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Review of Research on Corporate Climate Risk: Risk Phenomena and Economic Consequences

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Abstract

Climate risk has become one of the major risks facing human society in the 21st century, and its potential impact on financial markets has become a basic consensus. At present, scholars and institutions at home and abroad have carried out a large number of studies on climate risks, including qualitative analysis and quantitative calculation. This paper focuses on the micro enterprises, introduces the classification and characteristics of climate risk from the perspective of enterprises, sorts out the economic consequences of climate risk in domestic and foreign enterprises, expounds and evaluates the research status and main conclusions of corporate climate risk, and finally puts forward some suggestions for better promoting the management of corporate climate risk in China.

Keywords

Climate Risk; Enterprises; The Economic Consequences; Risk Management.

1. Introduction

As the problem of global warming becomes more and more serious, the risks caused by climate change are gradually paid attention to, and its performance in the financial market has attracted much attention. Under the joint influence of human activities and natural factors, the trend of global warming continues, and extreme weather and climate events show a trend of increasing and strengthening [1]. Climate change and extreme weather have become one of the most important medium and long-term risks in the world [2].

Enterprises are not only the main body of economic development, but also the main body of pollution and carbon reduction and scientific and technological innovation. On the one hand, global warming has significantly increased the frequency of extreme climate events, and the assets of some industries, especially agriculture, forestry, animal husbandry and fishery, are exposed to risks. On the other hand, in order to cope with climate change, governments and regulatory authorities of various countries will introduce more stringent laws and regulations, and in this process, the transformation pressure of enterprises will rise. In the future, as climate uncertainty increases, investors, businesses, markets and regulators will face more severe challenges.

At present, climate risk has become a hot topic in the financial market, and scholars and institutions at home and abroad have carried out a lot of research on its connotation, mechanism and measurement methods. Based on the perspective of corporate finance, this paper summarizes the existing literature and research on climate risk at home and abroad, extracts the specific content of climate risk, clarifies the economic consequences of corporate climate risk, sorts out the existing research on climate risk, and briefly points out the possible improvement direction in the future.

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2. Climate Risk Definition and Risk Performance

Table 1. Climate-related risks and their risk performance

Types	Climate related risks	Performance of risk
Transition risk	Policy and Law	
	● Room temperature gas emission pricing ● Emission reporting obligations ● Mandatory requirements and supervision of existing products and services ● Risk of litigation	● Increased operating costs ● Stranded assets ● Fines and judgments ● Products and services cost more and demand less
	Technology	
	● Switching costs to new technologies ● Risk of failure in R&D investment ● The cost of upgrading existing products and services	● Scrapping of existing assets ● Reduction of existing products and services ● New and alternative R&D expenditures ● Business process re-engineering
	Market	
	● Consumer preferences change ● Cost pass-through in the upstream supply chain ● Uncertainty about the direction of market winds	● Preferences and reduced demand due to wind shift ● Increase in production costs due to changes in input prices and output demand ● Asset repricing ● The source of income changes ● Fluctuations in stock prices
	Reputation	
	● Public environmental concerns ● Stakeholder attention ● Industry stigmatization	● Reduced demand for goods and services ● Indirect reduction of production capacity ● The negative impact on the labor force leads to a decrease in income ● Corporate credit declines and exacerbates financing constraints
Physical risk	Short term	● Reduced productivity due to transportation difficulties and supply chain disruptions ● Rising costs caused by threats to workers' lives and health ● Assets in areas with high incidence of extreme weather were directly damaged ● Higher indirect production costs due to climate change ● Rising capital costs due to equipment damage ● Stock prices are raised by the volatility of climate change ● Higher insurance spending
	● The increase in extreme weather ● An increase in climate disasters	
	Long term	
	● Extreme changes in precipitation patterns ● Extreme fluctuations in climate patterns ● Global warming ● Reduced species diversity	

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For the definition of climate risk, please refer to the China Financial Stability Report 2020 issued by the People's Bank of China, which defines climate risk as the potential uncertainties brought to economic and financial activities by climatic factors such as extreme weather, natural disasters and global warming as well as the process of society's transition to sustainable development. This is in line with the definitions of climate risk by the Working Group on Climate-Related Financial Disclosures (TCFD), the Basel Committee, and the Network for Green Finance of Central Banks and Supervisors (NGFS). In this paper, we will explore the uncertain impact of climate change on business operations from the perspective of micro-enterprises.

