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# Study on the Influence Mechanism and Adjustment Path of Climate Risk on China's High-Quality Economic Development

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**Abstract:** The quantitative analysis of the economic impact of climate risk is an effective means of understanding and taking reasonable preventative steps in relation to the climate-related economic crisis. This paper takes panel data from China's 31 provinces for 2009 to 2021, combined with a regulating intermediary effect model, to determine the climate risk faced in China and its influence mechanism on high-quality economic development, in an attempt to determine how to adjust the path. The results show that, first, when using a different regression model, we see that climate risks pose a significantly inhibiting effect on high-quality economic development in China. Secondly, when the climate risk increases by 1%, high-quality economic development drops by 0.0115%. When the climate risk increases by 1%, this leads to a 14.9672% increase in the likelihood of natural disasters, causing high-quality economic development to be indirectly reduced by 0.1300%. Thirdly, green innovation has a multidimensional effect; it can both directly and indirectly impact the negative effects of inhibition, and indirect adjustment has a greater effect than direct adjustment. Such regulation has a greater effect on the input than on the output. Therefore, we should seek to more accurately understand the dangers of climate risk, effectively improve the five aspects of development, and strengthen the input of green innovation and thus the output of high-quality economic development in China.

**Keywords:** climate risk; high-quality economic development; green innovation; moderating mediating effect



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## 1. Introduction

The twentieth Report of the Communist Party of China points out that high-quality economic development is an essential requirement of Chinese modernization, this being a scientific conclusion based on China's current development stage and impending development requirements, as well as the general requirements of economic life. We can ensure an overall situation of high-quality economic development by the use of new development concepts [1,2].

As China's economy develops and attains a higher quality, uncertain external factors (such as the greenhouse effect, black swan events and grey rhinoceros events) are becoming more inevitable [3]. Therefore, only by correctly understanding the harms posed by climate risk and quantitatively analyzing the impacts, and especially the impact of climate risk on high-quality economic development in different geographical regions with different degrees of development, can reasonable and effective preventive measures be put forward. These include strengthening the input and output of green innovation, and moderating and directing the impacts of climate risks on the high-quality development of China's economy, so as to effectively promote its high-quality development.

The existing literature focuses on the impact of climate risk on economic development. For example, climate risk is expressed in terms of average precipitation and average temperature [4], and economic development is expressed in terms of per capita income and total income [5]. The relevant results show that climate risk significantly inhibits economic development, but climate risk is a long-term type of risk; that is, it is derived from standardized numerical treatments of the average temperature registered around 1970. Generally, the impact of short-term climate risk is not taken into account, and economic development takes income as the main indicator. The actual state of high-quality economic development in China at the present stage is not also taken into account, such as considerations of high-quality economic development under the five development concepts, and whether there is a threshold effect in relation to the five development concepts.

Secondly, in terms of the content of the research, some scholars believe that climate risk increases natural disasters and natural disasters inhibit economic development [6,7], while others believe that green innovation promotes economic development [8]. However, the mediating effect among climate risk, economic development, natural disasters and green innovation is generally not taken into account.

Finally, in terms of research conclusions, the existing studies on the impacts of climate risk on economic development all state that climate risk significantly inhibits human production and life, thus inhibiting economic development [9–11]. However, some scholars believe that in regions with high degrees of development, such as Beijing and Shanghai, climate risk has shown a weaker inhibiting effect on high-quality economic development [12]. It might even stimulate, to some extent, the rise of emerging industries and new technologies, attract domestic and foreign investment, and promote high-quality economic development.

Therefore, using the existing panel data from 31 provinces in China (excluding Hong Kong, Macao and Taiwan) for 2009 to 2021, this paper selects different indicators to measure climate risk and high-quality economic development. The empirical analysis is carried out using a benchmark regression model, a panel threshold model and a moderated mediation effect model, with time and space dual-fixed effects and dummy variables. Firstly, we find that climate risk significantly inhibits the high-quality development of China's economy. Secondly, the five major development types (except shared development) all have a threshold effect, and the inhibiting effect of climate change weakens when a certain level of development is passed. Moreover, climate risk can directly or indirectly affect high-quality economic development through natural disasters, and its direct effect is less significant than its indirect effect. Finally, green innovation positively moderates the inhibitory effects of climate risk on high-quality economic development, negatively moderates the promotional effect of climate risk on droughts and floods and the inhibitory effects of droughts and floods on high-quality economic development, and the moderating effect of green innovation input is found to be greater than that of green innovation output.

The main contributions of this paper are as follows: (1) This paper employs more detailed interpretations of "climate risk" and "economic development" to study the impacts of short-term climate risk on China's high-quality economic development, so as to provide empirical evidence that will enable us to prevent climate–economic crises, promote high-quality economic development and achieve common prosperity. (2) In terms of research content, this paper takes into account the threshold effects for areas at different levels of development, and the variables mediating between climate risk and high-quality economic development, natural disasters and regulatory variables, and green innovation, and introduces these all into one model to make the conclusions more valid. (3) In terms of research conclusions, we find that climate risk can significantly inhibit high-quality economic development directly or indirectly, through natural disasters. The input and output of green innovation can either directly or indirectly inhibit high-quality economic development, and the effect of input is greater than that of output, all of which contributes to a more detailed understanding that will help us to prevent climate–economic risk.

## 2. Theoretical Analysis and Research Hypothesis

Based on the neoclassical growth theory of climate risk in economics, the "AD-AS" theory of high-quality economic development and the "input-output" theory of green innovation, this paper empirically analyzes the impact mechanism of climate risk on high-quality economic development.

In general, in the "AD-AS" theory as shown in Figure 1 [13], the occurrence of climate risk will lead to frequent cycles of natural disasters, leading to the movement of the total supply curve of inelastic commodities (such as food and daily necessities) from $AS_1$ upward left to $AS_2$, and the total demand curve from $AD_1$ downward right to $AD_2$, resulting in the price increase from $P_1$ to $P_2$. Under the condition that the total income remains unchanged, consumers spend more of their income on inelastic commodities and reduce other expenditures. However, for elastic commodities (such as diamonds, etc.), the aggregate supply curve remains the same, the aggregate demand curve moves to the lower left, and the overall price range does not change much. At the same time, green innovation can alleviate climate risks and natural disasters from both input and output aspects and promote high-quality economic development. Therefore, this thesis can be divided into the following three levels.

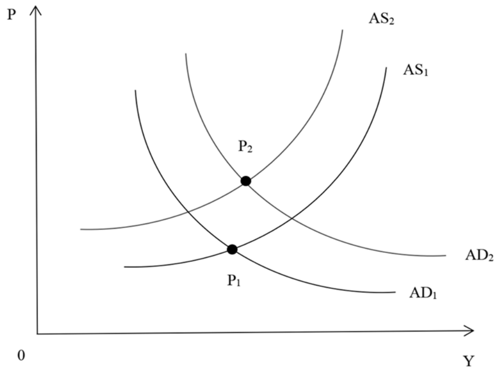



**Figure 1.** Change diagram of AD and AS.

Firstly, China's high-quality economic development can be divided into five aspects: innovative development, coordinated development, green development, open development and shared development [14]. For innovative development, climate risk will reduce GDP growth and increase investment rate, that is, hinder innovative development [15]. For coordinated development, climate risk will reduce the ratio of retail sales of consumer goods/GDP and increase the ratio of government debt/GDP, that is, hinder coordinated development [16]. For green development, it is believed that climate risk will increase the growth rate of energy consumption and waste water and gas emissions, which are obstacles to green development [17]. For open development, climate risk will reduce the total volume of imports and exports, total foreign investment and labor compensation, that is, hinder open development [18]. For shared development, climate risk will also reduce labor remuneration and increase the ratio of per capita consumption expenditure of urban residents/per capita consumption expenditure of rural residents, which is an obstacle to shared development [19]. As a result, when the total social demand remains unchanged or decreases, the total supply allocated to economic development will increase and prices will rise, leading to the decline in high-quality economic development. Therefore, we can propose the following hypothesis:

