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Supply chain resilience, ESG performance, and corporate growth

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ABSTRACT

This paper uses a sample of Chinese A-share listed companies from 2010 to 2022 to examine the impact of supply chain resilience and ESG (Environmental, Social, and Governance) performance on corporate growth, while exploring the pathways through which these factors operate. The study finds that strengthening supply chain resilience and enhancing ESG performance both contribute to sustainable corporate growth. The mediation analysis indicates that supply chain resilience accelerates corporate growth by optimizing the production process through improved total factor productivity, whereas ESG performance promotes corporate growth by alleviating financing constraints and broadening funding sources. Furthermore, heterogeneity analysis reveals that the impact of supply chain resilience varies among companies of different sizes and production factors. Specifically, the positive effects of supply chain resilience are more pronounced in small and technology-intensive firms. Similarly, the role of ESG performance varies depending on whether the CEO holds dual roles and at different stages of the corporate life cycle. In companies without dual CEO roles and during the growth phase of a company, ESG performance has a more significant positive impact on corporate growth.

1. Introduction

Since the 19th National Congress of the Communist Party of China, sustainable development and green growth have become pivotal goals for enterprises. In response to global dynamics and ecological protection strategies, China has formulated a series of policies to encourage green transformation among businesses. In the context of climate change and trade tensions, only by efficiently coordinating various demands and maintaining supply chain stability can enterprises pursue long-term development. The outbreak of the COVID-19 pandemic previously pushed many companies to the brink of bankruptcy due to supply chain disruptions, significantly impacting the stable economic development of the nation. As a result, the 20th National Congress of the Communist Party of China emphasized the urgent need to accelerate the construction of resilient supply chain systems as a top priority for enterprise development in China. A stable supply chain can provide a responsive supply-demand system, enabling enterprises to swiftly expand their market reach and achieve capital accumulation. Simultaneously, environmental degradation has compelled enterprises to balance economic benefits with environmental protection. Under external pressures and the pursuit of differentiated development, companies are increasingly focusing on their ESG performance. ESG, initially introduced by the United Nations Environment Programme in 2004, has become a key element in the strategic planning of the Chinese government and enterprises, especially with the implementation of the "dual carbon" goals. The Guiding Principles for Green Development, jointly issued by the National Development and Reform

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Commission and the Ministry of Environmental Protection, have further strengthened the requirements for corporate environmental protection and social responsibility. These principles advocate for reducing resource and energy consumption in the production process, promoting circular economy practices, and adopting low-carbon technologies. Meanwhile, the advancement of the global climate agenda means that Chinese enterprises face new challenges in international cooperation and market access. Balancing compliance with international environmental standards while maintaining competitive advantages has become a crucial issue to address. In practice, many companies have enhanced their environmental monitoring and management capabilities by introducing advanced environmental management systems and sustainability assessment models. In conclusion, facing global environmental challenges and dual pressures from domestic and international markets, Chinese enterprises are gradually shifting from traditional profit-driven models to strategies emphasizing sustainable development. They aim to progress steadily in the complex and volatile international environment by enhancing supply chain resilience and ESG performance. Therefore, studying the impact of supply chain resilience and ESG performance on corporate growth is of paramount importance.

Previously, numerous scholars have explored factors influencing corporate growth. Nizam et al. (2021) conducted an in-depth analysis of the relationship between the level of financial inclusion and corporate growth in the five ASEAN countries, highlighting the non-linear effect of financial inclusion on corporate growth. Beyond a certain threshold, the impact of financial inclusion on corporate growth becomes significantly negative. Stagliano and Andrieu (2017), using a global database, investigated factors affecting the sensitivity of long-term profit growth, finding that this sensitivity increases with political influence, as stronger political connections enhance investment tendencies based on expected profitability. Additionally, they revealed that corporate growth moderates the relationship between shareholder incentives and corporate social responsibility; specifically, corporate growth negatively moderates the optimal relationship between incentives and corporate social responsibility. In the research on supply chain development, Jia and Li (2024) and Qi et al. (2024) pointed out that digitalization can effectively enhance supply chain resilience, with a more pronounced effect in state-owned enterprises. However, this positive effect may diminish as government subsidy amounts increase. H. Zhang, P. C. Wang et al. (2024) argued that excessively high litigation risk is detrimental to improving supply chain resilience. Regarding ESG, Li et al. (2022) and H. Zhang, H. Q. Zhang et al. (2024); Zhang et al. (2024) found that ESG practices can effectively reduce a company's litigation and default risks, thus benefiting long-term sustainable development. Their verification revealed that internal control plays a mediating role; specifically, ESG performance enhances the processes of internal control systems, reducing litigation risk. Lian and Weng (2024) and Gafni et al. (2024) studied the impact of ESG performance on corporate operations, confirming that ESG optimizes the quality of financial reporting and improves investment efficiency. They noted that improved ESG performance can reduce performance volatility, ensure stable revenue growth, and thereby enhance investment efficiency. The factors influencing corporate ESG performance have also been widely discussed. Government environmental subsidies (Zhang et al., 2023), Confucianism (Huang et al., 2024), and economic globalization (Hu et al., 2023) have been profoundly examined for their impact on ESG performance. Research has found that the discontinuation of government environmental subsidies hinders the development of corporate ESG, while elements of Confucianism and economic globalization can promote corporate ESG activities.

