"A strong focus on transition risks is crucial to ensuring that climate policies succeed"

Policy brief

Risk governance and the low-carbon transition

International Risk Governance Center

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Executive summary

This IRGC policy brief focuses on the risks associated with the transition to a low-carbon society and economy. It is based on a multi-stakeholder expert workshop held in September 2020. It incorporates views and insights from academia, industry, non-governmental organizations and policy-making institutions.

Framing the issue

The starting point for our work on transition risk governance is the overarching importance of the climate change challenge. It is imperative that the world tackles climate change and mitigates the risks associated with it. The low-carbon transition is central to these efforts. For the purposes of this report, we use the phrase "low-carbon transition" in line with the climate-policy consensus embodied in the Paris Agreement (UNFCCC, 2015), encompassing all those policies and behaviour changes that aim at achieving the central goal of limiting global temperature increases to well below 2°C and ideally to 1.5°C above pre-industrial levels by the end of the century. In this policy brief, we argue that adopting a risk perspective can play an important part in supporting this goal.

The low-carbon transition will reduce physical risks from climate change, but it will also lead to transition risks, which we define as adverse ancillary impacts that could slow or derail the transition. Transition risks arise as a result of climate policies, technological developments and changes in preferences and behaviours that contribute to a transition to a low-carbon economy and society. These transition risks need to be identified, assessed and managed. Doing so will help to smooth the path of the low-carbon transition and reduce the likelihood of failure.

While the low-carbon transition is a challenge for all stakeholders, policy-makers have a particularly important role to play in defining and shaping the transition, and in managing the countervailing risks it will entail. Examples of important public and private sector initiatives on transition risk include *The Green Swan* report published by the BIS and Banque de France, and the recommendations of the Taskforce on Climate-related Financial Disclosures (TCFD) for businesses exposed to policies designed to drive the low-carbon transition (Bolton et al., 2020; TCFD, 2017). Key policy-related challenges in this area include:

- the systemic nature of the transition, caused by interconnectedness and leading to transboundary cascading effects;
- the requirement of flexibility in planning and implementation, learning from errors and iteration;
- balancing centralised power and coordination with more decentralised structures;
- building and maintaining a sufficient level of resilience for new or modified infrastructure, so as to be better prepared for unexpected or unusual stressors.

Mapping transition risks

Transition risks are likely to arise in many domains and sectors. We argue that further research is needed to build a more thorough understanding of the risk landscape and develop appropriate policy responses. The following categorisation of transition risks can be useful:

- **Social and political strain**: Changes entailed by the low-carbon transition have the potential to trigger significant social and political disruption if careful attention is not paid to issues such as inequality and social justice.
- **International impacts**: The transition has uneven effects internationally, and is likely to lead to some degree of reconfiguration of the international system.
- **Financial stresses**: As investors take on board the implications of the low-carbon transition, they reprice various assets accordingly. Without an early and predictable policy path, this could result in disruptive losses.
- **Macroeconomic challenges**: Significant uncertainty surrounds the impact of the low-carbon transition on GDP. In the labour market, while the net effect may be positive, there are sectoral and geographical concentrations of unemployment.
- **Corporate uncertainty**: The boundary conditions for some markets are already changing, and the transition entails shifts in supply and demand for certain commodities, assets, products and services.
- **Environmental damage**: Overall, the transition can be expected to deliver major benefits for the environment. However, there are also countervailing risks of environmental damage, for example, through land-use changes and the extraction and disposal of new critical materials.
- **Energy system strains**: If the transition away from the global energy system's reliance on fossil fuels is poorly planned, it could lead to interruptions in energy supply, for example, due to loss of flexibility and resilience, or to delays in replacing fossil-fuel plants.
- **Technological risks**: The development, deployment and scaling up of emerging low-carbon technologies may be a source of countervailing risks, including during the innovation process (for example, accidents due to design flaws or unexpected costs or disruption).
- **Model risk**: The risk that decisions will be affected by incorrect or inappropriately used models applies to any effort to map and measure transition risks—this is particularly true given the complexity and interconnectedness of the systems affected by the low-carbon transition.

Governance priorities

Transition risk is a very broad topic, and work on governance principles and priorities remains at an early stage. This report provides a series of proposals that we believe warrant further development by relevant researchers, policy-makers and practitioners.

Risk identification and evaluation

- **Develop a transition risk map**: More work is necessary to develop a comprehensive transition risk map. Greater attention is also needed on the pattern of interconnections and potential cascades between different risk categories.
- **Use foresight tools**: Scenario development and similar techniques can be a useful way of preparing for major changes across a range of interconnected systems, which are difficult to capture with conventional forecasting techniques.
- **Evaluate target benefits and co-benefits**: Transition risks cannot be considered in isolation. The expected benefits of progress on the low-carbon transition greatly exceed the likely scope and scale of any ancillary adverse impacts.
- **Elaborate a normative approach**: How to deal with transition risks cannot be decided solely in terms of efficiency or effectiveness. There is a strong normative element, which should be foregrounded in order to ensure transparency and debate around the values that are being prioritised.

Inclusion and consultation

- **Identify and engage stakeholders**: The scope and scale of the low-carbon transition mean that very many groups are likely to be impacted by transition risks. Engaging with these groups is crucial in ensuring that their perspectives are taken into account when decisions affecting them need to be taken.
- **Think beyond economic interests**: The evidence from previous transitions points to the importance of deep-rooted issues of identity, community, culture and place, which are not amenable to quantitative cost-benefit analysis.

- **Align interests where possible**: Where possible, policy-makers should seek to understand, acknowledge and align the interests and activities of the different groups of stakeholders involved in or affected by the low-carbon transition. Carbon "tax and dividend" proposals are an example of a policy that seeks to do this.
- **Map distributional issues**: We suggest that particular attention is paid to the distributional issues that may arise in relation to the low-carbon transition. The benefits and costs of transition policies frequently accrue to different people and places.

Policy development and implementation

- **Build on existing mitigation policies**: The low-carbon transition is already under way, and policies are being developed to deal with some transition risks. Where these measures can be shown to be successful, they should be adopted and extended.
- **Learn from other transitions**: There are risk governance lessons to be learned from other transitions, including previous energy transitions as well as other major societal shifts, such as globalisation and digitalisation.
- **Try to find "catalytic" policies**: These are relatively contained interventions that trigger broader and longer-lasting effects. An example is the success of Germany's solar feed-in tariffs.
- **Develop institutional capacity**: Both nationally and internationally, the governance priority is likely to involve working with existing institutions rather than creating dedicated new institutions.

Innovation in governance

- **Build "complexity literacy"**: Given the increasingly complex interconnections within and between the various systems on which we rely, there is a need for greater understanding of complexity and systems thinking, and their implications for policy. In essence, a focus on complexity means thinking in terms of relations and interconnections rather than individual agents.
- **Balance centralised and decentralised authority**: Centralised and decentralised authority can complement one another. While practical experience suggests that strong coordination is often needed to tackle multidimensional challenges, decentralisation (including participatory deliberation techniques) can help to deliver effective policy in complex systems.
- **Explore private-sector solutions**: Three important ways in which businesses will play a role in the low-carbon transition involve (i) their responses to hard law, (ii) the development of market-based soft law mechanisms, and (iii) the development of new products and services that have an impact on the transition.

Contingency planning

- **Prepare for disruption and improve resilience**: The story of climate policy includes repeated failures to meet targets, therefore a degree of caution is warranted about how much success is likely in mitigating transition risks (and maximising co-benefits). One of the lessons of IRGC's work on risk and resilience is the importance of preparedness for disruptions, accidents and crises.

The climate change challenge is grave and becoming increasingly urgent. As a result, low-carbon policies are being developed in most countries. Greater attention must now be paid to potential risks and adverse consequences from these policies. A strong focus on transition risks should be seen as an integral part of a strategy to ensure that climate policies succeed. Anticipating and dealing with transition risks will help to smooth the path of the low-carbon transition and reduce the risk of failure.

Transition risk is a very broad and relatively new subject. This report pulls together numerous strands of work being done on transition risk. It aims to catalyse further research and action, and to bring the topic to the attention of decision-makers in various policy domains. Our objective is to contribute to the success of the low-carbon transition and the ultimate goal of mitigating the risks of climate change. The consequences of failing in that effort are far greater than any of the transition risks you will find in this report.

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Introduction

The backdrop for this policy brief on transition risk governance is provided by the urgency of the climate change challenge. Countries have committed to drastic reductions in greenhouse gas emissions, but they continue to rise. The world is on track to miss the central goal of the Paris Agreement. If these trends persist, climate change-induced damage and disruption will increase in frequency and severity, including extreme weather, natural catastrophes and cascading effects across societies and economies around the world. It is imperative to tackle climate change and mitigate the risks associated with it. The transition to a low-carbon society and economy is central to these efforts. It will entail extensive changes across many domains, both public and private, national and international, regulatory and behavioural. Policy-makers' current priority has to be to set the low-carbon transition on a secure trajectory. In this policy brief, we argue that a risk perspective can play an important part in supporting this goal. The low-carbon transition will reduce physical risks from climate change, but it will also lead to transition risks, which need to be identified, assessed and managed.

The focus of this policy brief is on these transition risks, defined as adverse ancillary impacts with the potential to slow or derail the low-carbon transition.

This focus on transition risks should not distract from efforts to ensure that the low-carbon transition occurs. On the contrary, it will help to smooth the path of the low-carbon transition process and reduce the likelihood of failure. For this reason, we believe that transition risks warrant greater attention than they currently receive. Transition risk governance should be an integral part of the policy framework for climate change mitigation. In this sense, transition risk governance is closely related to our earlier work on the governance of emerging risks, which focuses on identifying, assessing and managing novel risks characterised by a high degree of uncertainty and ambiguity, as well as to our work on systemic risks that develop in complex adaptive systems (IRGC, 2015, 2018).