**H1:** *Climate risk will significantly inhibit the high-quality development of China's economy.*

Secondly, different degrees of development will lead to certain differences in the impact of climate risk on high-quality economic development [20]. Then, whether there is a threshold of development degree to a certain extent, making climate risk inhibit high-quality economic development within the threshold, and whether there is a weakened inhibitory effect of climate risk on high-quality economic development beyond this threshold, there is still an opposite promoting effect. Therefore, the following hypothesis is proposed:

**H2:** *When different development degrees exceed (are below) a certain threshold, the inhibition effect of climate risk on high-quality economic development is lower (higher).*

Thirdly, climate risk will lead to frequent periodicities and increasing severity of natural disasters each time they occur [21,22]. At the same time, there is a certain cyclical relationship between climate risk and natural disasters such as drought and floods [23], which leads to a decrease in consumer income and an increase in production and living costs, as well as the upward-right shift of the total supply curve of high-quality economic development. The aggregate demand curve moves to the lower left, resulting in lower prices, lower per capita consumption level, reduction in the five development indexes, and thus lower high-quality economic development. Green innovation can directly promote high-quality economic development [24] and indirectly affect high-quality economic development by reducing the impact of climate risk on natural disasters and the impact of natural disasters on high-quality economic development. At the same time, considering the "input-output" theory of green innovation, some studies show that the effect of cost input is not lost [25], and is even higher than the effect of output to some extent. Therefore, this paper proposes the following hypothesis:

**H3a:** *Climate risk may take advantage of natural disasters to strengthen its inhibitory effect on high-quality economic development.*

**H3b:** *Increasing green innovation directly or indirectly will reduce the inhibition effect of climate risk on high-quality economic development, with the indirect effect of green innovation being less than the direct effect, and the effect of input being greater than the effect of output.*

The basic assumptions of this paper are shown in Figure 2 below:

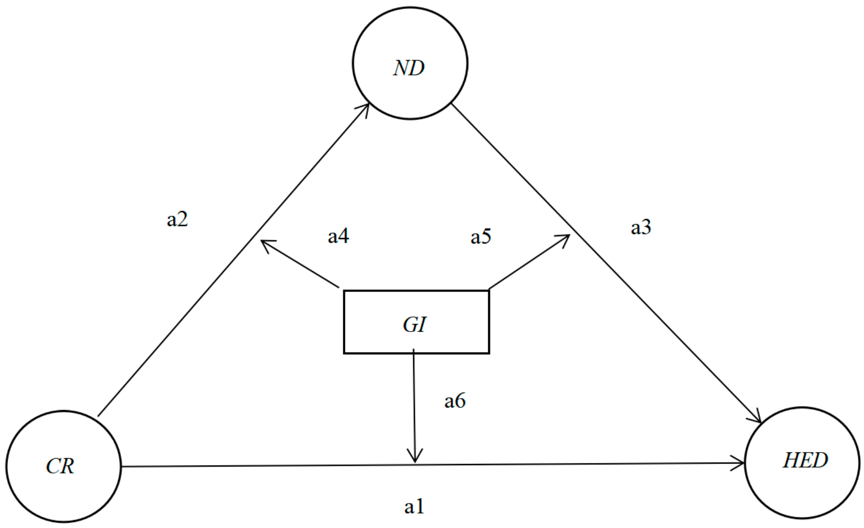



**Figure 2.** Hypothetical model diagram.

In Figure 2, *CR* represents climate risk, *ND* represents natural disaster, *HED* represents high-quality economic development, *GI* stands for green innovation and a1 is the impact of climate risk on high-quality economic development in China, which can be used to test Hypothesis 1 and Hypothesis 2. a2 represents the impact of climate risk on natural disasters; a3 represents the impact of natural disasters on high-quality economic development; a4 represents the impact of green innovation on climate risk and natural disasters; a5 represents the impact of green innovation on natural disasters and high-quality economic development; a6 represents the direct impact of green innovation on natural disasters and high-quality economic development. a2 and a3 can test H3a in Hypothesis 3; while a1 and a6 with a2; a4 and a3; and a2, a5 and a3 can test H3b in Hypothesis 3.

## 3. Research Methodology

### *3.1. Model Selection*

#### 3.1.1. Reference Regression Model

In order to verify Hypothesis 1, in this study, referring to the practice of existing scholars [26], it is understood that different geographical locations of different provinces will interfere with the impact of climate risk on the high-quality development of China's economy, so they should be excluded, while geographical locations of different provinces do not change with time. Therefore, the dual fixed-effects model of time and province shown in Equation (1) can be adopted to absorb the influence of geographical location on climate risk and the high-quality development of China's economy, and therefore reduce the influence of endogeneity on the model:

$$HED_{it} = a_0 + a_1 CR_{it} + a_2 X_{it} + \alpha_i + \beta_t + \varepsilon_{it} \quad (1)$$

$HED_{it}$ represents the comprehensive index of high-quality economic development of province $i$ in year $t$; $CR_{it}$ represents the climate risk index of province $i$ in year $t$; and $X_{it}$ represents the control variable. $a_0$ is the constant term; $\alpha_i$ represents the province fixed effect; $\beta_t$ represents the year fixed effect; and $\varepsilon_{it}$ represents the random disturbance term.

#### 3.1.2. Panel Threshold Model

In order to verify Hypothesis 2 and further explore whether there is a threshold effect on the impact of climate risk on high-quality economic development at different developmental levels, this paper constructs the panel threshold model shown in Equation (2) by referring to the existing literature [27]:

$$HED_{it} = a_0 + a_1 CR_{it} + a_2 M_{it} + a_3 W_{it} \times M \times I(M \leq \eta) + a_4 W_{it} \times M \times I(M > \eta) + a_5 X_{it} + \varepsilon_{it} \quad (2)$$

The value of this function is 1 when the conditions in parentheses are met; otherwise it is 0. $a_3$ and $a_4$, respectively, representing the coefficient of threshold variable $M$ when $M$ is less than or equal to $\eta$ and greater than $\eta$. The other variables have the same meaning as Equation (1).

#### 3.1.3. Models with Moderated Mediating Effects

In order to verify Hypothesis 3, on the basis of the above Formula (1) and referring to the existing literature [28,29], Formulas (3)–(8) are constructed for testing:

$$ND_{it} = a_0 + a_1 CR_{it} + \alpha_i + \beta_t + \varepsilon_{it} \quad (3)$$

$$HED_{it} = b_0 + b_1 ND_{it} + b_3 X_{it} + \alpha_i + \beta_t + \varepsilon_{it} \quad (4)$$

$$HED_{it} = c_0 + c_1 ND_{it} + c_2 CR_{it} + c_3 X_{it} + \alpha_i + \beta_t + \varepsilon_{it} \quad (5)$$

$$HED_{it} = l_0 + l_1 CR_{it} + l_2 GI_{it} + l_3 GI_{it} \times CR_{it} + l_4 X_{it} + \alpha_i + \beta_t + \varepsilon_{it} \quad (6)$$

$$ND_{it} = m_0 + m_1 CR_{it} + m_2 GI_{it} + m_3 GI_{it} \times CR_{it} + m_4 X_{it} + \alpha_i + \beta_t + \varepsilon_{it} \quad (7)$$

$$HED_{it} = n_0 + n_1 ND_{it} + n_2 GI_{it} + n_3 GI_{it} \times ND_{it} + n_4 X_{it} + \alpha_i + \beta_t + \varepsilon_{it} \quad (8)$$

In the appeal formula, $ND_{it}$ represents the natural disaster index of province $i$ in year $t$, and $GI_{it}$ represents the green innovation index of province $i$ in year $t$; Formula (3) corresponds to a2 in Figure 2, Formula (4) corresponds to a3 in Figure 2, and Formula (5) corresponds to a2 and a3 in Figure 2. The coefficient of interactive terms $GI_{it} \times CR_{it}$ and $GI_{it} \times ND_{it}$ in Equations (6)–(8) is used to measure its regulatory effect, that is, the regulatory effect of $l_3$ green innovation on climate risk affecting high-quality economic development, corresponding to a6 and a1 in Figure 2. $m_3$ and $n_3$ represent the inhibitory effect of green innovation on high-quality economic development by adjusting the climate risk of natural disasters.

