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ANALYSIS OF THE IMPACT OF CLIMATE CHANGE ON FINANCIAL RISK

NELEA CHIRILOV
Academy of Economic Studies of Moldova, Republic of Moldova
e-mail chirilov.nelea.vladimir@ase.md
ORCID ID: 0000-0003-4979-4633

DIANA RENCHECI
Academy of Economic Studies of Moldova, Republic of Moldova
e-mail rencheci.diana@ase.md
ORCID ID: 0000-0003-3535-7010

RODICA GABRIELA BLIDISEL
West University of Timisoara, Romania
e-mail rodica.blidisel@e-uvt.ro
ORCID ID: 0000-0001-7918-5105

Abstracts: Climate is widely recognized as a significant source of financial risk. The high frequency of natural disasters leads to asset losses, which negatively affect financial stability. Climate change is a significant factor driving financial risks, and the increasing pace of climate-related risks affects the efficiency of financial markets. The Republic of Moldova should pay greater attention to the risks posed by climate change. This paper analyzes the impact of climate change on financial risks. We examine the mechanism through which climate change affects financial stability from a market economy perspective, thereby enriching existing research with a detailed analysis of financial risk.

Climate change risks should be integrated into monetary and fiscal policies, and counter-cyclical adjustments for climate-induced financial risks need to be considered. At the same time, maintaining open financial markets under low-risk conditions can enhance the Republic of Moldova's financial security. The study is based on the results of a bibliometric analysis and consolidates theoretical and empirical literature on the information related to the impact of climate change on financial risks. The results provide a foundation for future analysis of climate change disclosures, taking into account the most recent developments in standards and frameworks.

Keywords: climate change risks; financial stability; financial risk, climate change, sustainability, SASB (Sustainability Accounting Standard Board), CDCS (Climate Disclosure Standards Board), TCFD (Task Force on Climate-related Financial Disclosures).
JEL Classification: M40, M41, M49, Q54, Q56

Introduction. Currently, climate change poses a significant threat to all sectors of the Republic of Moldova's economy. While many entities continue their activities as usual, seemingly unaware of the impending impacts of climate change, there are organizations that are attempting to deviate from the perilous path of climate-related impacts and have begun analyzing their financial situation from the perspective of climate-related risks in order to anticipate an increase in financial risks.

Entities that assess climate change risks cannot afford to ignore the connection between the financial stability of the organization and environmental stability. Managers of these entities recognize that natural and climate-related risks materialize as financial risks, impacting all aspects of the economy and the financial stability of the organization.

At the same time, many entities do not recognize that natural risks are financial risks and remain focused on monthly, quarterly, or annual financial results. Consequently, the cost of

climate-related risks is not adequately accounted for in financial activities, and natural aspects are not integrated into the entity's decision-making process.

We believe that within organizations, the impact of climate and natural risks on financial stability, as well as the dependence of funding sources on environmental changes, should be thoroughly evaluated.

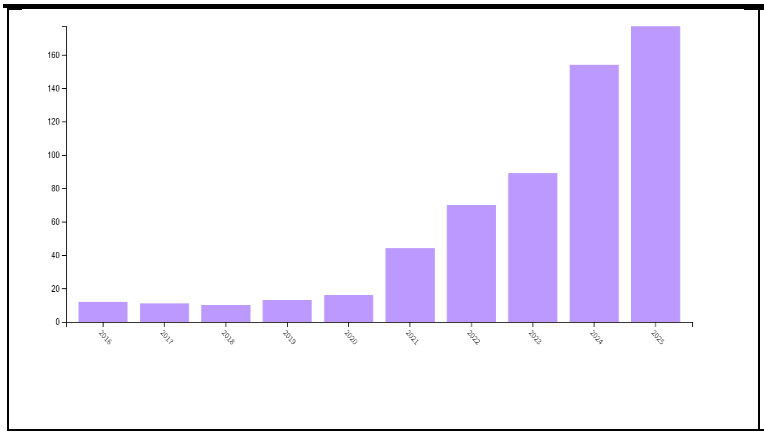
We note that Michael R. Bloomberg, an entrepreneur and philanthropist, mentions that "the climate risks are financial risks and a wider disclosure and better information transparency are crucial for the construction of a more sustainable and resilient economy, a safer future." (Bloomberg, 2017).