One of the policy challenges will be to make progress on decarbonisation and transition risk governance while also dealing with the ongoing impacts of climate change. Moreover, this

constellation of climate-related challenges occurs against the backdrop of other disruptive processes of major global change, including rapid technological development, changing patterns of global economic activity and the impact of the Covid-19 pandemic.

It is important to stress that the transition will also lead to positive side-effects: co-benefits and enabling factors that support the transition by unlocking positive dynamics. Another advantage of adopting the risk governance perspective is that it can help to find and strengthen these opportunities.

Transition risk is a very broad and relatively new subject. We seek here to pull together numerous strands of work being done on transition risk, with a view to prompting and informing further research and action, focused in particular on identifying concrete policy steps that should be taken in various fields (policy, science, etc.), and to bringing the topic to the attention of decision-makers in various policy domains. The objective of this report is not to provide a comprehensive account of all the risks associated with the low-carbon transition, nor to provide a definitive set of policy recommendations.

This IRGC policy brief is based on a multi-stakeholder expert workshop that we held in September 2020. It incorporates views and insights from academia, industry, non-governmental organisations and policy-making institutions. We start in Chapter 1 with a framing discussion of transition and transition risks, highlighting key policy-related challenges and the role of risk governance. In Chapter 2 we provide an overview of the risk landscape, outlining a range of transition risks and their interconnections. And in Chapter 3 we proceed to suggest a series of governance options for tackling these risks.

Our objective with this report is to contribute to the success of the low-carbon transition and the ultimate goal of mitigating the risks of climate change. The consequences of failing in that effort are far greater than any of the transition risks you will find in this report.

Chapter 1

Framing the issue

1. Transition and transition risk

This policy brief focuses on transition risk. More specifically, we are concerned with risks that arise as a result of climate policies, technological developments and changes in preferences and behaviours that contribute to a transition to a low-carbon economy and society. The low-carbon transition is required to reduce the physical risks from climate change. Anticipating and mitigating transition risks is crucial to ensuring the smooth and successful progress of the transition. A strong focus on transition risks should be seen as an integral part of a strategy to ensure that climate policies succeed.

A STRONG FOCUS ON TRANSITION RISKS SHOULD BE SEEN AS INTEGRAL TO ENSURING THAT CLIMATE POLICIES SUCCEED

This kind of trade-off between risks, in which mitigating one risk creates other, countervailing risks, is a familiar feature of risk governance (Graham et al., 2019; Wiener, 1998). The challenge is to ensure that the policy-making process is framed widely enough so that it considers not just the target benefits of risk-mitigating policies, but also their ancillary impacts, both negative (countervailing risks) and positive (co-benefits) (Graham et al., 1995).

In the case of climate policy and the low-carbon transition, the target benefit is the avoidance or minimisation of damage and disruption caused by climate change (see Figure 1, page 07). Given the scope and scale of the policies required to deliver the low-carbon transition, numerous countervailing risks may arise, which we discuss in the next chapter. Our argument in this report is that these countervailing risks warrant greater policy attention they

Key definitions

Low-carbon transition: we use this phrase in line with the climate-policy consensus embodied in the Paris Agreement, encompassing all those policies and behaviour changes that aim at achieving the central goal of limiting global temperature increases to well below 2°C and ideally to 1.5°C above pre-industrial levels by the end of the century.

Transition risks: we use this phrase to refer to adverse ancillary impacts of policies designed to deliver a low-carbon transition. We argue that anticipating and dealing with these risks should be an integral part of strategies for transitioning to a low-carbon society and economy.

currently receive. Not only do they entail harms which should be minimised for their own sake, but if unaddressed, they also have the potential to weaken support for the low-carbon transition and thereby increase the likelihood of the most damaging climate scenarios coming to pass. This point bears repeating. Tackling transition risks is key to delivering a smooth transition.

For the purposes of this report, we use the phrase "low-carbon transition" in line with the climate-policy consensus embodied in the Paris Agreement (UNFCCC, 2015).[1] In other words, the phrase encompasses all those policies and behaviour changes that aim at achieving the central goal of limiting global temperature increases to well below 2°C and ideally to 1.5°C above pre-industrial levels by the end of the century. Meeting this goal will require drastic reductions to current emissions of CO_2 and other greenhouse gases, as well as some level of removal of greenhouse gases from the atmosphere. The decarbonisation of the energy system will be central to this process, but the implications of the low-carbon transition will be far-reaching. Changes will be required in many areas of life and at multiple scales: individual, local, national and international. A growing body of work suggests that profound adjustments will be needed, affecting dominant norms, values, policies and thinking (Anderson et al., 2020; EEA, 2016).

> *COUNTERVAILING RISKS OF THE LOW-CARBON TRANSITION DESERVE GREATER POLICY ATTENTION THAN THEY CURRENTLY RECEIVE*

The world is on track to fall well short of what is needed to meet the central goal of the Paris Agreement. As well as jeopardising the mitigation of climate-related physical risks, this also leads to heightened transition risks. This is because the pace of transition is an important factor in the likelihood and severity of countervailing risks such as those outlined in Chapter 2. In simple terms, the more sudden the transition is, the more disruptive it is likely to be (Carney, 2015; Geels et al., 2018).

[1] Alternative formulations to "low-carbon transition" that capture subtly different pathways and goals include the "zero-carbon transition" and the "transition to climate neutrality".

Ideally, the transition begins early and moves along a gradual and clearly signalled policy path. It becomes much more challenging if the transition begins late and follows an abrupt and unpredictable path, heightening the risk of adverse impacts (Gros et al., 2016). Our current situation is one in which the likelihood of a late and disruptive transition is increasing. If serious progress on cutting emissions had started in 2010, annual reductions of 0.7% or 3.3% would have been required to meet targets of 2°C and 1.5°C respectively. By 2019, the required cuts had increased to 2.7% and 7.6%. We are on track to require a sharp and sudden transition. In view of this trend, it is increasingly important to anticipate and mitigate the broad range of countervailing risks that the low-carbon transition may cause or exacerbate.

In addition to the pacing of the transition, there is another challenge. It is too simplistic to view the transition as a relatively straightforward path from one equilibrium (our current high-carbon regime) to another (a future low-carbon regime). The reality will involve more complex transition dynamics, for two reasons. First, the transition will have to traverse terrain that is constantly shifting in response to factors both internal to the transition (such as the effectiveness of technologies at reducing or removing CO_2 emissions) and external to it (such as changes in national and international political dynamics). Second, the future low-carbon regime will not be a static endpoint for the transition, but will involve ongoing evolution and potential instability. One of the key challenges with climate policy is finding ways to incorporate this kind of uncertainty and complexity into the process of developing and implementing policy. We discuss this further in Chapter 3, where we highlight the importance of finding policy interventions that can change behaviours within a system rather than trying to target system-level outcomes.

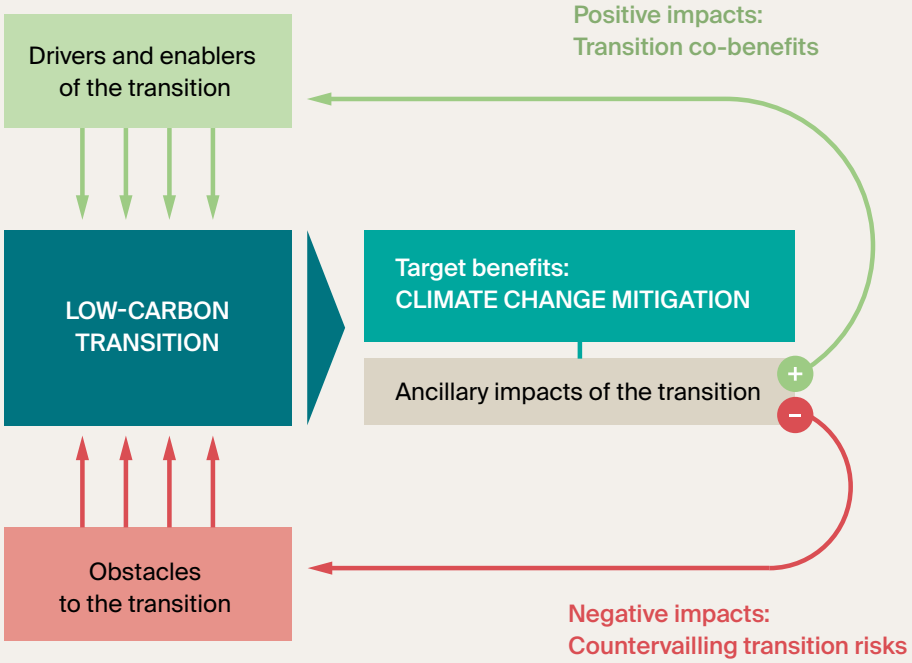

Figure 1: Schematic view of relevant components in the low-carbon transition process

2.

