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The Impact of Climate Change on Financial Stability

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Abstract: Climate risks and response policies have important impacts on a country's macroeconomic development and financial stability. Based on the data from 2005 to 2020, this paper takes temperature deviation as the main representative variable of climate risk to study the impact of climate change on financial stability. The two-way fixed-effect results show that there is a negative relationship between temperature deviation and financial stability, and the influence of temperature deviation has a lag. However, the effects of temperature deviation on financial stability varied across the samples. The central provinces, non-coastal provinces, non-Yangtze River Delta and Pearl River Delta provinces, and risk zone I had stronger temperature responses and financial stability was affected to a greater extent. The other regions experienced less of an impact.

Keywords: climate change risks; financial stability; temperature deviation

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1. Introduction

Climate is widely recognized as one of the major sources of financial risk. Climate change will accelerate the melting of ice and snow in the Arctic and increase the frequency of natural disasters, such as flooding, typhoons, droughts, and sea level rise [1]. The high frequency of natural disasters causes the loss of assets [2,3], which has a negative impact on social development [4].

The Intergovernmental Panel on Climate Change (IPCC, 2021) stated that the average surface temperature increased by about 1.09 °C between 2011 and 2020 compared to the period from 1850 to 1990. The negative effects of rising temperatures will exacerbate the additive and cascade effects of disasters, and risks will be transmitted across sectors and regions. Bolton [5] emphasized the importance of central banks and financial regulators in the process of mitigating climate change. The United Nations Framework Convention on Climate Change (UNFCCC) defined investment finance that requires global cooperation as climate finance.

Climate change brings negative consequences for financial institutions and financial markets. It leads to a decline in the rate of increment of financial assets and investment returns [6], which exacerbates financial market volatility. The level of systemic financial risk is pushed up indirectly through the banking, securities, and insurance markets under the high frequency of climate risks. Insurance companies are directly affected because they provide insurance against the loss of physical assets and property [7]. Climate change affects economic aggregate indicators, such as GDP [8,9], and presents regional differences [10].

Grippa [11] argued that climate change causes physical risk and transition risk, both of which will lead to economic losses and a decline in people's quality of life. Potential economic costs and financial losses due to long-term gradual changes in climate are considered as typical of physical risk. The frequent occurrence of climate extremes can reduce production efficiency [12–14], affect business profitability [15–17], and increase the credit cost of firms. The result is an increase in loan defaults and a decrease in cash flows. Simultaneously, asset devaluation is inevitable [18]. Risks will also rise for the banking sector.

Transition risk refers to policy and legal changes, technological upgrading, and market developments in response to the financial risks arising from climate change. This usually occurs in the process of low-carbon transition [19]. Rising energy and emissions costs can lead to cost shifting in the green transition, resulting in higher total production costs [20]. Companies with high energy consumption and emissions may even face production restrictions, shutdowns, or even withdrawal [21]. Policies to address climate change can impact employment [22,23], inflation, and GDP at least in the short and medium term [24].

The emergence of climate extremes poses a serious threat to the security of human life and social wealth. It is necessary to focus on the potential negative externalities between climate change and financial institutions [25]. At present, scholars prefer to study the climate models and policies of developed countries. China's economy is vulnerable to unsettled weather because of its abundant geographical area and population base. This paper aims to examine whether climate change has a significant effect on financial stability, which provides substantial research support for the development of China's financial market.

The main contributions are as follows: (1) This paper innovatively investigates the impact of climate change on the financial stability state index (FSCI) of China. We focus on the financial markets, rather than on a single sector of the financial system. Therefore, the results are more comprehensive, scientific, and referential. (2) In order to study the negative externalities generated by climate, this paper uses temperature deviation as the main explanatory variable in the regression process. The result is more credible. (3) We study the impact mechanism of climate change on financial stability from the perspective of the economic market, which enriches the existing research results with a detailed analysis of different samples.

The remainder of this study is structured as follows. The second part introduces the literature review and hypotheses. The third part details the methodology. The data are explained in the fourth part. Part five discuss the main regression results. Part six presents the robustness test. A heterogeneity analysis and mediation effect test are provided in the seventh part. The final part provides conclusions and recommendations.

2. Literature Review and Hypotheses

2.1. Literature Review

2.1.1. Financial Risk from Climate Change

Batten [26] reckoned that climate change severely effects the financial system's stability [27,28] and may trigger financial systemic risk [29]. When a chain reaction occurs in the substantial economy, the profits and capital stock of financial institutions will be depreciated with great intensity [30]. Financial institutions that are highly leveraged will amplify the impact of climate change on the real economy and financial markets, and financial asset pricing strategies will also change with the emergence of extreme weather [31]. The vulnerability of the financial system will increase as a result. A stable financial system can effectively perform the tasks of savings allocation, capital investment, risk pricing and distribution, and ulteriorly ensure the smooth operation of the payment system. Climate change hinders the development of the financial sector [32]. The banking industry should view progress on climate change as a major shock event [33]. To reduce the risks posed to the financial sector by climate disasters, the financial supervisory agency has mandated banks to increase their capital adequacy ratio [34].