Therefore, the impact of climate change on socio-economic activity is significant. Thus, considering the unpredictable nature and long-term implications of climate change, understanding financial exposure may pose a challenge for all enterprises in the Republic of Moldova. Among the organizations that have significantly shaped corporate climate-related disclosures, the TCFD stands out as particularly influential. It supports companies in evaluating in a climate-consistent manner (Lee et al., 2025). The TCFD highlights two main types of climate risks, which can be incorporated into the CDSB Framework and the SASB Climate Framework: physical and transition risks (IFRS Foundation, n.d.). Physical risks include extreme weather conditions. Droughts or flooding, as well as the long-term impact of rising global average temperatures represent examples of such risks (IFRS Foundation, n.d.). Transition risks include the global transition to a low-carbon economy, new regulations, and innovations in energy efficiency (IFRS Foundation, n.d.). Enterprises from the Republic of Moldova could be impacted by economic and financial effects generated by such climate risks. Therefore, actual and potential investors, as well as stakeholders, require greater clarity on how enterprises assess these climate risks and opportunities, and how they plan to respond. Understanding and communicating the potential financial effects of climate risks will generate more useful information for decision-making, thereby supporting a more informed process for investments, loans, credits, and other financial decisions.

In indigenous practice, there is also a risk that various impediments related to data transparency may arise; this topic is a concern for several researchers, as noted in the paper by Di Marco, R., Dong, T., Malatincova, R., Reuter, M., and Stromsten, T. (Di Marco et al., 2023).

Empirical analysis based on the results of the bibliometric analysis.

The study aimed to exploit in a quantitative manner the specialized analysis in the field of climate risks, financial risk, climate resilience, climate change, exploring a number of 601 articles published in the last 10 years, in the period 2015-2025, in fields such as Business Finance (417 articles), Economics (253 articles), Management (47 articles) (Web of Science, 2025; Scopus, 2025). The dynamics of publication of articles in the period 2015-2025 is presented in the figure below.



Publication Years	Record Count	% of 601
2025	177	29.451
2024	154	25.624
2023	89	14.809
2022	70	11.647
2021	44	7.321
2020	16	2.662
2019	13	2.163
2018	10	1.664
2017	11	1.830
2016	12	1.997
2015	5	0.832

Figure 1. Dynamic evolution of articles published in the period 2015-2025
Source: developed by the authors based on the bibliometric analysis of the databases of (Web of Science, 2025; Scopus, 2025)

The empirical results of the bibliometric analysis highlighted the fact that (Web of Science, 2025; Scopus, 2025):

- The journals in which this field is published are: Finance Research Letters (61 articles), Energy Economics (58 articles), International Review of Financial Analysis (45 articles), International Review of Economics and Finance (32 articles), Research in International Business and Finance (26 articles), etc.
- The most cited documents are the articles "Hedging Climate Change News", published in The Review of Financial Studies, written by Robert F Engle, Stefano Giglo, Brayn Kelly, Heebum Lee, Johannes Stroebel (2020) and "Dissecting green returns", published in the Journal of Financial Economics, written by L'ubos Pastor, Robert F. Stambaugh, Lucian A. Taylor (2020), (Engle et al., 2020; Pastor, Stambaugh and Taylor, 2020)
- The most cited authors are Cepni, Oguzhan; Gupta, Rangan; Urom, Creștin; Ji, Qiang; Jiraporn, Pornsit etc.
- The most relevant affiliations in terms of the number of articles are given by Lebanese American University Adnan Kassar School of Business, Copenhagen Business School Department of Economics, University of Pretoria Department of Economics, University of Pretoria Faculty of Economic and Management Sciences, etc.
- The most frequently used keywords in the analyzed scientific publications are climate change risks, financial risk, climate risks, climate resilience, climate change, uncertainty, economic activity, sustainability, financial performance, SASB (Sustainability Accounting Standards Board), CDSB (Climate Disclosure Standards Board), and TCFD (Task Force on Climate-related Financial Disclosures).
- The most frequently addressed topics are climate change, climate risk, financial flexibility, financial markets, risks of climate policy change, and impacts on financial markets.
- The most active countries/regions that addressed the topics in publications are the People's Republic of China (171 articles), the USA (109 articles), England (83 articles), Australia (81 articles), and France (68 articles). It is worth noting that during the period 2015-2025, 11 articles were published from Romania.
- It can be observed the existence of Romanian authors from West University of Timisoara, Babes Bolyai University from Cluj, and Bucharest University of Economic Studies, who have written on this field in recent times, namely: Stefea, Petru; Noja, Gratiela Georgiana; Baditoiu, Bianca Raluca; Buglea, Alexandru; Munteanu, Valentin Partenie; Cimpoieru,

Diana Corina Gligor; Boitan, Iustina Alina, Caraiani, Petre; Rebega, Laurentiu; Dan, Anamaria; Tiron-Tudor, Adriana.