Although existing research has addressed the factors enhancing supply chain resilience, the benefits of ESG practices, and the drivers of corporate growth, studies on how these three elements synergistically interact remain scarce. Furthermore, the detailed mechanisms and pathways through which supply chain resilience and ESG performance promote corporate growth are still unclear. Therefore, conducting a more systematic and comprehensive study to fill this research gap and explore the direct and indirect links between supply chain resilience, ESG performance, and corporate growth is particularly important.

Through empirical analysis of supply chain resilience, ESG performance, and corporate growth, this study finds that as a company strengthens its supply chain resilience and improves its ESG performance, its growth becomes more robust. However, the positive effects of both factors exhibit uneven development. Specifically, the impact of supply chain resilience is more pronounced in small and technology-intensive enterprises, while the influence of ESG performance is more significant during the growth phase and in companies where the CEO does not hold dual roles. Additionally, this study explores the pathways through which supply chain resilience and ESG performance affect corporate growth. The results indicate that enhanced supply chain resilience can accelerate corporate growth by improving total factor productivity to exceed industry standards. In the meantime, ESG performance can promote corporate growth by alleviating financing constraints and securing more funding.

This paper delves into the mechanisms by which supply chain resilience and ESG performance impact corporate growth, revealing their effects across different types of enterprises and stages of development. This not only enriches theoretical research but also provides scientific decision-making support for policymakers and corporate managers. Additionally, the study systematically examines the roles and pathways of supply chain resilience and ESG performance in promoting corporate growth, offering important theoretical foundations and practical guidance for enterprises striving for sustainable development in a complex and ever-changing global environment.

2. Theoretical analysis and hypotheses

2.1. Supply chain resilience and corporate growth

Supply chain resilience refers to the ability of a supply chain to quickly recover and maintain normal operations in the face of external shocks and internal errors. A well-developed supply chain is crucial for corporate development. Enhancing supply chain resilience enables a company to better predict and manage potential risks and uncertainties. By implementing contingency plans, diversifying suppliers, and establishing backup supply chains, companies can effectively respond to market fluctuations and supply chain disruptions, reduce inventory holding costs and production delays, and ensure the continuity of production and services. The

reduction in production costs translates into higher profit margins for reinvestment, driving corporate growth. At the same time, supply chain resilience enhances information flow and collaboration between departments, improving resource allocation and decision-making efficiency. Strengthening supply chain resilience often involves investing in information technology, such as ERP systems and supply chain management software. Technological upgrades facilitate the optimization of human resources. Through training and development, companies can ensure that employees have the necessary skills and knowledge to support the flexible operation of the supply chain and provide real-time data, enabling the company to maintain redundancy in each link to prepare for unexpected needs. Finally, improving supply chain resilience strengthens the close relationship between suppliers and distributors, allowing upstream and downstream information sharing and risk-sharing, thereby enhancing trust and loyalty between supply partners and laying a solid foundation for long-term cooperation and stable development. Therefore, Hypothesis 1 is proposed:

Hypothesis 1. Strengthening supply chain resilience is conducive to corporate growth.

2.2. ESG performance and corporate growth

ESG performance is a concept that incorporates environmental, social, and governance considerations into investment decisions. Its core aim is to explore a sustainable development path that balances commercial value and social responsibility. According to corporate reputation theory, strong ESG performance enhances a company's credibility and mitigates losses from negative events. This insurance effect helps companies better withstand external adverse shocks and operational risks, thereby strengthening market trust and customer loyalty, leading to higher market share and profitability (Song et al., 2023). Moreover, since the ecological environment is a public resource with unclear property rights, issues related to it cannot be completely resolved through market mechanisms alone. Government intervention and regulation are necessary (Wang, 2024). In this context, companies implementing ESG strategies can better adapt to and respond to institutional pressures from the external environment, including laws, regulations, industry standards, and societal expectations, thereby gaining legitimacy and social recognition to foster corporate growth (Vu et al., 2024). Additionally, companies with good ESG performance often focus more on long-term value and sustainable development. This developmental mindset drives them to invest more in research and development. A proactive R&D brand image attracts scientists, engineers, and innovative talent, and strengthening the talent pool is a crucial resource for driving corporate innovation (Pineau et al., 2022). Specifically, investments in environmental protection can lead to new eco-friendly products and technologies, enhancing market competitiveness. A robust internal management system can improve governance efficiency and corporate transparency, making it easier for institutional investors to access information about corporate developments. Strong social responsibility performance means that companies can offer comprehensive benefits to employees, maintaining high employee retention and preventing development vacuums caused by the departure of key management and technical personnel. In summary, enhanced ESG performance can promote corporate growth by improving risk management, accelerating innovation, and increasing employee stability. Therefore, this paper proposes the following hypothesis:

Hypothesis 2. ESG performance helps promote corporate growth.

