control	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	No	Yes	No	No
Industry FE	No	Yes	Yes	No	No
N	9214	9179	9167	2922	6239
Adj. R^2	0.43	0.43	0.44	0.28	0.58

Note: *t*-statistics in parentheses. *** $p < 0.01$, ** $p < 0.05$.

Furthermore, this paper separately examines the two dimensions of Patient_Capital, namely relational debt (Debt) and stable equity (Equity). The results are reported in Columns (2) and (3) of Table 5. The coefficient of Debt is 2.213 and statistically significant at the 5% level, while the coefficient of Equity is 0.096 and statistically significant at the 5% level. These findings indicate that both relational debt and stable equity are positively associated with ASCR. Therefore, the positive association between Patient_Capital and ASCR is not driven by the aggregation of the two dimensions and remains evident when each component is considered separately.

4.4.2. Alternative Dependent Variables

The method used to measure the dependent variable may influence the outcome of the benchmark regression analysis. In the baseline regression, the entropy weight method is used to weight the resistance and recovery capacity indicators when constructing the ASCR index. For robustness testing, this paper replaces the entropy weight method with equal-weight averaging, assigning equal weights to the two indicators and recalculating ASCR accordingly. As shown in Table 5, Column (4), the coefficient of Patient_Capital remains 0.100 and is statistically significant at the 1% level, indicating that the positive effect of patient capital on agricultural supply chain resilience is robust to alternative weighting schemes and does not depend on a specific index construction method.

4.4.3. Eliminate Outlier Years

The COVID-19 pandemic has had a profound impact on the global economy and business operations. Although such impacts may be temporary, their effect on the data is substantial. Excluding the 2020 sample helps control for abnormal fluctuations caused by the pandemic, thereby more accurately assessing the long-term relationship between Patient_Capital and ASCR and avoiding short-term shocks that can mask or distort long-term trends. Column (5) of Table 5 reports the regression results after excluding this abnormal year. The coefficient of Patient_Capital is 0.074 and remains significantly positive at the 1% level, confirming that Patient_Capital improves ASCR.

4.4.4. Control for High-Dimensional Fixed Effects

The benchmark regression already controls for firm and year two-way fixed effects, but the heterogeneity at provincial and industry levels may still affect the reliability of estimation results. To address this concern, this paper further introduces the province-year interaction fixed effect and the industry-year interaction fixed effect to more rigorously account for unobservable shocks that vary across regions and industries over time [63]. As shown in Columns (6) and (7) of Table 5, after controlling for these interaction fixed effects, the coefficient of Patient_Capital is still significantly positive, with no notable changes in economic or statistical significance relative to the baseline regression. Column (8) of Table 5 reports the results after simultaneously controlling for both sets of interaction fixed effects. The coefficient of Patient_Capital remains significant at the 1% level, indicating that the positive effect of Patient_Capital on ASCR is robust to the inclusion of high-dimensional fixed effects and is not meaningfully weakened by more fully accounting for spatial, temporal, and industry-level heterogeneity.

4.4.5. Eliminate Interference from Policies

The agricultural supply-side structural reform policy implemented in 2017 created an external shock for agricultural enterprises, which can be considered a quasi-natural experiment [64]. To test whether the role of Patient_Capital changes in response to this policy shock, this paper divides the sample by policy timing into a pre-policy period (2010–2016) and a post-policy period (2017–2024). The results in Columns (9) and (10) of Table 5 show that the positive effect of Patient_Capital remains statistically significant in both periods, suggesting that the research conclusions are not driven by the policy shock.

4.5. Mechanism Exploration

In the preceding analyses, this paper proposed three potential pathways through which Patient_Capital strengthens ASCR: improving internal management efficiency, promoting digital-intelligent transformation, and enhancing collaboration capabilities. This section examines whether the empirical evidence is consistent with these proposed mechanisms. This study adopts the improved testing method proposed by Jiang Ting [65]. Jiang's simulations show that the conventional stepwise method conflates correlation with causation, assumes mediator exogeneity without addressing endogeneity, and produces biased estimates of direct and indirect effects owing to omitted confounders or reverse causality. It also suffers from low statistical power, redundant sequential logic, and potential misjudgments, undermining the rigor required for causal inference in economics.

Given that the theoretical links between the mechanism variables and the dependent variable have been firmly established in prior research, this study focuses on examining whether Patient_Capital is associated with these mechanism variables.