Challenges for policy-makers

While the low-carbon transition is a challenge for all stakeholders, policy-makers have a particularly important role to play in defining and shaping the transition and managing the countervailing risks it will entail. In common with many aspects of climate policy and other policy domains characterised by high uncertainty, complexity and ambiguity, the low-carbon transition will require policy-makers to display ongoing creativity and openness to new ideas and ways of working. We briefly mention here several of the challenges that policy-makers face in respect of the low-carbon transition and will return to these challenges in Chapter 3, where we suggest priorities for policy-makers:

- The low-carbon transition itself and transition risks can have systemic impacts, caused by interconnectedness, leading to transboundary cascading effects. System thinking and related scientific work are increasingly translated into the policy domain and applications are emerging (Hynes et al., 2020; IRGC, 2018).
- The journey towards a low carbon future leads us into uncharted terrain. This requires flexibility in planning and implementation, learning from errors and iteration. This contrasts with prevailing policy-making practice, but promising innovative approaches exist, such as planned adaptive governance (IRGC, 2016).
- There appears to be no dedicated owner of transition risk governance, not least because a substantial part of risk will be emergent and external to the owners of a particular aspect of the transition.
- The responsibility for managing individual transition risks and executing mitigations can be delegated to experts and trusted parties. There is an important role for coordination from the centre, but as we discuss in Chapter 3, the complexity and uncertainty we face in the transition means strictly hierarchical decision-making appears insufficient. Inevitable errors and learning are better accommodated with decentralised structures.
- There will be winners and losers from the transition. Technologically advanced countries and industries, in particular, may profit from the shift to renewable energies. Considerations of power and influence are likely to arise—for example, over access to rare earth minerals needed for solar power and batteries—that may compound current geopolitical tensions. Certain sectors and countries will also lose economic and political power, including those that depend on the production or export of fossil fuels.
- Lack of aligned interests may potentially lead to conflicts among affected parties and trade-off decisions. There is no consensus about ways to address these trade-offs faced in policy-making and finance. The “just transition” discussion, which aims to minimise the adverse impacts of the transition on workers and communities, provides a glimpse of the societal challenges to come (IISD, 2017, 2018). These challenges will play out internationally between “winning” and “losing” countries, but they are also likely to have strong within-country effects. Even in wealthier countries, policy-makers are increasingly aware of the geographical dimension of numerous inequalities (such as differential impacts in rural and urban areas).
- Misalignment of interest is also prominent in the time horizon. Decision-makers are confronted with short-term costs and potential long-term benefits when their personal planning horizon is determined by election periods and/or financial incentives based on annual returns. A potentially useful perspective here is to shift to thinking about transition policies as investments rather than costs.
- Decisions of individuals as well as of policy-making institutions are driven by risk perception, which may drastically differ from objective estimates of risks. Differences in norms, culture, beliefs, trust and value systems drive risk perception, evaluations and judgements, and are acknowledged in research and the application of behavioural approaches (see, for example, Raue et al., 2018; Slovic, 2010). This has a strong effect on the constraints faced by policy-makers in different countries or regions, which can lead to significant international divergences. A concrete example here is the diversity of perceptions about the risks of nuclear power and the resulting differences in policy and regulatory decisions.

A POTENTIALLY USEFUL PERSPECTIVE HERE IS TO SHIFT TO THINKING ABOUT TRANSITION POLICIES AS INVESTMENTS RATHER THAN COSTS

INCLUSIVENESS IS CENTRAL TO THE RISK GOVERNANCE PERSPECTIVE: ENGAGING STAKEHOLDERS AND TAKING ACCOUNT OF THE WIDER SOCIETAL CONTEXT

Such challenges are neither new nor exclusively tied to the low-carbon transition. However, the urgency of dealing with climate change has increased dramatically, and an abrupt transition is likely to trigger significant countervailing risks. These risks require greater attention from policy-makers. Building on a growing body of interdisciplinary work on transition risks, and on the basis of the expert workshop convened by IRGC in September 2020, we have identified a series of governance priorities, which we discuss in Chapter 3.

3.

The risk governance perspective

Risk governance is the process whereby "society takes and implements collective decisions on activities with uncertain consequences in terms of potential costs and benefits" (Bourguignon, 2015). Adopting the risk governance perspective can help policy-makers to address the challenges they face by providing them with established frameworks and tools, developed for and applied in practical policy contexts. These range from standard risk management processes for the identification, assessment, modelling and mitigation of risks, to governance guidelines for dealing with emerging and systemic risks (IRGC, 2015, 2018). Shaping a successful low-carbon transition can be supported with the use of realistic cost-benefit and cost-effectiveness analyses, multi-criteria and risk-risk trade-off analyses, and studies of the costs of inaction as well as action. All of these can help to clarify complex policy challenges in the context of the low-carbon transition, and provide necessary inputs for informed decision-making.

Transition risk management requires the early identification of points of potential dissent, with a view to avoiding policy "showstoppers" that might derail the transition. With this in mind, inclusiveness is central to the risk governance perspective, in terms of actively engaging stakeholders and taking account of the wider societal context (Florin & Bürkler, 2017; Renn, 2015).

The value of approaching the low-carbon transition from the risk governance perspective is not restricted to identifying and mitigating potential risks and policy stumbling blocks. Risk governance can also help to smoothen the transition by revealing co-benefits and other enabling factors, which can contribute directly to the success of the transition process. There is work on systemic risk and resilience that can be applied in this context (Florin & Linkov, 2016; IRGC, 2018; Trump et al., 2018). The European Environment Agency (2019) highlights a range of enabling factors that can contribute to successful transitions, including innovation, experimentation, vision, skills and competencies. For example, building a culture that is tolerant of failure can be a powerful way of enabling greater experimentation.

Chapter 2

Mapping transition risks

1. Social and political strain

The changes entailed by the low-carbon transition have the potential to trigger significant social and political disruption if careful attention is not paid to issues of inequality and social justice (Laird, 2013). Energy is central to the way societies are structured, so a transformation of the energy system will have ramifications that ripple throughout society, well beyond the confines of the energy sector. There is already evidence of the potential anger that can be stirred by the distributional effects of the low-carbon transition. Those on low incomes are likely to be disproportionately affected by important aspects of the transition. This is primarily due to the prospect of transition policies (such as carbon taxes) leading to higher energy and commodity prices. The *gilets jaunes* movement in France is an example of the social unrest and the political backlash against transition policies that climate-related price changes can trigger if they are introduced without sufficient attention to their impacts. Another example is the unrest that arose in Ecuador in 2019 when the sudden withdrawal of fossil-fuel subsidies led to a surge in petrol prices. Job losses are a further source of social and political strain, particularly given the local concentration of much employment in greenhouse gas-intensive sectors.

THE LOW-CARBON TRANSITION HAS THE POTENTIAL TO TRIGGER SIGNIFICANT SOCIAL AND POLITICAL DISRUPTION

Managing the transition effectively will mean providing clear political answers to difficult normative questions about distributive justice and fairness: who bears the costs and who reaps the benefits of the low-carbon transition? If new taxes, technologies or energy systems fail to reach a threshold of public acceptability, it could lead to protest and

political instability. Important policy innovations in this area are beginning to gain traction. In Chapter 3, we discuss the growing focus on supplementing carbon taxes with "carbon dividends" directed at lower-income households.

An empirical study of four low-carbon transition policies in Europe (nuclear power in France, smart meters in Great Britain, electric vehicles in Norway and solar energy in Germany) documented nineteen "commonly recurring injustices", a plurality of which related to adverse impacts on vulnerable groups (Sovacool et al., 2019). The evidence from the shift away from coal that took place in the 20th century points to the potential for significant subnational impacts, including employment losses and the erosion of municipal budgets and community wellbeing (IISD, 2018; Morris et al., 2019). Both domestically and internationally, it makes sense to think of "low-carbon transitions" in the plural: different policies will be applied in different places, and many of these policies will have unequal impacts on different groups of people. If those inequalities are not tackled robustly, the risk is that the process of transition will be slowed or derailed because of rising political opposition.

The low-carbon transition has potential societal co-benefits that should be weighed against these various social and political risks. The scope and scale of the changes entailed by the transition mean there will be opportunities to rethink various aspects of how societies currently function. For example, the need for a wave of investment in new-generation infrastructure could facilitate altered patterns of urban planning, transport networks and work-life balance. The Organisation for Economic Cooperation and Development (OECD) has pointed to the importance of such well-being co-benefits in terms of securing support for the transition (OECD, 2019).

> *IN SOME COUNTRIES, THERE IS A RISK NOT JUST OF LOCALISED DECLINE BUT OF THE SOCIAL CONTRACT BREAKING DOWN*

2.

International impacts

Internationally, the low-carbon transition will have uneven effects, with access to capital and technology likely to be the key determinant of which countries will fare best (Eicke et al., 2019). The transition is therefore likely to be challenging for many low-income countries, although a process of "leapfrogging" may be possible for countries that are not starting with, for example, rigid power grids and associated ownership and power structures. The risk of severe transition-related disruption is greatest in those countries that are most economically reliant on fossil fuels, both as net exporters and importers (see also "Financial stresses" below). In some of these countries, there is a risk not just of localised decline as discussed above under "social and political strain", but of the social contract breaking down (Jaffe, 2020). If left unaddressed, particularly by richer and more technologically advanced countries, such pronounced domestic strife in volatile regions of the world could enflame international tensions, which may already have been roiled by a reshuffling of global status and prestige resulting from a devaluation of fossil fuel resources (Hafner & Tagliapietra, 2020). The uneven international pacing of the low-carbon transition is likely to entail significant transboundary carbon flows and boundary tax adjustments, and managing these will be complicated by the absence of internationally agreed accounting, reporting and verification systems. These cross-border issues could have a significant impact on globalisation and international trade, potentially leading to or exacerbating geopolitical tensions. The international unevenness of the low-carbon transition is not solely a matter of implementation and impact, but involves differences of attitudes and values that are relevant to the way the costs and benefits of transition are weighed.