Therefore, bibliometric analysis has proven its relevance through its ability to provide a systematic and highly objective understanding of the evolution, trends, and connections in the field of climate risks, financial risk, climate resilience, and climate change. By examining scientific publications that address these keywords, bibliometric analysis can highlight the evolution of research in the field, the contributions of the authors, the connections and interactions between the keywords and other relevant concepts.

The assessment of financial risk and the appraisal of the rationality of acquiring borrowed funding under climate change conditions are essential. In our view, there is no doubt that natural risks constitute financial risks. Therefore, when evaluating financial risks, particular attention must be paid to identifying the organization's financial risk areas. Five financial risk areas can be identified, as presented in Figure 2.

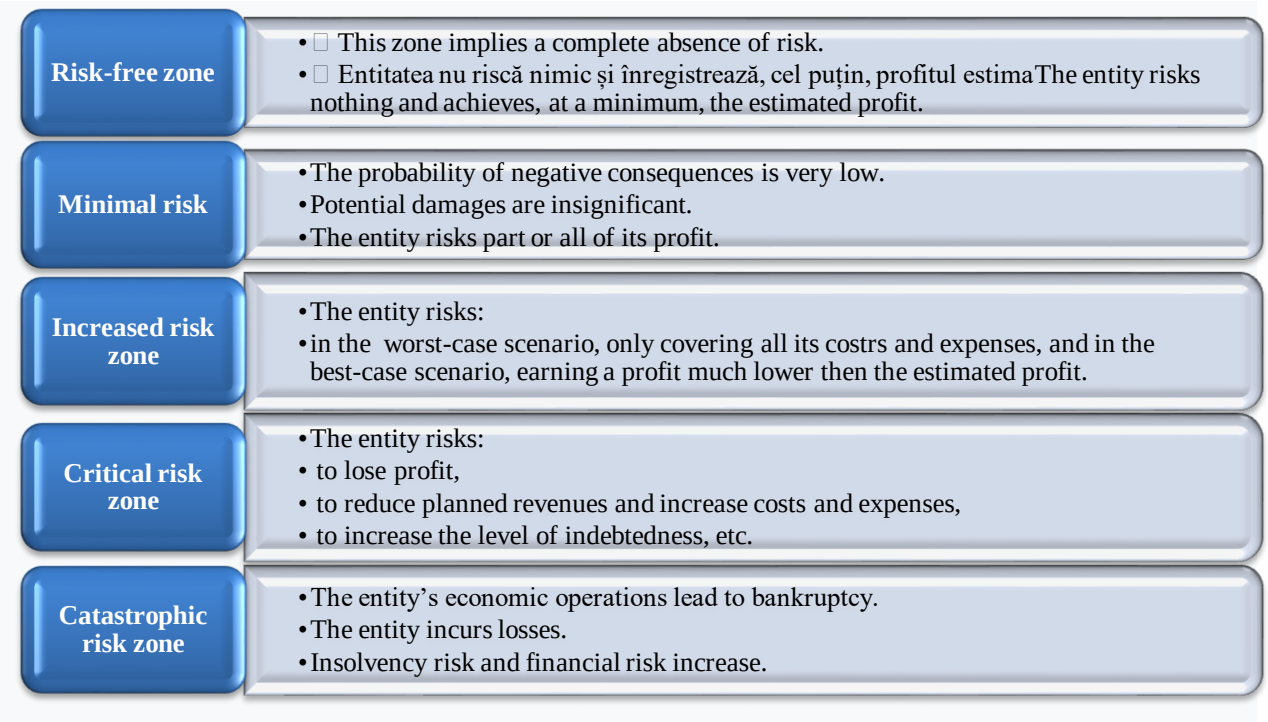


Figure 2. Financial risk areas in the economic and financial activity of the entity

Source: Developed by the author based on the generalization of bibliographic sources (Anghel, Robu and Lala-Popa, 2022; Petcu et al., 2023; Petcu, 2009; Spătaru, 2010; Ţiriulnicova et al., 2011; Robu, Anghel and Serban, 2014; Păvăloaia et al., 2010)

According to the information presented in Figure 2, it is evident that each entity should avoid the catastrophic risk area in its economic operations, as these risks can lead to financial instability and potentially bankruptcy. Thus, within the organization, there must be effective financial risk management, which will allow the achievement of the proposed objectives by minimizing the impact of financial risk on profit.