## *3.2. Variable Selection*

### 3.2.1. Primary Variable

According to the main idea of this paper, the explained and explanatory variables selected are, respectively, the comprehensive index of high-quality economic development and climate risk, the index of different development degrees (the threshold variable), green innovation (the moderating variable), and natural disasters (the mediating variable).

### 3.2.2. Explained Variable

The explained variable selected in this paper is the comprehensive index of high-quality economic development (HED). Referring to the existing literature [30], five development concepts are adopted: "Innovative development, coordinated development, green development, open development and shared development". We then carry out indexation processing on the positive and negative indicators of Formulas (9) and (10), and then calculate the information entropy of the five components based on the proportion of each indicator and sum it up as shown in Formula (11). Finally, the total contribution of each index and the weight of each index are used to calculate the comprehensive score, as shown in Equation (12):

$$X_{ab} = \frac{x_{ab} - x_{abmin}}{x_{abmax} - x_{abmin}} \tag{9}$$

$$X_{ab} = \frac{x_{ab_{\max}} - x_{ab}}{x_{ab\max} - x_{ab\min}} \tag{10}$$

$$Y_{bc} = \sum_{a=1} (X_{ab} \times \frac{X_{ab}}{sumX_{ab}}) \tag{11}$$

$$W_b = \sum_{a=1}^{a=5} (\frac{1}{5} \times Y_{bc}) \tag{12}$$

In Equation (12) above, $x_{ab}$ represents the data of province b under index a; $x_{abmax}$ and $x_{abmin}$ represent the maximum and minimum values of $x_{ab}$ data; $X_{ab}$ represents the exponential data of province b under index a; $Y_{bc}$ represents the total information entropy of the different developmental concepts c of province b; $W_b$ represents the comprehensive index of the high-quality economic development of province b. The specific indicators are shown in Table 1 below [31–33]:

### 3.2.3. Explanatory Variable

The explanatory variable selected in this paper is climate risk (*CR*). Referring to the existing literature [34,35], the standardized mean temperature (*SMT*) is used to represent climate risk. At the same time, considering the absence of annual mean temperature data over a long period of time and the existence of accidental factors in long-term mean temperature changes, this paper takes 10 years as the limit and uses standardized mean temperature as shown in Equation (13) to show climate risk:

$$SMT_b = \frac{MT_{bi} - averge(MT_{bi10})}{stdevp(MT_{bi10})} \tag{13}$$

$SMT_b$ represents the standardized mean temperature data of province b; $MT_{bi}$ represents the mean temperature data of province b in year i; $MT_{bi10}$ represents the sum of the 10-year mean temperature data of province b before year i (including year i); *SMT* measures the degree of change in the mean temperature relative to the data of the province 10 years ago. You can see in Table 2 below that the mean of the standardized mean temperature is 0.3174, the maximum is 2.5698, and the minimum is −2.3377, with negative values implying a reduction in climate risk. The standardized mean precipitation (*SMP*) was also used as a robustness test.

**Table 1.** Economic high quality index system.

| First-Order Index | Secondary Index | Three-Level Index | Function | Specific Meaning |
|---|---|---|---|---|
| Economic high quality | Innovative development | GDP growth rate | + | Regional GDP growth rate |
| | | Intensity of R&D investment | + | R&D expenditure/GDP of industrial enterprises above designated size |
| | | Investment efficiency | − | Investment rate/GDP growth rate |
| | | Technology trading activity | + | Technology transaction volume/GDP |
| | Coordinated development | Demand structure | + | Total retail sales of consumer goods/GDP |
| | | Urban–rural structure | + | Urbanization rate |
| | | Industrial structure | + | Tertiary industry output value/GDP |
| | | Government debt burden | − | Government debt balance per GDP |
| | Green development | Elasticity coefficient of energy consumption | − | Energy consumption growth rate/GDP growth rate |
| | | Wastewater per unit of output | − | Wastewater discharge per GDP |
| | | Unit of exhaust gas produced | − | Sulfur dioxide emissions per GDP |
| | Open development | Foreign trade dependence | + | Total imports and exports/GDP |
| | | Proportion of foreign investment | + | Total foreign investment/GDP |
| | | Degree of marketization | + | Regional marketization index |
| | Shared development | Proportion of workers' remuneration | + | Wages per GDP |
| | | Elasticity of personal income growth | + | Per capita disposable income growth rate/GDP growth rate |
| | | Urban–rural consumption gap | − | Per capita consumption expenditure of urban residents/per capita consumption expenditure of rural residents |
| | | Share of private fiscal expenditure | + | The proportion of local expenditure on education, medical and health care, housing security, social and employment in local budget expenditure |

**Table 2.** Descriptive statistical results of each variable.

| Variable | Obs | Mean | Std | Min | Max |
|---|---|---|---|---|---|
| HED | 403 | 0.2922 | 0.1298 | 0.1190 | 0.7860 |
| SMT | 403 | 0.3174 | 1.0258 | −2.3377 | 2.5698 |
| SMP | 403 | 0.2973 | 0.9736 | −2.1188 | 2.6699 |
| ID | 403 | 0.1343 | 0.1176 | 0.0163 | 0.8366 |
| CD | 403 | 0.4337 | 0.1354 | 0.1978 | 0.9150 |
| GD | 403 | 0.7526 | 0.0842 | 0.3839 | 0.9851 |
| OD | 403 | 0.1664 | 0.1379 | 0.0096 | 0.6367 |
| SD | 403 | 0.5377 | 0.1085 | 0.1412 | 0.8333 |
| Drought | 403 | 0.3846 | 0.5464 | 0.0002 | 4.256 |
| Flood | 403 | 0.3226 | 0.4486 | 0.0001 | 3.2797 |
| GII | 403 | 0.1036 | 0.0437 | 0.0455 | 0.7246 |
| GIO | 403 | 0.1046 | 0.0394 | 0.0404 | 0.4825 |
| CFIL | 403 | 1.6785 | 1.3403 | 0.0378 | 6.6299 |
| PS | 403 | 44.4599 | 28.7511 | 2.9580 | 129.2410 |
| LOTP | 403 | 4.7737 | 5.9998 | 0.0115 | 34.7990 |
| SOI | 403 | 0.4103 | 0.0830 | 0.1486 | 0.6196 |
| Urban | 403 | 25.0624 | 16.8865 | 0.6806 | 93.4361 |
| TIAEV | 403 | 17.3394 | 1.6418 | 12.5447 | 20.9995 |

3.2.4. Control Variable

Referring to the existing studies, the capital factor input level (million RMB, *CFIL*) is adopted in this paper, which demonstrates the fixed assets factor input of each province; population size by province (million, *PS*); technological progress level (million yuan, *LOTP*): R&D investment of each province; industrial structure (*SOI*): the ratio of secondary industry GDP/total GDP of each province; the ratio of urban population/total population in each province; total import and export volume (thousands of US dollars, *TIAEV*): the sum of import and export volume of each province is taken as the control variable. Specific explanations are as follows: the factor input of the fixed assets can effectively cope with the uncertainty of economic development [36]; the population size of each province is an unavoidable factor to be considered in the process of Chinese-style modernization [37]; the level of technological progress is conducive to promoting economic growth [38]; the greater the proportion of the output value of the secondary industry, the more serious the air pollution will be along with the economic development [39]; urbanization is the key to promoting high-quality economic development [40]; total import and export volume reflects China's economic strength, showing it can effectively cope with various risks [41]. The statistical values of each indicator are shown in Table 2.

3.2.5. Threshold Variable

In order to test Hypothesis 2, considering that different degrees of high-quality economic development may lead to different impacts of climate risks on high-quality economic development in China, innovative development (*ID*), coordinated development (*CD*), green development (*GD*), open development (*OD*) and shared development (*SD*) in Table 1 are all processed in Formulas (9) to (11), and the values of each development degree are obtained separately as the threshold variables.

3.2.6. Mediating Variables and Moderating Variables

In order to test Hypothesis 3, natural disaster (*ND*) is also selected as the mediating variable of climate risk for high-quality economic development in China, with the existing literature being referred to in the process [42,43]. The area affected by drought (millions of hectares, *drought*) and the area affected by floods (millions of hectares, *floods*) are, respectively, used to represent natural disasters. Drought and floods caused by climate risk affect people's production and life, thus affecting the quality of economic development.