2.3. Supply chain resilience, total factor productivity, and corporate growth

Total factor productivity (TFP) is a comprehensive indicator for measuring the efficiency of resource allocation and innovation capacity of a company. The adaptability and resilience of a supply chain in the face of uncertainty and shocks have a significant impact on improving TFP. First, enhanced supply chain resilience helps companies, particularly those in manufacturing, to adjust production plans and logistics arrangements in response to market demand, allowing for more efficient resource utilization and the avoidance of waste, thereby improving resource utilization efficiency per unit of output. Additionally, supply chain resilience can enhance a company's learning capability and knowledge accumulation through organizational learning. Specifically, when addressing supply chain disruptions, companies often need to develop new technologies and management methods, making training on supply chain process optimization essential. During this process, companies accumulate rich experiential knowledge, which lays the foundation for better future challenge management, improving decision-making quality and efficiency, and indirectly increasing TFP. At the same time, studies have found that improvements in TFP often facilitate rapid corporate growth. Initially, increased TFP means that companies can produce more products at lower costs, allowing them to reduce product prices without sacrificing profits and attract a broader consumer base. Furthermore, improved production efficiency enables companies to dedicate more time to new product development and upgrading existing products to meet diverse consumer needs, accelerating entry into new market segments and expanding market coverage. An expanded market share not only increases corporate profits but also enhances brand value, thereby boosting brand appeal. In conclusion, strengthening supply chain resilience helps companies improve TFP, and increased TFP can, in turn, promote revenue growth by expanding market share and enhancing brand attractiveness. Based on the above analysis, this paper proposes the following hypothesis:

Hypothesis 3. Supply chain resilience promotes corporate growth by enhancing total factor productivity.

2.4. ESG performance, financing constraints, and corporate growth

Information asymmetry theory suggests that information discrepancies between external investors and internal management can lead to financing constraints. In financial markets, incomplete information makes it difficult for investors to accurately assess a

company's true value and potential risks. Shrestha and Naysary (2023) and DasGupta (2022) note that strong ESG performance can alleviate this issue by improving corporate transparency and the quality of information disclosure, allowing investors to more accurately evaluate corporate risks and potential. This, in turn, reduces financing costs and provides ample funding support for corporate growth. Additionally, agency theory emphasizes that conflicts often arise between shareholders and management due to misaligned goals. Good ESG practices can mitigate these agency problems by strengthening internal control and supervision mechanisms, reducing management's moral hazard, and thus enhancing investor confidence and facilitating financing. Finally, proactive ESG strategies can attract more social capital and resources, alleviating financing constraints and further promoting corporate growth. In summary, strong ESG performance provides momentum for corporate growth by easing financing constraints. Based on this, the following hypothesis is proposed:

Hypothesis 4. ESG performance promotes corporate growth by alleviating financing constraints.

3. Research design

3.1. Data sources

This study selects Chinese A-share listed companies from 2010 to 2022 as the research sample. To mitigate the impact of extreme values on the research results, the data were processed as follows: (1) Excluding financial industry companies, ST and PT category companies, and delisted companies; (2) Removing observations with missing financial data and extreme values in the sample data; (3) Excluding companies that were insolvent during the study period; (4) Winsorizing the main variables at the 1% and 99% percentiles. This process resulted in a final sample of 18,983 observations. The data required for calculating supply chain resilience and corporate financial information were obtained from the CSMAR database, while ESG composite scores and ratings were sourced from the ESG responsibility reports disclosed by China Securities Index Co., Ltd.

3.2. Model specification and variable definition

The previous section theoretically analyzed the impact of supply chain resilience and ESG performance on corporate growth. To empirically test Hypotheses 1 and 2, this paper establishes the following two-way fixed-effects models for analysis.

$$Growth_{it} = \alpha_0 + \beta_1 SCR_{it} + \beta_2 Control_{it} + Year_t + Firm_i + \varepsilon_{it} \quad (1)$$

$$Growth_{it} = \alpha_0 + \beta_1 ESG_{it} + \beta_2 Control_{it} + Year_t + Firm_i + \varepsilon_{it} \quad (2)$$

Equation (1) is the regression model for the impact of supply chain resilience on corporate growth, where $Growth_{it}$ represents corporate growth, SCR_{it} denotes the supply chain resilience of firm i in year t, and $Control_{it}$ indicates the control variables. $Year_t$ and $Firm_i$ represent time-fixed effects and firm-fixed effects, respectively, and ε_{it} is the random error term in the estimation model. Equation (2) is the econometric model for the impact of ESG performance on corporate growth, where ESG_{it} represents the ESG performance of firm i in year t. The meanings of the other variable symbols are consistent with those in Equation (1).

1 Dependent Variable

Corporate Growth (Growth): The existing literature offers various methods to measure corporate growth, most commonly expressed as the asset growth rate. Esplin (2022) uses the total asset growth rate to measure corporate growth, while Hasan and Habib (2017) employ the net profit growth rate. To more accurately capture the trend of sustainable corporate growth, this paper follows the approach of Al Shaer et al. (2023) by using the revenue growth rate to represent corporate growth. The difference in the logarithm of revenue and the sustainable growth rate are used as alternative variables for subsequent robustness tests.

2 Independent Variable

Supply Chain Resilience (SCR): Supply chain resilience refers to the ability to return to its original state by taking restorative or

Table 1
Supply chain resilience indicator system.