2.1.2. Research on Climate Policy Modeling

Many scholars have focused on climate policy models. Nordhaus [35] found that climate policies need to pass through the economic system to exert policy effects. Batten [26] verified the transition risk by testing the economic impact of major climate events, and believes that policy corrections caused by climate change will affect the value of corporate assets through "brown" capital goods, thereby acting on financial stability. Dafermos [36] quantitatively analyzed how the financial system will be damaged if the low-carbon economy is inefficient. Dunz [37] added the climate sentiment of banks into the stock-flow consistency model (SFC model) to analyze the impact of the combination of green support policies on economic and financial stability. Roncoroni [38] proposed that the combination of a climate stress test and ex-ante network valuation of financial assets could effectively analyze the shocks consequence on financial stability caused by the imbalance of public utilities in climate policy scenarios (Figure 1).

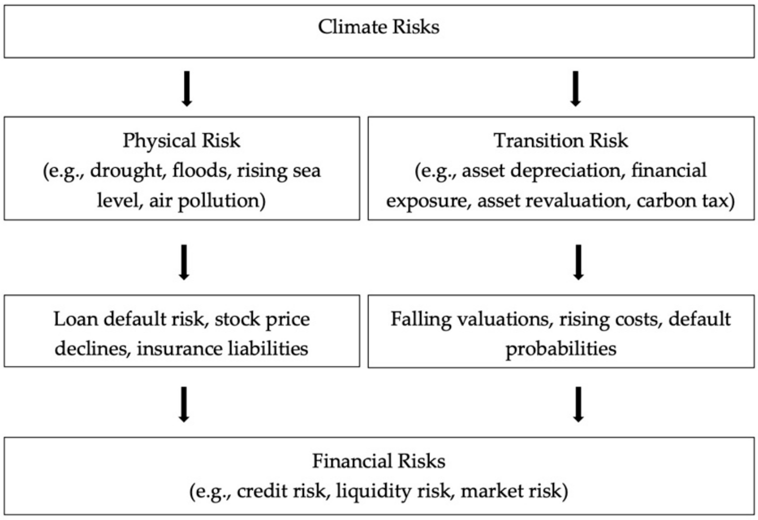

Figure 1. The relationship between climate risks and financial risks.

2.2. Hypotheses

The occurrence of extreme climate events can cause the devaluation of enterprises assets [39]. The higher the risk of extreme climate change in the area where the enterprise is located, the greater the profit volatility of the enterprise and the lower the likelihood of loan repayment [17,40]. If the average temperature of the Earth's surface rises by 2.5 °C above pre-industrial levels, about 2% of the world's financial assets will become risky assets. An arid climate will significantly reduce the total factor productivity of a country's agriculture [41]. Dafermos [15] measured the risk of climate change through the stock-flow model and found that climate risk would increase the default risk of financial and non-financial enterprise sectors by destroying physical assets and deteriorating the cash flow of enterprises. Insurance companies, the protection arm of financial institutions, face higher expenses under extreme climate risks and show less willingness to provide risk insurance. Thus, the insurance gap is widened [42]. At the same time, investor sentiment is related to extreme weather, and underestimating climate-related risks may lead to over-leveraging or asset price bubbles [43]. Based on the above analysis, this paper proposes the following research hypothesis:

Hypothesis 1 (H1). *Climate change will negatively affect the financial stability state index (FSCI).*

China is facing extreme climate risks, and climate change will influence macroeconomic output [8,44–47]. Dell [48] linked the total per capita economic growth to a linear function with independent variables for temperature and precipitation, and found that temperature changes have a negative impact on economic conditions in developing countries. Feyen [49] noted that extreme weather events accompanied by high frequency and intensity generate a significant impact on the productivity of specific crops and regions. Changes in temperature and precipitation patterns are the same.

Xue [50] found that the high temperatures caused by climate change will increase local financial pressure, reduce tax revenue, and exacerbate regional inequality in many aspects. Climate change can cause people to migrate away from their residences, negatively impacting local incomes [51]. Collier [52] certified that when farm incomes suffer from adverse prices or climate change, borrowers are unable to repay due to over-indebtedness, leading to a weakening or collapse of the banking system. High-temperature weather leads to lower productivity [53–55] and higher production costs [56]. In this case, the ability of enterprises to pay taxes is reduced, resulting in a decline in fiscal revenue, which in turn reflects regional financial stability. Based on the above analysis, this paper proposes the following research hypotheses:

Hypothesis 2 (H2). *Changes in temperature will negatively affect the gross regional product (GRP), which in turn effects the level of financial stability.*

Hypothesis 3 (H3). *Changes in temperature will negatively affect the local fiscal revenue (LFR), which in turn effects the level of financial stability.*

3. Methodology

3.1. Two-Way Fixed-Effect Model

The main advantage of panel data is that it can address the problem of missing variables, which are not present in many cross-sectional and time-series data. Missing variables are one of the main sources of endogeneity problems and are caused by unobservable individual differences or heterogeneity. If individual differences do not change over time, panel data provide an additional tool to address the problem of missing variables. Second, panel data have both cross-sectional and temporal dimensions, providing more information on the dynamic behavior of individuals. The estimation results are more stable if the panel data volume is large. The model is as follows:

$$FSCI_{it} = \alpha + \beta_1 TempD_{it} + \beta_2 lnLDR_{it} + \beta_3 lnCPI_{it} + \beta_4 lnPiifa_{it} + \beta_5 lnComT_{it} + \beta_6 TaxR_{it} + \varepsilon_{it} \quad (1)$$

where FSCI is the dependent variable and denotes the financial stability state index of China. TempD is the main explanatory variable and represents the temperature deviation. lnLDR, lnCPI, lnPiifa, lnComT, and TaxR are the control variables and denote the deposit-to-loan ratio, consumer price index, fixed asset investment price index, business turnover, and tax revenue, respectively. The subscripts i and t denote the region and year, respectively. α denotes the constant term, β_i denotes the variable coefficient, and ε_{it} denotes the residual.

