



## Managing Climate Risks for a Sustainable Future: Adaptation Strategies and Resilience Building

# Introduction to the special feature on managing climate risks for a sustainable future: adaptation strategies and resilience-building

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## Introduction

As climate change accelerates, climate risk has become international society's key concern. Climate action failure, extreme weather, and biodiversity loss are considered to be the top three most severe global risk factors over the next decade (WEF 2022). Substantial damages and irreversible losses due to climate change have been seen across the world (IPCC AR6 2022), and failure to limit global warming by 1.5 °C can lead to more serious climate hazards and extreme weather events. These will further damage the global ecosystem and cause significant loss of life and wealth.

The frameworks for conceptualising climate risks have evolved from simply looking into natural hazards or extreme climate events to including uncertainties related to regulation and litigation (Ji et al. 2021). Climate risks are clearly multi-dimensional in nature. While physical risks and their associated impacts are easier to understand, transitional risks due to policy reactions to climate change are more complicated and often difficult to measure. In reality, policy is the

key to managing climate risks in terms of both adaptation and building resilience against extreme climate events, but climate policies themselves are also a source of uncertainties, which adds to the complexity of the multi-dimensional system. This complexity leads to the need for an integrated climate assessment system (Emori et al. 2018).

Given the importance of climate policies and their associated transitional risks, comprehensive strategies and mechanisms are needed to effectively manage climate risks and achieve long-term sustainability. Ji et al. (2021), for example, point out the needs to consider adaptation and resilience-building at both macro and micro level. Policy-makers must be aware of the direct and indirect impacts of their policies, and there is insufficient investigation on these issues. Meanwhile, it is critically important to improve the level of climate governance, which can resolve agency problems between different levels of stakeholders (Zhang et al. 2021a; Wilson et al. 2022).

Following some recent discussions in this journal, such as Emori and Takahashi (2018) and Sugiyama et al. (2021), this special feature aims to provide a platform for the discussion and scholarly investigation of relevant issues. The collection of papers is mainly from, but not limited to, the participants of the 2021 International Conference on Climate and Energy Finance (ICEF) held in Xiamen, China. A combination of studies ranging from the international level to central government, local government, industrial sectors, and consumers is included in the collection. Before going into detailed findings, this editorial provides a brief review of some relevant literature and then discusses the implications for the way forward.

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## Literature review

Since the call for this special feature (Ji et al. 2021), a large volume of literature has appeared studying the impacts of climate risks and the existing strategies to adapt and mitigate these impacts. Most of the existing studies on climate risk use extreme weather events and the associated economic losses to measure physical climate risks (e.g. Botzen et al. 2020). Gallina et al. (2016) review the tools and methodologies for multi-risk climate change assessment. Their framework includes multiple natural hazards, exposure and vulnerability. Data provided by the international disasters database (EM-DAT) appear in many studies (e.g. Franzke and Czupryna 2020) as the foundation for measuring climate risks. The Notre Dame climate vulnerability assessment is also frequently used in the literature (Edmonds et al. 2020).

Some recent research has begun measuring long-term climate risks and near-term transition risks. Gambhir et al. (2022), for example, propose an integrated framework for exploring both types of risks. In their framework, long-term physical climate risks (to 2050) are mainly due to warming temperatures, whereas near-term transition risks (to 2030) are mainly from economy-wide mitigation costs, carbon pricing and energy transitions. The authors also suggest that transitional risks can be affected by technological progress, climate policy and other socio-economic factors. Climate policy uncertainty (CPU) is another way of capturing transitional risks. Gavriilidis (2021), for example, proposes a CPU measure based on news from major US newspapers that has been used to study impacts on financial speculation (Guo et al. 2022). Apart from a general aggregate measure of climate risks, there is also a growing interest in measuring climate risks from a bottom-up approach (Conway et al. 2019). Hain et al. (2022) take this to the firm level and compare six physical risk scores that can be used to study investors' and regulators' decision-making.

In addition to direct socio-economic losses, a recent strand of literature has investigated the indirect cost of climate change, i.e. the addition of extra risks in financial markets. Battiston et al. (2021) point out that central banks and monetary authorities have started to pay attention to climate risks and have developed models to assess the vulnerability of financial systems. D'Orazio (2021) suggests that failure to account for climate-related risks in post-pandemic recovery policies can lead to extra financial vulnerabilities and undermine the low-carbon transition. Measures should thus be taken to manage climate risks and build resilience in the global financial system. Lamperti et al. (2021) agree on the fact that climate risks can affect both the real economy and the financial sector. They propose a policy mix comprising three green financial policies to address climate-related risks.