The transition is likely to lead to some degree of reconfiguration in the international system, with new patterns of cooperation and competition emerging. It is much too early to predict the contours of such a geopolitical reconfiguration. A workshop of international energy and foreign-policy researchers in 2018 sketched out four future scenarios for the geopolitics of the transition, which highlight the breadth of possibility and uncertainty: (i) a "big green deal" in which global consensus is achieved and the costs and benefits of decarbonisation are equitably shared; (ii) a "technology breakthrough" that accelerates the transition but leads to a "clean-

tech cold war" between the US and China, as well as relative decline in other regions; (iii) the rise of "dirty nationalism" with populism and protectionism leading to a zero-sum approach between states that slows the transition; and (iv) a process of "muddling on" in which the transition is too slow to mitigate climate change but too fast for incumbent industries to adapt smoothly (Goldthau et al., 2019).[2]

3.
Financial stresses

The low-carbon transition will lead to stranded capital resulting from a "reassessment of the value of a large range of assets as costs and opportunities become apparent" (Carney, 2015). As investors take on board the implications of the low-carbon transition, they will reprice various assets accordingly, including, but not restricted to, fossil fuel reserves.[3] In principle, this is a healthy and welcome process, reflecting a reallocation of capital in the direction required for climate change to be kept within safe limits. However, a smooth transition requires an early and predictable policy path, allowing for prices to adjust without triggering disruptive volatility. By contrast, a late and sudden transition could undermine the stability of the global financial system, for example by triggering a "rush for the exits" and a sharp devaluation of fossil-fuel assets (GCGET, 2019). A lot of work has been done by market actors to improve the transparency of information related to transition risks, with an important role being played by the Taskforce on Climate-related Financial Disclosures (TFCD; see the "Corporate uncertainty" subsection, page 15).

A substantial proportion of fossil-fuel assets will be affected by the transition. As much as two-thirds of overall reserves may need to be written off — 80% of coal, 50% of natural gas and 33% of oil (Goldthau, 2017). Sudden changes on this scale would not just cause turmoil for private-sector investors and pension schemes, but would also affect sovereign debt markets and the fiscal position of many countries (Jaffe, 2020). The OECD notes that half of resource-rich countries rely on fossil-fuel for 50% of their fiscal revenues, while in numerous other countries, fossil-fuel consumption yields 5% of revenues (Elgouacem et al., 2020). Against this, it should be noted that some countries will find new opportunities as a result of the transition, for example, as producers of renewable energy.

> *A LATE AND SUDDEN TRANSITION COULD DESTABILISE THE GLOBAL FINANCIAL SYSTEM*

Another potential financial risk related to the low-carbon transition is that private investments in renewable energy may not yield the results that investors had hoped for, leading to a sudden divestment from renewable energy businesses. If this occurred, either public funds would be required to make up for the investment shortfall, or politically determined targets would not be reached.

4.
Macroeconomic challenges

Beyond its potential impact on the financial system, the low-carbon transition will also involve significant macroeconomic risks. The fact that a chapter of the most recent World Economic Outlook from the International Monetary Fund (IMF) focuses on these impacts highlights that economic policy-makers are taking economic transition risks increasingly seriously (IMF, 2020). The IMF analysis suggests that a comprehensive package of climate policies would deliver an initial boost to aggregate global growth (primarily in response to higher investment) followed by a period of weakened activity (as investment fades and as carbon pricing starts to exert an increasing drag). However, the IMF stresses the need for policy-makers to consider a wider range of transition impacts than the effect on GDP, notably including co-benefits of mitigating climate change, such as reduced mortality risk due to lower pollution.

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[2] For an earlier climate scenario exercise, see Spiegel & Bresch (2013).

[3] The devaluation of fossil-fuel resources is not the only potential cause of stranded capital. Differences in the timescales at which political, economic and climatic processes operate can also give rise to serious issues. For example, the switch to natural gas in the US energy system has led to lower carbon intensity in the short term, but many of these facilities will have to be retired before the end of their useful economic lifetimes if decarbonisation targets are going to be met (Morgan, 2016).

This is an area where "model risk" (see page 17) is particularly relevant, owing to the complexity and uncertainty that characterises the interconnections between climate, finance and macroeconomics. An early study of the "cascading losses" that would be triggered by a transition away from fossil fuels suggests that in addition to the direct impact on fossil-fuel producers, between 0.6% and 8.2% of overall productive capital stock would be wiped out in the economies studied. And as with financial risk, the adverse macroeconomic impacts would be heightened if the low-carbon transition were late and sudden: "A large amount of built infrastructure, industrial plants and machinery would have to be abandoned or entirely reconverted" (Campiglio et al., 2019). Of course, these economic losses would not occur in isolation—the transition will also see the construction of new infrastructure, plant and machinery.

> *THERE IS NO GUARANTEE THAT NEW JOBS WILL BE CREATED IN THE SAME PLACES OR REQUIRE THE SAME SKILLS AS JOBS THAT ARE LOST*

Another highly uncertain consideration is the economic impact of new patterns of social and economic life that may take root as a result of the low-carbon transition. For example, if mobility systems evolve to become more sustainable (less car ownership, more public transport, bicycles and car-sharing), it may lead to lower financial opportunities and economic growth, causing challenges for economic policy-makers. These considerations are likely to contribute to continued calls for better measures of societal wellbeing and progress than GDP growth, and may prompt wider discussion of the possibility that a successful transition will entail significant degrowth (Kallis et al., 2018; Parrique et al., 2019; Stiglitz et al., 2018).

Against the risks of lower growth, we should also consider the possibility of economic co-benefits. One such positive economic impact of the transition could be the spillover effects of the period of intense innovation required to develop and deploy low-carbon technology and infrastructure on a global scale.

In terms of labour market impacts, the net impact of the transition on employment levels may also be positive, with research pointing to average net job creation of 0.5 jobs per annual gigawatt hour (GWh) generated across all renewable energy technologies (Blyth et al., 2014). However, there is no guarantee that new jobs will be created in the same places that old jobs were lost, or that new jobs will match the skills of those who held the old jobs. Moreover, any labour-market disruption caused by the low-carbon transition will not occur in isolation, but against a backdrop of significant ongoing technology-driven changes in patterns of employment and unemployment.

In the energy sector, up to an estimated 1.6 million people are at risk of losing their jobs in the period 2021–2027 (Cameron et al., 2020). In some places, this will represent not just a macroeconomic shock, but a potential societal shock. Mitigating this kind of socio-economic risk is at the heart of the "just transition" literature, which focuses on the distributional aspects of the transition, both within and between countries (McCauley & Heffron, 2018). See, for example, the policies discussed on pages 25–26.

5.

Corporate uncertainty

Private sector actors are important to the process of transition. Many will benefit from new opportunities that the transition creates, but others will lose out. The boundary conditions for some markets are already changing and there will be shifts in supply and demand for certain commodities, assets, products and services as the low-carbon transition proceeds. This is at the heart of the work of the TCFD, which aims to make companies' physical and transition risk exposures more transparent through a voluntary regime of climate-related disclosures. In addition to financial-sector businesses, four non-financial sectors are particularly exposed: energy; transport; materials and buildings; and agriculture, food and forestry.

In its final recommendations, the TCFD highlights five key transition risks that companies might face. First is policy risk, which arises when a business is exposed to the uncertain impact of policies taken to drive the low-carbon transition. High levels of policy risk can have the effect of discouraging investment and innovation, thereby hampering the process of transition. Second, litigation risk relates to an expected increase in legal action being taken against companies accused of failing to mitigate or adapt to climate change. Third, technology risk involves the impact of new technologies that are introduced as part of the low-carbon transition. Fourth, market risk relates to the emergence of new winners and losers as supply and demand for various goods and services shifts during the transition. And finally, reputation risk arises if customers and communities begin to take the need for transition more seriously and therefore start to re-evaluate businesses accordingly (TCFD, 2017). This is not just a question of potential reputational damage for those businesses perceived to be obstructing the transition—there will also be strategic opportunities for companies that are seen to invest in resilience during turbulent times (Bresch et al., 2014).

> *MANY PRIVATE SECTOR ACTORS WILL BENEFIT FROM NEW OPPORTUNITIES THAT THE TRANSITION CREATES, BUT OTHERS WILL LOSE OUT*

6.

Environmental damage

There are major benefits for the environment from the low-carbon transition, much larger than the countervailing risks to which the transition may lead. The most obvious of these, and the "target benefit" of the transition (see Figure 1, page 7), is the prevention or reduction of the huge adverse environmental impacts that climate change will otherwise cause, such as extreme weather, rising sea levels, drought and wildfires. But the transition will also lead to environmental co-benefits, notably the positive human health effects of reducing air pollution that is caused primarily by coal and gas power generation and transportation fuelled by petrol and diesel (Lueken et al., 2016; National Research Council, 2010). As noted above, the transition also has the potential to deliver improvements in the built environment, such as the construction of more "liveable" cities (OECD, 2019).

> *THE BENEFITS FOR THE ENVIRONMENT OF THE LOW-CARBON TRANSITION ARE MUCH LARGER THAN THE COUNTERVAILING RISKS*

However, the transition may also lead to countervailing risks of environmental damage. There are no simple policy solutions in this area, and decision-making is complicated by numerous risk-risk trade-offs. The scaling up of renewable energy technologies is likely to have adverse environmental impacts, for example, through the extraction and disposal of new critical materials such as lithium (Hanger-Kopp et al., 2019). The scaling up of renewable energy can also lead to damaging land-use changes (Ausubel, 2007). Wind and solar power require lots of land and therefore result in habitat disruption and fragmentation (Gasparatos et al., 2017). Similarly, the use of biofuels as an alternative to oil may contribute to slowing climate change, but when scaled, it can lead to biodiversity loss as well as to increased emissions of carbon dioxide (from deforestation) and nitrous oxide (from nitrogen fertiliser). The requisitioning of agricultural land for biofuel cultivation can also disrupt food security and supply, potentially leading to spillover risks in the societal category (Olsson et al., 2014). Carbon-dioxide removal approaches can also have adverse impacts, particularly in relation to demand for land, water and soil nutrients (Florin et al., 2020). There are numerous other environmental countervailing risks to be considered, including the risk of increased methane emissions when natural gas is used; the risk of nuclear contamination from waste and accidents if nuclear energy is used; and the risk that large wind turbine farms may adversely affect wildlife (Wiener, 2002, 2016). Even the benefits from building the "more liveable cities" mentioned above need to be considered against potential countervailing risks—for example, if wealthier countries improve liveability by displacing various costs or harms to other parts of the world.

7.