4.5.1. Explore Internal Management Efficiency as a Mechanism

Given that a substantial body of literature has already established the effect of internal management efficiency on supply chain resilience [66,67], this study focuses solely on examining the influence of patient capital on internal management efficiency.

To examine the mechanism of internal management efficiency, this paper uses total asset turnover (Asset_Turnover) and investment inefficiency (Ineff) to capture the operational and investment dimensions, respectively. Results are reported in Table 6.

Table 6. The Mechanism of Internal Management Efficiency.

Variable	(1) Asset_Turnover	(2) Ineff
Patient_Capital	0.045 **	−0.021 ***
	(2.15)	(−2.60)
BM	−0.118 ***	−0.079 ***
	(−6.49)	(−11.56)
Board	−0.007	−0.010
	(−0.34)	(−1.27)
Dual	−0.018 **	−0.002
	(−2.19)	(−0.59)
Fixed	0.058 *	0.062 ***
	(1.81)	(5.16)
Growth	0.100 ***	0.038 ***
	(14.24)	(14.13)
Lev	0.035 **	0.087 ***
	(2.21)	(14.46)
PB	0.002 *	−0.003 ***
	(1.83)	(−7.26)
ROA	0.020	0.039 ***
	(1.61)	(8.28)
Size	−0.087 ***	−0.004
	(−14.09)	(−1.61)
Constant	2.609 ***	0.218 ***
	(18.87)	(4.17)
N	9224	9224
R^2	0.785	0.476
Adj. R^2	0.76	0.42

Note: *t*-statistics in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Column (1) shows that patient capital has a coefficient of 0.045 on Asset_Turnover, significantly positive at the 5% level, indicating that a one-unit increase in patient capital is associated with a 4.5 percentage-point improvement in asset turnover. This finding is consistent with the logic that long-term capital promotes operational optimization by alleviating short-term earnings pressure. The moderate statistical significance likely reflects that asset turnover in agricultural enterprises is constrained by industry-specific factors such as seasonality, climatic conditions, and biological production cycles, making efficiency gains a gradual process. Column (2) reveals that patient capital has a coefficient of −0.021 on Ineff, significantly negative at the 1% level, indicating that a one-unit increase in patient capital reduces investment inefficiency by 2.1 percentage points. This result is consistent with the governance role commonly attributed to patient capital in the literature. Long-term investors may be associated with reduced investment inefficiency through active monitoring. Compared with operational efficiency, the evidence linking patient capital to capital allocation quality appears statistically more robust. Overall, the results provide evidence consistent with internal management efficiency as a potential mechanism linking patient capital to supply chain resilience, with the investment efficiency channel receiving relatively stronger empirical support. The empirical evidence provides support for Hypothesis 2.

4.5.2. Explore Digital-Intelligent Transformation as a Mechanism

Since the relationship between digital-intelligent transformation and supply chain resilience is well-documented in prior research [68,69], we only report the effect of patient capital on digital-intelligent transformation.

The mechanism of digital-intelligent transformation is explored using the degree of intelligent transformation (Intel_Trans) and data assets (Data_asset), corresponding respectively to the technology deepening and data construction dimensions. Results are reported in Table 7.

Table 7. The Mechanism of Digital-Intelligent Transformation.

Variable	**(1) Intel_Trans**	**(2) Data_asset**
Patient_Capital	0.014 ***	0.065 *
	(3.61)	(1.94)
BM	0.013 ***	−2.244 ***
	(4.15)	(−77.62)
Board	−0.001	−0.038
	(−0.32)	(−1.15)
Dual	−0.001	0.032 **
	(−0.77)	(2.47)
Fixed	0.007	−0.869 ***
	(1.09)	(−17.09)
Growth	0.002	−0.003
	(1.29)	(−0.31)
Lev	−0.015 ***	0.144 ***
	(−4.87)	(5.65)
PB	−0.000	0.017 ***
	(−0.92)	(11.01)
ROA	−0.008 ***	0.086 ***
	(−3.15)	(4.31)
Size	0.007 ***	0.944 ***
	(6.04)	(96.18)
Constant	−0.138 ***	3.066 ***
	(−5.27)	(13.95)
N	9224	9224
R^2	0.488	0.921
Adj. R^2	0.43	0.91

