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с доклади от кръгла маса

ИНДУСТРИАЛНИЯТ БИЗНЕС И ПРЕДПРИЕМАЧЕСТВОТО В УСЛОВИЯТА НА ГЛОБАЛНИ ТРАНСФОРМАЦИИ

16 октомври 2026 г.



СТОПАНСКА АКАДЕМИЯ „Д. А. ЦЕНОВ“ – СВИЩОВ

Сборник с доклади от кръгла маса:

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Докторант Синюе Ду[1]

Резюме: *Докладът изследва дали зелените технологични иновации повишават стойността на фирмите в китайския индустриален сектор и дали финансовите ограничения отслабват тази връзка. Анализът използва годишни панелни данни за китайски A-share листвани компании за периода 2015-2024 г. Фирмената стойност се измерва чрез Tobin's Q, зелената иновация - чрез закъснен брой зелени патенти, а финансовите ограничения - чрез абсолютната стойност на SA индекса. Резултатите показват положителна връзка между зелените патенти и Tobin's Q, но отрицателно и значимо взаимодействие с финансовите ограничения. Следователно пазарната стойност на зелените иновации намалява, когато фирмите имат по-слаб финансов капацитет за комерсиализация и внедряване. Изводите подчертават значението на финансирането за превръщането на зелените технологии в устойчива фирмена стойност.*

Ключови думи: *зелени технологични иновации; стойност на фирмата; финансови ограничения; Tobin's Q; китайски индустриален сектор.*

JEL: G32; O32; Q55; Q56

GREEN TECHNOLOGICAL INNOVATION AND FIRM VALUE IN CHINA'S INDUSTRIAL SECTOR: THE MODERATING ROLE OF FINANCING CONSTRAINTS

Xinyue Du, PhD Student

Abstract: *This paper examines whether green technological innovation contributes to firm value in China's industrial sector and whether financing constraints weaken this relationship. Using annual panel data from the WIND database for Chinese A-share listed firms from 2015 to 2024, the study focuses on industrial enterprises and employs fixed-effects models with firm and year effects. Firm value is measured by Tobin's Q, green technological innovation is measured by lagged green patent output, and financing constraints are measured by the absolute value of the SA index. The empirical results show that lagged green patent output is positively associated with Tobin's Q. This result suggests that the market treats green innovation as a value-relevant intangible asset. However, the interaction between green patent output and financing constraints is negative and statistically significant. The marginal-effect analysis further shows that the positive valuation effect of green innovation declines as financing constraints increase. The findings suggest that green patents create market value only when firms have sufficient*

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financial capacity to commercialize and deploy them. This paper contributes to research on green innovation, firm value, and innovation finance by identifying financing constraints as an important boundary condition for the valuation of green technological innovation.

Keywords: *green technological innovation; firm value; financing constraints; Tobin's Q; China's industrial sector.*

JEL: G32; O32; Q55; Q56

1. Introduction

Industrial enterprises are facing increasing pressure to improve productivity while reducing environmental costs. Environmental upgrading is no longer only a regulatory issue; it has become part of firms' long-term competitiveness, technological renewal, and capital-market evaluation. In this context, green technological innovation is especially important because it links environmental improvement with the creation of firm-specific knowledge. Following the classic view that innovation reshapes competitive advantage (Schumpeter, 1934), green innovation can be understood as a strategic response to environmental transition and industrial upgrading.

For industrial firms, green technological innovation may influence firm value through several channels. Green patents can signal cleaner production capability, environmental knowledge, and readiness for future regulation. They may also help firms improve resource efficiency, reduce compliance risk, and develop products or processes that match changing market demand. The natural-resource-based view argues that environmental capabilities can become sources of competitive advantage when they are embedded in firm routines and strategic assets (Hart, 1995). Similarly, the Porter hypothesis suggests that environmental pressure can stimulate innovation and improve competitiveness under appropriate conditions (Porter & van der Linde, 1995).