3.2. Mechanism Analysis

To further confirm the existence of the mechanism, this paper introduces a stepwise regression method to construct the mediating effect model by referring to the relevant studies by Hayes [57] and Baron [58]. The model is set as follows:

$$FSCI_{it} = \alpha + \beta_1 TempD_{it} + \beta_2 Control_{it} + \mu_i + \varphi_i + \varepsilon_{it} \quad (2)$$

$$ECO_{it} = \alpha + \delta_1 TempD_{it} + \delta_2 Control_{it} + \mu_i + \varphi_i + \varepsilon_{it} \quad (3)$$

$$FSCI_{it} = \alpha + \gamma_1 TempD_{it} + \gamma_2 ECO_{it} + \gamma_3 Control_{it} + \mu_i + \varphi_i + \varepsilon_{it} \quad (4)$$

We consider that climate change negatively impacts regional economies and further reduces financial stability. In models (3) and (4), ECO_{it} is used as the mechanism variable to reflect local economic indicators, which are the gross regional product (GRP) and local fiscal revenue (LFR), separately. The intermediate effect is measured by δ_1 and γ_2. ε is a random perturbation term, and the other variables are consistent with Formula (1) (Figure 2).

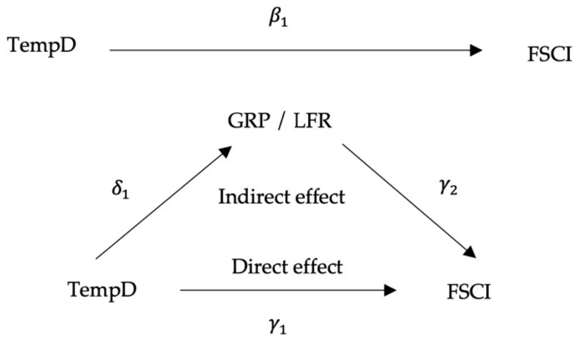

Figure 2. The impact mechanism of climate change on the financial stability state index of China.

There are three steps. The first step is to test the coefficient β_1 in Formula (2), which is the total effect of temperature deviation on FSCI. The second step checks the coefficient δ_1 in Formula (3), that is, the relationship between temperature deviation and ECO. The third step is to test the coefficients γ_1 and γ_2 in Formula (4) after controlling for the intermediary variable. If both δ_1 and γ_2 are significant, the mediating effect is significant. However, if the mediating effect is not supported, the Sobel test is required. Otherwise, there is no need.

4. Sample Selection and Data Sources

4.1. Sample Selection

This paper takes 30 provinces (except Tibet) as the research target and selected the annual data from 2005 to 2020 for analysis. The data were obtained from the website of the National Bureau of Statistics, CSMAR database, ESP database, the China City Statistical Yearbook, and so on.

4.2. Data Sources

4.2.1. Dependent Variable

This paper calculates the financial stability state index (FSCI) of China by using a principal component analysis (PCA). To ensure the scientificity and rationality of the index, we selected 12 indicators from four dimensions: the financial market, financial institutions, macroeconomic environment, and international environment. The idea of a PCA is to use the method of dimensionality reduction to divide the variables with high correlation and close connection into the same class of variables, and each class of variables represents an essential factor, thus forming a few unrelated comprehensive indicators. Because of the inconsistency of the statistical units in the collected data, it is necessary to carry out dimensional processing in the data analysis.

$$X_{it}^{*} = \frac{\left(X_{it} - \overline{X}_i\right)}{\sigma_i} \tag{5}$$

where X_{it}^{*} denotes the data value of the ith data at time t after quantization, X_{it} denotes the actual value of the ith data at time t, $\overline{X}_i$ denotes the mean of variable X_i, and σ_i denotes the standard deviation of variable X_i.

According to the method of PCA, the weight of the different basic indicators is given, and then the financial stability state index (FSCI) of China is synthesized. The FSCI is set as follows:

$$FSCI_t = \sum \omega_i^{*} X_{it}^{*} \tag{6}$$

where $FSCI_t$ represents the financial stability state index at the t period, and ω_i represents the weight of variable $X_{it}^{*}.\omega_i$ needs to satisfy the condition that $\Sigma\omega_i = 1$.