Note: *t*-statistics in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Column (1) shows that patient capital has a coefficient of 0.014 on Intel_Trans, significantly positive at the 1% level, indicating that a one-unit increase in patient capital is associated with a 1.4 percentage-point improvement in intelligent transformation. This finding is consistent with the theoretical expectation that long-term financing may facilitate digital technology adoption by relieving short-term profitability constraints. Technology adoption is strongly capital-driven in nature: the stable funding provided by patient capital can be directly channeled into investments in smart equipment and digital systems, making the effect of this pathway relatively direct and readily detectable in statistical terms. Column (2) reveals that patient capital has a coefficient of 0.065 on Data_asset, significantly positive at the 10% level, indicating that a one-unit increase in patient capital is associated with a 6.5 percentage-point increase in data assets, supporting the logic that patient capital provides long-term financial security for data element accumulation. The moderate significance of this pathway likely arises because data asset accumulation requires not only financial support but also the synchronous refinement of complementary conditions such as data governance systems and organizational learning, with the full effect materializing over a longer horizon. Nonetheless, this pathway remains statistically significant, providing initial evidence for the positive role of patient capital in fostering data element accumulation. Taken together, the results provide evidence consistent with digital-intelligent transformation as a potential mechanism linking patient capital and agricultural supply chain resilience. The empirical evidence provides support for Hypothesis 3.

4.5.3. Explore Collaboration Capabilities as a Mechanism

As the role of collaboration capabilities in enhancing supply chain resilience has been extensively demonstrated by existing studies [70,71], this paper limits its analysis to the impact of patient capital on collaboration capabilities.

For the mechanism of collaboration capabilities, this paper employs the degree of inter-enterprise cooperation (Cooperation) and cooperative culture (Coop_Culture), approaching from the two dimensions of external relationship connection and internal culture orientation. Results are reported in Table 8.

Table 8. The Mechanism of Collaboration Capabilities.

Variable	(1) Cooperation	(2) Coop_Culture
Patient_Capital	3.222 ***	0.055 *
	(3.31)	(1.80)
BM	−2.157 **	−0.213 ***
	(−2.57)	(−8.13)
Board	−0.195	0.128 ***
	(−0.20)	(4.23)
Dual	0.849 **	0.004
	(2.29)	(0.31)
Fixed	−6.390 ***	−0.058
	(−4.33)	(−1.25)
Growth	1.081 ***	0.008
	(3.33)	(0.84)
Lev	−3.984 ***	−0.019
	(−5.39)	(−0.81)
PB	0.287 ***	−0.006 ***
	(6.33)	(−4.08)
ROA	−0.524	−0.038 **
	(−0.91)	(−2.10)
Size	1.444 ***	0.182 ***
	(5.07)	(20.55)
Constant	−22.052 ***	−0.408 **
	(−3.46)	(−2.05)
N	9224	9224
R^2	0.568	0.761
Adj. R^2	0.52	0.74

Note: *t*-statistics in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Column (1) shows that patient capital has a coefficient of 3.222 on Cooperation, significantly positive at the 1% level, indicating that a one-unit increase in patient capital is associated with a 3.222 percentage-point increase in equity-based institutional ties with financial institutions. This pattern is consistent with the expectation that patient capital enhances enterprises' cooperative attractiveness through signaling and thereby broadens external resource networks. The formation of external institutional ties relies on capital injection and strategic alignment, making the effect relatively direct and more readily observable in the current period. Column (2) reveals that patient capital has a coefficient of 0.055 on Coop_Culture, significantly positive at the 10% level, indicating that a one-unit increase in patient capital is associated with a 5.5 percentage-point increase in the frequency intensity of cooperation-related terms. The moderate statistical significance of this pathway is consistent with the inherent nature of organizational cultural change: the internalization of values and the transformation of behavioral norms require leadership modeling, incentive alignment, and sustained employee buy-in. Capital can provide external conditions, but cannot substitute for the prolonged cultivation process within the organization, and the full effect therefore becomes visible over a longer horizon. Taken together, the results provide evidence consistent with collaboration capabilities as a potential mechanism linking patient capital and agricultural supply chain resilience. The empirical evidence provides support for Hypothesis 4.