The market valuation literature provides another foundation for this study. R&D and patent indicators can contain useful information about firms' intangible assets and future growth opportunities (Griliches, 1981). Patent-based knowledge indicators are also associated with market value because investors may treat innovation outputs as signals of technological capability and expected cash flows (Hall et al., 2005). Applied to green technological innovation, this logic suggests that green patent output may be positively reflected in Tobin's Q if investors believe that environmental innovation can generate future benefits.

However, the value of green innovation is unlikely to be realized automatically. Green technologies often require continuous investment, specialized equipment, organizational learning, and commercialization capacity. These requirements make financing conditions important. Innovation projects are typically uncertain, intangible, and difficult for external investors to evaluate, which can increase the cost of financing (Hall & Lerner, 2010). Access to internal

cash flow and external finance is therefore important for sustaining innovation and growth (Brown et al., 2009). When a firm faces stronger financing constraints, the market may question whether green patents can be transformed into operational efficiency, market reputation, or future profitability.

This paper examines whether green technological innovation is associated with firm value in China's industrial sector and whether financing constraints weaken this relationship. The analysis uses panel data from the WIND database for Chinese A-share listed firms from 2015 to 2024, with the main regression sample covering industrial enterprises from 2016 to 2024 after lagging green patent output. Firm value is measured by Tobin's Q, green technological innovation is measured by lagged green patent output, and financing constraints are measured by the absolute value of the SA index proposed by Hadlock and Pierce (2010). The empirical models include firm and year fixed effects and cluster standard errors at the firm level.

The study contributes to the literature in three ways. First, it provides firm-level evidence on the value relevance of green technological innovation in China's industrial sector. Second, it introduces financing constraints as a boundary condition that shapes whether green innovation is recognized by the market. Third, it connects the green innovation literature with the financing-of-innovation literature by showing that environmental knowledge assets require financial capacity before they can be fully valued. The findings show that lagged green patent output is positively associated with firm value, while financing constraints weaken this positive relationship.

2. Literature Review and Hypothesis Development

Technological innovation has long been regarded as a central source of firm growth and economic development. Schumpeter (1934) argued that innovation changes the competitive process by introducing new products, processes, and combinations of resources. In the firm-level literature, the resource-based view further explains why innovation can create value: firms gain advantage when they possess valuable, rare, and difficult-to-imitate resources (Barney, 1991). Green technological innovation is a specific form of innovation that combines technological upgrading with environmental objectives. It is especially relevant for industrial firms because production processes, emissions, energy use, and regulatory exposure are closely tied to their long-term competitiveness.

The natural-resource-based view provides a useful theoretical foundation for understanding green innovation. Hart (1995) argues that pollution prevention, product stewardship, and sustainable development can become sources of competitive advantage when environmental capabilities are embedded in firm routines. Porter and van der Linde (1995) similarly contend that environmental pressure can stimulate innovation that offsets part of the cost of compliance and improves resource productivity. Although the strength of this argument depends on industry conditions and firm capabilities, it suggests that green technological

innovation may be more than a regulatory response. For industrial firms, green patents can represent accumulated environmental knowledge, cleaner production capability, and preparation for policy and market changes.

Empirical studies also show that environmental innovation is shaped by regulation, capabilities, and market conditions. Horbach (2008) finds that environmental innovation is influenced by regulation, cost savings, and organizational capabilities. Berrone et al. (2013) show that institutional pressure can encourage green inventions, especially when firms face strong environmental scrutiny. At the macro level, Acemoglu et al. (2012) emphasize that technological change can be directed toward cleaner paths when incentives and policy conditions support such a shift. These studies support the idea that green technological innovation is not merely a technical activity; it is also connected to strategic positioning under environmental transition.

The link between innovation and firm value is also supported by research on patents and market valuation. Griliches (1981) shows that R&D and patent indicators contain information about the market value of firms. Hall et al. (2005) further demonstrate that patent citations and patent-based knowledge indicators are associated with firm market value. This literature is important for the present study because green patents are observable innovation outputs that investors can use to assess a firm's technological capability and future growth potential. If green patents signal useful environmental knowledge and strategic readiness, they should be positively reflected in Tobin's Q.