Goal Level	Primary Indicator	Secondary Indicator	Description
Supply Chain Resilience	Supply Chain Resistance	Capital Occupancy	Measured using the natural logarithm of the ratio of accounts receivable to revenue. A lower value indicates higher stability in supply chain relationships.
		Customer Stability	Proportion of stable customers among the top five customers over consecutive years. A higher value suggests more robust supply chain relationships.
	Supply Chain Recovery Capability	Supply and Demand Fluctuation	Measured using the "bullwhip effect" as referenced by Qi et al. (2024). A lower value indicates stronger supply chain recovery capability.
		Economic Performance Variation	Assessed using the residuals from Model (3). Larger residuals imply stronger supply chain recovery capability.

adaptive actions in response to external shocks. It measures how quickly and effectively a supply chain can react and recover when faced with unexpected situations. Supply chain resilience can be assessed from two aspects: supply chain stability and supply chain recovery capability (M. Liu et al., 2023). This paper calculates a comprehensive score for supply chain resilience using the entropy method, as referenced in existing research. A higher score indicates stronger supply chain resilience and a greater ability to withstand risks. Table 1 presents the indicator system for calculating supply chain resilience.

In Table 1, the economic performance model is specified as follows:

$$EP_{it} = \alpha + \beta_1 Size_{it} + \beta_2 Lev_{it} + \beta_3 Growth_{it} + \beta_4 Age_{it} + \beta_5 Board_{it} + Firm_{it} + Year_{it} + \varepsilon_{it} \quad (3)$$

where EP_{it} represents the change in economic performance of firm i in year t, measured by the ratio of earnings before interest and taxes (EBIT) to the number of employees. The model includes firm size (Size), financial leverage (Lev), revenue growth rate (Growth), firm age (Age), and board size (Board) as control variables.

ESG Performance (ESG): The ESG evaluation data from China Securities Index Co., Ltd. are characterized by their relevance to the Chinese market, broad coverage, and timeliness. Following the methodologies of Schiemann and Tietmeyer (2022) and Junior et al. (2024), this study uses the ESG composite scores published by China Securities Index Co., Ltd. to measure corporate ESG performance. Additionally, China Securities evaluates companies across 14 dimensions to provide ratings. In line with the study by Duncombe et al. (2023), these ratings are assigned values from 1 to 9, corresponding to ratings from CCC to AAA, from low to high, for robustness testing.

3 Mediating Variables

Total Factor Productivity (TFP): There are various methods for calculating a company's total factor productivity. This study follows the approach of Chen (2024) and S. M. Liu et al. (2023) by using the Generalized Method of Moments (GMM) to calculate TFP at the micro-level. Compared to other methods, the GMM algorithm effectively avoids endogeneity issues. Furthermore, the GMM algorithm provides consistent estimates, ensuring the stability and reliability of the results even with a large sample size.

Financing Constraints (KZ): This study uses the KZ index to measure the degree of a company's financing constraints. A higher KZ index indicates more severe financing constraints (Guariglia & Liu, 2014).

4 Control Variables

According to existing research, the factors influencing corporate growth are diverse. Following the studies by Feng et al. (2024) and Wang (2024), this paper selects the following control variables: leverage (Lev), board size (Board), proportion of independent directors (Indep), shareholding ratio of the top ten shareholders (Top10), capital concentration (Capital), proportion of intangible assets (IAR), Tobin's Q (tobinQ), and firm age (Age). The variables involved in the study and their specific calculation methods are detailed in Table 2.

3.3. Descriptive statistics

This study collected and analyzed 18,983 data samples, with descriptive statistics presented in Table 3. The average supply chain

Table 2
Variable symbols and calculation methods.

Type	Variable	Symbol	Definition
Dependent Variable	Corporate Growth	Growth1	Revenue growth rate: (Current year revenue - Previous year revenue)/Previous year revenue
		Growth2	Logarithmic difference in revenue: ln(Current year revenue) - ln(Previous year revenue)
		Growth3	Sustainable growth rate: Return on equity × Retention rate/(1 - Return on equity × Retention rate)
Independent Variable	Supply Chain Resilience	SCR	Constructed using indicators of supply chain stability and recovery, calculated using the entropy method
	ESG	ESG1	Composite ESG score from China Securities Index Co., Ltd.
		ESG2	ESG rating from China Securities Index Co., Ltd.
Mediating Variable	Total Factor Productivity	TFP	Total factor productivity calculated using the GMM method
	Financing Constraints	KZ	KZ index of financing constraints
Control Variable	Leverage	Lev	Total debt/Total assets
	Board Size	Board	Number of board members
	Proportion of Independent Directors	Indep	Number of independent directors/Total number of board members
	Top Ten Shareholders' Shareholding Ratio	Top10	Shareholding ratio of the top 10 shareholders/Total shares
	Capital Intensity	Capital	Total assets/Net profit
	Proportion of Intangible Assets	IAR	Net intangible assets/Total assets
	Tobin's Q	tobinQ	Market value/Total assets
	Firm Age	Age	ln(Observation year - Year of establishment)

resilience (SCR) score is 0.6241, with a standard deviation of 0.2984, and minimum and maximum values of 0.0167 and 0.9967, respectively. This indicates that while most companies can effectively maintain supply chain stability and adaptability, there is still potential risk in the development of supply chain resilience for some companies. Corporate growth shows significant volatility, particularly with the lowest value of Growth2 reaching −4.2003. The average values for ESG1 and ESG2 are 73.0947 and 4.1223, respectively, indicating that most companies already exhibit good ESG performance.