4.6. Heterogeneity Analysis

4.6.1. Heterogeneity of Supply Chain Positioning

With regard to supply chain positioning, chain leader enterprises occupy a central role within the industrial chain. Their scale, market share, and innovation capabilities significantly influence the overall structure and operational efficiency of the industrial chain, thereby potentially influencing the relationship between Patient_Capital and ASCR. To verify this possibility, this paper draws on existing research [72], and identifies chain-leader enterprises through social network analysis, assigning a value of 1 to chain leaders and 0 to non-chain leaders. The results are shown in Table 9, Column (1) and Column (2). The results show that the positive association between Patient_Capital and ASCR is more pronounced among non-chain-leader enterprises. This is likely because these enterprises are in a relatively marginal position in the industrial chain and face greater market competition pressure and resource constraints. Compared to chain-leader enterprises, they have a greater need to allocate resources toward optimizing supply chain structures and enhancing supply–demand stability.

Table 9. Heterogeneity Analysis.

Variable	**Supply Chain Position**		**Supply Chain Transparency**		**Supply Chain Coordination**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Non-Leader	**Leader**	**Low Transp**	**High Transp**	**Weak Bullwhip**	**Strong Bullwhip**
Patient_Capital	0.109 ***	0.005	0.102 ***	0.033	−0.036 **	0.116 ***
	(9.64)	(0.18)	(8.90)	(1.29)	(−2.09)	(8.16)
Control	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−0.331 ***	0.095	−0.235 ***	−0.116	−0.114	−0.333 ***
	(−4.40)	(0.59)	(−3.12)	(−0.64)	(−1.16)	(−3.34)

Table 9. *Cont.*

Variable	Supply Chain Position		Supply Chain Transparency		Supply Chain Coordination	
	(1)	(2)	(3)	(4)	(5)	(6)
	Non-Leader	Leader	Low Transp	High Transp	Weak Bullwhip	Strong Bullwhip
N	8038	1186	7780	1354	4018	5039
R^2	0.485	0.425	0.523	0.490	0.571	0.526
Adj. R^2	0.43	0.36	0.46	0.35	0.47	0.44

Note: *t*-statistics in parentheses. *** $p < 0.01$, ** $p < 0.05$.

4.6.2. Heterogeneity of Supply Chain Transparency

Turning to supply chain transparency, this attribute captures the extent to which information flows and sharing practices are openly maintained among supply chain participants. It plays an important role in determining supply chain coordination efficiency and risk resilience and may therefore influence the relationship between Patient_Capital and ASCR. To verify this possibility, this paper refers to the method of Dina Ribbink et al. (2025) [73], measuring supply chain transparency through the explicit disclosure of major supplier and customer counts in enterprise annual reports. The mean value is then used as the classification criterion. If the sample value exceeds the mean, it is assigned a value of 1; otherwise, a value of 0 is assigned. The regression results are shown in Table 9, Columns (3) and (4), revealing that the impact of Patient_Capital on ASCR is more significant in the low-transparency group. This may be due to the fact that in enterprises with low supply chain transparency, the problem of information asymmetry is more prominent, the foundation of internal and external trust is relatively weak, and the coordination and response capabilities of all links in the supply chain are restricted. Under such circumstances, higher levels of Patient_Capital may provide greater benefits by alleviating information-related constraints and supporting long-term coordination. In contrast to this, due to the information reserve and synergy foundation of high-transparency enterprises, the marginal role of Patient_Capital in alleviating information limitations is relatively limited.

4.6.3. Heterogeneity of Supply Chain Coordination Capabilities

In terms of supply chain coordination capabilities, the bullwhip effect, a well-documented phenomenon in supply chain operations, refers to the amplification of order variability as it moves from downstream to upstream. It has long been regarded as a symptom of inefficiency and misalignment within supply chains [74]. A stronger bullwhip effect generally reflects weaker supply chain coordination capabilities [75]. The existence of the bullwhip effect amplifies supply and demand fluctuations and inventory costs and operational risks, thereby weakening the overall supply chain resilience of enterprises. In order to test the difference in the role of Patient_Capital in supply chains with different coordination capabilities, this paper refers to related research [76], measures the bullwhip effect as the ratio of the standard deviation of production volume to the standard deviation of demand, and takes the sample mean value as the basis for division: the sample greater than the mean value is assigned to 1, and the sample less than the mean value is assigned to 0. The group regression results are shown in Table 9, Columns (5) and (6). It shows that the effect of Patient_Capital on improving ASCR is more significant in the strong-bullwhip-effect group. This may be attributed to the fact that enterprises with a strong bullwhip effect suffer from more severe information distortion and weaker supply–demand coordination, and therefore have greater room for improvement. In such contexts, the injection of Patient_Capital can play a more impactful role by helping enterprises optimize information-sharing mechanisms, strengthen collaborative relationships with upstream and downstream partners, and reduce operational disruptions caused by demand variability. In contrast, enterprises with a weak bullwhip effect already possess relatively efficient coordination systems, leaving limited marginal gains from additional capital infusion. These results are consistent with a compensatory role of patient capital, as a stronger association between Patient_Capital and ASCR is observed among enterprises with weaker coordination capabilities.