As for the classification of climate risks, there are two types widely recognized by academia and industry, namely, climate physical risk and climate transition risk. Climate physical risk mainly refers to the risk of property damage caused by extreme weather, natural disasters and related events. This risk is particularly significant in the current context of global warming, environmental degradation and biodiversity reduction, which may cause direct damage to economic activities [3]. Climate physical risks may come from short-term sudden natural disasters or long-term climate changes, which affect the business site and employee safety of enterprises, thus causing direct asset losses or supply chain disruptions. Climate transition risks are risks arising from the transformation process of enterprises towards sustainable development, including climate policy change, technological innovation and market sentiment change [4].

Physical risk and transition risk are interrelated and interact with each other, showing three remarkable characteristics. First, universality. Compared with traditional financial risks, climate risks are more common and more contagious. In the context of global warming and economic globalization, not only countries and regions exposed to severe climate problems will suffer damage, but also countries and regions with low exposure to climate risks. It is clear, then, that climate change does not affect only some parts of the world, so the idea of shared global governance is the solution to the problem. Second, long-term. The formation of climate problems is not short-term, but derived from the accumulation of climate change in a long period of time. Different from general financial risks, its risk cycle is far beyond the traditional financial cycle. Third, complexity. As a relatively new concept, there is no mature research on climate risk. At the same time, since the climate system is a dynamic process with many influencing factors, the measurement and assessment of climate risk at both macro and micro levels is full of complexity. Table 1 summarizes climate-related risks and their risk performance.

3. Economic Consequences of Corporate Climate Risk

The global environment continues to deteriorate, the global warming trend is difficult to contain, and extreme weather and climate disasters occur frequently, bringing a negative impact on both the real economy and the financial market that cannot be underestimated. In the interpretation of China Financial Stability Report 2020, the linkage between climate risk and credit risk, market risk and liquidity risk is mentioned. Extreme climate events may lead to asset losses and casualties of enterprises, increase direct and indirect production costs of enterprises, and reduce the value of collateral of enterprises, thus reducing the credit granting of banks and other financial institutions to enterprises, reducing the credit rating of enterprises and increasing the credit risk of financial institutions. In addition, due to the existence of climate risks, corporate debtors increase the required rate of return on their debts, and shareholders and institutional investors require higher risk compensation, which further deteriorates the capital structure of enterprises and increases the bankruptcy cost, which leads to the default of debtors and the shrinkage of the value of assets related to enterprises with high carbon emissions held by financial institutions, and increases their liquidity risks. It is not conducive to the stability of the macro-financial system.

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Yang Zihui et al. [5] comprehensively quantified the impact of "green swan" risks on financial stability by combining the newly developed risk assessment model of climate transition and the cutting-edge multiple network model. In the long run, transitional climate risks will greatly enhance the vulnerability of China's financial institutions and exacerbate systemic financial risks. Nhamo et al. [6] assessed the potential to build a sustainable and climate-resilient economy post-COVID-19. The findings show that climate finance has declined in the wake of COVID-19 and there are clear gaps in climate finance, including reallocation from climate-related ministries and delays in project implementation. This decline in climate action poses a risk to sustainability and climate resilience.

The frequency, intensity and duration of extreme weather events profoundly affect human life and production. A large number of studies have proved that the power industry, energy industry, material industry, agriculture, forestry, animal husbandry and fishery and other upper and middle reaches of the industry have suffered serious physical risks. In the empirical process, drought index, low temperature freezing index, typhoon index, waterlogging index and high temperature index all have a negative impact on the financial performance and enterprise performance of these industries, and relevant industries urgently need to incorporate climate change risk into their risk management framework [7]. Downstream commercial and consumer sectors such as home appliances, automobiles and textiles are also subject to increasing transformation risks.