While the need to manage a broader range of climate risks has long been accepted by international society, there is a major challenge to developing optimal strategies and building resilience: conflicts of interest and the need for proper governance systems (Rothe 2011). These matters are present at both the national (Howarth et al. 2020) and transnational levels (Persson and Dzebo 2019; Liu et al. 2021). Brink and Wamsler (2018) suggest that collaborative governance between municipalities and citizens is needed to address climate risks. Overall, the literature demonstrates a growing interest in understanding the nature of climate risks and exploring general strategies for adapting to and mitigating their negative impacts.

## Key findings and insights

This special feature contains seven papers covering cross-country studies as well as national- and industrial-level investigations. The first paper is by Chen et al. (2022), who use a sample of 108 developing countries from 2004 and 2018 in their empirical study. The paper starts by building an empirical linkage between climate risks and foreign direct investment (FDI), which is a critically important form of international capital flow to the economic advancement of developing countries. The paper demonstrates that both physical risks and transition risks can have significant negative consequences for FDI.

These negative consequences can, however, be neutralised by strong national governance. Specifically, the authors use the World Bank's World Governance Indicators (WGI) to capture national-level governance. The WGI data contain comprehensive information on the quality of governance, covering six key dimensions: Voice & Accountability, Political Stability and Lack of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. Both individual quality of governance and aggregate level of governance can mitigate damage from climate risks.

China is the largest carbon emitter in the world and also subject to serious challenges and significant economic impacts from climate risks (Sun et al. 2019; Zhang et al. 2021b). By committing to carbon neutrality before 2060, China will go through a fundamental transition towards a low-carbon economy, which carries considerable transitional risks. In general, developing adaptation strategies and building resilience are central issues for China, and are worthy of investigation. Four papers in this special feature fall into this category.

First, Dong et al. (2022) study the impact of China's announcement of its commitment to carbon neutrality. Achieving carbon neutrality requires strong policy interventions in China, which will bring significant uncertainties to

the business sector. While the real effect may take time to realise, capital markets tend to react faster with price movements (Liu et al. 2022). Following this logic and use data from the Chinese stock market, Dong et al. (2022) investigate the announcement effect of China's carbon-neutral policies with a combination of panel data model and event study method.

Specifically, the authors look into two types of news announcements during the sample period, namely, vision and action. While vision is used to represent national-level strategies, action is related to department-level policy responses. In general, the empirical results provide clear evidence that China's capital market responds to both types of news announcement, though each respective reaction is different. The reactions are also clearly heterogeneous across industries.

The second paper exploring climate policies in China is Zhou et al. (2022), and it also focuses on China's carbon neutrality targets and associated policy choices. The path toward carbon neutrality is uncertain and requires a comprehensive mix of policies. The question of how to resolve the misalignment of the central government and local authorities is a major issue for countries like China. This problem can be interpreted as a typical principal–agency relationship, in which there may exist conflicts of interest leading to so-called 'central-local gaps' (Ran 2013). While general emission targets are set by the central government, it is then up to the local government to achieve these targets. Local officials are inevitably constrained by the trade-off between economic growth and climate mitigation.

Zhou et al. (2022) take the perspective of Chinese municipal governments and study the evolution of climate policy instruments over time. In their sample, 4 municipalities and 109 prefecture-level cities are included over the period 2011–2019. Specifically, the authors take carbon pricing and green investment as two instruments with which to illustrate the central-local gaps. Unlike the clear target of establishing a nationwide carbon market, which facilitates the evolution of carbon pricing in China, a lack of long-term targets in green investment makes policy less effective. Overall, this study points to the importance of a target-centred governance mechanism for resolving China's agency problems.

Emission trading scheme (ETS) was introduced in the EU as a market-based mechanism for reducing carbon emissions. China has also adopted ETS as an important measure for mitigating climate change. Seven pilot programs were implemented around 2013, and then a national trading system was established in 2021. The system, however, has obvious problems and requires proper governance.

The third paper in this special feature (Wu et al. 2022) works on issues related to the Chinese ETS. The paper's key finding is that incomplete sectoral coverage of the existing ETS can trigger strategic behaviour from the relevant

industries, which can affect the market's effectiveness. This finding is in line with an earlier study by Zhu et al. (2020), who use firm-level data in the pilot programs and show that firms have incentive to manipulate the market to gain benefits.

Wu et al. (2022) take both industrial and regional perspectives in investigating strategic behaviour in the Chinese ETS. Their results confirm the existence of strategic behaviour and show that it is more significant in the electricity and steel sectors. Regional effects also exist in that China's eastern regions have more strategic power in the carbon market. While the sectoral expansion of the Chinese ETS is necessary to achieve the carbon-neutral target, this study highlights the need for policymakers to pay attention to potential strategic behaviour in the market. Dynamic adjustment of allowance allocation and other regulatory measures are needed to prevent sectoral and regional disparities.