4. Empirical analysis

4.1. Baseline regression

Table 4 presents the baseline regression results. Columns (1) and (2) explore the correlation between supply chain resilience and corporate growth. Column (1) accounts only for fixed individual differences and time effects, while column (2) adds financial and governance structure variables that influence corporate growth. The results indicate a strong positive correlation between corporate growth and supply chain resilience, suggesting that as supply chain resilience strengthens, corporate growth improves. Columns (3) and (4) test Hypothesis 2. Column (3) fixes the time and individual effects, while column (4) adds control variables on top of the fixed effects. The regression coefficients are 0.0018 and 0.0015, respectively, both of which are significantly positive at the 1% confidence level. This implies that better ESG performance can accelerate corporate revenue growth.

4.2. Robustness checks

4.2.1. Supply chain resilience

(1) Sample Size Adjustment

Considering the impact of the 2015 Chinese stock market crash and the 2021 COVID-19 pandemic on supply chain development, this study excludes data from 2015 to 2021 for regression analysis, following the approach of Stagliano and Andrieu (2017) and S. J. Zhang et al. (2024). As shown in Table 5, after adjusting the sample size, the positive effect of supply chain resilience on corporate growth remains robust, enhancing the accuracy and credibility of the research findings.

(2) Variable Substitution

The existing literature provides various standards for measuring corporate growth. To enhance the accuracy of previous results, this study follows the approach of Al Shaer et al. (2023) by using the difference between the logarithm of current-year revenue and the logarithm of previous-year revenue as an alternative measure of corporate growth. The regression results, shown in Table 5, indicate that after substituting the variable, the positive impact of supply chain resilience on corporate growth remains significant, confirming the robustness of the previous findings.

(3) Adding Fixed Effects

The emphasis on supply chain management varies significantly across industries due to factors such as industry characteristics, product or service complexity, market demand volatility, and globalization. For instance, in industries like manufacturing, fast-moving consumer goods, and pharmaceuticals and medical devices, companies pay more attention to supply chain stability and risk resistance

Table 3
Summary statistics.

VarName	Obs	Mean	SD	Min	Max
Growth1	18983	0.1260	0.2528	−0.5109	1.0726
Growth2	18983	0.0891	0.2508	−4.2003	0.7288
Growth3	18983	0.0428	0.1363	−1.7555	7.0808
SCR	18983	0.6241	0.2984	0.0167	0.9967
ESG1	18983	73.0944	5.1738	41.1900	90.9300
ESG2	18983	4.1222	1.0521	1.0000	8.0000
TFP	18983	5.5895	0.8285	2.6572	10.6122
KZ	18983	1.3339	2.0867	−10.0158	11.5175
Lev	18983	0.4105	0.2005	0.0071	0.9976
Board	18983	8.4343	1.6256	3.0000	18.0000
Indep	18983	0.3766	0.0558	0.1667	0.8000
Top10	18983	0.5733	0.1484	0.1037	0.9657
Capital	18983	2.4414	2.9448	0.0881	155.8566
IAR	18983	0.0451	0.0485	0.0000	0.6773
tobinQ	18983	2.0942	1.8896	0.6812	122.1895
Age	18983	2.9012	0.3405	1.0986	4.0254

Table 4
Baseline regression results.

	(1)	(2)	(3)	(4)
	Growth1	Growth1	Growth1	Growth1
SCR	0.0201***	0.0210***		
	(2.6457)	(2.8272)		
ESG1			0.0018***	0.0015***
			(3.3537)	(2.8711)
Lev		0.1246***		0.1305***
		(5.5626)		(5.8090)
Board		0.0014		0.0014
		(0.5070)		(0.4780)
Indep		0.0500		0.0428
		(0.7817)		(0.6701)
Top10		0.3370***		0.3318***
		(11.3669)		(11.2216)
Capital		−0.0215***		−0.0214***
		(-5.1063)		(-5.0941)
IAR		−0.4286***		−0.4245***
		(-5.4731)		(-5.4357)
tobinQ		0.0105***		0.0106***
		(4.7076)		(4.7298)
Age		−0.0553		−0.0535
		(-1.5795)		(-1.5248)
_cons	0.1135***	0.0478	−0.0020	−0.0481
	(22.7137)	(0.4087)	(-0.0516)	(-0.3916)
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
N	18983	18983	18983	18983
adj. R^2	0.155	0.193	0.155	0.194

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

Table 5
Robustness tests for supply chain resilience and corporate Growth.

	Change the sample size	Substitution variable	Increasing fixed effect
	Growth1	Growth2	Growth1
SCR	0.0167**	0.0209***	0.0206***
	(2.0311)	(2.7353)	(2.7673)
_cons	−0.0099	0.0504	0.0425
	(-0.0780)	(0.4638)	(0.3653)
Control	YES	YES	YES
Year FE	YES	YES	YES
Firm FE	YES	YES	YES
Industry FE	NO	NO	YES
N	15828	18983	18983
adj. R^2	0.188	0.233	0.196

due to competition and delivery timeliness. In contrast, in industries like construction and culture, where projects are specific or development relies more on creativity, companies may not prioritize supply chain resilience in decision-making. Considering the impact of industry factors, this study includes industry fixed effects in the analysis. As shown in Table 5, the positive impact of supply chain resilience on corporate growth remains significant at the 1% level, further confirming the robustness of the results.