Edith Ginglinger et al. [8]used enterprise asset data to measure physical risks, and found that physical climate risks brought greater expected distress costs and higher operating costs. Nehrebecka[9] pointed out that banks will evaluate the default rate of enterprises exposed to climate risks and further evaluate the possibility of default through climate stress testing. Li Yunhe et al. [10] used the data of corporate climate risk exposure (CCRE) to also support this view, and proposed that climate transition risks have the same effect on corporate financial leverage.

Firms generally choose more conservative financial strategies after becoming aware of climate risks. Wei Zhang et al. [11] examined the impact of climate risk on corporate precautionary cash holdings in the research background of Chinese listed companies. The results show that climate risk has a significant positive effect on the precautionary cash holdings of firms. Henry He Huang[12] used the global climate risk index compiled and published by Germany Observation for assessment. The conclusion is that firms located in countries with more severe weather are more likely to hold more cash in order to build financial slack and thus increase organizational resilience to climate threats.

The studies of the above scholars all show that climate risks have brought serious negative consequences to enterprises. Macro climate risks exacerbate the vulnerability of the entire financial system, and most mainstream industries are threatened by physical risks and transformation risks. At the micro level, enterprises have to reduce the threat from climate risk by reducing leverage, increasing cash reserves, or diversifying investments across regions.

4. Evaluation and Prospect of Existing Research Related to Climate Risk

By reviewing the literature on climate risk, it can be seen that the current research discusses more about the macro impact of climate issues, but less about the micro level such as the climate issues faced by enterprises and the climate risks caused by them. The reasons are mainly concentrated in the following two points:

First, there is a data gap in corporate climate risk assessment. Domestic enterprises are insufficient in carbon emission data and lack of effective certification of financial data. In view of the great challenge of carbon accounting for Scope 3 emissions, the industry generally adopts the carbon emission factor estimation method as a expediency [15]. However, the lack of unified

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standards and data verification means makes it difficult to compare data, and the attribution of Scope 3 emissions is also controversial. In addition, necessary information related to climate exposure, such as sectoral classification based on carbon intensity and geo-location data based on sensitivity to climate hazards, is scarce. There are also insufficient data to describe vulnerability to climate risk, such as information on the size and price volatility of assets sensitive to energy prices, carbon emissions, or carbon prices.

Second, the scenarios and tools used by financial institutions in the analysis of transition risks are significantly different, and their theoretical basis and model construction are relatively weak. Due to different capital, loan distribution and geographical location, financial institutions of different sizes have different needs and capabilities for climate risk analysis, lack unified verification and application of analysis results, and fail to provide effective guidance for internal risk management and regulatory policy formulation. At the same time, the current transformation risk analysis of the financial sector lacks systematic and horizontal comparison ability, and lacks clear regulatory indicators and calculation guidance, making it difficult to carry out system-level risk monitoring and intra-industry comparison.

In order to improve the scientific and systematic nature of China's transition risk analysis and enhance the credibility, applicability and comparability of the analysis results, it is urgent to promote innovation in database construction, methodology and tool development, and systemic risk research. Specifically, there are the following points:

First, we should strengthen the construction and improvement of professional databases to improve the quality and access of climate data. Regulators, financial institutions and third parties should jointly build databases covering key data such as asset classes, risk exposure and carbon intensity to provide a solid foundation for transition risk analysis. For the data that is not easy to obtain, a unified and scientific estimation system shall be established, and strict data quality control and regular update shall be implemented. At the same time, a strict third-party certification system has been established to strengthen the external verification of data.

Second, develop transition risk scenario tools and guidelines in line with China's dual carbon goals to improve the comparability of stress test results. Drawing on international experience, adjusting parameters and assumptions based on NGFS scenarios and national conditions, improving the climate stress testing tool reflecting Chinese characteristics, and enhancing its application in financial analysis. For financial institutions of different ability levels, the calculation requirements of tools and indicators of corresponding complexity will be provided, and the requirements for their climate risk assessment will be gradually increased.

Third, we should conduct in-depth research on the impact of climate risks on financial stability and macroprudential policy response strategies. At present, the climate stress test of the People's Bank of China focuses on a single financial institution and has not yet fully considered risk transmission and the identification of systemic risk. On the basis of the pilot work, combined with the gradual promotion of carbon neutral industrial transformation policies, multi-level systemic transformation risk analysis should be carried out to provide decision-making support for financial regulation.

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