4.2.2. Independent Variable and Mediating Variables

Temperature deviation (TempD) is the main explanatory variable and stands for climate change. The standard deviation of temperature should be a better measure than the absolute change in temperature [59]. Song [60] measured the impact of temperature deviation on bank systemic risk by using quarterly temperatures versus historical averages. In this paper, the Chinese market is studied. Temperature deviation refers to the degree that the average temperature of each province deviates from the average temperature of our country in each year. The specific algorithm is the annual average temperature value of a province in a certain year minus the annual average temperature value of China. The annual average temperature data comes from the website of the National Center for Environmental Information (NCEI). According to the daily meteorological indicators recorded at each station, the daily average temperature value of each region is calculated, and then the annual average temperature is calculated according to the daily value.

There are two mediating variables in this paper. (1) The gross regional product (GRP): as a monetary unit of macroeconomic measurement, it is used to reflect the macroeconomic performance of a country. Climate change may affect the GDP growth rate [61]. This paper focuses on climate change and financial stability in each province, so the gross regional product is used. (2) The local fiscal revenue (LFR) reflects the level of local finance. Enterprises in disaster areas that depend on natural resources for survival are passive owing to the extreme climate, thus decreasing local fiscal revenue [62]. This paper believes that climate change will impair local fiscal revenue, so it is chosen as one of the intermediary variables.

4.2.3. Control Variables

(1) Loan-to-deposit ratio (LDR): It is measured by the ratio of loan balance to deposit balance at the end of each year. From the point of view of profitability, the higher the value, the better. On the contrary, the lower the value, the better from the perspective of risk protection.
(2) Consumer price index (CPI): It reflects the price changes of commodities within a certain time, where the commodities mainly refer to the necessities related to the life of residents. It is a hot economic indicator of the financial market, reflecting the impact of consumer consumption on the financial market.
(3) Price index of investment in fixed assets (Piifa): A relative number that reflects the trend and magnitude of change in the price of fixed assets within a certain time. A large negative fluctuation in fixed asset investment will have a large negative impact on regional financial stability.
(4) Commercial turnover (ComT): It reflects the total amount of commodity market turnover in a certain time. A decline in commodity trading indicates that the market is under liquidity pressure, and financial markets may be vulnerable at this time.
(5) Tax revenue (TaxR): It is a part of the fiscal revenue. The higher the tax revenue, the smoother the operation of the financial market.

5. Empirical Results

5.1. Descriptive Statistics

Table 1 below provides the descriptive statistics results for the main variables. Considering the convenient calculation of data, this paper took the logarithm of the relevant complex data value variables, including LnLDR, LnCPI, LnPiifa, and LnComT.

Table 1. Descriptive statistics.

Variable Type	Variables	N	Minimum	Mean	Maximum	Std Dev.
Dependent Variable	FSCI	480	−3.7600	−0.1563	4.2600	2.0317
Independent Variable	TempD	480	0.2600	1.4121	2.6400	0.4377

Table 1. *Cont.*

Variable Type	Variables	N	Minimum	Mean	Maximum	Std Dev.
Control Variables	LnLDR	480	−0.8015	−0.2959	0.1520	0.1778
	LnCPI	480	4.5814	4.6312	4.7013	0.0170
	LnPiifa	480	4.5643	4.6298	4.7300	0.0302
	LnComT	480	2.4336	7.0470	9.9661	1.4921
	TaxR	480	0.0338	1.5802	10.0639	1.6601
Mediating Variables	GRP	480	0.0543	1.9433	11.0761	1.8822
	LFR	480	0.0034	0.2034	1.2924	0.2039

5.2. Baseline Regression Results

The fixed-effects model, random-effects model, and OLS results are reported in Table 2, respectively. In this paper, the Hausman test is conducted based on model (1) with the sample data. It reveals that the fixed effect is better than the random effect, so the benchmark model is set as a two-way fixed-effect model. The estimated values of the coefficients of the two-way fixed-effects model and their significance are closer to the estimated results of the benchmark model. The temperature deviation means the degree of climate change.

Table 2. Baseline regression results.

Variables	(1)	(2)	(3)	(4)
	Two-Way Fixed-Effects Model	Two-Way Fixed-Effects Model	Random-Effects Model	OLS
	FSCI	FSCI	FSCI	FSCI
TempD	−0.386 ***	−0.309 ***	−0.629 ***	−0.629 ***
	(0.081)	(0.088)	(0.163)	(0.163)
LnLDR		−0.092	5.217 ***	5.217 ***
		(0.348)	(0.404)	(0.404)
LnCPI		−8.282 **	−28.148 ***	−28.148 ***
		(4.116)	(5.855)	(5.855)
LnPiifa		1.152	8.876 ***	8.876 ***
		(2.408)	(3.253)	(3.253)
LnComT		0.212 **	−0.064	−0.064
		(0.085)	(0.065)	(0.065)
TaxR		0.095 **	0.638 ***	0.638 ***
		(0.038)	(0.058)	(0.058)
Constants	−1.996 ***	29.477	90.986 ***	90.986 ***
	(0.142)	(21.519)	(19.856)	(19.856)
Year	YES	YES	—	No
Province	YES	YES	—	No
N	480	480	480	480
Adjust-R2	0.949	0.950	—	0.431

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The baseline regression results are presented in columns (1) and (2) of Table 2, respectively. Column (1) contains only explanatory and explained variables, while column (2) further adds control variables. Columns (3) and (4) show the random-effects model and OLS results. We controlled for provinces and years in the model for the accuracy of the analysis.

