
22. Climate change and financial regulation

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1. A NEW CHALLENGE FOR FINANCIAL REGULATORS

There is increasing public awareness of the challenge posed by anthropogenic climate change and a strong political commitment to address it. At the 2015 Paris Agreement, now signed by 195 countries, world leaders called for holding the increase in global average temperature to below 2°C above pre-industrial levels and for pursuing efforts to limit it to 1.5°C. However, a recent report by the Intergovernmental Panel on Climate Change (IPCC) warned that, without more ambitious policies beyond those in place by the end of 2020, median global warming is expected to reach 3.2°C above the pre-industrial era by the end of the 21st century (IPCC, 2022). The commitments for the reduction of greenhouse gas (GHG) emissions made by the countries participating in the 28th United Nations Climate Change Conference of the Parties (COP28), held in Dubai in November–December 2023, are consistent with a median 2.5°C temperature rise above pre-industrial levels by 2100 (Climate Action Tracker, 2023).

From an economic perspective, climate change is a negative externality of the production and consumption of carbon-intensive goods, while climate mitigation is a public good. The market would therefore not reflect the social price of carbon, while, at the same time, the private return of investments in decarbonization would be lower than their social return, resulting in suboptimal provision of climate mitigation actions. An extensive literature has explored the factors behind the market and government failures that prevent an optimal response to the climate challenge. These include the lack of historical precedent, extreme uncertainty, non-linearities, and tipping points of climate pathways (Stern, 2008); the conceptual difficulties associated with fat-tailed distributions and catastrophic outcomes (Dasgupta, 2008; Weitzman, 2014); the endogeneity of technical change (Acemoglu et al., 2012); time inconsistency or the “tragedy of the horizon” (Carney, 2015); and collective action and free rider problems (for a review of the literature, see Krogstrup and Oman, 2019).

The theoretical “first-best” policy to address these failures and stimulate the massive economic transformation needed to tackle the climate challenge is to get carbon prices right through carbon taxes or emissions trading systems with equivalent effect, and to encourage R&D and investment in climate mitigation through subsidies (possibly financed by the recycling of carbon tax revenues) (Stern, 2006; Parry et al., 2014; IMF, 2019). These fiscal policies are indispensable for any effective climate mitigation strategy. But the magnitude and complexity of the challenge, as well as political economy considerations, argue in favor of a broader policy effort, and there are calls for central banks and financial regulators to “play their part.”

This chapter reviews the potential role of financial regulation in the transition to a low-carbon economy. Although central banks and regulatory agencies are working on climate-related issues in a number of areas (e.g., their own disclosures), this chapter focuses on their regulatory function, including both microprudential regulation and supervision and macroprudential

policies aimed at safeguarding the stability and orderly functioning of the financial system as a whole. In order to keep the discussion relevant for a range of different jurisdictions, the chapter takes a broad view of financial regulation, encompassing all rules and policies applying to the financial sector regardless of who is the rule-maker (legislator, supervisor, or other regulatory agency). Specifically:

- The chapter reviews ongoing efforts to assess climate-related risks to the financial system and incorporate relevant considerations into financial regulation. Despite the progress, it argues that data gaps are still significant, and the diagnostic and policy toolkits are not yet sufficiently developed to allow clear visibility of the risks and precise targeting of policies.
- Proposals to assign central banks and financial regulatory agencies explicit environmental goals in order to promote decarbonization in the financial system and the economy as a whole would stretch to the limit their current mandates and legal frameworks. While these mandates can of course be expanded, the chapter argues that “green”-promoting regulatory action would raise major governance and operational challenges for regulators, while, on the basis of the available evidence, it is unlikely to have a significant real-world impact.
- Finally, regardless of whether the legal mandates for central banks and financial regulators change or stay the same, the chapter argues that entering this new territory creates risks and may have unintended consequences. These are rarely discussed, perhaps for fear of being perceived as insufficiently concerned about climate change. But understanding these risks is crucial if financial policies are to be effective in supporting the transition to a low-carbon economy.

2. CLIMATE-RELATED FINANCIAL RISK AND ITS MEASUREMENT

Pressure to adapt financial regulatory frameworks to incorporate climate-based considerations has come from multiple directions, first and foremost from the financial industry itself. By the turn of the millennium, it was clear, especially among insurers, that the rising frequency and severity of extreme weather events, combined with societal changes (population growth, demographic shifts, geographic concentration of wealth), were already affecting their risk profile.¹ This was underpinned by the first IPCC report that focused on the economic and financial impact of climate change (IPCC, 2001; see also Easterling et al., 2000; Tol, 2002).