At the same time, green innovation (*GI*) is selected as the regulating variable. According to the existing data, the measurement standard of green innovation is mainly expressed by the number of green patents. Considering that the number of green patents is divided into the input and output of green innovation, respectively, by the number of green patent applications (*GII*) and the number of green patents (*GIO*), indirect and direct regulation can therefore be analyzed from different angles [44,45].

### *3.3. Data Source*

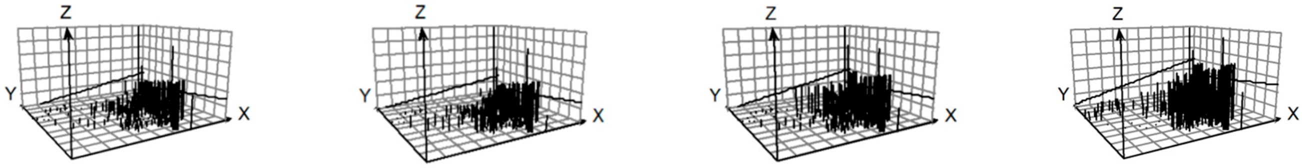
In this paper, provincial panel data of 31 provinces in China (excluding Hong Kong, Macao and Taiwan) from 2009 to 2021 are selected as samples. The data were taken from meteorological station observation data of the NCDC, China Statistical Yearbook, China Agricultural Yearbook, China Monthly Statistical Report on Import and Export of Agricultural Products (December), China Statistical Yearbook of Science and Technology, etc. Table 2 lists the descriptive statistical results of each variable.

## **4. Empirical Analysis**

### *4.1. The Impact of Climate Risk on High-Quality Economic Development in China*

4.1.1. Development Trend Analysis

In order to visually show the trend chart of high-quality economic development, this paper uses ArcGIS 10.6 software to select the comprehensive index of high-quality economic development in 2009, 2013, 2017 and 2021 as sample data, respectively, and draw the trend chart as shown in Figure 3 (where X represents the east, Y represents the north, and Z represents HED):




(**a**) 2009 (**b**) 2013 (**c**) 2017 (**d**) 2021

**Figure 3.** A provincial trend map of China's high-quality economic development over time.

In Figure 3, HED presents the disequilibrium feature of "high in the east and low in the west, high in the north and low in the south" in the space–time, and presents a divergent trend, which mainly shows that the eastern region gradually rises, while the western region decreases year by year, and the difference between the two expands year by year. At the same time, in order to explore the relationship between CR and HED, this paper uses MATLAB software to build three-dimensional surface diagrams of CR, HED and Year, as shown in Figure 4 below:

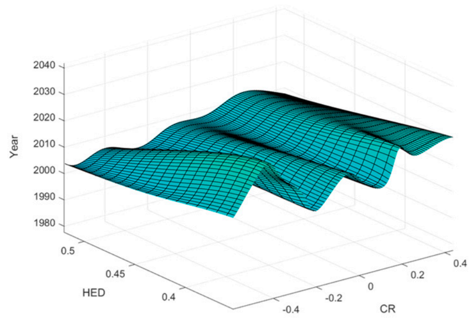



**Figure 4.** Three−dimensional surface diagram of CR, HED and Year.

It can be seen in Figure 4 that the three-dimensional curved surface of CR, HED and Year presents a wavy shape in the direction of CR, which means that in the same year, regions with higher level of high-quality economic development and higher or lower climate risk exist simultaneously. For example, in 2009, the eastern and northeastern regions had higher levels of economic development, while the eastern climate risk was lower and the northeastern climate risk was higher.

#### 4.1.2. Baseline Regression Result

In order to verify Hypothesis 1, we combined Formula (1) to consider the impact of a standardized mean temperature for climate risk on high-quality economic development; as shown in column (1) of Table 3 below, the influence factor is −0.0115 and is significant at the 1% level. Therefore, climate risk significantly inhibits the high-quality development of China's economy. Among the control variables, the capital factor input, population size, and industrial structure significantly inhibits the high-quality development of China's economy at the 1% level, and technological progress, urbanization and total import and export volume significantly promote the high-quality development of China's economy.

#### 4.1.3. Endogeneity Test

In this paper, several variables that have a significant impact on high-quality economic development are added to avoid the model endogeneity problems caused by missing important variables. The following two aspects are mainly taken into consideration: first, regions with a high economic quality development index (such as Beijing, Shanghai, Zhejiang, Guangdong, etc.) have large pollution emissions, which leads to frequent extreme climates in these regions. In other words, there is a reverse causal relationship between high-quality economic development and climate risk. Second, last year's high-quality development index will continue to stimulate this year's innovative, coordinated, green, open and shared development. That is to say, the current period of high-quality economic development may be influenced by the previous period of high-quality economic development.

**Table 3.** Impacts of climate risk on high-quality economic development in China.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| L−HED | | | 0.8339 *** | | | | |
| | | | (27.68) | | | | |
| CR | −0.0115 *** | −0.0066 * | −0.0023 ** | −0.0015 ** | −0.0034 ** | −0.0159 *** | −0.0070 ** |
| | (−2.89) | (−1.79) | (−2.04) | (−2.25) | (−2.03) | (−3.72) | (−2.07) |
| CFIL | −3.1724 *** | −3.1424 *** | −3.4524 | −3.0324 ** | −5.1424 | −2.0824 *** | −3.6324 *** |
| | (−5.76) | (−6.32) | (−1.14) | (−2.23) | (−0.46) | (−6.05) | (−6.66) |
| PS | −0.0029 *** | −0.0028 *** | −0.0005 | −0.0023 ** | −0.0051 *** | −0.0033 *** | −0.0029 *** |
| | (−5.28) | (−5.05) | (−1.59) | (−2.05) | (−3.06) | (−5.43) | (−5.27) |
| LOTP | 1.3024 *** | 1.2924 *** | 1.5124 * | 2.2424 *** | 1.124 *** | 1.1824 *** | 1.2824 *** |
| | (12.19) | (11.06) | (1.94) | (6.84) | (5.36) | (11.18) | (12.06) |
| SOI | −0.2604 *** | −0.2433 *** | −0.0356 | −0.2259 ** | −0.4617 *** | −0.2694 *** | −0.2331 *** |
| | (−4.93) | (−4.68) | (−1.17) | (−2.42) | (−4.87) | (−4.80) | (−4.43) |
| Urban | 0.0030 ** | 0.0028 ** | 0.0007 | 0.0005 | 0.0057 * | 0.0024 * | 0.0031 ** |
| | (2.30) | (2.39) | (0.96) | (0.20) | (1.67) | (1.81) | (2.37) |
| TIAEV | 0.0383 *** | 0.0397 *** | 0.0068 *** | −0.2031 ** | 0.0336 *** | 0.0409 *** | 0.0393 *** |
| | (12.20) | (12.65) | (3.33) | (−2.59) | (6.73) | (11.72) | (12.2) |
| Fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 403 | 372 | 372 | 124 | 124 | 322 | 403 |
| $R^2$ | 0.7361 | 0.7330 | 0.9156 | 0.7921 | 0.7746 | 0.7610 | 0.7320 |
| Sargan tests of the *p*-value | | 0.665 | 0.998 | | | | |

*, ** and *** are significant at the 10%, 5% and 1% levels, respectively.

To this end, we use the instrumental variable method to solve the first endogeneity problem caused by reverse causality. The lag period for climate risk is taken as the instrumental variable to conduct 2SLS regression. The specific results are shown in column (2) of Table 2. At the same time, we take the lag period of high-quality economic development as the instrumental variable, apply the system GMM model combined with Formula (1) for regression to solve the second endogenous problem and the results are shown in column (3) of Table 2. It can be seen that the P values of the Sargan test in these two columns are all greater than 0.1, that is, all instrumental variables are valid, and the regression results show that climate risk significantly inhibits the high-quality development of China's economy.