4.7. Further Analysis

Currently, greenhouse gas emissions remain high, issues of resource over-exploitation and waste pollution are becoming increasingly prominent, and people's awareness of environmental protection and sustainable development is continuously rising. Enterprise green behavior is not only a manifestation of actively assuming social responsibility but also a response to stakeholders' environmental demands, and it is the only way for the sustainable development of enterprises. So, how will enterprise green behavior affect the effectiveness of Patient_Capital? To this end, this paper explores the impact of enterprise green behavior on the relationship between Patient_Capital and the agricultural supply chain from two perspectives: enterprise green strategy and green production. Since enterprise ESG performance (ESG) integrates environmental protection into the enterprise governance structure and core decision-making, permeating the entire system of strategic goals, resource allocation, and value creation, this paper uses ESG as a measure of enterprise green strategy. The green total factor productivity (Green_TFP) incorporates environmental constraints into the evaluation of production efficiency, quantifying the synergy between economic benefits and environmental benefits in enterprises under a green production model. Therefore, Green_TFP is used as a measure of enterprise green production.

Table 10 shows the impact of enterprise green strategies on the relationship between Patient_Capital and ASCR. Column (1) contains no control variables, while Column (2) contains all control variables. The results in Table 10 show that in Column (1) without adding control variables, the coefficient of the interaction term Patient_Capital × ESG is 0.017 and is significantly positive at the 1% level. Similarly, in Column (2), after adding all control variables, the coefficient of the interaction term Patient_Capital × ESG is 0.015 and is significant at the 1% level. The above results show that good ESG can significantly strengthen the role of Patient_Capital in promoting ASCR. Enterprises with strong ESG usually have a more standardized governance structure, more transparent information disclosure, and more stable stakeholder relationships. These institutional characteristics are consistent with the governance goals of Patient_Capital, thereby contributing to ASCR.

Table 10. Moderating Effect of Enterprise Green Strategy.

Variable	(1) ASCR	(2) ASCR
Patient_Capital	0.031	0.035
	(1.23)	(1.42)
ESG	−0.013 ***	−0.012 ***
	(−5.50)	(−5.16)
Patient_Capital × ESG	0.017 ***	0.015 ***
	(3.08)	(2.83)
Constant	0.465 ***	−0.274 ***
	(43.41)	(−4.02)
Control	No	Yes

Table 10. *Cont.*

Variable	(1) ASCR	(2) ASCR
N	9224	9224
R^2	0.434	0.477
Adj. R^2	0.37	0.42

Note: *t*-statistics in parentheses. *** $p < 0.01$.

Referring to existing research [77], this paper uses the EBM model and GML index to measure Green_TFP so as to analyze the impact of green production on the relationship between Patient_Capital and ASCR. The results are shown in Table 11. Similarly, Column (1) excludes control variables, while Column (2) includes all control variables. It can be found that whether in Column (1) or Column (2), the coefficient of the interaction term Patient_Capital × Green_TFP is significantly positive at the 1% level, indicating that for enterprises with higher Green_TFP, Patient_Capital has a positive impact on ASCR. Its internal mechanism is that an enterprise with high Green_TFP means that it has strong green technology absorption capacity, clean process application level, and resource management efficiency in production and can more effectively allocate Patient_Capital to enhance agricultural supply chain adaptation and investment in operational robustness.

Table 11. Moderating Effect of Green Total Factor Productivity.

Variable	(1) ASCR	(2) ASCR
Patient_Capital	0.029 *	0.033 **
	(1.90)	(2.23)
Green_TFP	0.087 ***	0.051 ***
	(8.81)	(5.26)
Patient_Capital × Green_TFP	0.118 ***	0.103***
	(6.68)	(5.99)
Constant	0.438 ***	−0.254 ***
	(74.84)	(−3.73)
Control	No	Yes
N	9224	9224
R^2	0.438	0.479
Adj. R^2	0.38	0.42

Note: *t*-statistics in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Conclusion and Suggestions

Understanding how Patient_Capital supports ASCR is important for ensuring the stable supply of agricultural products, coping with complex external shocks, and promoting the modernization of the agricultural industry chain, which has far-reaching practical significance.