Energy system strains

If the transition away from the global energy system's reliance on fossil fuels is poorly planned and/or implemented, it could lead to interruptions in energy supply. In its recent report *Power Systems in Transition*, the International Energy Agency (IEA) cautions that "the challenge for policy-makers and system planners is to update policies, regulation and market design features to ensure that power systems remain secure" (IEA, 2020). Potential vulnerabilities include, for example, loss of flexibility and resilience, or imbalances between supply and demand if the replacement of fossil-fuel plants with renewable energy capacity is not properly planned (Baritaud, 2012). In addition, renewable sources of energy have higher variability in production than fossil fuels. In Latin America, for example, the comparatively high share of hydropower in the energy mix already increases the vulnerability of the electricity system to loss of snowpack and annual variations in rainfall (World Economic Forum, 2019). If significant energy supply interruptions were to occur during the low-carbon transition, it could lead to significant spillover effects. For example, the economic risks discussed above would be greatly exacerbated in a scenario in which businesses could not rely on the continuity of energy supply. Finally, some transition technologies may also place additional strain on energy systems—removing carbon from the atmosphere using Direct Air Carbon Capture and Storage (DACCS) entails high demand for heat and electricity (Florin et al., 2020).

However, there are also potential benefits for the energy system. The low-carbon transition is likely to result in a more decentralised and diversified global energy network, with a greater proportion of energy being produced domestically and with energy trade

being conducted via regional interconnections rather than via asymmetric reliance on a small number of global suppliers. This shift to a more decentralised and symmetrical energy system—"the internet of energy"—will almost certainly be a source of increased resilience in the energy system (Casertano, 2012; GCGET, 2019).

> *IF THE LOW-CARBON TRANSITION CAUSES ENERGY SUPPLY INTERRUPTIONS, IT COULD LEAD TO SIGNIFICANT SPILLOVER EFFECTS*

8.

Technology risk

Technology has a crucial role to play in the low-carbon transition. The development, deployment and scaling up of emerging low-carbon technologies—notably related to renewable energy sources, battery storage, increased energy efficiency and negative emissions technologies (NETS) such as carbon capture and storage—may be a source of countervailing risks. In most instances, these risks will crystallise in one or more of the risk categories discussed above, such as environmental degradation or labour-market disruption. But it is also worth considering other risks that may arise as a result of the innovation process, such as accidents due to design flaws or unexpected costs or disruption if a technology's lifespan turns out to be lower than projected (Hanger-Kopp et al., 2020). In addition, the nature of the countervailing risks that the transition entails will depend significantly on the technological profile or composition of the transition. For example, the potential risks of nuclear power as a climate mitigation strategy (Lehtveer & Hedenus, 2015) differ from those of wind power (Ledec et al., 2011). These, in turn, are different from the risks associated with climate engineering technologies, which include concerns about "moral hazard" and a weakening of efforts to reduce emissions (Florin et al., 2020; Preston, 2013).

9.

Model risk

It is worth noting that model risk—the risk that decisions will be affected by incorrect or inappropriately used models—applies to any effort to map and measure transition risk (Derman, 1996). This is particularly true given the complexity and interconnectedness of the systems affected by the low-carbon transition. Climate and energy models can provide useful directional information regarding the achievability of climate targets. There are limitations in terms of the quantitative aspects of transition risk that climate and energy models can currently capture. However, it is possible that AI and machine learning could facilitate the development of more dynamic and accurate models, for example, via new smart-monitoring systems.

There are also potentially serious implications depending on which models are used.[4] For example, in the area of macroeconomic risk, depending on the model used, GDP can be projected to increase or decrease as a result of the low-carbon transition (Mercure et al., 2019). However, many risk management processes—particularly at the enterprise level—rely on the availability of quantitative estimates, meaning that transition risk will not be taken seriously without such estimates. This creates a tension between micro- and macro-level quantitative modelling in this area, leading to a danger of models being chosen and applied without fully accounting for their assumptions and implications. The goal should be to use models cautiously in an area like transition risk, striving to complement generic models with national, regional or sector context and nuance. A further point of caution relating to the use of quantitative modelling is that it can constrain the risk mapping exercise. Research suggests that experts tend to focus on financial and environmental transition risks because they are amenable to quantitative modelling. Broader stakeholder groups—such as governments, businesses and NGOs—are much more likely to cite more qualitative categories such as societal and political risks (Hanger-Kopp et al., 2020). These can be more easily accommodated using foresight tools rather than predictive modelling.

[4] For a guide to the trade-offs and assumptions in a range of climate-related models, see Berg et al. (2018).

Chapter 3

Governance priorities

In this chapter, we set out a list of potential recommendations for the governance of low-carbon transition risks. These rest primarily on suggestions made during the course of our expert workshop in September 2020, but they also draw on insights, evidence and recommendations from other academic and policy work in this area. To repeat a point that has already been made in this report, transition risk is a very broad topic, and work on governance principles and priorities remains at an early stage. Accordingly, the recommendations that follow should be understood not as a definitive list of next steps, but as a series of proposals that we believe warrant further development by relevant researchers, policy-makers and practitioners. We have grouped our recommendations into five clusters: risk identification and evaluation; inclusion and consultation; policy development and implementation; innovation in governance; and contingency planning. Our hope is that these suggestions will serve as a catalyst for further work in this area.

1.

Risk identification and evaluation

Develop a transition risk map

Much more work is needed to develop a clearer sense of the adverse impacts that might be caused or shaped by the low-carbon transition. In Chapter 2, we provided a summary overview of some key transition risk categories, but more detailed work is required to refine this list and to build a more sophisticated picture of how, where and when these risks might crystallise. This is likely to emerge as the synthesis of more detailed risk-assessment or risk-mapping exercises. These might involve a series of deep-dive analyses, assessing how transition risk will play out in different countries, communities, sectors and companies. Work of this nature will facilitate a more nuanced focus on transition dynamics than is possible in this current report. It makes a critical difference whether transition policies are implemented in a timely and predictable manner, or in a late and disorderly manner. Likewise, the composition of the transition matters—for example, different policies and technologies will entail different potential risks.

> *ATTENTION IS NEEDED ON THE INTERCONNECTIONS AND POTENTIAL CASCADES BETWEEN DIFFERENT RISK CATEGORIES*

Some work is already being done on the scoping or mapping of transition risks, such as empirical research by Susanne Hanger-Kopp and colleagues (2020) that highlights the different emphasis placed on different risks by different stakeholder groups. This kind of work should be stepped up. It will be important to go beyond the kind of static categorisation of risks we have carried out in Chapter 2. Greater attention is needed on the pattern of interconnections and potential cascades between different categories—for example, from financial disruption to societal instability to geopolitical tension (IRGC, 2018; Schweizer, 2019). Such interconnection mapping might help to identify key nodes in the system, where intervention might be most effective or where positive feedback loops are to be found. We return to this question of complex-system dynamics in the subsection "Innovation in governance" on page 28.

Use foresight tools

The process of risk identification discussed above is fraught with difficulty given the planetary scale of the low-carbon transition and the uncertainty that exists as to when and how it will unfold. The prospect of major change across a range of interconnected systems—inherent in the idea of transition—makes it problematic to extrapolate too far from past and current patterns of activity. For this reason, it is necessary to go beyond conventional forecasting approaches that rely heavily on past data to predict the future (IRGC, 2018). One way of doing this is through the use of foresight techniques, such as scenario development, which aim to build plausible narratives of possible futures.[5] One advantage of these methods is their ability to incorporate and provoke reflection on unpredictable and dramatic changes in the system(s) being analysed. In this sense, foresight work can be seen as an "on-ramp to complexity", a relatively intuitive way of starting to approach risk and policy through a complexity lens, as discussed further in the "Innovation in governance" section (Wilkinson et al., 2013).[6]

Another approach with potential application to transition risk is horizon scanning, which focuses on detecting and interpreting weak signals of impending shifts in current circumstances (Sutherland & Woodroof, 2009). The low-carbon transition involves the interaction of numerous actors and sectors, raising challenges of timing and coordination among them as risks crystallise. Horizon scanning can focus attention on the governance challenges entailed by such pacing issues.

One advantage of foresight methods such as scenario building and horizon scanning is their openness to diverse insights and inputs from numerous disciplines and perspectives. They can provide a corrective to the "model risk" discussed

[5] The recommendations of the TCFD include the use of stress tests against a range of transition scenarios.

[6] For a skeptical discussion of the utility of scenarios, see section 8.6 of Morgan (2017).

in the previous chapter, but any assumptions and models underpinning scenarios should be clearly stated so that risks are not obscured. A potential disadvantage of foresight methods is that they are difficult to integrate with the quantitative tools and methods that form the bedrock of risk management systems in many organisations. This is particularly true for enterprise risk management, especially in the financial sector, where it can be difficult for more discursive, narrative risk methodologies to "compete" with quantitative assessments and forecasts. There is a need for risk cultures to evolve towards a greater appreciation for qualitative assessments and the introduction of integrative risk assessment frameworks that balance both quantitative and qualitative methods. In that spirit, a recent report entitled *The Green Swan*, published by the Banque de France and the Bank of International Settlements (BIS), suggests that in an era of climate-related risks, the onus is on those who have relied on quantitative modelling to become more open to new methods (Bolton et al., 2020). The report calls for an "epistemological break" and greater use of scenario-based analysis, noting that "scientific methods and intellectual habits that were useful and healthy under certain circumstances, can progressively become problematic and hamper scientific research" (Bolton et al., 2020).

