

An Analysis of the Effects of Trade Policy Uncertainty on Corporate Green Investment: The Viewpoints of Market Competition and Green Innovation

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Abstract

Trade policy uncertainty is changing the logic of decision making of corporate operations in the context of the constant reconfiguration of the global trading system. In this paper, Chinese A-share listed companies over the period of 2017-2024 are chosen as the research sample to analyze the impact of trade policy uncertainty on corporations' green investment and the transmission mechanisms behind it. The results show that trade policy uncertainty has a strong positive driving impact on corporate green investment, and the result is unchanged even after a sequence of robustness tests. The mechanism analysis shows that trade policy uncertainty can affect corporate green investment in two ways, which are based on the level of market competition and green innovation. The heterogeneity tests indicate that this effect is especially strong in the case of polluting companies, companies in the east, and companies in high-tech sectors. The current study will add a new twist to the study of corporate sustainable development, considering the macro-policy-making environment and offer recommendations to the companies to develop green transformation strategies in the face of uncertainty.

Keywords

trade policy uncertainty, green investment, degree of market competition, green innovation

1. Introduction

In recent years, the world economy has experienced significant changes, and the growing unilateralism as well as repeated trade conflicts have seen trade policy uncertainty as a significant external variable that has been impacting the operations of companies. Particularly, since 2018, the occurrence and further increase of the Sino-US trade friction have significantly enhanced the level of external operating environment uncertainty of Chinese businesses. Increased trade policy uncertainty can be associated with an increase in export prices and the need to adjust supply chains, but also with the change in investment plans and the processes of technological innovation, and thus impact the competitiveness of industries and the performance of firms. Under these circumstances, there has emerged the question of how companies are changing their business strategies and optimizing resource allocation during times of uncertainty, as both academia and industry focus on it.

Meanwhile, due to the growing threat of climate problems and the popularity of sustainable development principles, green investment has increasingly become one of the most important ways that companies can

pursue high-quality development. Besides being a symbol of corporate environmental responsibility, green investment is also seen as a strategic tool to improve long-term competitiveness and move towards sustainable development. Since China announced the objectives of carbon peaking and carbon neutrality in 2020, the green transformation of enterprises has faced the emergence of new opportunities as well as new challenges. Due to increased trade policy uncertainty, companies could either reduce green investment to relieve short-term operating stresses or increase green spending to strengthen long-run resilience. Such trade-off should be researched thoroughly both theoretically and empirically.

The economic implications of trade policy uncertainty have been widely explored in the current literature. Other researchers have discovered that trade policy uncertainty tends to have a negative effect on both corporate investment and innovation [2, 13], but some have claimed that uncertainty will instead trigger a sense of crisis awareness in companies, causing them to increase their competitiveness when faced with external shocks. In terms of corporate green investment, the available research largely focuses on two directions: its internal features and external context. In an internal setting, the level of executives' environmental awareness, the nature of ownership, and the quality of corporate governance have all been demonstrated to impact green investment behaviour significantly [9, 5, 8]. Externally, the environmental regulation, media coverage, and green finance development are considered as the most important drivers [4, 3, 7]. Nevertheless, there is a lack of attention to the issue of how trade policy uncertainty at the macro-level impacts green investment of businesses. Besides, the ways in which trade policy uncertainty impacts green investment are not clear, and this is the main question that this paper seeks to answer.

The research sample of this paper consists of Chinese A-share listed companies over the years 2017-2024 and it examines how trade policy uncertainty impacts corporate green investment and its transmission mechanisms. It can be seen that trade policy uncertainty significantly drives green investment, and such an influence does not change even after the inclusion of control variables, the substitution of fixed effects, and the application of clustered robust standard errors. The mechanism analysis indicates that trade policy uncertainty impacts green investment via two paths, i.e., increasing the level of market competition and promoting green innovation. The heterogeneity test shows that the impact is stronger among heavily polluting companies, companies in the eastern region, and companies belonging to the high-tech industry.

Summarizing the marginal contributions of the presented study, it could be stated as follows. To begin with, it adds to the limits of the investigation of the economic impact of trade policy uncertainty by being among the initial studies that have chosen to concentrate on its implications on corporate green investment, thus expanding the angle of analyzing the relationship between the macro-policy context and corporate sustainable development. Secondly, it helps open the black box of the dual transmission channels through which trade policy uncertainty impacts green investment, namely, the level of market competition and the stimulation of green innovation, adding to the existing body of literature on the mechanisms of action of trade policy uncertainty on corporate green investment. Thirdly, it explores moderating roles of heterogeneity in the base regression using firm-level, regional-level, and industry-level aspects, offering theoretical frameworks to various types of firms developing diversified green development strategies.