#### 4.1.4. Robustness Test

This paper also carries out the robustness result measure, which is shown in Table 3 above, by combining Formula (3) and Stata software: in columns (4) and (5), considering the impact of the global financial crisis in 2008, the data of the three years after 2008 are excluded, and the impact of the COVID-19 pandemic in 2020 is also taken into account. In addition, the five development concepts were first proposed in October 2015, and are divided into two groups for consideration in this paper. That is, column (4) represents the data of the four years from 2012 to 2015, and column (5) represents the data of the four years from 2016 to 2019. The results still show that climate risk will significantly inhibit high-quality economic development. In order to avoid the influence of climate risk with high score, the first 80% of the data of climate risk ranking from small to large were used for regression in column (5), and the result (−0.0034 **) was also demonstrative of significant inhibition. In order to avoid the weak influence of climate risk on the low indicators of high-quality economic development, the regression analysis is conducted on the middle and bottom 80% of the data of high-quality economic development ranked from small to large in column (6). The result (−0.0159 ***) is that climate risk also significantly inhibits high-quality economic development at the 1% level. In column (7), standardized mean precipitation is used for measurement, and the impact factor is −0.0070 **, which means that different ways of measuring climate risk are still in line with conclusions for the high-quality development of China's economy. However, the inhibitory effect of the standardized average precipitation on the high-quality development of China's economy, given by the value 0.0070, is lower than that of the impact of the standardized average temperature on the high-quality development of China's economy, which is given by the value of 0.0115; therefore, the influence of temperature change on the high-quality development of China's economy is higher than that of precipitation change. Therefore, temperature change is selected as the measurement of climate risk in the following paper. To sum up, climate risk significantly inhibits high-quality economic development; that is, Hypothesis 1 is valid.

### 4.2. Test of Threshold Effect

In order to test Hypothesis 2, considering whether there are threshold values for the effect of climate risk on high-quality economic development under different development indexes, this paper still takes the innovative development, coordinated development, green development, open development, and shared development indexes as threshold variables, and uses a Bootstrap repeated sampling method to test their threshold characteristics. The sampling was repeated 300 times, and the results are shown in Table 4.

**Table 4.** Estimation results of threshold characteristics.

| Threshold Variable | Threshold Type | F Value | *p* Value | Critical Value | Threshold Estimate | 95% Confidence Interval |
|---|---|---|---|---|---|---|
| ID | Single | 16.82 | 0.017 | 1% | 0.6467 | [0.6338, 0.6708] |
| CD | Single | 22.20 | 0.000 | 1% | 0.7643 | [0.6890, 0.7823] |
| GD | Single | 14.47 | 0.030 | 1% | 0.8683 | [0.8607, 0.8683] |
| OD | Single | 26.62 | 0.007 | 1% | 0.3957 | [0.3885, 0.3998] |
| | Double | 16.61 | 0.017 | 1% | 0.4771 | [0.4552, 0.5145] |
| SD | Single | 4.54 | 0.353 | 10% | 0.4066 | [0.4024, 0.4081] |

In Table 4 above, there is a single threshold for the innovative development, coordinated development, and open development indexes at the 1% level, and a double threshold for the open development index at the 1% level, while there is no threshold effect for the shared development index. The specific regression results are shown in Table 5 below.

As can be seen from Table 5, with the innovation development index as the threshold variable, when the innovation development index is less than or equal to the threshold value of 0.6467, the inhibitory effect of climate risk on high-quality economic development is at the significant level of 1% (−0.0710 ***). However, when the innovation development index is greater than the threshold value of 0.6467, the inhibitory effect is significant at the 5% level (−0.0034 ***) and the value is less than 0.0710, indicating that when the innovation development index exceeds the threshold, the inhibitory effect of climate risk on high-quality economic development is weakened. The same conclusion exists when the coordinated development and green development indexes are the threshold values.

Taking the open development index as the threshold variable, when the open development index is less than or equal to the threshold value of 0.3957, the inhibitory effect of climate risk on high-quality economic development is 0.0405 at the significance level of 1%. When the threshold value of the open development index is greater than 0.3957 and less than or equal to 0.4771, the inhibition effect of climate risk on high-quality economic development is 0.0039 at the significance level of 1%. When the threshold value of the open development index is greater than 0.4771, the inhibitory effect of climate risk on high-quality economic development is 0.0020 at the significant level of 1%. It can be seen that with the increase in the threshold range, the inhibitory effect of climate risk on high-quality economic development decreases, and strengthening open development is an effective measure. The appellate conclusion makes Hypothesis 2 valid. When the development index exceeds a certain threshold, the inhibitory effect of climate risk on high-quality economic development is weakened.

**Table 5.** Regression results of panel threshold model.

| Variable | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| CR | −1.2024 ** | −1.3624 *** | −1.1624 ** | −1.2924 ** | −1.1524 ** |
| | (−2.34) | (−2.76) | (−2.26) | (−2.60) | (−2.19) |
| PS | −0.0028 * | −0.0029 ** | −0.0024 * | −0.0042 *** | −0.0024 * |
| | (−1.95) | (−2.04) | (−1.67) | (−2.86) | (−1.66) |
| LOTP | 2.2224 * | 2.8424 ** | 1.8724 * | 2.2824 ** | 6.4124 |
| | (1.90) | (2.38) | (1.61) | (2.05) | (0.57) |
| SOI | −0.1686 *** | −0.1823 *** | −0.1929 *** | −0.1777 *** | −0.1654 *** |
| | (−3.06) | (−3.34) | (−3.48) | (−3.28) | (−2.84) |
| Urban | 0.0030 ** | 0.0025 * | 0.0028 ** | 0.0033 ** | 0.0039 *** |
| | (2.15) | (1.83) | (2.03) | (2.39) | (2.74) |
| TIAEV | 0.0366 *** | 0.0390 *** | 0.0364 *** | 0.0374 *** | 0.0343 *** |
| | (6.57) | (6.97) | (6.51) | (6.82) | (6.09) |
| Interval one | −0.0710 *** | −0.0380 *** | −0.0570 *** | −0.0405 *** | |
| | (−4.28) | (−5.05) | (−4.02) | (−5.45) | |
| Interval two | −0.0034 *** | −0.0022 *** | −0.0039 *** | −0.0039 *** | |
| | (−2.94) | (−2.89) | (−2.99) | (−3.97) | |
| Interval three | | | | 0.0020 *** | |
| | | | | (3.43) | |
| N | 403 | 403 | 403 | 403 | 403 |
| $R^2$ | 0.5935 | 0.5983 | 0.6259 | 0.4806 | 0.6168 |

*, ** and *** are significant at the 10%, 5% and 1% levels, respectively.

*4.3. Mediation Effect Analysis*

In order to test Hypothesis 3, we used Stata to analyze the data from Equations (3) to (8), and obtained the following results.

4.3.1. Regression Results of Mediating Effect

Among natural disasters, drought and flood have the greatest impact on economic development. Therefore, considering the impacts of different natural disasters, individually, and combining Formulas (3)–(5), the regression results are shown in Table 6 below:

Column (1) in Table 6 above shows the significant inhibitory effect of climate risk on high-quality economic development at the 1% level (−0.0115 ***), which is the regression result of Equation (1). Column (2) shows the impact degree of climate risk on drought (8.0850*), indicating that a 1% change in standardized mean temperature leads to a 8.0850% increase in drought-affected areas, which is the regression result of Equation (3). Column (3) shows the impact degree of drought on high-quality economic development (−1.5224 **). An increase of 1% in the affected area will lead to a decrease of 1.5224% in high-quality economic development, which is the regression result of Equation (4). In column (4), drought and climate risk are analyzed in the regression equation at the same time, namely, the regression result of Equation (5). It can be seen that the impact factors for drought are −1.3124 and −1.5224 in column (3) and are similar in both significance and value, with the impact factor of climate risk being 0.0116 larger than that of column (1). Combining the results of these two factors, it can be seen that drought absorbs the inhibition effect of climate risk on high-quality economic development. Climate risk can directly inhibit high-quality economic development, or indirectly inhibit high-quality economic development in the area affected through drought, and the direct effect is smaller than the indirect effect.