For this purpose, it is necessary to have a comprehensive and precise assessment of financial risks.In this context, financial risk directly affects the return on equity. Therefore, the assessment of financial risk under climate change conditions can be carried out using the financial leverage indicator.

Financial leverage reflects the impact of an entity's indebtedness on its return on equity and indicates the percentage by which the return on equity will change as a result of attracting borrowed funds into the entity's economic circuit (Anghel, Robu and Lala-Popa, 2022; Petcu et

al., 2023; Petcu, 2009; Spătaru, 2010; Ţiriulnicova et al., 2011; Robu, Anghel and Serban, 2014; Păvăloaia et al., 2010)

Borrowed funding sources generate interest expenses for the entity, but also a certain return on assets, and the difference between them influences the level of return on equity either positively or negatively. This influence is precisely quantified through financial leverage and reflects the variation in return on equity resulting from the use of borrowed financial resources.

The formula for calculating financial leverage is:

$$\text{Financial leverage} = (\text{Return on assets} - \text{Average interest rate charged}) \times \text{Debt ratio} \times (1\text{-}i)$$

When the entity examines the rationality of attracting borrowed funds and the effect of changes in the debt level on return on equity, both return on assets and return on equity are analyzed, calculated as follows:

$$\text{Return on assets} = \frac{\text{Profit before tax and interest}}{(\text{Average equity} + \text{Average interest-bearing debt})} \times 100$$

For the purpose of assessing the rationality of attracting borrowed funds, the numerator of the return on assets formula uses the indicator of profit before tax and interest, while the denominator takes the average value of equity and interest-bearing debt.

$$\text{Return on equity} = \frac{\text{Net profit}}{\text{Average equity}} \times 100$$

The efficiency of indebtedness on return on equity is determined by the ratio between the return on assets (Ra) and the interest rate on borrowed funding sources (Rd), which is presented in Table 1. Thus, if:

- Ra > Rd, this situation is profitable for the owners, as their remuneration will increase. Attracting loans and borrowings is rational, and the owners will benefit from the financial leverage effect, meaning that the return on equity increases under these conditions.
- Ra < Rd, in this case, attracting loans and borrowings is not rational, as appreciation consumes equity, thereby reducing the entity's performance. Consequently, the return on equity decreases under these conditions.

Table 1. Characteristics of changes in the financial leverage effect

Condition	Interpretation	Risk	Conclusion
1	2	3	4
Re > Rd	Positive indebtedness effect. Positive financial leverage effect.	Low financial risk.	- A positive financial leverage effect results in an increase in return on equity due to a higher level of indebtedness. - Contracting the loan is recommended.
Re < Rd	Negative indebtedness effect. Negative financial leverage effect – "hammer" effect.	High financial risk.	- The "hammer" effect decreases return on equity, which requires finding an optimal debt level where return on equity equals return on assets. - Contracting the loan is not recommended, as the insolvency risk is increased.

Source: Developed by the author based on the generalization of bibliographic sources (Anghel, Robu and Lala-Popa, 2022; Petcu et al., 2023; Petcu, 2009; Spătaru, 2010; Ţiriulnicova et al., 2011; Robu, Anghel and Serban, 2014; Păvăloaia et al., 2010)

The assessment of the rationality of attracting borrowed funds is conducted under both climate change conditions and in the context of developing a business plan, to determine the optimal option for acquiring borrowed resources. This process is commonly referred to as a "financing alternatives analysis."