Columns (1) and (2) show that the temperature deviation has a significant negative impact on the financial stability state index (FSCI) of China at the level of 1%, indicating that the annual average temperature of a province deviates by 1 unit from the annual average temperature of China, resulting in a decrease of 0.386 and 0.309 units in the local financial stability level, respectively. Higher temperatures can lead to problems such as warming, less green space, and higher coastlines. Climate-sensitive cities may also face extreme heat or cold phenomena that could disrupt the original economic operating system and even affect financial stability. The random-effects model and OLS results in columns (3) and (4) are also significantly negative, consistent with the fixed-effects model results. This demonstrates that the negative correlation between temperature deviation and FSCI is robust under different model settings.

The control variables reveal that lnCPI, lnComT, and TaxR affect financial stability. lnCPI is negatively correlated with FSCI at the 5% level, indicating that the higher the lnCPI, the weaker the level of financial stability. An appropriate level of lnCPI can maintain the smooth operation of the market, while an excessive rise will lead to inflation. lnComT and TaxR are positively correlated with FSCI at the 1% level, indicating that the more active the commodity market and the higher the tax revenues, the more stable the financial market and the stronger government regulation are.

6. Robustness Test

6.1. Endogeneity Test

We performed an endogeneity test because there may be variables associated with perturbations in the econometric model, which may cause the model estimates to be inaccurate. Instrumental variables must be strictly exogenous and related to the endogenous explanatory variables.

Wang [63] believes that the rise in temperature accelerates global warming. An increase in forest and wetland area can effectively affect regional temperature [64–66], regulating the regional climate [67,68], reducing the heat island effect [69], and mitigating potential risks from climate change [70]. Large-scale afforestation is considered an effective way of re-establishing forest ecosystems [71,72]. The increase in forest area can effectively reduce the concentration of carbon dioxide and maintain a stable trend of temperature. Therefore, two variables, the total afforestation area (Taa) and the proportion of wetland area in the national land area (Wnla), were selected as the instrumental variables for the endogeneity test.

We used the two-stage least-squares (2SLS) method and the regression results are presented in Table 3. The first stage shows that the instrumental variable is significantly negatively related to the temperature deviation. The second stage pinpoints that the relationship between temperature deviation and FSCI remains significantly negative at the 1% level, after the endogeneity problem is controlled for. Thus, the robustness of the benchmark regression results is confirmed. In addition, the statistical value of the F statistic was greater than the 10% level, indicating that the selection of instrumental variables was effective.

Table 3. Endogeneity test.

Variables	(1)	(2)	(1)	(2)
	Total Afforested Area (Taa)		Wetland Area/National Land Area (Wnla)	
	First Stage	Second Stage	First Stage	Second Stage
TempD		−7.683 ***		−0.611 *
		(2.729)		(0.368)
LnLDR	0.204 *	6.534 ***	0.379 ***	5.214 ***
	(0.112)	(1.038)	(0.106)	(0.393)
LnCPI	−2.420	−42.590 ***	−1.450	−28.111 ***
	(1.631)	(14.104)	(1.512)	(5.588)
LnPiifa	1.396	17.548 **	0.781	8.854 ***
	(0.905)	(6.959)	(0.840)	(3.043)
LnComT	0.049 ***	0.258	0.016	−0.065
	(0.018)	(0.315)	(0.017)	(0.073)

Table 3. *Cont.*

Variables	(1)	(2)	(1)	(2)
	Total Afforested Area (Taa)		**Wetland Area/National Land Area (Wnla)**	
	First Stage	**Second Stage**	**First Stage**	**Second Stage**
TaxR	0.005	0.715 ***	0.029 *	0.638 ***
	(0.016)	(0.136)	(0.015)	(0.064)
Total afforested area	−0.373 ***			
	(0.117)			
Wetland area/National land area			−0.108 ***	
			(0.012)	
Constants	5.937	125.678 **	4.618	90.897 ***
	(5.532)	(50.897)	(5.127)	(18.193)
N	480	480	480	480
F value	10.204		87.6976	

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6.2. Alternative Key Variables

In order to verify the stability of the baseline model (1), this part selected the temperature deviation data with a one-period lag for regression to test whether there is a lag effect on climate change. The data results of columns (1) and (2) in Table 4 explain that the temperature deviation is still negatively correlated with FSCI at the level of 1%, indicating that the impact of temperature change on the financial market has a lag.

Table 4. Regression results of alternative key variables.

	(1)	(2)	(3)	(4)	(5)	(6)
	FSCI	**FSCI**	**FAG**	**FAG**	**FAG**	**FAG**
L. TempD	−0.401 ***	−0.342 ***			0.007 ***	0.006 ***
	(0.084)	(0.092)			(0.002)	(0.002)
TempD			0.007 ***	0.006 ***		
			(0.002)	(0.002)		
LnLDR		−0.202		0.004		0.004
		(0.362)		(0.007)		(0.007)
LnCPI		−7.572 *		−0.172 **		−0.190 **
		(4.394)		(0.080)		(0.085)
LnPiifa		0.368		0.040		0.022
		(2.489)		(0.047)		(0.048)
LnComT		0.158 *		−0.004 **		−0.005 ***
		(0.088)		(0.002)		(0.002)
TaxR		0.082 *		0.004		−0.001
		(0.042)		(0.007)		(0.008)
Constants	−1.957 ***	30.126	0.022 ***	0.661	0.022 ***	0.832 *
	(0.145)	(22.753)	(0.003)	(0.420)	(0.003)	(0.441)
Year	YES	YES	YES	YES	YES	YES
Province	YES	YES	YES	YES	YES	YES
N	450	450	480	480	450	450
Adjust-R2	0.948	0.949	0.793	0.795	0.780	0.784

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Furthermore, we chose the proportion of the financial industry's added value to GDP (FAG) instead of FSCI as the explained variable to address the financial markets. The FAG reflects the total financial costs borne by the real economy. The higher the ratio, the greater the total financial cost paid by the real economy; that is, the heavier the burden on the real economy.