**Table 6.** Regression results of the mediation effect model.

| | (1) HED | (2) Drought | (3) HED | (4) HED | (5) Flood | (6) HED | (7) HED | (8) HED |
|---|---|---|---|---|---|---|---|---|
| CR | −0.0115 *** | 8.0850 * | | −0.0116 *** | 6.8822 * | | −0.0117 *** | −0.0126 *** |
| | (−2.89) | (1.45) | | (−2.78) | (1.90) | | (−2.94) | (−2.85) |
| Drought | | | −1.5224 ** | −1.3124 ** | | | | −1.3624 ** |
| | | | (−2.87) | (−2.30) | | | | (−2.17) |
| Flood | | | | | | −0.1010 ** | −0.1110 ** | −0.1201 * |
| | | | | | | (−1.97) | (−2.20) | (−1.74) |
| Control variable | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| N | 403 | 403 | 403 | 403 | 403 | 403 | 403 | 403 |
| $R^2$ | 0.7361 | 0.1209 | 0.7296 | 0.7361 | 0.1808 | 0.7303 | 0.7373 | 0.7393 |

*, ** and *** are significant at the 10%, 5% and 1% levels, respectively.

Column (5) shows the impact degree of climate risk on floods (6.8822 *), indicating that a 1% change in standardized mean temperature leads to a 6.8822% increase in flood-affected areas, which is the regression result of Equation (3). It is smaller than the impact factor for drought, indicating that climate risk has a greater impact on drought-affected areas. Column (6) shows the degree of impact of drought on high-quality economic development (−0.1010 **). A 1% increase in flood-affected areas will lead to a 0.1010% reduction in high-quality economic development, which is also the regression result of Equation (4). The value is also smaller than that of drought, indicating that drought has a greater impact on high-quality economic development. Column (7) puts flood and climate risk into the regression equation at the same time for analysis, as can be seen in the regression result of Equation (5). It can be seen that the impact factors for flood are −0.1110 and −0.1010 in column (3) and are similar in both significance and value. The impact factor for climate risk is −0.0117, which is slightly larger than that of column (1), −0.0115. Therefore, floods can increase the inhibition effect of climate risk on high-quality economic development. Climate risk can directly inhibit high-quality economic development, or indirectly inhibit high-quality economic development in flood disaster areas, and the direct effect is smaller than the indirect effect.

In column (8), climate risk, drought, and floods are put into the regression equation as explanatory variables. The impact factor for climate risk (−0.0126 ***) is greater than the result of column (1), and the impact factor for drought (−1.3624 **) is greater than the result of column (4). The impact factor for floods (−0.1201 *) is greater than the result in column (7). Therefore, the impact of a natural disaster cannot be taken into account separately, but the impact of drought and floods should be understood comprehensively, that is, the climate risk increases by 1%, and the high-quality economic development directly decreases by 0.0115%. It can also increase by 14.9672% through natural disasters (the sum of drought and floods), indirectly reduce high-quality economic development by 0.1300%, and the direct effect of climate risk is less than the indirect effect, that is, H3a in Hypothesis 3 is true.

#### 4.3.2. The Moderating Effect of Green Innovation Input

The inhibition effect of climate risk reduction on high-quality economic development may also be designed to be the regulation effect of green innovation input and output. Combining Formulas (6)–(8), the regulation of green innovation input is shown in Table 7 below:

**Table 7.** Regression results of the moderating effect of green innovation input.

| | (1) HED | (2) Drought | (3) Flood | (4) HED | (5) HED |
|---|---|---|---|---|---|
| CR | −0.0266 ** | 5.0125 * | 20.2939 * | | |
| | (−2.18) | (1.70) | (1.76) | | |
| GII | 0.2599 ** | −10.2220 * | −137.8084 *** | 0.2784 * | 0.2270 * |
| | (2.41) | (−1.91) | (−2.83) | (1.75) | (1.69) |
| Drought | | | | 0.1580 | |
| | | | | (0.75) | |
| Flood | | | | | −0.2560 * |
| | | | | | (−1.76) |
| GII × CR | 0.1431 ** | −27.4222 ** | −129.3860 ** | | |
| | (2.24) | (2.03) | (−1.79) | | |
| GII × Drought | | | | −0.1754 ** | |
| | | | | (−2.00) | |
| GII × Flood | | | | | −0.2291 ** |
| | | | | | (2.12) |
| Control variable | Yes | Yes | Yes | Yes | Yes |
| Fixed effect | Yes | Yes | Yes | Yes | Yes |
| N | 403 | 403 | 403 | 403 | 403 |
| $R^2$ | 0.7434 | 0.1209 | 0.2031 | 0.7364 | 0.7365 |

*, ** and *** are significant at the 10%, 5% and 1% levels, respectively.

Column (1) in Table 7 above shows the results of Equation (6). The interaction term $GI_{it} \times CR_{it}$ coefficient is 0.1431, indicating that green innovation input positively regulates climate risk and has a significant inhibitory effect on high-quality economic development at the 5% level. Column (2) shows the results of Equation (7). The interaction term $GI_{it} \times CR_{it}$ coefficient is −27.4222, indicating that green innovation input negatively regulates climate risk and promotes drought, which is significant at the 5% level. Column (3) also shows the results of Equation (7). The interaction term $GI_{it} \times CR_{it}$ coefficient is −129.3860, indicating that green innovation input negatively regulates climate risk, which is significant at the level of 5%. Column (4) shows the results of Equation (8). The interaction term $GII \times Drought$ coefficient is −0.1754, indicating that green innovation input negatively moderates the inhibitory effect of drought on high-quality economic development, which is significant at the 5% level. Column (5) also shows the results of Equation (8). The interaction term $GI_{it} \times Flood$ coefficient is −0.2291, indicating that green innovation input negatively regulates the inhibitory effect of flood on high-quality economic development, and it is significant at the 5% level. The regulatory effect of green innovation on floods is greater than that of drought. To sum up, H3b of Hypothesis 3 is valid.

#### 4.3.3. The Moderating Effect of Green Innovation Output

The regulatory regression results of green innovation output obtained by adopting the same approach are shown in Table 8 below.

**Table 8.** Regression results of the moderating effect of green innovation output.

| | (1) HED | (2) Drought | (3) Flood | (4) HED | (5) HED |
|---|---|---|---|---|---|
| CR | −0.0176 * | 8.9097 * | 5.39684 * | | |
| | (−1.53) | (1.79) | (1.68) | | |
| GIO | 0.2743 ** | −21.14262 * | −157.1551 *** | 0.3545 ** | 0.2751 ** |
| | (2.08) | (−1.89) | (−2.77) | (2.16) | (2.00) |
| Drought | | | | 0.3810 * | |
| | | | | (1.66) | |
| Flood | | | | | −0.1570 * |
| | | | | | (−1.73) |
| GIO × CR | 0.0610 ** | −13.5510 ** | −68.4120 ** | | |
| | (2.56) | (−2.02) | (−2.00) | | |
| GIO × Drought | | | | −0.1149 ** | |
| | | | | (−2.05) | |
| GIO × Flood | | | | | −0.1130 ** |
| | | | | | (2.58) |
| Control variable | Yes | Yes | Yes | Yes | Yes |
| Fixed effect | Yes | Yes | Yes | Yes | Yes |
| N | 403 | 403 | 403 | 403 | 403 |
| $R^2$ | 0.7422 | 0.1211 | 0.2003 | 0.7380 | 0.7365 |

*, ** and *** are significant at the 10%, 5% and 1% levels, respectively.

The results of columns (1) to (5) in Table 8 are the same as those in Table 7, highlighting that green innovation output positively moderates the inhibitory effect of climate risk on high-quality economic development, green innovation output negatively moderates the promoting effect of climate risk on drought or flood and green innovation output negatively moderates the inhibitory effect of drought or floods on high-quality economic development. The positive adjustment effect of green innovation output on climate risk on high-quality economic development (0.0610 **) is smaller than that of green innovation input (0.1431 **). The negative adjustment effect of green innovation output on climate risk for drought (−13.5510 **) and floods (−68.4120 **) is less than that of green innovation input. Drought (−0.1149 **) and floods (−0.1130 **) negatively moderated by green innovation output had less of an inhibitory effect on high-quality economic development than that of green innovation input. This may be because green patents have a certain loss between input and output, resulting in the regulation effect of green innovation input being greater than that of green innovation output. Additionally, that also means that H3b in Hypothesis 3 is true.