At the same time, the value of green technological innovation is unlikely to be automatic. Innovation outputs must be commercialized, scaled, and integrated into products or processes before they can generate financial benefits. Cohen and Levinthal (1990) argue that firms need absorptive capacity to recognize, assimilate, and exploit external knowledge. This logic also applies to green innovation. A green patent may indicate a technical achievement, but its valuation effect depends on whether the firm can transform the patented knowledge into operational efficiency, regulatory advantage, market differentiation, or future cash-flow expectations. This reasoning provides the basis for expecting a positive association between green technological innovation and firm value.

Financing constraints may change this relationship. Innovation projects are difficult to finance because they are uncertain, intangible, and often lack collateral value. Hall and Lerner (2010) explain that information asymmetry, uncertainty, and limited pledgeable assets make R&D financing more costly than ordinary investment financing. Brown et al. (2009) show that access to finance matters for innovation and growth, especially when firms rely on external equity or internal cash flow to sustain R&D activity. These arguments are particularly relevant for green technological innovation because green projects often require long payback periods, specialized equipment, and continuous investment before market benefits become visible.

Financing constraints can therefore weaken the valuation effect of green innovation. A firm may hold green patents, but if it lacks sufficient financial resources, investors may doubt whether the firm can commercialize those patents or scale them into profitable operations. Hadlock and Pierce (2010) provide a widely used size-age measure of financing constraints, which is useful in panel settings because it relies on relatively stable firm characteristics. In the present paper, stronger financing constraints are expected to reduce the positive valuation effect of green patents. This does not mean that green patents lose all value under financial pressure. Rather, it means that the market may discount green innovation when the firm appears financially unable to deploy it effectively.

The present study focuses on a narrow but important question: whether financing constraints limit the market value of green technological innovation. This focus provides a clear empirical test while remaining connected to industrial upgrading, green development, and firm-level innovation strategy. Based on the above literature, the paper proposes the following hypotheses:

H1: Green technological innovation is positively associated with the firm value of Chinese industrial enterprises.

H2: Financing constraints negatively moderate the relationship between green technological innovation and firm value, so that the positive valuation effect of green innovation is weaker when financing constraints are stronger.

3. Methodology

The empirical design examines whether green technological innovation affects firm value and whether this relationship is moderated by financing constraints. The design is intentionally focused on the link among green technological innovation, market valuation, and firm-level financial conditions. This framework allows the paper to test whether financing constraints operate as a boundary condition for the value effect of green innovation.

The empirical analysis uses an annual panel dataset of Chinese A-share listed firms obtained from the WIND database for the period 2015-2024. Financial firms and ST firms are excluded because their accounting structure, regulatory environment, and market valuation are not directly comparable with ordinary operating firms. Observations with non-positive total assets, operating revenue, or Tobin's Q are also removed. The main analysis focuses on industrial enterprises, including manufacturing, mining, and utilities-related firms. Because green technological innovation is measured with a one-year lag, the regression sample covers 2016 to 2024. The preferred industrial sample used in the main results contains 22,396 firm-year observations from 3,471 firms.

The dependent variable is firm value, measured by Tobin's Q. Tobin's Q is appropriate for this study because it captures market valuation rather than only accounting profitability. Earlier studies on R&D, patents, and market value show that innovation-related intangible assets can be reflected in stock-market valuation (Griliches, 1981; Hall et al., 2005). Since green technological innovation may

affect investors' expectations about environmental capability, regulatory preparedness, and future growth opportunities, a market-based indicator is better suited to the research question than a purely accounting-based measure.

The main explanatory variable is green technological innovation. It is measured by the natural logarithm of one plus the number of green patent applications. Patents are widely used as observable indicators of innovation output, while green patents are especially relevant for studying environmental innovation and resource-oriented competitive advantage (Berrone et al., 2013; Hart, 1995; Horbach, 2008). The variable is lagged by one year to reduce simultaneity between current market valuation and current innovation activity. This lag structure also reflects the idea that the market needs time to observe and assess whether green innovation can be translated into technological capability or competitive advantage.