2. Theoretical Analysis and Research Hypotheses

2.1 The Impact of Trade Policy Uncertainty on Corporate Green Investment

Uncertainty in trade policy is an important external environmental factor that companies encounter, and it has a strong impact on their strategic decisions and resource allocation. In the context of the increasing tendency towards green and sustainable development, the analysis of how trade policy uncertainty impacts the behavior of corporations in making green investments has important theoretical implications to learn the interactive nature of the macro-policy environment and micro-level corporate decisions. This part examines the process of how trade policy uncertainty impacts corporate green investment based on strategic management theory and stakeholder theory and looks at the issue from two points of view- as a risk management strategy and as a stakeholder engagement strategy.

The growth of trade policy uncertainty from the risk management point of view significantly increases the level of uncertainty in the operating environment, and at the same time raises the market risk, operational risk, and compliance risk. Based on the theory of strategic management, in the case of radical changes in the external

environment, companies are likely to reactively change their strategies to enhance their capability to prevent risks and develop organizational resilience to resist shocks of uncertainty [14]. Green investment as part of the corporate sustainable development approaches is not only helpful to help businesses comply with more and more strict environmental regulation rules, but also plays a significant role of an «insurance» in uncertain conditions, to prevent possible environmental compliance and policy risks. The tightening of environmental regulations is inevitable as the concept of green development is deepened further and the dual carbon objective is introduced in China. Given such external shocks due to trade policy uncertainty, companies have the opportunity to effectively minimize the penalties of environmental violations by promoting green investments and thus become more flexible and resilient in an uncertain environment. Also, green investment helps to increase the efficiency of resource allocation, decrease energy consumption and production expenses, and hence promote competitive advantage in the long term under conditions of uncertainty. The study by Zhou et al. [9] also demonstrates that corporate environmental investment can be used effectively to improve the ability of the firms to deal with environmental risks. Therefore, trade policy uncertainty could lead firms to diversify external risks and solidify the basis of long-term sustainable development via higher green investment, according to the risk management viewpoint.

According to stakeholder theory, when there is trade policy uncertainty, companies should be more proactive in responding to the needs of different stakeholders in order to achieve a continued supply of resources and recognition of legitimacy. The stakeholder theory proposed by Freeman [15] suggests that the growth of an enterprise depends on the inputs and engagement of various stakeholders, and that firms need to consider the overall interests of all stakeholders and not just those of shareholders. With increased trade policy uncertainty, the issue of corporate environmental performance being raised by stakeholders, including governments, investors, consumers, and communities, has become much more prominent. On the government front, as a reaction to trade tensions, China has rolled out a wave of policy initiatives that support green development, which allows firms to realign their policies with government directions and access both policy backing and resource allocation through green investment. On the investor front, due to the widespread adoption of the concept of ESG investments, institutional investors are now putting more focus on corporate environmental performance, and green investment is gradually emerging as a major signal of attracting long-term capital [1]. On the consumer front, the increase in green consumption consciousness has given environmentally friendly products more market competition power. Moreover, the study conducted by Wang and Yang [5] shows that good ESG performance helps firms to acquire reputational capital and win stakeholder confidence. Thus, in a scenario where trade policy uncertainty prevails, the increase of green investment to meet the demands of stakeholders, ensure recognition of legitimacy, and acquire resource support is a crucial strategic choice of companies on the way to sustainable development.

The given analysis shows that in the context of an increase in trade policy uncertainty, companies have enough incentives and reasons to invest more in green investment to become competitive and achieve sustainable development. Therefore, the following hypothesis has been suggested:

H1: Trade policy uncertainty exerts a positive driving effect on corporate green investment.

2.2 Mechanisms of the Impact of Trade Policy Uncertainty on Corporate Green Investment

In reference to the transmission channels of how trade policy uncertainty impacts corporate green investment, this paper will consider two factors, namely the extent of market competition and green innovation.

In terms of the level of market competition, trade policy uncertainty increases the level of market competition and forces companies to invest in green investment. In particular, trade policy uncertainty causes important shifts in the international trade environment, and hence, changes the competitive environment within which companies are working. On the one hand, trade frictions increase the market access barriers of exporting companies, forcing others to move into the domestic market, which further increases the domestic market competition. On the other hand, trade policy uncertainty makes firms vulnerable to more uncertain international market demand, forcing them to develop differentiation strategies to retain their shares. The intensification of competition leads to green investment becoming a significant tool of differentiation strategy implementation by firms. Firstly, green investment helps to create the environmental image and the brand value of the company, enabling it to become preferable to consumers in the intense competition. The dissemination of green consumption ideas and the enforcement of environmental legislation have enabled