## 5. Discussion, Conclusions, and Implications

### *5.1. Discussion*

Indeed, "development" is the main theme in today's world, and how to realize the sustainable development of ecology and the high quality of economic development is the focus of current academic research [46,47]. As the biggest developing country in the world, China's development experience has implications for all countries. China's issues of drought, floods, and other natural disasters suppressing high-quality economic development require green innovation as an effective way to relieve the inhibition [48,49], which will also in turn affect the pace of global economic growth [50]. Therefore, correct understanding of the climate risks for China's economy actively improves the green innovation input and output of adjustment and is a critical step in preventing climate risk.

However, this article acknowledges that the effects of climate risk on quality and economic development are still big issues. First of all, from the point of view of research, for different indicators (climate risk and high-quality economic development), measurements should refer to the literature more frequently and should be calculated using different methods to reduce the error brought about by the endogenous model. Secondly, in terms of research data, this study uses China's provincial data, therefore the final results may be affected by regional economic development and may not be entirely accurate at the national scale. Thirdly, there are many factors affecting the development of China's economy, and we should take into account that climate will inhibit the development of agricultural economy in conjunction with other factors that affect the development of the economy as a whole; therefore, this requires further investigation.

*5.2. Conclusions*

The panel data of 31 provinces in China (excluding Hong Kong, Macao, and Taiwan) taken from 2009 to 2021 were used to prove the three hypotheses in this paper using the benchmark regression model, panel threshold model, and adjusted mediation effect model, and the following conclusions were reached.

Firstly, climate risk significantly inhibits high-quality economic development in China, which holds true for multiple model scenarios. Moreover, a high-scoring climate risk has a stronger inhibitory effect on high-quality economic development.

Secondly, when different development degrees (except shared development) exceed a certain threshold, climate risk has a lower inhibitory effect on high-quality economic development.

Thirdly, a 1% increase in climate risk can directly reduce high-quality economic development by 0.0115%. It can also increase by 14.9672% through natural disasters, which can indirectly reduce high-quality economic development by 0.1300%. The indirect effect is greater than the direct effect.

Finally, green innovation positively moderates the inhibitory effect of climate risk on high-quality economic development, negatively moderates the promoting effect of climate risk on drought or floods; in addition, the inhibitory effect of drought or floods on high-quality economic development and the moderating effect of green innovation input is greater than that of green innovation output.

*5.3. Implications*

The conclusions of this paper are mainly to provide enlightenment for quantifying the understanding of climate risk, effectively improving the degree of development and reasonably strengthening the input and output of green innovation to ensure the high-quality development of China's economy, which are mainly reflected in the following three aspects.

Firstly, climate change is unpredictable, but the harm is obvious in terms of production and human life and more direct impacts on economic development, so realizing its harmfulness can help us accurately take preventive measures. Dredge drainage facilities in advance before the rainy season, for example, could help us avoid floods causing harm to production and human life.

Secondly, development is a key global theme, and the high-quality development of the Chinese economy is an important way to realize the road of common prosperity for all, also helping to further reduce climate risk for the inhibitory effect of high-quality economic development. Furthermore, the five development ideas—"innovation, coordination, green, open and sharing"—help to promote the quality of economic development and can be applied in different geographic areas.

Thirdly, climate risk will lead to frequent natural disasters, thus inhibiting high-quality economic development. Green innovation input and output can directly positively or indirectly regulate the inhibiting effect of climate risk on high-quality economic development. Therefore, green innovation can be strengthened, not only from the perspective of green patents, but also from the belief that "lucid waters and lush mountains are gold and silver mountains". Strengthening public awareness and the education of everyone will help to consolidate the protection of "clean water and green mountains", ensuring damaging behavior is brought under control by the relevant laws, thus further developing green innovation and promoting high-quality economic development.

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## References

1. Chang, Y.; Lai, L. Effects and Mechanisms of China's Pilot Free Trade Zones on Green and High-Quality Development from the Dual-Circulation Perspective. *Sustainability* **2023**, *15*, 947. [CrossRef]
2. Fu, Y.; Zhuang, H.; Zhang, X. Do environmental target constraints of local government affect high-quality economic development? Evidence from China. *Environ. Sci. Pollut. Res.* **2023**, *30*, 56620–56640. [CrossRef]
3. Wang, C.-H.; Chen, H.; Jiang, Z.-Y.; Zhang, X.-X. Design and experimental validation of an all-day passive thermoelectric system via radiative cooling and greenhouse effects. *Energy* **2023**, *263*, 125735. [CrossRef]
4. Kim, J.-S.; Jain, S. Precipitation trends over the Korean peninsula: Typhoon-induced changes and a typology for characterizing climate-related risk. *Environ. Res. Lett.* **2011**, *6*, 034033. [CrossRef]
5. Bogmans, C.; Kiyasseh, L.; Matsumoto, A.; Pescatori, A. Energy, Efficiency Gains and Economic Development: When Will Global. Energy Demand Saturate. *IMF Work. Pap.* **2020**, *20*, 253. [CrossRef]
6. Pan, J.; Zhang, Y. The strategic process and role transformation of climate change in China: From preventing "black swan" disasters to confronting "gray rhinoceros" risks. *China Popul. Resour. Environ.* **2018**, *28*, 1–8.
7. Sun, C.; Zhang, Q. Climate Change, Government Capacity and Dynasty Rise and Fall: An Empirical Study Based on the historical experience of China in 2000 years. *Econ. Q. Rev.* **2019**, *18*, 311–336. [CrossRef]
8. Peng, W.; Yin, Y.; Kuang, C.; Wen, Z.; Kuang, J. Spatial spillover effect of green innovation on economic development quality in China: Evidence from a panel data of 270 prefecture-level and above cities. *Sustain. Cities Soc.* **2021**, *69*, 102863. [CrossRef]
9. Cao, Z.; Chen, S. Migration mechanism, current situation and countermeasures of climate migration from the perspective of climate risk. China Population. *Resour. Environ.* **2012**, *22*, 45–50.
10. Dominguez, C.; Jaramillo, A.; Cuéllar, P. Are the socioeconomic impacts associated with tropical cyclones in Mexico exacerbated by local vulnerability and ENSO conditions? *Int. J. Clim.* **2020**, *41*, E3307–E3324. [CrossRef]
11. Ding, Y.; Sun, Q. Impacts of climate risk on Agricultural economic development in China: Heterogeneity and Mechanism Analysis. *Financ. Res.* **2022**, *11*, 111–131.
12. Liu, Q.; Fan, W.; Zhang, W.; Wang, Y. Financing mechanism and China's role in global climate public goods supply. China Population. *Resour. Environ.* **2018**, *28*, 8–16.
13. Jianu, I. A comprehensive view on the manifestations of aggregate demand and aggregate supply shocks in Greece, Ireland, Italy and Portugal. *Theor. Appl. Econ.* **2016**, *XXIII*, 207–224.
14. Yun, J.J.; Mohan, A.V.; Zhao, X.; Dey, A.; Gupta, A.; Singh, G. Open Innovation at Different Levels for Higher Climate Risk Resilience. Science. *Technol. Soc.* **2017**, *22*, 388–406. [CrossRef]
15. Weryński, P. Resentment Barriers to Innovation Development of Small and Medium Enterprises in Upper Silesia. *Sustainability* **2022**, *14*, 15687. [CrossRef]
16. Liu, X. Analysis of Hebei's Development Path in the Coordinated Development of Beijing, Tianjin and Hebei. *Acad. J. Bus. Manag.* **2022**, *4*, 41–46. [CrossRef]
17. Chen, B.; Xu, X.; Zhang, Y.; Wang, J. The temporal and spatial patterns and contributing factors of green development in the Chinese service industry. *Front. Environ. Sci.* **2022**, *10*, 126–131. [CrossRef]
18. Hunter, A. Making Open Development Inclusive: Lessons from IDRC Research. *Can. J. Commun.* **2021**, *46*, 389–391. [CrossRef]