4.2.2. ESG performance

(1) Instrumental Variable Method

There may be a bidirectional causal relationship between ESG performance and corporate growth. Specifically, the development of ESG can promote rapid corporate growth, and the funds accumulated from corporate growth can further support ESG practices. Additionally, the presence of omitted variables can lead to endogeneity. To minimize the bias caused by endogeneity in this study, we use the approach of Uyar et al. (2022), employing the number of holdings by general ESG funds as an instrumental variable for ESG performance in endogeneity testing. Corporate ESG performance is highly correlated with the number of holdings by general ESG funds, as these funds can influence corporate decision-making through enhanced capital support and market pressure, encouraging positive changes in ESG performance. However, the number of holdings by general ESG funds does not directly impact corporate

growth, satisfying the relevance and exogeneity principles of instrumental variables. Table 6 presents the two-stage regression results. The results indicate that the instrumental variable passes the under-identification test (Kleibergen-Paap rk LM p-value <0.1) and the weak instrument test (Kleibergen-Paap Wald rk F-value exceeds the Stock-Yogo 10% critical value of 16.38), confirming the validity of the instrumental variable. Furthermore, the first-stage regression verified the impact of the instrumental variable on the independent variable, consistent with previous findings, showing a coefficient of 0.0378 for IV and ESG1, which is significantly positive at the 1% level. In the second stage, the regression coefficient for Growth1 and ESG1 is 0.0940. This result indicates that after controlling for endogeneity, the positive impact of ESG performance on corporate growth remains significant, ensuring the credibility of the research conclusions.

(2) Variable Substitution

Following the study by Shanaev and Ghimire (2022), ESG ratings are used as an alternative variable to the composite ESG score for regression analysis. Additionally, the sustainable growth rate is used as a substitute for the revenue growth rate to measure corporate growth. The results, as shown in Table 7, columns (1) and (2), indicate that changes in the measurement standards for the independent and dependent variables do not affect the outcome that ESG practices promote corporate growth, thereby enhancing the credibility of the research findings.

4.3. Mechanism analysis

4.3.1. Total factor productivity

Total factor productivity (TFP) refers to output growth achieved through technological progress, management improvement, and efficiency enhancement without increasing input factors (Chen, 2024; Wang et al., 2024). Enhancing supply chain resilience can effectively increase TFP by optimizing resource allocation, improving information flow, strengthening collaboration, promoting technological and managerial innovation, and enhancing market competitiveness, and then promote the growth of business income. To test Hypothesis 3, this paper establishes the following mediation effect model:

$$Growth_{it} = \alpha_0 + \beta_1 SCR_{it} + \beta_2 TFP_{it} + \beta_3 Control_{it} + Year_t + Firm_i + \varepsilon_{it} \quad (4)$$

In the above equation, TFP_{it} represents the total factor productivity of firm i at year t, calculated using the GMM algorithm. The other variables are consistent with those in the baseline regression.

The mechanism by which total factor productivity mediates the relationship between supply chain resilience and corporate growth is detailed in Table 8. Column (1) verifies the correlation between supply chain resilience and corporate growth, while column (2) includes both supply chain resilience and total factor productivity in the regression to explore the mediation pathway of total factor productivity. The results indicate that supply chain resilience promotes corporate growth by enhancing total factor productivity. Specifically, optimizing supply chain resilience improves a company's ability to respond to external shocks, enabling it to maintain efficient operations even under resource constraints. Additionally, companies adopting advanced digital technologies and management tools, such as big data analytics, the Internet of Things, and blockchain, achieve real-time monitoring and optimal configuration of the entire supply chain process. This technological optimization not only enhances resource utilization efficiency and reduces waste and redundancy but also improves overall production efficiency. Finally, supply chain resilience improves information flow and knowledge sharing. A resilient supply chain enables real-time information sharing and rapid response across all links, accelerating the decision-making process through efficient information transmission and knowledge sharing. This allows companies to quickly adapt to market changes and demand fluctuations, thereby promoting corporate growth.

4.3.2. Financing constraints

Financing constraints refer to the difficulties companies face in obtaining external funds, typically caused by information asymmetry, insufficient collateral, or credit risk (Chen et al., 2022; Du & Geng, 2024). These constraints primarily affect the stability of

Table 6
Endogeneity test.

	First Stage	Second Stage
	ESG1	Growth1
IV	0.0378***	
	(7.5241)	
ESG1		0.0940***
		(6.2946)
Control	YES	YES
Year FE	YES	YES
Firm FE	YES	YES
N	18983	18983
Kleibergen-Paap rk LM statistic	67.673*** (0.0000)	
Kleibergen-Paap Wald rk F statistic	56.611*** (16.38)	
Endogeneity Test p-value	0.0000	

Table 7
Robustness tests for ESG and corporate Growth.

	(1)	(2)
	Growth1	Growth3
ESG2	0.0053**	
	(2.1768)	
ESG1		0.0007**
		(2.0859)
_cons	0.0372	−0.2205***
	(0.3174)	(-3.2204)
Control	YES	YES
Year FE	YES	YES
Firm FE	YES	YES
N	18983	18983
adj. R^2	0.193	0.209

Table 8
Mediation effect of total factor productivity.