Evaluate target benefits and co-benefits

Transition risks cannot be considered in isolation. As we noted in Chapter 1, the expected benefits of progress on the low-carbon transition greatly exceed the likely scope and scale of any adverse impacts of the transition. It bears repeating that the existence of transition risks is not an argument for inaction on climate change. On the contrary, our core argument is that identifying and managing transition risks will help to ensure the durability of progress towards a low-carbon economy and society. In the IRGC risk governance framework, one of the key steps is risk evaluation (Florin & Bürkler, 2017). This is distinct from the process of assessing the likelihood and impact of a given risk, or public perceptions of a risk. Rather, risk evaluation reflects a societal (or organisational) judgement as to how much of a given risk is tolerable (a judgement that will vary depending on what risk-management interventions are available). In the case of the low-carbon transition, the countervailing risks that we are focusing on cannot be evaluated in isolation. They must be considered alongside the expected benefits of the transition (or the expected costs of failing to transition).

> *IDENTIFYING AND MANAGING TRANSITION RISKS WILL HELP TO ENSURE THE DURABILITY OF PROGRESS TOWARDS A LOW-CARBON ECONOMY AND SOCIETY*

For example, if we consider fossil-fuel labour market disruption, the question is not simply how much unemployment a region or country can cope with. In areas already dealing with economic and societal strain, the answer to that question might be none, or very little. But the policy judgement required cannot focus on unemployment alone. The question decision-makers face is: "Given the wider costs of failing to transition away from fossil fuels, how much labour-market disruption do we need to manage?" In this broader evaluative context, the policy priority is likely to shift from trying to avoid labour-market disruption to designing policy interventions (economic regeneration, reskilling, income support) that will minimise the harm caused by such disruption and maximise the potential benefits, such as the creation of new jobs. A number of examples of such interventions are included in the section "Policy development and implementation" on page 25.

The low-carbon transition can be viewed as a clear instance of a risk-risk trade-off (Graham et al., 1995). This refers to situations in which measures introduced to deal with one risk are themselves a source of further "countervailing" risks (as well as potential ancillary benefits, or "co-benefits"). Often policy can be too narrowly circumscribed, so that it fails to account for these linkages. Therefore, the policy challenge is to weigh both the target benefits and the ancillary impacts (both countervailing risks and co-benefits) of any measures being considered.

> *THE POLICY CHALLENGE IS TO WEIGH BOTH THE TARGET BENEFITS AND THE ANCILLARY IMPACTS, BOTH COUNTERVAILING RISKS AND CO-BENEFITS*

For example, as discussed, the transition to new sources of energy will lead to job losses, but it will also create new jobs—a key policy challenge relates to the fact that these jobs will not necessarily be in the same places or require the same skills (Kapetaki & Ruiz, 2020).

Elaborate a normative approach

How to deal with transition risks cannot be decided solely in terms of efficiency or effectiveness. There is a strong normative element, which should be foregrounded in order to ensure transparency and debate around the values that are being prioritised. A topic as far-reaching as climate change and the low-carbon transition raises fundamental political and even philosophical questions about the kind of societies in which we want to live. To go back to the question of risk evaluation in the previous subsection, judgments about the tolerability of risk are grounded in normative values. Sometimes these values may be relatively straightforward and widely agreed upon, but in other instances they may be contested, adding an additional layer of difficulty to the decision-making process. In the case of countervailing transition risks, policy-makers (and stakeholders more generally) should reflect on the normative assumptions that underpin their risk-management priorities. For example, possible priorities might include: minimising the economic cost of transition, avoiding societal disruption, protecting the environment, maximising the speed of the transition, or minimising any resulting inequality.

> *JUDGMENTS ABOUT THE TOLERABILITY OF RISK ARE GROUNDED IN NORMATIVE VALUES*

There are major normative questions here. Climate-related risks, including transition risks, are perhaps an example of a situation in which "risk disputes are really disputes over the good life" (Kahan et al., 2006). According to Kahan et al., in such circumstances "the challenge that risk regulation

poses for democracy is less how to reconcile public sensibilities with science than how to accommodate diverse visions of the good within a popular system of regulation". It is notable that one of the most prominent responses to transition risk—the idea of a "just transition"—is framed in explicitly normative terms that prioritise various normative dimensions: the availability of decent work, the eradication of poverty, the reduction of inequality and the environmental sustainability of economic activity (ILO, 2015; UNFCCC, 2015). It would be useful if contrasting approaches to transition risk (and to climate policy more broadly) could be equally explicit about their normative priorities, with a view to facilitating an open debate about values disputes and how to resolve them. It cannot be assumed that different actors or stakeholders share the same normative starting points, and the question of consultation and deliberation is developed in the next section. If this is a challenge within individual societies, it is all the more so at the international level, where normative tensions can be greater and decision-making institutions weaker.

2.

Inclusion and consultation

Identify and engage stakeholders

Deciding how to manage transition risks requires careful attention to the stakeholders involved. The scope and scale of the low-carbon transition mean that very many groups are likely to be affected in one way or another by transition risks.[7] Identifying these groups is a crucial first step in ensuring that their perspectives are taken into account when decisions affecting them need to be taken. There is a normative aspect to this—what Jenkins et al. (2016) refer to as "recognition justice". In Chapter 2, we highlighted the distributional challenges that can arise in different risk categories because of the differential impact in different places and on different people. One of the fundamental distributional issues relates to decision-making itself, and the gaps that frequently exist between those who are taking transition-related decisions and those who are affected by them. Given the inherently global scale of the low-carbon transition, these gaps are frequently international in character.

> *GAPS FREQUENTLY EXIST BETWEEN THOSE WHO ARE TAKING TRANSITION-RELATED DECISIONS AND THOSE WHO ARE AFFECTED BY THEM*

Some of the processes of identifying key stakeholder groups are likely to occur relatively organically as part of the risk mapping exercise discussed above, which will involve disaggregating the overall idea of transition risk into multiple concrete answers to the "risk of what and to whom" question. But it warrants separate attention to ensure that all relevant groups are accounted for. Such a list might include, for example:

- decision-makers who can cause transition risk;
- decision-makers who can manage transition risk;
- people who are adversely affected (either directly or indirectly);
- people who stand to benefit;
- civil society groups and the media;
- the general public.

Having identified the key stakeholders, and the relationships between them, the next challenge is to design processes for engaging with them, as a means of maximising the quality, legitimacy and efficacy of decision-making related to transition risks. In our work on the role of stakeholder engagement in the risk governance process, IRGC highlights three different modes of engagement with stakeholders: information-sharing, consultation and co-deliberation (IRGC, 2020). In their review of the literature on public perceptions of low-carbon energy technologies, Peterson et al. (2015) highlight the importance of engagement processes as a determinant of attitudes towards the transition, and therefore also as an influence on its progress.[8] In its statement of the key principles of the just transition, the International Labour Organisation (ILO) stresses the importance of social dialogue at all stages of the policy process (ILO, 2015). The policy toolkit for more participatory

[7] For a review of the literature on who is likely to be adversely affected by the low-carbon transition, see Green & Gambhir (2020).

[8] See also Renn & Schweizer (2020).

> *EVIDENCE FROM PREVIOUS TRANSITIONS POINTS TO THE IMPORTANCE OF DEEP-ROOTED ISSUES OF IDENTITY, COMMUNITY, CULTURE AND PLACE*

and deliberative decision-making processes is evolving quickly and in the section on "Innovation in governance", we highlight the potential role to be played in transition risk governance by citizen assemblies of various sorts.

Think beyond economic interests

It is important to think beyond narrow economic costs and benefits when making policy aimed at managing transition risks, not least because the costs and benefits of the transition are so difficult to estimate.[9] There will obviously be economic winners and losers in the shift from fossil-fuel to low-carbon energy technologies. Some workers will lose jobs in old technology sectors while others will have increased opportunities in new and expanding sectors. But it would be a mistake to see that process of labour-market churn solely from a perspective of economic costs and benefits. The evidence from previous energy transitions points to the importance of deep-rooted issues of identity, community, culture and place, which are not amenable to quantitative cost-benefit analysis (Carley et al., 2018; Peterson et al., 2015; Sovacool & Griffiths, 2020). This highlights again the need for integrated assessments of both quantifiable and non-quantifiable aspects of the transition. Questions of individual and social identity are potent sources of political motivation in adversely affected regions, and so have a direct bearing on the policy-making process and the development of politically feasible interventions.[10] Behavioural science is an increasingly widely used policy tool for understanding and responding to such differences in individual and group responses to risk.

It is also important to note that questions of identity and culture do not arise solely in respect of workers whose jobs and communities are at risk. It is also worth asking to what extent cultural factors—related to sectoral norms and professional status, for example—affect the judgements of political and corporate actors about the desirability and feasibility of transition-related policies.

Align interests where possible

Where possible, policy-makers should seek to understand, acknowledge and align the interests and activities of the different groups of stakeholders involved in or affected by the low-carbon transition. One example here might be the growing popularity of policies that develop carbon tax proposals into "carbon tax-and-dividend" proposals, as is now advocated by the IMF among others (Claeys et al., 2019; IMF, 2020; Sandbu, 2020b). The idea behind these proposals is to ensure that the revenues from carbon taxes are channelled towards offsetting the impact on lower-income households of transition-driven higher prices, thereby mitigating ancillary economic impacts and reducing the likelihood of political opposition. Similarly, one way of looking at the TCFD's recommended disclosure regime is as a means of fixing an information asymmetry in a way that moves investor incentives closer into alignment with the interest of society more widely in a reallocation of capital from fossil-fuel dependent technologies and activities to low-carbon ones.