19. Yan, C. The Generation Mechanism of Relational Rules Consciousness Under the Concept of Shared Development. *Soc. Sci.* **2022**, *11*, 126. [CrossRef]
20. Lin, B. China's High-Quality Economic Growth in the Process of Carbon Neutrality. *China Financ. Econ. Rev.* **2022**, *11*, 3–22. [CrossRef]
21. Campello, T.; Pedro, H.; Gonçalves, D.A.; de Mendes, A.; Collaço, F.; dos Lopes Santos, K.; Canil, K.; de Cabral, S.J.W.; Jacobi, P.R. Vulnerability of the São Paulo Macro Metropolis to Droughts and Natural Disasters: Local to Regional Climate Risk Assessments and Policy Responses. *Sustainability* **2020**, *13*, 114. [CrossRef]
22. Wei, J.T.; Khan, S. Climate risk, natural resources, and climate change mitigation options in BRICS: Implications for green recovery. *Environ. Sci. Pollut. Res.* **2023**, *30*, 29015–29028. [CrossRef] [PubMed]
23. Wang, L.; Shu, Z.; Wang, G.; Peng, T.; Lin, Q.; Zhou, J. Spatial and temporal evolution of multi-scale meteorological drought in the Hanjiang River Basin from 1961 to 2018. *Resour. Environ. Yangtze Basin* **2021**, *30*, 1649–1658.
24. Fang, X.; Jin, D. Research on green innovation benefits of GEM listed companies. *Econ. Res. J.* **2020**, *55*, 106–123.
25. Zhang, W.; Xu, F.; Wang, X. How Green Transformational Leadership Affects Green Creativity: Creative Process Engagement as Intermediary Bond and Green Innovation Strategy as Boundary Spanner. *Sustainability* **2020**, *12*, 3841. [CrossRef]
26. Liverpool-Tasie, L.S.; Parkhi, C.M. Climate Risk and Technology Adoption in the Midstream of Crop Value Chains: Evidence from Nigerian Maize Traders. *J. Agric. Econ.* **2020**, *72*, 158–179. [CrossRef]
27. Yu, S.; Hu, X.; Yang, J. Housing prices and carbon emissions: A dynamic panel threshold model of 60 Chinese cities. *Appl. Econ. Lett.* **2020**, *28*, 170–185. [CrossRef]
28. Guo, Y.; Guo, B.; Zhang, R. Study on the influence of digital economy on carbon emission intensity under the background of double carbon: Based on the moderated mediation effect test. *Mod. Manag. Sci.* **2022**, 138–147.
29. Zhang, N.; Sun, J.; Tang, Y.; Zhang, J.; Boamah, V.; Tang, D.; Zhang, X. How Do Green Finance and Green Technology Innovation Impact the Yangtze River Economic Belt's Industrial Structure Upgrading in China? A Moderated Mediation Effect Model Based on Provincial Panel Data. *Sustainability* **2023**, *15*, 2289. [CrossRef]
30. Sun, H.; Gui, H.; Yang, D. China's provincial economy in the development of high quality measure and evaluation. *J. Zhejiang Acad. Soc. Sci.* **2020**, *36*, 14+4–155. [CrossRef]
31. Song, Y.; Zhang, Y.; Zhang, Y. Economic and environmental influences of resource tax: Firm-level evidence from China. *Resour. Policy* **2022**, *77*, 102751. [CrossRef]
32. Zhang, Y.; Song, Y.; Zou, H. Non-linear effects of heterogeneous environmental regulations on industrial relocation: Do compliance costs work? *J. Environ. Manag.* **2022**, *323*, 116188. [CrossRef] [PubMed]
33. Luo, C.; Wei, D.; Su, W.; Lu, J. Association between Regional Digitalization and High-Quality Economic Development. *Sustainability* **2023**, *15*, 1909. [CrossRef]
34. Wratten, E.E.; Cooley, S.W.; Mann, P.J.; Whalen, D.; Fraser, P.; Lim, M. Physiographic Controls on Landfast Ice Variability from 20 Years of Maximum Extents across the Northwest Canadian Arctic. *Remote Sens.* **2022**, *14*, 2175. [CrossRef]
35. Gupta, R.; Nel, J.; Salisu, A.A.; Ji, Q. Predictability of economic slowdowns in advanced countries over eight centuries: The role of climate risks. *Finance Res. Lett.* **2023**, *54*, 103795. [CrossRef]
36. Liu, G.; Duan, Y.; Liu, Y. Economic policy uncertainty, asset reversibility and fixed asset investment. *Econ. Res. J.* **2019**, *54*, 53–70.
37. Mu, G.; Hou, M.; Guo, C.; Zhang, Y. On the Chinese Modernization with huge population Scale: Opportunities, advantages, Risks and Challenges. *J. China Agric. Univ. Soc. Sci. Ed.* **2023**, *40*, 5–22. [CrossRef]
38. Zheng, J.; Jing, J. Based on skill bias the decomposition of economic growth momentum of technological progress. *J. South. Econ.* **2023**, 28–48. [CrossRef]
39. Li, D.; Zhao, X.; Ke, J. Fiscal adjustment and change of industrial structure and economic growth. *J. Jianghuai BBS* **2022**, 71–79. [CrossRef]
40. Zhao, Y. Factor Allocation Promoting Common Prosperity?—Based on the perspective of land urbanization and urban-rural income gap. *J. Yun-Nan Univ. Financ. Econ.* **2022**, *38*, 22–41. [CrossRef]
41. Wei, Y.; Zhang, X.; Sun, Y.; Bai, Y.; Wang, S. Analysis and forecast of China's Import and export situation in 2021. *Proc. Chin. Acad. Sci.* **2021**, *36*, 47–53. [CrossRef]
42. Benedict, S.J. The effects of hierarchy, centralization and formalization on municipal fiscal health: An empirical test of the bureaucratic ideal. *Public Adm.* **2017**, *95*, 791–806. [CrossRef]
43. Losso, A.; Challis, A.; Gauthey, A.; Nolan, R.H.; Hislop, S.; Roff, A.; Boer, M.M.; Jiang, M.; Medlyn, B.E.; Choat, B. Canopy dieback and recovery in Australian native forests following extreme drought. *Sci. Rep.* **2022**, *12*, 21608. [CrossRef]
44. Wang, Y.G.; Li, X. Promoting or inhibiting: The impact of government R&D subsidies on corporate green innovation performance. *China Ind. Econ.* **2023**, *419*, 131–149. [CrossRef]
45. Ahmed, R.R.; Akbar, W.; Aijaz, M.; Channar, Z.A.; Ahmed, F.; Parmar, V. The role of green innovation on environ-mental and organizational performance: Moderation of human resource practices and management commitment. *Heliyon* **2023**, *9*, e12679. [CrossRef]
46. Stamatios, N.; Michalis, S.; Grigorios, K.; Garyfallos, A.; Miltiadis, C.; Spyros, G.; Athanasios, B.; Apostolia, K. Renewable Energy and Economic Growth: Evidence from European Countries. *Sustainability* **2018**, *10*, 2626. [CrossRef]
47. Smionescu, M.; Păuna, C.B.; Diaconescu, T. Renewable Energy and Economic Performance in the Context of the European Green Deal. *Energies* **2020**, *13*, 6440. [CrossRef]

48. Kose, N.; Bekun, F.V.; Alola, A.A. Criticality of sustainable research and development-led growth in EU: The role of renewable and non-renewable energy. *Environ. Sci. Pollut. Res. Int.* **2020**, *27*, 12683–12691. [CrossRef] [PubMed]
49. Sadeghi, A.R.; Bahadori, Y. Urban Sustainability and Climate Issues: The Effect of Physical Parameters of Streetscape on the Thermal Comfort in Urban Public Spaces; Case Study: Karimkhan-e-Zand Street, Shiraz, Iran. *Sustainability* **2021**, *13*, 886. [CrossRef]
50. Ryzhkov, A.F.; Bogatova, T.F.; Maslennikov, G.E.; Osipov, P.V.; Nizov, V.A. Creation of energy-efficient and environmentally friendly energy sources on fossil fuels to address global climate issues. *J. Phys. Conf. Ser.* **2020**, *1677*, 012115. [CrossRef]