green products to occupy more of the market premium space, and companies can use green investment to earn green premiums and increase profitability. Secondly, green investment will allow companies to develop green supply chain management systems, thus minimizing the risks in the supply chain and enhancing the efficiency of operations. Due to increased competition in the market, companies signal positively to the market by investing in green projects, indicating their ability to achieve sustainable growth and potential to create value over time, which helps them get competitive benefits in financing as well as in product markets. Moreover, according to the research conducted by Li et al. [2], trade policy uncertainty increases inter-firm competition, and forces companies to respond to environmental changes with technological innovation and strategic adaptation. Intense market competition drives firms to increase green investment and acquire competitive advantages by using differentiated green strategies, as Zhang and Wang [8] also report. Thus, trade policy uncertainty, as increasing market competition, pushes companies to enlarge green investments in order to achieve differentiation advantages in competition. Thus, the next hypothesis is offered:

H2: The uncertainty of trade policy can encourage investment in green projects in corporations by increasing the level of market competition.

In regard to green innovation, trade policy uncertainty tends to be associated with increased green trade barriers, and companies must then use green innovation to satisfy the environmental standards of international markets and improve long-term competitiveness. Green innovation is a vital route to sustainable development that assumes a significant mediating role in the context of trade policy uncertainty. To begin with, trade policy uncertainty puts more green trade barriers on firms' exports, and the tightened environmental regulations and carbon tariff measures of developed countries force them to become reliant on green technological innovation to comply with the international market access requirements. Through the increase of green research and development spending and the creation of environmentally friendly products and clean production technologies, firms can not only break down green trade barriers but also enhance the competitiveness of their products in worldwide markets. Secondly, green innovation has both dual externality properties, including knowledge spillover effects, which are beneficial to technological progress, and environmental spillover effects, which are detrimental to pollution emissions. In a setting of trade policy uncertainty, it is possible to attain win-win situations of environmental protection and enhanced competitiveness through green innovation. Chen and Zhang [1] have shown that green innovation may be facilitated by trade policy uncertainty due to better corporate ESG performance, and green patent application growth is a direct indication of greater investment in green technology R&D. Works by Shen and Huang [4] also indicate that environmental pressures from outside can also be successful in prompting a firm to engage in green technological innovation efforts. Finally, the fact that green patents have grown is a key indicator of corporate green innovation output, indicating that there is more investment in green technology R&D and causing an overall increase in the level of green investment. Patents and intellectual property gained through green innovation allow companies to create technological barriers in uncertain environments, improving their core competitiveness and position in the market. This means that trade policy uncertainty leads firms to increase green investment because of green innovation promotion. Based on this, the following hypothesis is offered:

H3: Trade policy uncertainty promotes corporate green investment by fostering green innovation.

3. Research Design

3.1 SAMPLE Selection and Data Sources

The study chooses Chinese A-share listed companies between 2017 and 2024 as the research sample. The reason behind selecting such a time is that in the past years, especially after the start of the Sino-US trade friction in 2018, there has been a notable increase in trade policy uncertainty in China, offering an ideal natural experimental environment to conduct this study. The screening process of the sample is conducted as follows: (1) financial listed companies are not included because they may be affected by industrial-specific characteristics which can affect the results of the research; (2) ST and *ST companies are excluded to guarantee the regular operational conditions of the sample companies; (3) the observations containing missing values of the key variables are excluded; (4) the continuous variables are winsorized to the 1st and 99th percentile to remove the effect of outliers. Post the screening mentioned above, the final sample is 29,477 firm-year observations.

- 3.2 The data considered in this paper are mainly taken from the following databases: (1) the trade policy uncertainty data originate in the China Trade Policy Uncertainty Index developed by Baker et al. [12] and it is measured as the frequency of news reports in popular media, e.g., the South China Morning Post, and could also be well indicative of the level of uncertainty in the Chinese trade policy ; (2) corporation green investment data are manually collected using the data on corporate green investment and green R&D spending, where the data are retrieved through the CSMAR database and the Wind database; (3) corporations finance data are retrieved based on the information available in the CSMAR database; and (4) green patent data are retrieved based on the information available in the CNRDS database, such as total green patent applications, green invention patent applications, and green utility model patent applications.

3.3 Variable Definitions

The dependent variable is Corporate green investment (Green Invest). This study adopted the same approach used by other researchers in that it also measures the level of corporate green investment through the ratio of environmental investment to operating revenue of companies [1, 9]. The indicator is very effective in showing the investment intensity in environmental protection of a company, and its large values indicate high levels of corporate green investment.

Independent variable: Trade policy uncertainty (TPU). The current research uses the China Trade Policy Uncertainty Index developed by Baker et al. [12] as a composite measure that is measured through both textual analysis approaches and can effectively capture the extent of uncertainty in China trade policies. Higher values of such an index mean that there is a greater degree of trade policy uncertainty.