The results in columns (3)–(6) show that the temperature deviation is significantly and positively related to the FAG at the 1% level. It indicates that the higher the temperature deviation, the higher the proportion of the financial industry's added value to GDP. In this case, the operation cost of the real economy will increase, and the operation efficiency of the financial industry will also decrease.

6.3. Delete Special Years

Financial market conditions are easily influenced by external factors. The sample contains two events, the financial crisis in 2008 and COVID-19 in 2019. Considering the lagging effects of COVID-19, we removed the years 2008 and 2020.

The regression results are reflected in Table 5. The relationship between temperature deviation and FSCI is still negatively correlated at the 1% level, indicating that the effect of temperature on financial stability is not affected by special events.

Table 5. Regression results with special years removed.

	(1)	(2)	(1)	(2)
	Removing Year 2008		**Removing Year 2020**	
	FSCI	**FSCI**	**FSCI**	**FSCI**
TempD	−0.378 ***	−0.297 ***	−0.288 ***	−0.205 **
	(0.081)	(0.089)	(0.084)	(0.090)
LnLDR		−0.000		−0.264
		(0.361)		(0.360)
LnCPI		−7.777 *		−9.478 **
		(4.614)		(4.129)
LnPiifa		0.947		1.822
		(2.606)		(2.408)
LnComT		0.214 **		0.259 ***
		(0.085)		(0.091)
TaxR		0.010 ***		0.009 **
		(0.004)		(0.004)
Constants	−2.007 ***	28.094	−2.135 ***	31.419
	(0.142)	(23.794)	(0.144)	(21.598)
Year	YES	YES	YES	YES
Province	YES	YES	YES	YES
N	450	450	450	450
Adjust-R2	0.949	0.950	0.941	0.943

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

7. Mechanism Analysis

7.1. Heterogeneity Analysis

7.1.1. Classify Samples by Region

The financial resources, infrastructure development, and economic development levels differ significantly among the different regions, and there may be some heterogeneity in the impact of climate change on financial stability. Therefore, the 30 provinces are divided into three parts: eastern, central, and western. The regression results are shown in Table 6.

According to Table 6, the regression coefficients for the central and western provinces are significantly negatively correlated at the 1% and 5% levels, respectively. They display that climate change significantly affects the level of financial stability in the central and western provinces. Among them, the central provinces are economically developed, and have convenient transportation and a strong agricultural foundation. The temperature deviation value will affect the productivity of local enterprises and agricultural productivity, increase the operational risk of financial institutions, and weaken the level of financial stability.

At the same time, due to the "urban heat island effect", factors such as large population density, many urban buildings, and less green space may lead to poor temperature mobility and lower economic efficiency.

Table 6. Regression results for different region tests.

	(1)		(2)		(3)	
	Central Provinces		Eastern Provinces		Western Provinces	
	FSCI		FSCI		FSCI	
TempD	−1.102 ***	−0.500 ***	−0.137	−0.172	−0.330 *	0.271
	(0.130)	(0.188)	(0.142)	(0.155)	(0.183)	(0.232)
LnLDR		0.380		−0.097		0.185
		(0.644)		(0.561)		(0.773)
LnCPI		−9.965		−13.367 *		−0.081
		(11.143)		(6.853)		(6.843)
LnPiifa		−3.240		5.134		4.070
		(3.921)		(3.936)		(4.651)
LnComT		0.202		−0.313 **		−0.013
		(0.254)		(0.140)		(0.149)
TaxR		1.015 ***		0.117 ***		1.007 ***
		(0.253)		(0.045)		(0.218)
Constants	−1.134 ***	57.790	−2.362 ***	37.820	−2.119 ***	−21.427
	(0.212)	(50.277)	(0.272)	(35.505)	(0.276)	(38.852)
Year	YES	YES	YES	YES	YES	YES
Province	YES	YES	YES	YES	YES	YES
N	144	144	192	192	144	144
Adjust-R2	0.960	0.966	0.950	0.953	0.946	0.955

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Some of the western provinces, such as Sichuan, Qinghai, and Gansu, belong to the Qinghai–Tibet Plateau. Its significance may be related to the "non-urban heat island effect". Nevertheless, due to its underdeveloped economy, the influence of climate is weakened when the control variables are added.

The regression results for the eastern provinces are not significant, indicating that the influence of temperature on FSCI is weak. This may be because it contains many coastal cities. Coastal cities in China are dominated by subtropical and temperate monsoon climates. The average annual temperature is relatively stable, and the water content is large, which can offset part of the influence of high temperatures. There is no doubt that coastal cities are also affected by the "ocean economy", hence the impact of temperature deviation on local financial conditions is not obvious.