Mitigating climate change and building resilience require more than aggregate-level efforts; it is often important to understand industrial-level performance and also actions from the demand side. For example, Li et al. (2019) show that consumer lifestyle matters in carbon emissions. They use household survey data to explore demand-side emissions in China, and they suggest that individual lifestyles and social awareness can have significant impacts on emissions.

In the fifth paper, Zhang et al. (2022) take the production and consumption of denim jeans as an example to study the environmental impacts of consumption goods. Their empirical analysis is based on 1392 surveys conducted in mainland China. Ecological knowledge is found to be critical in affecting consumer behaviour, and thus the authors suggest emphasising the potential role of production-based environmental information disclosure. This study contributes to the literature on the awareness–behaviour gap (e.g. Li et al. 2021), which refers to the notion that people may not act in environmentally friendly ways even if they are aware of the need to do so. Educating the general public by releasing key ecological information in the process of production can potentially be helpful.

The sixth paper, by Islam et al. (2022), moves to study sustainability issues in Pakistan, the world's fifth most populous nation. The paper begins with the concept of Inclusive Wealth (IW), which it defines as the social value of all a nation's capital assets, i.e. natural capital, human capital and produced capital (Dasgupta et al. 2022). The IW framework is a very important measure for evaluating a nation's position towards its sustainable development goals (SDG). The United Nations Environment Programme (UNEP)'s IW index aims to track progress on economic sustainability and people's wellbeing around the world, and is thus a useful tool for the United Nations (Duraiappah and Muñoz 2012). Pakistan is one of the nation's most vulnerable to climate risks (Fahad and Wang 2020), and thus studying

the dynamics of IW in this country can offer meaningful implications.

Islam et al. (2022) show that the relative share of each component of IW changes over time in Pakistan. While the share of produced capital continues to increase, the share of natural capital declines over the same sample period. The authors suggest that Pakistan's natural capital has experienced systematic undervaluation in typical analysis, and that the tradeoffs between natural capital and produced capital are often ignored by policymakers. Based on this analysis, the authors argue that sustainable development in Pakistan requires a deep understanding of the interrelationships among three types of capital in the IW framework.

The last paper in this special feature is written by Tanaka et al. (2022), who investigate the impacts of weather conditions on electricity supply, demand and prices in Germany. The energy sector is crucial to both economic development and long-term sustainability. The ability to access and afford modern energy is also a key measure of social welfare (Zhang et al. 2019). Failure to maintain a stable energy supply can trigger serious consequences and is thus a main factor for government to consider. However, the energy sector produces the most carbon emissions, and thus its low-carbon transition is critical to attaining climate goals.

Climate change is often associated with more frequent and severe weather events, which also affect electricity supply and demand. A recent example is the Texas winter blackouts, which affected millions of people in the US (Makhholm 2021), indicating that even the most advanced system is not invulnerable to climate risks. Tanaka et al. (2022) also demonstrate that weather conditions can have significant impacts on electricity supply and demand. There is clear evidence of regional differences, which complicates the overall scenario.

## The way forward

A growing body of evidence has shown that global warming is happening more quickly than what has been anticipated (IPCC AR6 2022). Heatwaves, floods and other extreme weather events have become more frequent and caused significant economic losses across the world. Despite the forming of a global coalition for coping with climate change, and the commitment of carbon neutrality by more countries, challenges remain significant. From the collection of papers in this special issue, we can observe a thriving area of research that deserves further investigation. Many questions remain to be answered for both academia and policymakers.

There is, first of all, a need to measure climate risks in different aspects and at all levels, from the national to the industrial, firms and even individual levels. Climate risk is far from a simple aggregation of natural disasters or associated economic losses. Transitional risk appears to be more

important, as it can induce direct and indirect economic costs. It is, of course, difficult to obtain a unanimous measure that is applicable to all different scenarios.

Second, research in this special feature highlights the importance of improving climate governance. At the aggregate level, stronger governance can improve the effectiveness of policies for managing climate risks. Moving to the disaggregate level, improving climate governance can reduce agency costs among different stakeholders in and out of an economy. Taken together, governance is the key to managing climate risks at all levels.

By definition, climate risks have clear regional differences and thus should be treated differently when considering the policies of adaptation and resilience-building. Both developing and developed nations are subject to climate challenges, though policy scenarios should be fundamentally different and adjusted according to the characteristics of individual nations/regions.

Overall, by gathering a series of cutting-edge studies in this important area, this special feature contributes to the literature by offering clear policy implications. It sheds light on ongoing debates, but, more importantly, it opens up a number of interesting directions for debates that are worthy of further investigation. Apart from the issues mentioned above, we have to realise that the situation is continuously changing. More efforts are needed to better understand the complexity of climate risks. Difficulties also exist in the global political environments, which makes broader coalition, governance and regional cooperation harder.

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