For a correct evaluation of the rationality of attracting borrowed funds, it is very important to collect accurate information, as follows:

a) The average value of interest-bearing debt is determined using the simple arithmetic or chronological means based on data relating to previously obtained long-term and short-term bank loans.

b) The calculated average interest rate does not coincide with the bank interest rate for borrowed loans as reflected in the bank contract. The calculation formula is:

$$\text{Calculated average interest rate} = \frac{\text{Interest payable on interest-bearing debt}}{\text{Average value of interest-bearing debt obtained}} \times 100$$

c) The interest payable on borrowed loans is collected from the analytical record under the account "Interest Expenses." If the analysis is conducted during the business plan development stage, it is based on data from previously concluded bank contracts and the business plan, which corresponds to the amount of interest expenses for loans and borrowings.

d) Income tax expenses are taken from the Profit and Loss Statement. If the analysis is conducted during the business plan development stage, it is determined by multiplying the income tax rate by the profit before tax.

Next, the financial risk under climate change conditions will be assessed, and the rationality of attracting borrowed financial resources will be evaluated based on the effect of changes in the debt level on return on equity.

For this analysis, two state-owned entities from the Republic of Moldova engaged in the production of wine and grape-based alcoholic products were selected: "Cricova" Wine Factory S.A. and "Barza Albă" S.A. The choice of these entities stems from the fact that their activities rely on grapes, whose harvests depend on climate changes observed in Moldova in recent years, namely extreme heat waves, abnormally warm winters with little snow, and the blurring of seasonal boundaries. For example, in the years 2023-2024, September and October seemed like extensions of summer; some plants flowered in January, while there were frosts in May. The years 2023-2024 were also characterized by a significant precipitation deficit, particularly during the summer. Dry periods were increasingly followed by violent torrential rains accompanied by hail, which damaged vineyards and flooded the fields. Consequently, grape harvests were reduced, and the grapes produced were of lower quality.

Table 2. Assessment of financial risk and evaluation of the rationality of attracting borrowed financial resources under climate change conditions

Indicators	„CRICOVA" S.A.			„BARZA ALBĂ" S.A.		
	2023	2024	Absolute deviation	2023	2024	Absolute deviation
1	2	3	4	5	6	7
1. Average equity, thousand MDL	330.911,04	352.156,91	21.245,87	348.381,85	356.609,37	8.227,52
2. Average interest-bearing debt (long- and short-term bank loans), thousand MDL	124.987,84	136.900,08	11.912,24	7.747,44	26.944,98	19.197,54
3. Interest expenses, thousand MDL	12.459,87	10.479,25	-1.980,62	532,90	1.487,84	954,94
4. Profit (loss) before tax, thousand MDL	30.836,95	36.261,92	5.424,97	10.065,27	12.508,97	2.443,70
5. Profit (loss) before tax and interest, thousand MDL (ind.4 + ind.3)	43.296,82	46.741,18	3.444,35	10.598,17	13.996,81	3.398,64
6. Income tax expenses, thousand MDL	4.176,61	4.895,59	718,97	1.299,35	1.493,84	194,49

7. Net profit (loss) for the accounting period, thousand MDL (ind.4 – ind.6)	26.660,34	31.366,33	4.706,00	8.765,93	11.015,13	2.249,21
8. Calculated average interest rate, % (ind.3 ÷ ind.2 × 100)	9,97	7,65	-2,31	6,88	5,52	-1,36
9. Return on assets, % [ind.5 ÷ (ind.1 + ind.2) × 100]	9,50	9,56	0,06	2,98	3,65	0,67
10. Return on equity, % (ind.7 ÷ ind.1 × 100)	8,06	8,91	0,85	2,52	3,09	0,57
11. Debt ratio, units (ind.2 ÷ ind.1)	0,38	0,39	0,01	0,02	0,08	0,05
12. Income tax rate, % (ind.6 ÷ ind.4 × 100)	13,54	13,50	-0,04	12,91	11,94	-0,97
13. Financial leverage effect, % [(ind.9 – ind.8) × ind.11 × (100 – ind.12) ÷ 100]	-0,15	0,64	0,79	-0,08	-0,12	-0,05
14. Financial risk zones	Increased risk	Minimal risk		Increased risk	Increased risk	

Source: Developed by the author based on data selected from the financial statements and the analytical records of the accounts "Financial Expenses" and "Income Tax Expenses."
Note: The average value of equity and interest-bearing debt (indicators 1 and 2 in Table 2) was calculated using the simple arithmetic mean based on balance sheet data.