Variables of the mechanism: (1) Market competition degree (HHI). It is measured by the Herfindahl–Hirschman index in this study as it measures the level of market competition encountered by firms [10]. The greater the HHI value, the greater the level of market competition experienced by the firm. (2) Green innovation (Green Patent). It is measured by the natural logarithm of one plus the total number of green patent applications in this study to determine the level of corporate green innovation [11]. Green patents are a significant measure of the output of corporate green innovation as they show the investments and results in green technology research and development.

Control variables. The following factors that can impact corporate green investment are controlled in this study: firm size (Size): measured as the natural logarithm of total assets; leverage ratio (Lev): measured as the ratio of total liabilities to total assets; return on assets (ROA): measured as the ratio of net profit to total assets; gross profit margin (Gross Profit): measured as the ratio of (operating revenue - operating costs) to operating revenue; current ratio (Liquid): measured as the ratio of current assets to current liabilities; quick ratio (Quick): measured as the ratio of (current assets - inventory) to current liabilities; cash flow ratio (Cash Flow): measured as the ratio of operating cash flow to total assets; and financial leverage (FL): measured as the ratio of long-term liabilities to total assets. Also, year fixed effects and industry fixed effects are adjusted to exclude the effects of time trends and industry features on the research results.

Table 1: Variable Definitions

Variable Name	Symbol	Definition
Corporate green investment	Green Invest	Environmental investment / Operating revenue
Trade policy uncertainty	TPU	China Trade Policy Uncertainty Index
Degree of market competition	HHI	Herfindahl–Hirschman Index
Green innovation	Green Patent	$\ln(\text{Total green patent applications} + 1)$
Firm size	Size	Natural logarithm of total assets
Leverage ratio	Lev	Total liabilities / Total assets
Return on assets	ROA	Net profit / Total assets
Gross profit margin	Gross Profit	$(\text{Operating revenue} - \text{Operating costs}) / \text{Operating revenue}$
Current ratio	Liquid	Current assets / Current liabilities
Quick ratio	Quick	$(\text{Current assets} - \text{Inventory}) / \text{Current liabilities}$
Cash flow ratio	Cash Flow	Operating cash flow / Total assets
Financial leverage	FL	Long-term liabilities / Total assets

3.4 Model Specification

In order to analyze how trade policy uncertainty may affect corporate green investment, the benchmark regression model given below is developed:

$$GreenInvest_{i,t} = \alpha_0 + \alpha_1 TPU_{i,t} + \alpha_2 Controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t}$$

where $GreenInvest_{i,t}$ denotes the level of green investment of firm i in year t ; $TPU_{i,t}$ denotes the trade policy uncertainty faced by firm i in year t ; $Controls_{i,t}$ is a set of control variables; $Year$ and $Industry$ represent year fixed effects and industry fixed effects, respectively; and $\varepsilon_{i,t}$ is the random error term. The sign and significance of the coefficient α_1 are the primary focus. If α_1 is significantly positive, it indicates that trade policy uncertainty promotes corporate green investment, thereby supporting Hypothesis H1.

In order to examine the process by which trade policy uncertainty influences corporate green investment, this paper will adopt the mechanism testing approach suggested by Jiang [6] and will develop the following mechanism testing model:

$$M_{i,t} = \beta_0 + \beta_1 TPU_{i,t} + \beta_2 Controls_{i,t} + \sum Year + \sum Industry + \varepsilon_{i,t}$$

where $M_{i,t}$ represents the mechanism variable, which consists of the level of market competition (HHI) and green innovation (Green Patent) and the rest of the variables are defined similar to those in the baseline regression model. When it is significant, it implies that there is a mechanism effect, i.e., trade policy uncertainty impacts corporate green investment via this mechanism variable.

4. Empirical Results and Analysis

4.1 Descriptive Statistics

The descriptive statistics of the main variables are given in Table 2. The table indicates that the average value of corporate green investment (Green Invest) is 0.3794, and the standard deviation is 0.4853, and the minimum and maximum values are 0 and 1, respectively, which means that the green investment levels of the sample firms differ widely, and there are some sample firms that have not engaged in any green investment. The average value of trade policy uncertainty (TPU) is 346.8980, and the standard deviation of TPU is 157.3137, with a minimum of 201.4487, and a maximum of 687.6163, and this means that there is high variability in trade policy uncertainty during the sample period, and it will be adequate to use this in this study.