The moderating variable is financing constraints. The study uses the size-age approach to construct the SA index proposed by Hadlock and Pierce (2010). Firm size is measured as the natural logarithm of total assets in millions, and firm age is measured by listing age. The SA index is first calculated, and then its absolute value is used as the financing-constraint indicator so that higher values indicate stronger constraints. The calculation is expressed as follows:

$$SA_{it} = -0.737\, Size_{it} + 0.043\, Size_{it}^{2} - 0.040\, Age_{it}$$

$$FC_{it} = |\, SA_{it} \,|$$

Table 1. Variable definitions

Variable	Symbol	Measurement	Role
Firm value	TobinQ	Tobin's Q reported in the dataset; winsorized at the 1st and 99th percentiles.	Dependent variable
Green technological innovation	GTI	Natural logarithm of one plus the number of green patent applications, lagged by one year and standardized.	Main explanatory variable
Financing constraints	FC	Absolute value of the SA index based on firm size and listing age; standardized in the regression model.	Moderating variable
Firm size	Size	Natural logarithm of total assets.	Control variable
Debt ratio	Lev	Total liabilities divided by total assets.	Control variable
Revenue growth	Growth	Annual growth rate of operating revenue.	Control variable
Cash flow	Cashflow	Operating cash flow divided by total assets.	Control variable
Profitability	ROA	Net profit divided by average total assets.	Control variable
Ownership concentration	Top1	Shareholding ratio of the largest shareholder.	Control variable
Board size	Board	Number of board directors.	Control variable
Independent directors	Indep	Proportion of independent directors on the board.	Control variable
Institutional ownership	Inst	Institutional investors' shareholding ratio.	Control variable

Source: Author's compilation based on the WIND database and variable construction described in this study.

A higher value of financing constraints means that the firm faces greater difficulty in obtaining sufficient internal or external funds. Innovation is often difficult to finance because R&D projects are uncertain, intangible, and hard for external investors to evaluate (Brown et al., 2009; Hall & Lerner, 2010). In the context of green technological innovation, financing constraints may reduce the firm's ability to commercialize green patents, scale new technologies, or sustain long-term innovation projects. Therefore, financing constraints are expected to weaken the valuation effect of green technological innovation.

The model also includes firm-level control variables that may affect market valuation. Firm size controls for scale and resource capacity. Debt ratio controls for capital structure and financial risk. Revenue growth captures business expansion and market expectations. Cash flow and ROA control for liquidity and profitability. Ownership concentration, board size, independent-director ratio, and institutional ownership control for governance and ownership characteristics. All continuous variables are winsorized at the 1st and 99th percentiles to reduce the influence of extreme observations.

The baseline model first estimates the relationship between lagged green technological innovation and firm value. The specification is written as follows:

$$TobinQ_{it} = \alpha + \beta_1 GTI_{i,t-1} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

In this model, TobinQ represents firm value for firm i in year t, and GTI represents lagged green technological innovation. The control vector includes the firm-level control variables described above. Firm fixed effects capture time-invariant firm characteristics, such as persistent business models and unobserved organizational traits. Year fixed effects control for macroeconomic conditions, market-wide shocks, and regulatory changes that affect all firms in the same year.

To test the moderating role of financing constraints, the study adds financing constraints and the interaction between lagged green technological innovation and financing constraints. The moderation model is expressed as follows:

$$TobinQ_{it} = \alpha + \beta_1 GTI_{i,t-1} + \beta_2 FC_{it} + \beta_3 GTI_{i,t-1} \, x \, FC_{it} + \gamma Controls_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

The coefficient of interest is the interaction coefficient. A negative coefficient would indicate that financing constraints weaken the relationship between green technological innovation and firm value. This would mean that green patents are more likely to be valued by the market when firms have enough financial capacity to transform innovation outputs into commercial or strategic benefits. A positive coefficient would suggest that the market values green innovation more strongly under financial pressure, which would imply a different signalling interpretation. All models use firm and year fixed effects, and standard errors are clustered at the firm level to account for serial correlation within firms over time.