Based on the data presented in Table 2, it can be observed that, for the analyzed entities, return on equity increased by 0.85 percentage points at "Cricova" Wine Factory S.A. and by 0.57 percentage points at "Barza Albă" S.A. in 2024 compared to 2023. This increase was due to the higher growth of net profit relative to the average value of equity.

Return on assets also showed positive dynamics, increasing by 0.06 percentage points at "Cricova" Wine Factory S.A. and by 0.67 percentage points at "Barza Albă" S.A. in 2024 compared to 2023. The increase in return on assets was driven by the growth of profit before tax and interest, alongside the increase in the average value of equity and interest-bearing debt.

Under these conditions, the debt level of the analyzed entities rose marginally, by 0.01 percentage points at "Cricova" Wine Factory S.A. and by 0.05 percentage points at "Barza Albă" S.A. in 2024, compared to 2023, because of resorting to interest-bearing debt.

At "Cricova" Wine Factory S.A., in 2023, the return on assets was 9.50%, while the calculated average interest rate was 9.97%. Therefore, the financial leverage effect was negative (-0.15%), indicating a „hammer" effect, which led to a decrease in return on equity. Under these circumstances, contracting interest-bearing debt was not recommended, as both insolvency risk and financial risk were elevated.

At the same time, at "Cricova" Wine Factory S.A., in 2024, the calculated average interest rate was 7.65%, which was lower than the return on assets of 9.56%. In 2024, the leverage effect was positive (0.64%), resulting in an increase in return on equity. Given the climate changes observed in 2024, particularly rising temperatures and irregular precipitation, which reduced grape harvests, "Cricova" Wine Factory S.A. considers contracting interest-bearing debt under secure conditions.

Thus, at "Cricova" Wine Factory S.A., the reduction of the calculated average interest rate by 2.31 percentage points, together with an increase in return on assets by 0.06 percentage points in 2024 compared to 2023, led to an increase in the financial leverage effect by 0.79 percentage points. As a result, the return on equity became nearly equal to the return on assets. We can conclude that the entity's attraction of borrowed funds was rational, contributing to a 0.85% increase in return on equity in 2024 compared to 2023. In response to the climate changes observed in 2024, "Cricova" Wine Factory S.A. improved the efficiency of equity, increased the ability to

remunerate owners, and enhanced the financial performance of the entity. Instead, the situation was opposite for "Barza Albă" S.A. In 2023-2024, the return on assets was lower than the calculated average interest rate and the financial leverage effect was negative, namely -0.08% in 2023 and -0.12% in 2024. At "Barza Albă" S.A., the average interest rate decreased by 1.36%, while return on assets increased by 0.67% in 2024 compared to 2023, resulting in a reduction of the financial leverage effect by 0.05%.

Conclusions. We believe that, under climate change conditions, managers of entities and investors should not act blindly, as they are already facing the financial consequences of environmental instability, and must integrate this understanding into their decision-making processes. There is no doubt that natural disasters pose significant financial risks.

Based on the synthesis of knowledge acquired regarding climate and financial risks, we can conclude that their assessment involves comparing the level of risk with its acceptable threshold. Under climate change conditions, there is no economic activity without financial risk, and risk must be calculated at the maximum permissible limit. Financial risk arises in the relationship between an entity and financial institutions (banks, financial companies, investment and insurance firms, etc.), and it is important for both the entity and the financial institutions to evaluate the impact of climate and natural risks on the economy and the financial system.

This is no longer merely a matter of awareness; it is now essential to integrate the impact of risks generated by climate change and environmental degradation into all actions – before financial risks occur that could have been avoided.

The findings of our paper are relevant to businesses and stakeholders, highlighting the growing significance of climate change and its impact on organizations. We recommend that policymakers in the Republic of Moldova go beyond general regulatory requirements and develop specific climate policies as recommendations for investors and stakeholders. Companies must integrate climate risk management into their strategic planning and budgeting, particularly in high-carbon industries such as energy and manufacturing. This strategy will help them gain trust and transparency. Investors have to enhance their climate literacy and integrate ESG factors into their future investment decisions.

Taking into account our findings, we suggest that companies with higher exposure to climate change should experience greater financial volatility. In this way, comparable climate change information will help investors to make decisions in a transparent manner.

This study offers both theoretical insights and practical guidance on how climate risks impact financial risks. In this way, future research will improve methodological and practical approaches to analyzing climate change risks at the enterprise level.

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