7.1.2. Sample Classification According to Coastal, Yangtze River Delta, and Pearl River Delta

This section compares coastal provinces, non-coastal provinces, Yangtze River Delta (YRD) and Pearl River Delta (PRD) and non-Yangtze River Delta (YRD) and Pearl River Delta (PRD) regions subsamples based on their common characteristics of being "coastal". Consistent with the previous results, temperature deviation has a significant negative effect on FSCI at the 1% level in the non-coastal and non-YRD and PRD regions, while the coastal and YRD and PRD regions are not significantly affected by climate change because of the maritime economy (Table 7).

Table 7. Regression results for coastal, Yangtze River Delta, and Pearl River Delta cities.

	(1)				(2)			
	Coastal Provinces		**Non-Coastal Provinces**		**Non-YRD and PRD**		**YRD and PRD**	
	FSCI		**FSCI**		**FSCI**		**FSCI**	
TempD	−0.158	−0.188	−0.783 ***	−0.586 ***	−0.395 ***	−0.324 ***	−0.027	0.612
	(0.150)	(0.164)	(0.105)	(0.121)	(0.090)	(0.094)	(0.309)	(0.433)
LnLDR		0.087		0.962 **		0.035		2.424 *
		(0.703)		(0.452)		(0.415)		(1.217)
LnCPI		−14.634 *		−5.112		−9.373 **		−4.560
		(7.818)		(4.834)		(4.623)		(11.865)
LnPiifa		5.357		−0.716		2.427		−1.678
		(4.178)		(2.778)		(2.799)		(6.505)
LnComT		−0.344 **		0.290 ***		0.200 **		−0.070
		(0.148)		(0.105)		(0.089)		(0.569)
TaxR		0.121 **		0.433 ***		0.216 **		0.125
		(0.048)		(0.107)		(0.084)		(0.075)
Constants	−2.313 ***	42.975	−1.556 ***	23.749	−1.966 ***	28.822	−2.743 ***	26.172
	(0.297)	(40.232)	(0.164)	(25.278)	(0.153)	(24.538)	(0.592)	(56.507)
N	176	176	304	304	400	400	80	80
Adjust-R2	0.945	0.949	0.955	0.959	0.944	0.946	0.966	0.968

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

7.1.3. Sample by Climate Risk Level

This paper refers to the article by Tang [72], which divides China into three climate risk zones in terms of hazard, exposure, and risk resistance. The financial stability under different climate risk extents is explored. The climate risk is highest in risk zone I and lowest in risk zone III.

The results in Table 8 show that there is a significant negative correlation at the 1% level between temperature deviation and financial stability for risk region I, indicating that the greater the temperature deviation, the lower the financial stability. It means that the financial stability of risk region I is vulnerable to the negative effects of climate change.

Table 8. Regression results of climate risk areas.

	(1)		(2)		(3)	
	Risk Zone I		**Risk Zone II**		**Risk Zone III**	
	FSCI		**FSCI**		**FSCI**	
TempD	−0.821 ***	−0.941 ***	−0.050	0.055	−0.405 ***	−0.148
	(0.240)	(0.278)	(0.145)	(0.150)	(0.134)	(0.164)
LnLDR		2.515 **		0.431		−1.636 ***
		(1.003)		(0.549)		(0.614)
LnCPI		−13.543		−17.679 **		−2.113
		(10.133)		(7.157)		(5.828)
LnPiifa		1.133		3.950		1.216
		(4.634)		(3.880)		(3.907)
LnComT		1.358 ***		0.333 **		−0.147
		(0.260)		(0.133)		(0.126)
TaxR		−0.008		0.187 ***		−0.036
		(0.070)		(0.066)		(0.100)
Constants	−1.190 **	48.021	−2.508 ***	58.813	−2.003 ***	2.147
	(0.454)	(50.674)	(0.257)	(37.985)	(0.189)	(30.463)
Year	YES	YES	YES	YES	YES	YES
Province	YES	YES	YES	YES	YES	YES
N	128	128	192	192	160	160
Adjust-R2	0.948	0.960	0.944	0.949	0.957	0.958

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

7.2. Mechanism Analysis

We explored the influence of the independent variables on the dependent variables, and the relationship between temperature deviation and FSCI was verified in the baseline regression. This paper further examines the mechanism of climate change on FSCI and examines whether the gross regional product (GRP) and local fiscal revenue (LFR) have mediating effects. Formulas (2)–(4) are used to test it, and the relevant results are shown in Tables 9 and 10.

Table 9. Regression results of the mechanism.