	(1)	(2)
	Growth1	Growth1
SCR	0.0210***	0.0122*
	(2.8272)	(1.7060)
TFP		0.1795***
		(22.0364)
_cons	0.0478	−0.7564***
	(0.4087)	(-6.2126)
Control	YES	YES
Year FE	YES	YES
Firm FE	YES	YES
N	18983	18983
adj. R^2	0.193	0.242

operations and long-term development by reducing investment capacity and increasing financial pressure. However, ESG practices can mitigate the negative impacts of financing constraints by reducing information asymmetry. Good ESG performance enhances corporate reputation and transparency, boosts investor confidence, and lowers financing costs, making it easier for companies to secure funding for innovation and research, ultimately promoting sustainable growth. To test Hypothesis 4, this paper establishes the following mediation effect model:

$$Growth_{it} = \alpha_0 + \beta_1 ESG_{it} + \beta_2 KZ_{it} + \beta_3 Control_{it} + Year_t + Firm_i + \varepsilon_{it} \quad (5)$$

In the equation above, KZ_{it} represents financing constraints, while the other variables remain consistent with those in the baseline regression.

The mediation effect results are shown in Table 9. Column (2) illustrates the pathway of financing constraints, indicating that ESG practices can alleviate external financing constraints, enabling firms to secure more investment for profit generation and corporate growth. Specifically, investors and financial institutions often perceive companies with strong ESG performance as having the potential

Table 9
Mediation effect of financing constraints.

	(1)	(2)
	Growth1	Growth1
ESG1	0.0015***	0.0011**
	(2.8711)	(2.1569)
KZ		−0.0323***
		(-16.7862)
_cons	−0.0481	−0.0574
	(-0.3916)	(-0.4719)
Control	YES	YES
Year FE	YES	YES
Firm FE	YES	YES
N	18983	18983
adj. R^2	0.194	0.212

for long-term sustainable development. As a result, these companies can access lower financing costs and broader financing channels. Additionally, the influx of investors and funds enhances the firm's financial flexibility and ability to respond to market fluctuations and unexpected events, allowing for more flexible resource allocation and strategic investment, thereby promoting rapid corporate growth.

5. Further analysis

5.1. Supply chain resilience

5.1.1. Firm Size

The effect of supply chain resilience may vary depending on firm size. Therefore, this study divides firms into large and small firms based on the median total assets calculated annually and conducts regression analyses for each group. As shown in Table 10, the promotion effect of supply chain resilience on corporate growth is significant at the 1% level for small firms, while it is not significant for large firms. The reason for this difference may be that small firms often have limited resources, and supply chain disruptions have a greater impact on their operations. For small firms, any disruption in the supply chain can lead to production halts, order delays, and customer loss, severely affecting revenue. Thus, enhancing supply chain resilience can significantly reduce these risks, ensuring business continuity and stability, thereby directly promoting revenue growth. In contrast, large firms typically have a diversified supplier network and stronger financial capabilities, enabling them to more effectively mitigate the impact of supply chain disruptions. Consequently, the marginal impact of improved supply chain resilience on their revenue is relatively small. Additionally, during the financing process, investors and financial institutions pay more attention to the supply chain stability and risk management capabilities of small firms. By enhancing supply chain resilience, small firms can improve their financial stability and credit ratings, making it easier to obtain financing support and resource investment. For large firms, due to their established market reputation and capital accumulation, the impact of supply chain resilience improvement on their financing capability is relatively minor.

5.1.2. Production factors

Differences in production factors result in varied strategic priorities and degrees of supply chain dependency for companies. Based on existing research, this study classifies firms into technology-intensive, labor-intensive, and capital-intensive categories according to industry codes. As shown in the regression results in Table 10, the positive effect of supply chain resilience is significant only in technology-intensive firms. This disparity can be attributed to the fact that products of technology-intensive firms typically have high added value and rely heavily on key components and materials in the production process. These components often come from suppliers around the globe, and any supply chain disruption can directly impact production schedules and product delivery, leading to revenue loss. Enhancing supply chain resilience can significantly reduce the risk of disruptions, ensuring the timely supply of critical components, maintaining production continuity and product quality, and directly promoting corporate growth. In contrast, capital-intensive firms, due to their substantial investments in production equipment and facilities, have a lower sensitivity to supply chain disruptions and can mitigate these impacts through inventory management and buffer stocks during production. Labor-intensive firms rely more on human resources, with relatively lower demand for materials and equipment in their supply chains, so improvements in supply chain resilience have a limited impact on corporate growth.

Additionally, the competitive advantage of technology-intensive firms lies in their ability to quickly respond to market demands and continually innovate. Enhancing supply chain resilience can accelerate the development and launch of new products, shorten product life cycles, increase market share, and promote corporate growth. In comparison, capital-intensive firms mainly rely on large-scale production and heavy asset investment, with innovation speed and market responsiveness constrained by the investment cycle and scale. Labor-intensive firms primarily depend on labor cost advantages, with lower innovation capabilities and market responsiveness, thus the marginal contribution of improved supply chain resilience to their growth is limited.