> *SOME ELEMENTS OF POLICY IN THIS AREA ARE NON-NEGOTIABLE, SUCH AS THE OVERARCHING GOAL OF MITIGATING CLIMATE CHANGE*

However, it is important to be realistic about the likely extent of interest-alignment that will be possible. The network of intersecting and conflicting interests involved in the transition may often make it

[9] One reason for this is the difficulty of forecasting market conditions many years into the future. For example, in the early 2000s, the idea of negative interest rates was largely theoretical, whereas it has become relatively common in the wake of the 2008 financial crisis.
[10] Bourguignon (2015) contrasts cost-benefit analyses, which focus on ensuring benefits outweigh costs, with cost-effectiveness analyses, which take greater account of political feasibility.

difficult or impossible to find neat win-win solutions. In these circumstances, decision-makers will have to try to overcome blockages and return to questions of fairness (or other normative anchors, as discussed earlier) in order to deal with questions where distributional issues between winners and losers cannot be avoided. Some have suggested that ultimately a successful low-carbon transition may require the alignment of mindsets and values as well as of interests. We would sound a note of caution on this point. Both domestically and internationally, values pluralism (and tension) is likely to be a persistent feature of the climate-policy arena. The key challenge for policy-makers is to navigate these differences rather than hope that they will be resolved. Among other things, this requires identifying which elements of policy in this area are non-negotiable, such as the overarching goal of mitigating climate change.

Map distributional issues

As an extension of the risk mapping exercise discussed in the previous section, we suggest that particular attention is paid to the distributional issues that may arise in each case. The benefits and costs of transition policies frequently accrue to different people and places. Likewise, risks and responsibilities. What Barrett (2013) notes in respect of climate change adaptation can be extended to the low-carbon transition: there can be an "inverse distribution of risk and responsibility" between those making decisions and those affected by them. Understanding the details of these disparities is crucial to the process of designing and implementing policy trade-offs that will be effective, popular and durable. These distributional questions may typically operate on a geographical basis (between countries, or between regions within countries) or a sectoral basis. There are also intergenerational issues to consider, owing to the long-term effects of action (or inaction) now. However, we should be careful not to overstate the intergenerational risks or disparities to which transition policies might lead. Failure to deliver a low-carbon transition would lead to much greater intergenerational injustices (Shue, 2005; Sovacool & Dworkin, 2014). Again, these considerations highlight the pressing normative challenges that the low-carbon transition entails, including in this instance the question of the "social discount rate" used to weigh the climate-related interests of current and future generations (Caney, 2009).

3.

Policy development and implementation

Build on existing mitigation policies

The development of effective measures to manage transition risk should be shaped in large measure by the recommendations contained in the two preceding sections: the development of a risk map or landscape which takes careful account of the perspectives of different stakeholder groups (Webler et al., 2015). However, the low-carbon transition is already under way, and policies are being developed to deal with some of the risks that have arisen as a result, particularly in relation to labour-market challenges. Where these measures can be shown to be successful, they should be adopted and extended. However, we reiterate the importance of the interconnectedness of the various transition risk categories. It is important to consider also the ancillary impacts of any policies being implemented, whether adverse (countervailing risks) or positive (co-benefits) (Graham et al., 1995; Wiener, 1998). The possibility of spillovers and cascades is a typical challenge for risk governance. These first- and second-order impacts may occur in different systems, for example, on different sides of important institutional dividing lines, or between different countries or government departments.

> *WHERE EXISTING MEASURES CAN BE SHOWN TO BE SUCCESSFUL, THEY SHOULD BE ADOPTED AND EXTENDED*

As noted above, one example of a policy designed to mitigate transition risk is the "carbon tax and dividend" approach, which marries higher carbon prices with redistributive mechanisms to ensure that the transition does not disadvantage poorer households. The fact that the IMF is now heralding this approach suggests that it has moved into the policy-making mainstream and is likely to be replicated in a growing number of countries (IMF, 2020). Another policy approach that is likely to gain further traction is the allocation of resources to boosting the resilience of regions that are most likely to be adversely affected by the low-carbon transition. An example of such a scheme is the European Union's Just Transition Fund, under

which additional resources will be allocated to subnational regions largely on the basis of three criteria: (i) carbon intensity, (ii) employment in coal and lignite mining, and (iii) employment in industry. Funds allocated under the scheme must be spent on economic regeneration, reskilling and job-search support for workers, or the restoration of industrial land (Cameron et al., 2020). Such schemes may raise challenges around eligibility criteria and the transparency of funding allocations. One of their advantages is that they are designed to respond to the issues of community and place mentioned earlier.

We suggest that further research would be helpful to identify and compare policies or initiatives that have already been developed around the world to respond to risks that have arisen as a result of the low-carbon transition. The creation of a databank of such initiatives might speed their replication or adaptation in new countries or organisations. Examples might include initiatives designed to deal with harms caused along critical-material supply chains, which are likely to increase in scale as the low-carbon transition proceeds (Dehghani-Sanij et al., 2019; Mathieux et al., 2017). Where the current understanding of possible transition risks is at an early stage, the key next step may involve further work on risk identification rather than the implementation of mitigation measures.

It may also be possible to extend general approaches to transition risk. The underlying rationale of the TCFD is that increased transparency about exposure to transition risk will allow for better decision-making in respect of those risks. This principle may have application in other areas, such as the publication of detailed country-level budget data revealing the extent of fiscal dependence on fossil-fuel revenues, as proposed by the OECD, or the extent of fossil-fuel subsidies (Elgouacem et al., 2020).

Learn from other transitions

There are risk governance lessons to be learned from other transitions. This includes both previous energy transitions as well as other major societal shifts, which, though they differ in important respects from the low-carbon transition, may have analogous disruptive potential, such as globalisation and digitalisation (Geels, 2005; Geels et al., 2017; Sandbu, 2020a). Indeed, one of the reasons that there are numerous examples of policies designed to mitigate the adverse labour-market impacts of the low-carbon transition, like those mentioned above, is that there is a wealth of evidence about the effects on individuals and communities of economic shocks that affect different regions or sectors of the economy very differently. Claeys et al. (2019) argue that the European Union did not need to design a new compensation mechanism to deal with the labour-market impacts of the low-carbon transition. Instead, it could have expanded a structurally very similar mechanism—the European Globalisation Adjustment Fund—that had been established in 2006 to support workers who lost their jobs as a result of structural changes in world trade patterns. More generally, the lessons learned about mitigating the labour-market risks caused by transitions have been codified by the International Labour Organisation (ILO, 2015).

> *THERE IS A WEALTH OF EVIDENCE ABOUT THE EFFECTS ON INDIVIDUALS AND COMMUNITIES OF ECONOMIC SHOCKS*

Mazzucato and McPherson (2019) point to a range of lessons that might be learned from the digital transformation. Chief among these is the importance of better stakeholder engagement and democratic questioning and control. They also point to the importance of ownership, drawing analogies between the role of data-ownership in the digital economy and the likely role of residential micro-generation in the low-carbon energy system. Another possible lesson to be drawn from the digital transformation relates to the so-called pacing problem: the difficulty of establishing governance rules for a complex system in which profound changes are taking place at a rapid pace (Marchant et al., 2011). Solutions that have been suggested for the technological pacing problem may have a role to play in developing effective responses to transition risks if and when their occurrence intensifies. These include iterative strategies designed to ensure that regulations evolve rather than obsolescing (Bennear & Wiener, 2019), as well as a range of approaches designed to promote regulatory experimentation and agility (Zetzsche et al., 2017).

Try to find "catalytic" policies

A catalytic policy is a relatively contained intervention that triggers broader and longer-lasting effects. As Cantner and Vannuccini (2018) put it in the context

of innovation policy, "a catalytic policy should spark the flame of innovative activities, rather than being its permanent source". The policy challenge here is to identify those policies which might purposefully yield positive catalysis. An example here might be the success of Germany's solar feed-in tariffs (Lauber & Mez, 2004). On the face of it, it is likely to be easier to find such catalytic windows of opportunity when designing policies aimed at driving the transition forward, rather than with policies designed to mitigate risks that arise as a consequence of the transition. Given the uncertainty that surrounds transition risk, as well as the normative and stakeholder-related challenges discussed above, it may be the case that process-related innovations—such as those discussed in the section on governance innovation, below—are most likely to catalyse progress in this area.

Develop institutional capacity

One obstacle to the development and implementation of policies to mitigate transition risks is the absence of clear institutional "ownership" for this issue. There may be some logic in trying to identify—or create—a single organisation at the international level that might take responsibility for driving and coordinating progress on transition risk. However, this seems a remote prospect given the current global institutional landscape, and so the global governance challenge is likely to be one of working in and across a multiplicity of institutions that have a stake in the transition. For example, the United Nations Framework Convention on Climate Change (UNFCCC) process which delivered the Paris Agreement can be slow and cumbersome, but it is an important element of the transition risk landscape.

THE ABSENCE OF CLEAR INSTITUTIONAL "OWNERSHIP" FOR TRANSITION RISK IS AN OBSTACLE

The International Energy Agency (IEA) is another prominent part of the institutional constellation, as are the world's development banks. The G20 has also been mooted for a possible role, building on the fact that the TCFD was established by the G20's Financial Stability Board (Goldthau, 2017).

At a national level, the priority for transition risk governance lies in working with whatever sources of institutional weight and momentum are already available in each country, rather than seeking to create dedicated new organisations. There is a potential tension here between centralisation and decentralisation. The OECD has highlighted the efficacy of the so-called "centre of government" — that is, the administrative structure serving the president or prime minister — at various tasks with clear relevance for transition risk, such as strategic planning and coordination (OECD, 2018). However, driving policy from the centre of government can lead to a dilution of the expertise and distinct perspectives that are housed in individual government departments, potentially undermining what the OECD (2005) has elsewhere referred to as a "whole of government" approach. We return to the tension between of centralised and decentralised decision-making in the section on "Innovation in governance".

On recent evidence, central banks may be a potential source of official institutional support for efforts to tackle transition risk. As mentioned earlier, *The Green Swan* report published by the BIS and the Banque de France is an intellectually ambitious attempt to understand the governance implications of the complex physical and transition risks that climate change poses to the financial system (Bolton et al., 2020). It is also noteworthy that the former governor of the Bank of England, Mark Carney, was instrumental in focusing widespread attention on the potential disruptiveness of transition risks, both through his speeches and his work on the FSB and TCFD (Carney, 2015). Mr Carney's personal impact on the way transition risk is perceived in the financial sector points to another factor that will be crucial to the success or otherwise of efforts to manage transition risks: leadership.