Table 2: Descriptive Statistics

Variable	Observations	Minimum	Maximum	Mean	Median	Standard Deviation
Green Invest	29477	0.0000	1.0000	0.3794	0.0000	0.4853
TPU	29477	201.4487	687.6163	346.8980	277.8678	157.3137
Size	29477	20.1922	26.4153	22.3804	22.1661	1.2881
Lev	29477	0.0584	0.8939	0.4128	0.4061	0.1999
ROA	29477	-0.2611	0.1984	0.0320	0.0357	0.0672
Gross Profit	29477	-0.0268	0.8501	0.2910	0.2586	0.1789
Liquid	29477	0.3578	15.1755	2.5571	1.7378	2.4577
Quick	29477	0.2130	13.9470	2.0961	1.3353	2.2625
Cash Flow	29477	-0.1421	0.2380	0.0501	0.0487	0.0648
FL	29477	-1.0420	5.9314	1.1695	1.0192	0.7770

4.2 Baseline Regression

The regression findings on the effects of trade policy uncertainty on company green investment are presented in Table 3. Column (1) has only year and industry fixed effects, whereas column (2) contains all control variables. It is observed that the regression coefficient of trade policy uncertainty (TPU) is significant at the level of 1 percent (the coefficient = 0.0004, t-value = 3.3414), which means that trade policy uncertainty has a strong positive influence on corporate green investment, which validates Hypothesis H1. Economically, a one-standard-deviation rise in the trade policy uncertainty index (about 157.3137) is related to approximately 0.0629 percentage-point growth in the amount of corporate green investment. Given the magnitude of the

change in the trade policy uncertainty index within the sample period (201.4487-687.6163) this effect has important economic importance.

Table 3: Baseline Regression

Variable	(1)	(2)
TPU	0.0004*** (3.3414)	0.0004*** (3.3414)
Size		0.0509*** (19.7993)
Lev		-0.0337 (-1.5426)
ROA		0.1591*** (3.2175)
Gross Profit		-0.3204*** (-15.4688)
Liquid		-0.0042 (-0.6092)
Quick		-0.0079 (-1.0675)
Cash Flow		0.1166** (2.4849)
FL		0.0051 (1.5069)
Constant	-0.7405*** (-11.5005)	-0.7405*** (-11.5005)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	29,477	29,477
R-squared	0.191	0.191
Adj. R2	0.188	0.188

Note: *t*-statistics are reported in parentheses; ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

4.3 Robustness Checks

In order to test the robustness of the conclusions of the research, this paper performs robustness tests based on three viewpoints, which are shown in Table 4.

Then, new control variables are added. In order to exclude the influence of factors like ownership type, loss position, and capital expenditure, this paper introduces three control variables-the state-owned enterprise dummy variable (SOE), the loss dummy variable (Loss), and capital expenditure (CAP)-to the baseline model to be re-estimated. Column (1) indicates that the regression coefficient of trade policy uncertainty (TPU) is 0.0004, which is significantly positive at the 1 percent level (*t*-value = 3.3907), implying that the conclusion still holds true even with the inclusion of control variables.

Secondly, fixed effects are substituted. This paper substitutes industry fixed effects with province fixed effects in order to control unobservable variables on the regional level to re-estimate. Column (2) demonstrates that the regression coefficient of TPU is 0.0003, which is significantly positive at the 5 percent significance level (*t*-value = 2.0213), which implies that the conclusion is resilient after substitution of the fixed effects.

Fourthly, the clustered robust standard errors are included. In order to eliminate possible violations of the homoscedasticity assumption, this paper re-estimates the baseline model with firm-level clustered robust standard errors. As it is shown in column (3), the regression coefficient of the TPU is 0.0004, which is statistically significant at the significance level of 1 per cent (*t*-value = 3.6155), which means that even after adding clustered robust standard errors, the research conclusion remains unchanged.

Table 4: Robustness Checks

Variable	(1) Additional control variables	(2) Replacement of fixed effects	(3) Addition of clustered robust standard errors
TPU	0.0004*** (3.3907)	0.0003** (2.0213)	0.0004*** (3.6155)
Size	0.0421*** (15.4257)	0.0475*** (18.5618)	0.0509*** (9.6073)
Lev	-0.0422* (-1.8681)	-0.1220*** (-5.5540)	-0.0337 (-0.8846)
ROA	0.1645*** (3.1356)	0.3060*** (5.9775)	0.1591** (2.3263)
Gross Profit	-0.2921*** (-13.4859)	-0.3697*** (-20.7239)	-0.3204*** (-8.6205)
Liquid	-0.0034 (-0.4649)	-0.0156** (-2.3367)	-0.0042 (-0.3559)
Quick	-0.0106 (-1.3651)	0.0004 (0.0558)	-0.0079 (-0.6246)
Cash Flow	0.1194** (2.4397)	0.2703*** (5.5665)	0.1166** (1.9644)
FL	0.0050 (1.4626)	0.0096*** (2.6791)	0.0051 (1.2207)
SOE	0.0798*** (11.8411)		
Loss	-0.0075 (-0.8457)		
CAP	-0.0001 (-0.7612)		
Constant	-0.5683*** (-8.3752)	-0.5821*** (-9.0778)	-0.7405*** (-6.0881)
Year FE	Yes	Yes	Yes
Industry FE	Yes	No	Yes
Province FE	No	Yes	No
Observations	27,509	29,477	29,477
R-squared	0.196	0.093	0.191