5.2. ESG performance

5.2.1. Dual role of CEO and chairman

The dual role of a company's CEO and chairman is closely related to the independence and transparency of governance structures, conflicts of interest, and accountability mechanisms, all of which significantly impact a company's ESG practices. Therefore, differences in dual role situations may influence the effectiveness of ESG initiatives. This study conducts a differential analysis based on this factor. The regression results, shown in Table 11, indicate that ESG practices have a more pronounced positive effect on corporate growth in companies where the CEO and chairman roles are separate. This difference may arise because, in non-dual-role companies, the chairman and CEO positions are held by different individuals, leading to a decentralized governance structure that typically offers greater transparency and independence. An independent board of directors can more effectively oversee and evaluate the formulation and execution of corporate development strategies, ensuring the optimal allocation of resources and effective risk management. In contrast, in companies where the CEO and chairman roles are combined, decision-making may suffer from power concentration and lack of oversight, which can hinder the full potential of ESG practices.

5.2.2. Life cycle

A company's growth opportunities, capital investments, technological innovation, risk control, and brand building needs vary across different stages of development. Therefore, the impact of ESG performance on corporate growth is influenced by the development stage of the company. Based on existing research, this study classifies companies into growth, maturity, and decline stages

Table 10
Heterogeneity analysis.

Growth1	Enterprise Scale		Production Factors		
	Large	Small	Technology-intensive	Asset-intensive	Labor-intensive
SCR	0.0139	0.0263**	0.0253**	0.0131	0.0086
	(1.2833)	(2.4219)	(2.4134)	(0.7327)	(0.6190)
_cons	0.3179*	−0.0126	0.3756*	0.5153	−0.2189
	(1.6528)	(-0.0648)	(1.8438)	(1.5153)	(-1.0434)
Control	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
N	9490	9493	8969	3095	6919
adj. R^2	0.237	0.194	0.208	0.225	0.213

Table 11
Heterogeneity analysis.

Growth1	Duality		Lifecycle		
	Serve Concurrently	Not Serve Concurrently	Maturity Stage	Growth Stage	Decline Stage
ESG1	0.0014**	0.0007	0.0003	0.0030**	0.0012
	(2.2773)	(0.6601)	(0.3616)	(2.3398)	(1.1033)
_cons	−0.0010	−0.2522	−0.5484***	−0.3936	−0.6929
	(-0.0064)	(-0.8897)	(-3.0715)	(-1.3850)	(-1.4887)
Control	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES
N	13159	5824	9826	4747	4410
adj. R^2	0.195	0.231	0.217	0.320	0.229

using differences in cash flow to conduct a differential analysis. The results, shown in Table 11, indicate that the positive effect of ESG performance on revenue growth is more significant during the growth stage. This is likely because companies in the growth stage are undergoing rapid expansion and market penetration. By implementing effective ESG activities, they can attract more investors, customers, and partners, thereby increasing market share. In contrast, during the maturity and decline stages, companies experience relatively stable market positions and fewer growth opportunities. Additionally, companies in the growth stage have a more urgent need for capital and resources, and strong ESG performance can attract more green financial support, promoting business expansion and growth. In comparison, mature companies generally have stable capital structures and lower financing needs, while companies in the decline stage face limited growth potential and decreased financing attractiveness, making the impact of improved ESG performance on growth less significant.

6. Conclusion and recommendations

This study examines the impact of supply chain resilience and ESG performance on corporate growth using all A-share listed companies as the research sample. The results indicate that as supply chain resilience strengthens and corporate ESG practices advance, corporate growth improves. The findings remain robust even after substituting variables, adding fixed effects, and excluding extreme years. Mediation analysis reveals that supply chain resilience promotes revenue growth by enhancing total factor productivity, thereby fostering corporate growth. ESG performance aids corporate growth by alleviating financing constraints. Heterogeneity analysis shows that supply chain resilience has a more significant effect on corporate growth in small and technology-intensive firms; in firms where the CEO also serves as chairman, the impact of ESG on corporate growth is evident, indicating that the effects of supply chain resilience and ESG performance vary across different types of companies. Moreover, ESG performance is particularly impactful during a company's growth stage. Therefore, based on these findings, the following targeted recommendations are proposed: First, companies should enhance supply chain resilience by adopting diversified supplier networks, advanced supply chain management technologies, and flexible inventory management systems to improve transparency, visibility, and responsiveness, ensuring a stable supply of critical materials and components and mitigating risks. Second, companies should advance ESG practices, including strengthening environmental management by reducing carbon emissions and pollution, promoting green production, and obtaining certifications such as ISO 14001. They should also enhance social responsibility and employee welfare and optimize corporate governance by ensuring board independence and transparency, establishing dedicated ESG committees, and implementing comprehensive ESG strategies with regular ESG disclosures. Additionally, companies should consider firm size and industry characteristics. Small firms should prioritize enhancing supply chain resilience by building close relationships with upstream and downstream partners to share information and resources, improving overall risk resistance. Technology-intensive firms should increase R&D investment to leverage technological innovation, ensuring the stable supply of key technologies and high-value-added products.

Regarding corporate life cycle management, growth-stage companies should invest more in ESG, implementing comprehensive strategies to enhance reputation and brand value, attracting more investment and quality customers. Furthermore, companies should establish scientific performance evaluation mechanisms to regularly assess the implementation of ESG and supply chain management, continuously optimizing strategies based on evaluation outcomes to achieve optimal growth at different development stages. In conclusion, companies should adopt diversified strategies in enhancing supply chain resilience and advancing ESG practices, considering differences in firm size, industry characteristics, and life cycle stages. Targeted measures should be formulated to achieve sustainable development and enhance overall growth and competitiveness.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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