4.

Innovation in governance

Build "complexity literacy"

In addition to building institutional capacity, as discussed, there is a need to build greater understanding of complexity, systems thinking and their implications for policy. Given the increasingly complex interconnections within and between the various systems on which we rely — societal, economic, technological, ecological, etc. — the development of a "complexity lens" through which policy problems and solutions can be judged is becoming increasingly urgent. Complex systems can give rise to systemic risks, and these are becoming an increasingly familiar part of life (IRGC, 2018). The accelerating climate crisis is perhaps the gravest example, but others include the 2007-08 financial crisis and the Covid-19 pandemic. All have tested the limits of traditional modes of risk governance and policy-making more generally. Some of the lessons to be learned are more about "how" than "what" — that is, how to make decisions that reflect the dynamics of complex systems, rather than what the specific policy prescriptions are (Kupers, 2020a).

In essence, a focus on complexity means thinking in terms of relations and interconnections rather than individual agents. "In complexity policy the goal is to influence the emergent behaviour of a system, rather than that of each individual. This is done through tweaking the rules that deliver this emergence" (Kupers, 2020b). An example of emergence from nature is the flocking of birds, where elaborate system-level behaviour results from relatively simple relational rules or constraints. When applied to a policy context, the lesson is to tweak the relational constraints in the system rather than attempting to wield direct control over the whole. An example from the field of climate policy is the Paris Agreement, which adopted a more bottom-up and iterative approach to setting nationally defined targets than did previous agreements. Arguably, this altered the relations between the parties to the agreement — notably in terms of trust,

signalling and crowding-in—in ways that could shift the system-level outcome (Carattini et al., 2019). The TCFD can be seen in similar terms: a voluntary, norms-based system that seeks to transform the emergent behaviour of the system by altering relational constraints within the system—notably the information asymmetry that exists between investors and corporate managers in relation to transition-risk exposures. That said, it is interesting to note that governments may now be starting to put regulatory weight behind the TCFD recommendations (HM Treasury, 2020).

> *THE ACCELERATING CLIMATE CRISIS IS PERHAPS THE GRAVEST EXAMPLE OF A SYSTEMIC RISK*

Balance centralised and decentralised authority

Given the importance of stakeholder engagement in the process of identifying and evaluating transition risks, one governance innovation in the political sphere that may be useful is the idea of the citizen assembly and similar forms of "mini-public" (Suiter et al., 2020). These move beyond consultation into active co-deliberation, bringing together representative panels of citizens to make bottom-up decisions on complex or contentious societal issues. Also of potential relevance to transition risk is evidence suggesting that "mini-public deliberation" can help to improve the quality and perceived legitimacy of decision-making in normatively charged policy areas (Farrell et al., 2020).

More generally, Elinor Ostrom's work on "polycentric governance" argues that decentralisation is crucial to delivering effective policy in complex systems. Mancur Olson's standard theory of collective action holds that the misalignment of incentives means that a central authority is required to coordinate and enforce decisions. In her work on international climate policy, Ostrom argues instead that collective action results from policies that "enhance the level of trust by participants that others are complying" (Ostrom, 2009). In particular, she highlights four factors that are conducive to collective action: a recognition among participants that change is needed; the availability of information; the possibility of communication among participants; and visibility of participants' behaviour changes. Each of these factors can be seen operating in the Paris Agreement and TCFD examples discussed in the previous subsection.

The idea here is not to replace the functions of central authority with decentralised decision-making. Practical experience highlights that strong coordination, as well as political and economic power, are often needed to tackle multidimensional challenges. Rather, the idea is that centralised and decentralised authority (the "centre of government" and "whole of government" approaches, to use the OECD terms discussed earlier) can complement each other. This has been evident during the Covid-19 crisis, where aspects of both centralised and decentralised systems have been instrumental in successful responses to the pandemic (Heitmueller & Roemheld, 2020). Complexity theory does not suggest that centralised policy-making is not needed. Rather, it suggests that it can be more effective for central interventions to focus on shaping relations within the system being governed instead of trying to mandate and enforce the desired system-level outcome. In other words, it is about creating conditions under which the emergent behaviour of the systems leads to the desired outcome.

Explore private-sector solutions

The private sector will play an important role in the low-carbon transition, and therefore also in both the creation and mitigation of transition risks. It is worth considering what the role of businesses should be in whatever processes of transition risk governance emerge. Developments in the energy and transport sectors will be crucial, but transition risk will create opportunities and challenges across a much wider range of businesses, notably in the insurance and financial sectors because of their expertise in managing and transferring risk.

Here we outline three of the ways in which businesses will play a role in the transition, involving hard law, soft law and the development of new products and services.

First, and perhaps most obviously, businesses must comply with whatever hard-law rules and regulations apply to the low-carbon transition, such as new requirements relating to carbon-neutrality targets that a growing number of governments are introducing. As business activity adapts, it will have to comply with whatever rules apply—such as environmental standards and employment law—

although an absence of international coordination will create openings for regulatory arbitrage.

Second, "soft law" instruments and arrangements may be a way of coordinating action on transition risk in the absence of hard-law solutions. The TCFD is an example of a soft law institution that emerged through a deliberative process and that is designed to shape private-sector behaviour in a way that will mitigate transition risk. Reliance on soft law entails important problems, particularly in relation to enforceability and accountability (Marchant & Allenby, 2017). However, there are potential benefits: (i) soft law arrangements tend to be easier to scale internationally because they are not tied to the government of a single jurisdiction; (ii) it can be easier with soft law than hard law to adapt in response to changing circumstances; (iii) soft law can open opportunities for early adopters and for more ambitious experimentation than may be feasible with hard law; and (iv) the results of soft law innovation may help to build the evidence base for subsequent hard law approaches.

> *THE PRIVATE SECTOR WILL PLAY AN IMPORTANT ROLE IN BOTH THE CREATION AND MITIGATION OF TRANSITION RISKS*

A third potential contribution of the private sector is through the development of products, services and processes. While businesses in most sectors will be able to innovate in ways that lead to a reduced carbon footprint and so help to advance the transition, there may be a particular role for the broad financial sector to develop new products that focus more directly on transition risk governance. Examples here could include the development of transition risk disclosure tools (such as rating systems), or the creation of transition-related risk transfer products in the insurance or financial sectors, such as "carbon risk bonds" mooted by the European Systemic Risk Board (Gros et al., 2016). Or it could just relate more generally to businesses finding ways to shape their contribution to the low-carbon transition in ways that minimise countervailing risks and maximise co-benefits. The maximisation of co-benefits has been stressed by the OECD as an important part of accelerating progress on the low-carbon transition (OECD, 2019).

5.

Contingency planning

Prepare for disruption and improve resilience

We conclude with a note of caution. As the preceding sections make clear, there is a lot of work to be done both to understand more about transition risks—what they are, where they are likely to arise and who will be affected—and to develop risk governance strategies. The story of climate policy includes repeated failures to meet targets, so a degree of caution is warranted about how much success is likely on mitigating countervailing risks (and maximising co-benefits), particularly if and when the pace of the transition accelerates. Moreover, many of the recommendations set out in this section are far from straightforward policy fixes. They require innovation, creativity and cooperation (both domestic and international) on numerous dimensions. Success should not be taken for granted, and one of our hopes is that our survey of transition-risk priorities might spur other researchers and practitioners to elaborate more detailed strategies for putting them into practice.

The prospect of failure should be taken seriously. One of the lessons of IRGC's work on risk and resilience in complex adaptive systems is the importance of preparedness for disruptions, accidents and crises (IRGC, 2018). The primary objective may be to use targeted interventions in the various systems affected by the transition, to deliver better emergent outcomes. But in case these efforts are not successful, it is prudent to put in place scenario-based plans for shocks and recovery. As far as possible, these plans should maintain the focus on stakeholder engagement and decentralisation discussed above. The priority is to build "the capacity of various stakeholders to help their system address and overcome future shocks and stresses" (IRGC, 2018). This is particularly important given the fact that there is little prospect of transition-related stability for the foreseeable future. A growing number of countries are setting target dates such as 2050 for carbon neutrality, but even if these targets are met it will not mean that a stable equilibrium has been reached. Transition-related perturbations in many of the world's interconnected systems (ecological, societal, technological, financial, geopolitical, etc.) are likely to persist even in a best-case policy scenario.

Conclusion

The climate change challenge is grave and becoming increasingly urgent. As a result, low-carbon policies are being developed in most countries. Greater attention must be paid to the potential adverse ancillary impacts of these policies, which we have defined in this report as transition risks.

This is a very broad and relatively new subject. Our objective in this report has not been to provide a comprehensive analysis of all possible transition risks and responses. Instead, we have sought to pull together numerous strands of work being done on transition risk, highlighting the variety of the risks that can be expected to crystallise and the importance of interconnections between them.

We have also suggested a series of governance priorities related to transition risks. These should be understood not as a definitive list of next steps, but as proposals for further development and refinement by researchers, policy-makers and practitioners with particular domain-expertise in areas that will shape or be shaped by the low-carbon transition. To start with, more work is needed to develop a more comprehensive map of the transition risk landscape, to provide a more sophisticated overview of how, where and when transition risks might emerge and a better understanding of the potential interconnections and cascades between different risk categories. Other recommendations relate to policy development and implementation, as well as to the use of innovative governance approaches that can help with the formulation of collaborative response strategies.

A strong focus on transition risks should be seen as an integral part of a strategy to ensure that climate policies succeed. Anticipating and dealing with transition risks will help to smooth the path of the low-carbon transition. It is this contribution to the overarching goal of mitigating climate change that shapes our conviction that transition risks warrant greater attention than they currently receive.

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