Note: The t-statistics are given in parentheses and * ** and ** indicate the significance of the statistics at 1, 5, and 10 per cent levels, respectively.

5. Mechanism Tests

This analysis indicates that there is a significant positive impact of trade policy uncertainty on corporate green investments. The present section also explores the transmission processes of the effect, such as the extent to which the level of market competition (HHI) and green innovation (Green Patent) are intermediary routes between trade policy uncertainty and corporate green investment. As per the concept of causal inference developed by Jiang [6], this paper will use a two-stage methodology to test the mechanism. The first stage is the baseline regression that has already been reported above and has already established the significant and positive effect of trade policy uncertainty on corporate green investment. The second stage is the testing of the mechanism variables using trade policy uncertainty.

The results of the mechanism tests are reported in Table 5. The baseline regression results are presented in Column (1), Column (2) tests the impact of trade policy uncertainty on the extent of market competition, and Column (3) tests the effect of trade policy uncertainty on green innovation.

(1) Market competition mechanism. Column (2) indicates that the regression coefficient between the trade policy uncertainty and the degree of market competition (HHI) is 0.0129, which is statistically significant at the 1 percent level (t-value = 15.4971). It means that trade policy uncertainty exerts a strong positive impact on the level of market competition. One explanation may be that when there is a situation of trade policy uncertainty, the competitive environment changes and the companies experience more severe competitive pressures. In order to achieve benefits in competition, companies are more likely to increase their green

investment as a strategy of differentiation, thus improving the corporate image and market competitiveness. At the same time, increased competition drives companies to focus more on long-term sustainable growth and to strive to obtain recognition and support of stakeholders by investing in green initiatives. The finding confirms Hypothesis H2.

(2) Green innovation mechanism. Column (3) indicates that the regression coefficient of trade policy uncertainty with respect to green innovation (Green Patent) is 0.0016 and significant at the 1 percent level (t -value = 6.0698). It means that trade policy uncertainty plays a substantial role in driving corporate green innovation. The reason behind this could be that trade policy uncertainty usually goes along with the increasing green trade barriers, making it necessary for firms to depend on green innovation to achieve international environmental standards. Besides, in the presence of external uncertainty, companies can enhance investments in green innovation to ensure competitiveness over the long term. As an important indicator of corporate green innovation production, the significant rise of green patents demonstrates that companies have actually increased their R&D spending on green technologies under the trade policy uncertainty circumstances, and this increases the amount of green investment. The obtained finding confirms Hypothesis H3.

The presented analysis suggests that trade policy uncertainty is an effective mechanism for increasing the level of corporate green investment via two channels, namely, the intensity of market competition and green innovation. It is this finding that explains the main transmission channels through which a change in the macro-policy environment influences corporate sustainable development activities.

Table 5: Mechanism Tests

Variable	(1)	(2)	(3)
	Invest	HHI	Green Patent
TPU	0.0004*** (3.3414)	0.0129*** (15.4971)	0.0016*** (6.0698)
Size	0.0509*** (19.7993)	0.0076 (0.4209)	0.5846*** (103.2212)
Lev	-0.0337 (-1.5426)	-0.0976 (-0.6388)	0.0386 (0.8018)
ROA	0.1591*** (3.2175)	-0.9690*** (-2.8014)	-0.0784 (-0.7207)
Gross Profit	-0.3204*** (-15.4688)	0.3006** (2.0748)	-0.0559 (-1.2265)
Liquid	-0.0042 (-0.6092)	0.0705 (1.4465)	-0.0867*** (-5.6562)
Quick	-0.0079 (-1.0675)	-0.0894* (-1.7251)	0.0765*** (4.6923)
Cash Flow	0.1166** (2.4849)	0.4781 (1.4563)	-0.1671 (-1.6177)
FL	0.0051 (1.5069)	0.0261 (1.0925)	-0.0529*** (-7.0485)
Constant	-0.7405*** (-11.5005)	4.3938*** (9.7545)	-12.3820*** (-87.3706)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Observations	29,477	29,477	29,477
R-squared	0.191	0.895	0.460

*Note: t-statistics are reported in parentheses; ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.*

6. Heterogeneity Analysis

The above discussion shows how trade policy uncertainty can have a positive impact on corporate green investment in general. Nevertheless, companies of various nature may behave in a different way towards trade policy uncertainty. The present section performs heterogeneity analyses by three dimensions, i.e., the pollution attributes of the firm, regional disparities, and industry attributes, to define the heterogeneous nature of the relationship between trade policy uncertainty and corporate green investment.