The empirical strategy provides a focused test of one clear mechanism: financing constraints as a boundary condition for the valuation effect of green technological innovation. By combining lagged innovation measures, firm and year

fixed effects, and firm-clustered standard errors, the design aims to produce a transparent and interpretable estimate of the conditional relationship between green innovation and firm value.

4. Empirical Results

This section reports the empirical results for the relationship between green technological innovation and firm value. The main analysis uses Tobin's Q as the dependent variable and lagged green patent output as the measure of green technological innovation, following the literature that links patents and innovation-related intangible assets to market value (Griliches, 1981; Hall et al., 2005). Financing constraints are measured by the absolute value of the SA index, where a higher value indicates stronger constraints (Hadlock & Pierce, 2010). The preferred specification focuses on industrial listed firms, while all non-financial listed firms are reported as a comparison. All regressions include firm and year fixed effects, and standard errors are clustered at the firm level.

The final industrial sample contains 22,396 firm-year observations from 3,471 firms. The use of lagged green patent output helps reduce simultaneity between innovation activity and contemporaneous market valuation. It also fits the economic logic that investors normally need time to observe whether green innovation can be converted into technological capability, regulatory advantage, or market reputation.

Table 2. Descriptive statistics

Variable	N	Mean	Std. dev.	Min	Max
Tobin's Q	22,396	1.9908	1.2112	0.8260	8.1327
Lagged green patent output	22,396	1.0835	1.2657	0.0000	5.0304
Financing constraints	22,396	3.5159	0.3172	2.9238	4.2771
Firm size	22,396	22.3178	1.2428	19.9389	26.3826
Debt ratio	22,396	0.4033	0.1923	0.0547	0.9061
Revenue growth	22,396	0.1365	0.3341	-0.5577	2.0090
Cash flow	22,396	0.0543	0.0645	-0.1462	0.2417
ROA	22,396	0.0393	0.0668	-0.2345	0.2237

Source: Author's calculation based on the cleaned WIND annual panel dataset.
Notes: The sample includes non-financial and non-ST industrial listed firms. Continuous variables are winsorized at the 1st and 99th percentiles.

Table 2 shows that the sample contains substantial variation in market valuation, green patent output, and financing constraints. Tobin's Q is above one on average, so the market values many sample firms above the book value of their assets. At the same time, the dispersion in Tobin's Q is wide, which confirms that market valuation differs greatly across industrial firms. Lagged green patent output also varies considerably. This variation is important for testing whether green technological innovation has market relevance, since green patents may represent environmentally oriented knowledge assets rather than routine operating inputs (Berrone et al., 2013; Hart, 1995).

Table 3. Correlation matrix

Variable	1	2	3	4	5	6
1. Tobin's Q	1.000					
2. Lagged green patents	-0.177	1.000				
3. Financing constraints	-0.093	0.103	1.000			
4. Size	-0.318	0.555	0.296	1.000		
5. Debt ratio	-0.230	0.314	0.271	0.440	1.000	
6. ROA	0.225	-0.040	-0.131	0.057	-0.364	1.000

Source: Author's calculation based on the cleaned WIND annual panel dataset.
Notes: Pairwise Pearson correlations are reported for the main industrial sample.

Table 3 reports pairwise correlations among the main variables. The correlation matrix is used only as preliminary evidence because it does not control for firm characteristics, firm fixed effects, or year fixed effects. Even so, it shows that financing constraints are negatively related to Tobin's Q, while the relationship between green patent output and firm value needs to be examined in the regression framework. The correlations among the control variables remain within a range that does not suggest an obvious collinearity problem for the main specification.