	(1)	(2)	(3)
	FSCI	**GRP**	**FSCI**
TempD	−0.309 ***	−0.307 ***	−0.241 ***
	(0.088)	(0.069)	(0.089)
LnLDR	−0.092	0.340	−0.168
	(0.348)	(0.274)	(0.344)
LnCPI	−8.282 **	−4.127	−7.361 *
	(4.116)	(3.235)	(4.065)
LnPiifa	1.152	−0.742	1.318
	(2.408)	(1.892)	(2.374)
LnComT	0.212 **	0.046	0.202 **
	(0.085)	(0.066)	(0.083)
TaxR	0.095 **	0.909 ***	−0.108
	(0.038)	(0.030)	(0.067)
GRP			0.223 ***
			(0.061)
Constants	29.477	22.978	24.350
	(21.519)	(16.910)	(21.256)
Year	YES	YES	YES
Province	YES	YES	YES
N	480	480	480
Adjust-R2	0.950	0.896	0.951
Sobel test		No need	

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 10. Regression results of the mechanism.

	(1)	(2)	(3)
	FSCI	**LFR**	**FSCI**
TempD	−0.309 ***	−0.010 ***	−0.259 ***
	(0.088)	(0.002)	(0.089)
LnLDR	−0.092	−0.008	−0.054
	(0.348)	(0.010)	(0.346)
LnCPI	−8.282 **	−0.269 **	−6.986 *
	(4.116)	(0.113)	(4.111)
LnPiifa	1.152	0.052	0.903
	(2.408)	(0.066)	(2.391)
LnComT	0.212 **	−0.000	0.214 **
	(0.085)	(0.002)	(0.084)
TaxR	0.095 **	0.124 ***	−0.503 **
	(0.038)	(0.001)	(0.219)
LFR			4.828 ***
			(1.741)
Constants	29.477	1.003 *	24.633
	(21.519)	(0.592)	(21.425)

Table 10. *Cont.*

	(1)	(2)	(3)
	FSCI	LFR	FSCI
Year	YES	YES	YES
Province	YES	YES	YES
N	480	480	480
Adjust-R2	0.950	0.991	0.951
Sobel test		No need	

Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 9 includes the three-step method for testing the GRP. Column (1) estimates the total effect of temperature deviation on FSCI. The coefficient is significantly negative at the 1% level, indicating that the level of financial stability is low when the temperature is unstable. Column (2) shows the role of temperature deviation on the GRP, and the estimated coefficient is significantly negative at the 1% level, indicating that climate change weakens local productivity forces and reduces economic operation efficiency. From column (3), we introduce the GRP into the baseline model. The GRP coefficient is significantly positive at the level of 1%, indicating that the direct effect is subsistent. Therefore, H2 is supported.

In Table 10, Column (2) reports the role of temperature deviation on LFR, and the estimated coefficient is significantly negative at the 1% level, indicating that temperature deviation negatively affects the substantial economy and reduces the government's income. The LFR coefficient in Column (3) is also significantly positive at the 1% level, and a mediating effect is present. Therefore, H3 is supported.

8. Conclusions and Recommendations

8.1. Conclusions

Climate change is an important factor that causes financial risks, and the rising speed of climate risks affects the efficiency of financial markets. Developing countries should pay more attention to the risks posed by climate change. This paper analyzes the impact of climate change on the financial stability state index (FSCI) of China by using the panel data of 30 provinces from 2005 to 2020, and conducts a robustness test, heterogeneity analysis, and intermediate effect test, respectively. The results are shown as follows:

(1) We first examined the relationship between climate change and FSCI through a two-way fixed-effect model. The results introduce the idea that climate change significantly negatively affects the level of financial stability. This means that the hypothesis is valid. The greater the temperature deviation, the lower the level of financial stability.
(2) In order to further prove the rationality of the model, we examined the robustness of the benchmark model using an endogeneity test, replacing the major variables and deleting special years. The effects of climate change on FSCI are still significant, which confirms the robustness of our previous discussion.
(3) Climate conditions are inconsistent between provinces. A heterogeneity analysis examined the climate change situation and its impact on FSCI in the different provinces of China. The samples were classified according to province type, coastal characteristics, and climate risk area. The impact of temperature change on FSCI is greater in the central provinces, non-coastal regions, non-Yangtze River Delta and Pearl River Delta regions, and risk zone I, but smaller in other regions.
(4) Finally, the internal way that climate change affects FSCI was tested using a mediation model, and the regression was significant. The impact of climate change on FSCI is mediated by gross regional product (GRP) and local fiscal revenue (LFR).

There are limitations to the article. Considering the data availability of the financial stability index of China (FSCI), this paper selected the data from 2005 to 2020 for study. Expanding the sample size is the way forward. In addition, some of the literature suffers from the problem of difficult access, which may lead to a lack of in-depth analysis of the literature to a certain extent.

8.2. Recommendations

First, there is a need to improve the methodology for monitoring financial stability and to strengthen early warnings for key indicators. The relevant authorities should promote macro-prudential stress testing of climate change risks, with the banking sector as the main unit. This would allow for a quantitative analysis of the financial risks and adequately model the impact of external shocks on the financial system. As a result, the resilience of the financial system could be intensified through the identification and assessment of climate risks.

Second, climate change risks should be incorporated into monetary and fiscal policy, and the counter-cyclical adjustment of financial risks from climate change needs to be considered. At the same time, keeping financial markets open on a low-risk basis can improve China's financial security.

Finally, disclosure systems for climate risk information need to be further improved. Information disclosure helps the central bank to obtain climate data in its entirety, which provides basic support for policy setting and the use of monetary policy tools. The impact of climate shocks on the financial system will also be minimized as the level of disclosure increases.

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