6.1 Firm-Level Heterogeneity Analysis

The two types of firms, polluting and non-polluting, are greatly different in relation to environmental regulation pressures and social responsibility fulfilment, which can cause them to respond to trade policy uncertainty differently. The sample in this research is divided between polluting and non-polluting firms depending on whether they are considered a polluting or non-polluting firm, and subsample regressions are performed. The results of the regression are shown in Table 6. Column (1) indicates that the regression coefficient of trade policy uncertainty (TPU) is 0.0007 in the polluting firm subsample and statistically significant at 1% (t-value = 2.6275). Column (2) indicates that the regression coefficient of TPU in the non-polluting firm subsample is 0.0003 and statistically significant at 5 percent (t-value = 2.4022). These findings show that the motivating influence of trade policy uncertainty on green investment is greater among the polluting firms. An explanation could be that the pressure imposed by environmental regulations on polluting firms is stronger, and under conditions of trade policy uncertainty, they are more motivated to increase green investment to address the demands of environmental policies and at the same time enhance their environmental performance to receive policy backing.

Table 6: Firm-Level Heterogeneity Analysis

Variable	(1)	(2)
	Polluting firms	Non-polluting firms
TPU	0.0007*** (2.6275)	0.0003** (2.4022)
Size	0.0661*** (12.1881)	0.0452*** (15.4147)
Lev	-0.0153 (-0.3221)	-0.0254 (-1.0294)
ROA	0.4144*** (3.3863)	0.1286** (2.3822)
Gross Profit	-0.4574*** (-9.1464)	-0.3037*** (-13.3251)
Liquid	0.0471*** (2.7293)	-0.0131* (-1.7229)
Quick	-0.0707*** (-3.7944)	0.0036 (0.4506)
Cash Flow	0.3573*** (3.3699)	0.0485 (0.9283)
FL	0.0015 (0.2255)	0.0054 (1.3552)
Constant	-0.9301*** (-6.6697)	-0.6608*** (-9.0909)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	6,557	22,920
R-squared	0.139	0.118

Note: t-statistics are reported in parentheses; ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

6.2 Regional-Level Heterogeneity Analysis

The degree of economic development, openness, and political environment of different regions vary greatly, and this can cause regional differences in the impact of trade policy uncertainty on green investment. The research splits the sample into three categories, i.e., eastern, central, and western regions, dependent on the registration of the firm's location, and runs the regression separately. Regression outcomes are given in Table 7. Column (1) indicates that in the eastern region subsample, the regression coefficient of trade policy uncertainty (TPU) equals 0.0004, and it is statistically significant at the 1 percent level (t-value = 2.6870). Column (2) and (3): The regression coefficients of trade policy uncertainty in the central and western region subsamples are insignificant. The findings suggest that the driving effect of trade policy uncertainty on green investment is largely focused on the companies that belong to the eastern region. One possible reason is that eastern region companies are more integrated into international value chains and react more strongly to changes in trade policies. Also, the eastern region has a more advanced green finance system and stronger

environmental policy backing, which allows businesses to make better use of green investment in reaction to external environmental factors.

Table 7: Regional-Level Heterogeneity Analysis

Variable	(1)	(2)	(3)
	Eastern	Central	Western
TPU	0.0004*** (2.6870)	0.0005 (1.4849)	0.0005 (1.6002)
Size	0.0441*** (14.7688)	0.0560*** (7.5387)	0.0637*** (9.0634)
Lev	-0.0528** (-2.0517)	-0.0200 (-0.3373)	-0.1043* (-1.8180)
ROA	0.1269** (2.2546)	0.3419** (2.4485)	0.2189 (1.5221)
Gross Profit	-0.3289*** (-13.4585)	-0.4683*** (-8.2411)	-0.2645*** (-4.8557)
Liquid	-0.0047 (-0.5887)	-0.0113 (-0.6106)	-0.0352* (-1.6656)
Quick	-0.0078 (-0.9114)	0.0070 (0.3571)	0.0163 (0.7241)
Cash Flow	0.0797 (1.4673)	-0.0184 (-0.1467)	0.7129*** (5.3769)
FL	0.0042 (0.9901)	0.0044 (0.5683)	-0.0039 (-0.4665)
Constant	-0.6109*** (-8.1901)	-0.7558*** (-4.1477)	-0.8886*** (-4.9845)
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Observations	21,370	4,493	3,614
R-squared	0.167	0.232	0.312

Note: The t-statistics are shown in parentheses; *, ** and *** indicate the significance of 1, 5, and 10 percent, respectively.