Table 4. Green technological innovation, financing constraints, and firm value

Variable	(1) All firms	(2) All firms	(3) Industrial firms	(4) Industrial firms
Lagged green patent output	0.0257***	0.0162	0.0276**	0.0203*
	(0.0095)	(0.0099)	(0.0111)	(0.0116)
Financing constraints		-0.7500***		-0.6374***
		(0.0800)		(0.0983)
Lagged green patent output x financing constraints		-0.0276***		-0.0306***
		(0.0092)		(0.0115)
Controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Clustered standard errors	Firm	Firm	Firm	Firm
Observations	31,060	31,060	22,396	22,396
Firms	4,723	4,723	3,471	3,471
Within R-squared	0.129	0.140	0.127	0.134

Source: Author's fixed-effects regression results based on the cleaned WIND annual panel dataset.
*Notes: The dependent variable is Tobin's Q. Standard errors clustered by firm are reported in parentheses. Lagged green patent output and financing constraints are standardized. Controls include firm size, debt ratio, revenue growth, cash flow, ROA, ownership concentration, board size, independent-director ratio, and institutional ownership. ***, **, and * denote significance at the 1%, 5%, and 10% levels.*

Table 4 presents the fixed-effects regression results. Columns (1) and (2) use the full non-financial listed-firm sample as a comparison group, while Columns (3) and (4) focus on industrial firms. Column (1) shows that lagged green patent output is positively associated with Tobin's Q in the full sample. This result is consistent with the view that innovation outputs can contribute to market valuation when investors regard them as credible intangible assets (Griliches, 1981; Hall et al., 2005). After adding financing constraints and the interaction term in Column (2), the interaction between lagged green patent output and financing constraints is

negative and statistically significant at the 1% level. This result suggests that financing constraints weaken the valuation effect of green technological innovation.

The industrial-firm results are reported in Columns (3) and (4). In Column (3), lagged green patent output has a positive coefficient of 0.0276 and is statistically significant at the 5% level. This finding indicates that green technological innovation is associated with higher market valuation among industrial enterprises. The result fits the natural-resource-based view that environmental capabilities can become firm-specific strategic resources when they are embedded in products, processes, and routines (Hart, 1995). In Column (4), the coefficient on financing constraints is negative and highly significant, showing that financially constrained firms tend to have lower Tobin's Q. The interaction term is also negative and statistically significant at the 1% level. The estimated coefficient is -0.0306, which means that the positive valuation effect of green innovation becomes weaker as financing constraints increase.

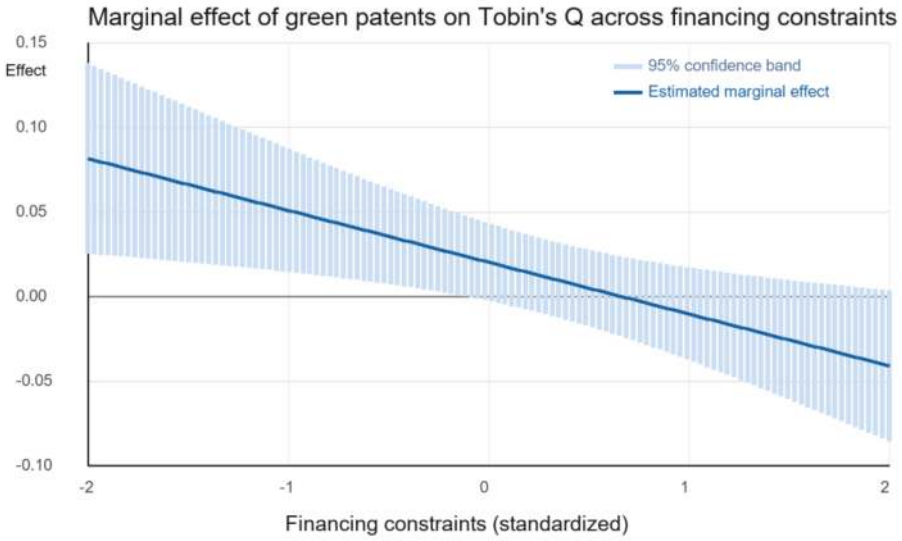

Figure 1. Marginal effect of lagged green patent output across financing constraints

Source: Author's calculation based on Column (4) of Table 4 and the cleaned WIND annual panel dataset. The light-blue band represents the 95% confidence interval.