Drawing on panel data of China's A-share listed agricultural enterprises from 2010 to 2024 and adopting a dynamic capabilities perspective, this paper provides robust evidence of a positive association between Patient_Capital and ASCR. Mechanism exploration shows that Patient_Capital is positively associated with variables reflecting internal management efficiency, digital-intelligent transformation, and collaboration capabilities, which are consistent with three possible mechanisms linking Patient_Capital and ASCR. The heterogeneity analysis further reveals that the effect of Patient_Capital varies according to enterprise supply chain characteristics and is more pronounced in non-chain-leader enterprises, low-transparency firms, and those with a strong bullwhip effect.

In addition, strong ESG performance and high green total factor productivity positively moderate the effect of Patient_Capital on ASCR.

These conclusions carry profound economic, managerial, and theoretical implications. Economically, the resilience-enhancing effect of patient capital on agricultural supply chains holds substantive operational significance—especially for agricultural enterprises with thin margins, long production cycles, and high exposure to climatic and market shocks. Improvements in resilience can translate into fewer inventory losses, more stable supplier relationships, and faster post-disruption recovery, all of which are directly relevant to enterprise survival and competitiveness. Theoretically, the evidence suggests that patient capital is associated with differences in enterprises' capital allocation, information processing, and collaboration-related characteristics. These associations are consistent with several potential pathways linking patient capital and supply chain resilience, thereby enriching the understanding of how patient capital contributes to the achievement of SDG 2, SDG 9, and SDG 12. Managerially, heterogeneity analysis reveals that the resilience-enhancing effect of patient capital is most pronounced in enterprises lacking structural advantages, namely non-chain-leader enterprises, low-transparency firms, and those with a strong bullwhip effect. This pattern is consistent with a compensatory role of patient capital, and thus managers of such enterprises have the strongest incentive to actively cultivate relationships with patient capital providers. The finding that ESG performance and green total factor productivity positively moderate this effect further implies that financial patience and sustainability investments should be pursued simultaneously rather than sequentially. Based on the above conclusions, the following recommendations are proposed:

First, from the policy perspective, governments should not only expand the supply of Patient_Capital—for instance, through long-term credit and institutional investor participation—but also guide it toward strengthening ASCR. For enterprises facing severe financing constraints and pronounced bullwhip effects, policy efforts should prioritize investments in agricultural infrastructure, such as irrigation, logistics, and storage, along with risk-sharing mechanisms and insurance systems that stabilize production under external shocks. For chain-leader enterprises, regulators could promote green finance instruments and ESG-linked credit facilities, thereby channeling Patient_Capital into long-term, sustainability-oriented, and innovation-driven projects. Second, from the enterprise perspective, enterprises should proactively introduce Patient_Capital not only as a source of financial stability but also as a governance arrangement associated with stronger internal management efficiency, digital-intelligent transformation, and collaboration capabilities. By leveraging the long-term orientation of patient investors, enterprises can strengthen resource allocation efficiency, information processing capacity, and partnership networks, thereby reinforcing supply chain resilience in complex operating environments. Third, from the investor perspective, institutional investors and long-term creditors can move beyond passive financing by actively engaging in governance to support the sustainable development of agricultural enterprises. This involves directing Patient_Capital toward sectors that strengthen long-term resilience. By empowering enterprises to build sustainable development capabilities, investors can achieve consistent and stable returns.

Although this study makes important contributions, several limitations should be acknowledged. First, since the sample is limited to listed agricultural enterprises, caution should be exercised when generalizing the findings to small and medium-sized enterprises and non-listed enterprises; future research could broaden the sample coverage to include enterprises of different sizes and financing environments, thereby examining whether the associations documented in this paper are applicable to a wider range of agricultural operators. Second, certain variables are constructed through textual analysis of corporate disclosures, which may partly reflect disclosure strategies rather than actual practices; future research could combine textual data with objective operational indicators to enhance measurement validity. Third, despite multiple endogeneity corrections, the estimated associations may still be influenced by unobserved factors; future research could exploit exogenous policy shocks as quasi-natural experiments to strengthen causal identification. Finally, the generalizability of these findings beyond China's institutional context remains an open question; cross-country comparative studies would help examine whether the potential mechanisms discussed in this study hold across different regulatory and financial environments.

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