6.3 Industry-Level Heterogeneity Analysis

The technological innovation capacity and the intensity of R&D investments of high-tech industries and non-high-tech industries vary significantly, which can result in different reactions to trade policy uncertainty. The current research separates the sample into two groups, high-tech and non-high-tech, depending on the industry to which the firm belongs, and estimates them separately. Table 8 provides the results of the regression. Column (1) indicates that in the high-tech industry subsample, the regression coefficient of trade policy uncertainty (TPU) is 0.0005, and it is statistically significant at the 1 percent level (t-value = 3.3177). Column (2) indicates that in the non-high-tech industry subsample, the regression coefficient of trade policy uncertainty is insignificant. These findings show that trade policy uncertainty is a stronger motivator of green investment for high-tech industry companies. One possible reason could be that high-tech companies focus more on long-term development and technological innovations and have higher R&D capacity and technological resources. In the presence of external uncertainty, they are also more prone to improve their core competitiveness by investing more in green investment and green innovation.

Table 8: Industry-Level Heterogeneity Analysis

Variable	(1)	(2)
	High-tech industries	Non-high-tech industries
TPU	0.0005*** (3.3177)	0.0002 (0.9342)
Size	0.0552*** (16.6202)	0.0424*** (10.4108)
Lev	-0.0024 (-0.0847)	-0.0848** (-2.4451)
ROA	0.1983*** (3.2917)	0.0958 (1.1012)
Gross Profit	-0.4376***	-0.1168***

Variable	(1)	(2)
	High-tech industries	Non-high-tech industries
	(-16.7094)	(-3.4077)
Liquid	-0.0158*	0.0095
	(-1.6766)	(0.9243)
Quick	0.0097	-0.0308***
	(0.9680)	(-2.7701)
Cash Flow	0.0959	0.1295*
	(1.6216)	(1.6767)
FL	0.0083*	0.0012
	(1.7820)	(0.2452)
Constant	-0.8394***	-0.5245***
	(-10.1830)	(-5.0643)
Year FE	Yes	Yes
Industry FE	Yes	Yes
Observations	18,754	10,723
R-squared	0.174	0.227

Note: *t*-statistics are reported in parentheses; ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

On the whole, the test results of heterogeneity suggest that trade policy uncertainty has a significant impact on the green investment of corporations mainly within the framework of polluting companies, companies operating in the eastern region, and companies working in high-tech industries. The result is useful to different kinds of firms in coming up with diverse green development policies.

7. Conclusions and Implications

7.1 Research Conclusions

The present research is based on Chinese A-share listed companies during the period 2017-2024 as a sample population to investigate the impact of trade policy uncertainty on corporate green investment and associated transmission channels. The results are: Firstly, trade policy uncertainty has a strong positive impact on corporate green investment and it holds even when a sequence of robustness tests is conducted. Secondly, trade policy uncertainty influences corporate green investment by two mechanisms: the extent of market competition and green innovation. Thirdly, this promoting effect is stronger in the polluting firms, the firms in the east region, and the firms in high-technology industries. The present study explains the main channels through which macro-policy environment changes influence corporate sustainable development and theoretically supports the practice and offers practical guidance to the firms to respond to external uncertainty and develop green development strategies.

7.2 Policy Implications

To start with, governments ought to enhance the policy framework that facilitates the corporate green transformation. Since companies have an endogenous drive to increase green investment, governments can use the incentives of taxes, green finance, and other mechanisms to lower the cost of green transformation, direct companies to incorporate green development in their business plans, and provide more encouragement on corporate R&D in green technologies so that companies may be able to surmount the green trade barriers.

Secondly, a differential policy support system of green development needs to be put in place. Various kinds of businesses react to the uncertainty of trade policy in different ways; thus, governments need to develop specific green innovation support policies towards the polluting firms and high-tech firms with the aim of increasing the accuracy of the policy interventions.

7.3 Limitations and Future Research Directions

The study has the following limitations. Firstly, the trade policy uncertainty index is evaluated at a macro level and cannot reflect the heterogeneity of perceptions of uncertainty by firms on an individual basis. Secondly, the sample size selected is restricted to Chinese A-share listed companies, and additional tests are

needed to make the conclusions more generalizable. Future studies may develop trade policy uncertainty indicators at the firm level, explore the details of the micro mechanisms influencing the corporate green investments, and perform country comparison analyses to add more value to the relevant theory and practice.

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Conflicts of Interest

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