Figure 1 visualizes the moderating effect. When financing constraints are low, the marginal effect of lagged green patent output on Tobin's Q is positive. As financing constraints increase, the marginal effect declines and approaches zero. This pattern supports the regression evidence that financing constraints reduce the market value created by green technological innovation. In practical terms, green patents may signal environmental capability, regulatory preparedness, and future growth potential, but firms need sufficient financial resources to commercialize these innovation outcomes. This interpretation is consistent with research showing that innovation projects are financially demanding and often depend on access to internal cash flow or external equity (Brown et al., 2009; Hall & Lerner, 2010). If

external and internal finance is constrained, the market may discount the firm's ability to turn green innovation into firm value.

Overall, the empirical results support a conditional interpretation of green technological innovation. Green innovation is positively related to firm value in China's industrial sector, but this relationship is not independent of the firm's financial environment. Financing constraints play a disciplining role in the valuation process: they lower firm value directly and weaken the value relevance of green innovation. These findings extend the Porter hypothesis logic by showing that the value of environmentally oriented innovation depends on both the existence of green patents and the financial capacity needed to deploy them (Porter & van der Linde, 1995).

5. Discussion

The findings support the view that green technological innovation can be value relevant for industrial enterprises. The positive coefficient on lagged green patent output indicates that the market recognizes green innovation as more than a compliance activity. In the context of Chinese industrial firms, green patents may signal cleaner production capability, environmental knowledge, and preparedness for policy and market changes. This interpretation is consistent with the natural-resource-based view, which suggests that environmental capabilities can become sources of competitive advantage when they are embedded in firm routines and strategic resources (Hart, 1995). It is also in line with the valuation literature showing that patents and innovation-related intangible assets contain information about firm value (Griliches, 1981; Hall et al., 2005).

At the same time, the results show that the value effect of green technological innovation is conditional rather than automatic. The negative and significant interaction between lagged green patent output and financing constraints indicates that stronger financing constraints reduce the market value associated with green innovation. This finding supports the idea that innovation requires financial capacity after the invention stage. Green patents can represent technological potential, but firms still need resources to commercialize these patents, scale cleaner technologies, purchase specialized equipment, and integrate environmental knowledge into products or production processes. When financing constraints are strong, investors may discount this potential because the firm appears less able to turn green innovation into future cash flows. This logic is consistent with research showing that innovation projects are uncertain, intangible, and financially demanding (Brown et al., 2009; Hall & Lerner, 2010).

The findings therefore add a financing perspective to the literature on green innovation and firm value. Porter and van der Linde (1995) argue that environmental pressure may stimulate innovation and improve competitiveness, while later studies emphasize that environmental innovation is shaped by regulation, institutional pressure, and firm capabilities (Berrone et al., 2013; Horbach, 2008). The present evidence suggests that financial capacity should be

treated as part of this capability structure. A firm may possess green technological outputs, but the market value of those outputs depends on whether the firm has enough financial flexibility to deploy them. This argument also connects with the absorptive-capacity perspective, because firms must create or acquire knowledge and then exploit it effectively (Cohen & Levinthal, 1990).

The results have practical implications for managers, investors, and policy makers. For managers of industrial enterprises, the findings suggest that green patenting should be accompanied by financing plans, commercialization arrangements, and resource allocation decisions. A patent-focused strategy alone may not be enough if the firm lacks the funds to transform inventions into operational improvements or marketable products. For investors, the results indicate that green innovation indicators should be evaluated together with financial constraints. Green patents may be a positive signal, but the signal is stronger when the firm has sufficient financial capacity to support implementation. For policy makers, the evidence suggests that policies encouraging green innovation may be more effective when they are connected with green finance, credit access, and mechanisms that reduce the financing burden of industrial upgrading.

Several limitations should also be acknowledged. First, the paper uses green patent output as the main measure of green technological innovation. This measure is observable and suitable for firm-level panel analysis, but it cannot fully capture patent quality, technological novelty, or the actual environmental effect of innovation. Second, Tobin's Q reflects market valuation, which may be influenced by investor sentiment and broader capital-market conditions. Third, the SA-based financing-constraint measure is useful because it relies on relatively stable firm characteristics (Hadlock & Pierce, 2010), but it cannot capture every source of financing difficulty faced by industrial firms. Future research could use patent citations, green invention quality, green credit data, or product-level environmental outcomes to further examine how green innovation is transformed into firm value.

6. Conclusion

This paper examines the relationship between green technological innovation and firm value in China’s industrial sector, with a particular focus on the moderating role of financing constraints. Using panel data from the WIND database for Chinese A-share listed firms from 2015 to 2024 and a preferred industrial-firm regression sample covering 2016 to 2024, the study estimates fixed-effects models with firm and year effects. Green technological innovation is measured by lagged green patent output, firm value is measured by Tobin's Q, and financing constraints are measured by the absolute value of the SA index.

The empirical results show that lagged green patent output is positively associated with firm value among industrial enterprises. This finding supports the argument that green technological innovation can serve as a value-relevant intangible asset when it signals environmental capability, technological readiness, and future growth potential. The results also show that financing constraints negate-

vely moderate this relationship. As financing constraints become stronger, the positive marginal effect of green patent output on Tobin's Q declines. Therefore, both hypotheses are supported: green technological innovation is positively related to firm value, while financing constraints weaken this positive relationship.

The main conclusion is that green innovation and financial capacity should be considered together. Green patents may create market value, but this value depends on the firm's ability to finance commercialization and implementation. For industrial firms pursuing cleaner production and green upgrading, the results suggest that environmental innovation should be supported by stable financing, effective resource allocation, and credible commercialization pathways. For policy makers, the findings imply that green innovation policy and green finance policy are complementary. Strengthening the financial conditions under which firms deploy green technologies may help industrial enterprises transform environmental innovation into sustainable firm value.

References

Acemoglu, D., Aghion, P., Bursztyn, L., & Hemous, D. (2012). The environment and directed technical change. *American Economic Review* 102(1), 131-166. https://doi.org/10.1257/aer.102.1.131

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management* 17(1), 99-120. https://doi.org/10.1177/014920639101700108

Berrone, P., Fosfuri, A., Gelabert, L., & Gomez-Mejia, L. R. (2013). Necessity as the mother of 'green' inventions: Institutional pressures and environmental innovations. *Strategic Management Journal* 34(8), 891-909. https://doi.org/10.1002/smj.2041

Brown, J. R., Fazzari, S. M., & Petersen, B. C. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *The Journal of Finance* 64(1), 151-185. https://doi.org/10.1111/j.1540-6261.2008.01431.x

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly* 35(1), 128-152. https://doi.org/10.2307/2393553

Griliches, Z. (1981). Market value, R&D, and patents. *Economics Letters* 7(2), 183-187. https://doi.org/10.1016/0165-1765(87)90114-5

Hadlock, C. J., & Pierce, J. R. (2010). New evidence on measuring financial constraints: Moving beyond the KZ index. *The Review of Financial Studies* 23(5), 1909-1940. https://doi.org/10.1093/rfs/hhq009

Hall, B. H., Jaffe, A., & Trajtenberg, M. (2005). Market value and patent citations. *RAND Journal of Economics* 36(1), 16-38.

Hall, B. H., & Lerner, J. (2010). The financing of R&D and innovation. In B. H. Hall & N. Rosenberg (Eds.), *Handbook of the Economics of Innovation* (Vol. 1, pp. 609-639). Elsevier. https://doi.org/10.1016/S0169-7218(10)01014-2

Hart, S. L. (1995). A natural-resource-based view of the firm. *Academy of Management Review* 20(4), 986-1014. https://doi.org/10.5465/amr.1995.9512280033

Horbach, J. (2008). Determinants of environmental innovation: New evidence from German panel data sources. *Research Policy* 37(1), 163-173. https://doi.org/10.1016/j.respol.2007.08.006

Porter, M. E., & van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *Journal of Economic Perspectives* ***9***(4), 97-118. https://doi.org/10.1257/jep.9.4.97

Schumpeter, J. A. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Harvard University Press.