Pressure also came from shareholders and the market. During the last two decades or so, there has been a gradual increase in investor and shareholder interest in environmental, social, and governance (ESG) issues. After the global financial crisis, this shift in investor focus accelerated (Lee, 2021). Its influence is increasingly felt in boardrooms, investment committees, and shareholder meetings. No less important was a shift in tactics: while the majority of proposals by ESG advocates until the early 2000s sought companies to adopt social or environmental goals or to take specific action with respect to a business activity, the tone began to change in the middle of the decade, with an increasing number of proposals seeking disclosure, risk assessment, and oversight of particular issues (Papadopoulos, 2019). This changed the conversation from an argument about ethics to an economic discussion about how

environmental and social risks can impact the long-term value of a company, an investment project, or a portfolio.

These shifts in investor focus and tactics have had two notable effects:

- They have increased awareness and discussion of climate-related risks for financial and non-financial companies.
- They have spurred the rapid growth of ESG-labeled funds and “green” bonds issued to raise finance for “green” assets and climate mitigation projects and, relatedly, a proliferation of ESG or “green” scores and standards.² This, in turn, laid bare the scarcity of relevant data and the difficulties of measurement, and fueled concerns about mislabeling and “greenwashing” and calls for better governance of these standards.

Last but not least, political leaders demanded action. Following the Paris Agreement, which explicitly called for making finance flows consistent with a pathway toward low GHG emissions and climate-resilient development, the G20 Finance Ministers and Central Bank Governors tasked the Financial Stability Board (FSB) in 2015 to “convene public- and private-sector participants to review how the financial sector can take account of climate-related issues.”³ The Climate Pact agreed by COP26 in Glasgow in November 2021 reconfirmed and expanded this expectation on the financial sector by calling upon “multilateral development banks, other financial institutions and the private sector to enhance finance mobilization in order to deliver the scale of resources needed to achieve climate plans” (United Nations Framework Convention on Climate Change (UNFCCC), 2021).

Regulators reacted with a lag to market developments and shifting political priorities, but since the middle of the last decade, a work program has gradually emerged, aiming to measure the magnitude and identify the transmission channels of climate-related risks for the financial system.

The interactions between climate and economic systems have been studied for decades, but the focus on the impact of climate-related factors on the financial system is more recent. Integrated Assessment Models (IAMs), such as William Nordhaus’s DICE model (Nordhaus, 1992, 1994), had been widely used to analyze the potential economic costs of climate change, as well as the costs and benefits of climate mitigation actions. But it was not until the previously mentioned pioneering study by the Finance Initiative of the UN Environment Program (UNEPFI, *op. cit.*) that research started focusing specifically on the impact on financial systems—initially on insurance, but also on other sectors.

By the middle of the 2010s, a small number of central banks and regulatory agencies, mainly in Europe, had started studying climate-related risks. In a landmark speech in 2015, Mark Carney, then Governor of the Bank of England, outlined the conceptual framework that is still used to classify the impact of climate-related factors on financial systems (Carney, *op. cit.*). This impact can manifest itself through two different channels: (i) the physical repercussions of climate change on the economy and financial system, for example, from rising sea levels, changing agricultural production patterns, or the increasing severity and frequency of extreme weather events, usually referred to as physical risk;⁴ and (ii) the economic effects of policies to mitigate climate change, notably increases in carbon pricing, on asset prices and financial markets, referred to as transition risk. Carney’s speech was followed by similar interventions by other central bankers.⁵ The Bank of England’s Prudential Regulation Authority

(PRA) was the first regulator to publish a detailed analysis of climate-related risks for the insurance sector and attempt to incorporate these into stress tests for insurers (PRA, 2015, 2017). Similar early initiatives were undertaken by the Swedish, Dutch, and French regulators and, outside Europe, by the Brazilian insurance supervisor and the California Department of Insurance (in the US, insurance supervision is the responsibility of individual states).⁶

These initiatives were accelerated following the creation of the Network for Greening the Financial System (NGFS). The NGFS was established in December 2017 by eight central banks and financial regulatory agencies as a “coalition of the willing,” whose purpose is to “contribute to the development of climate- and environment-related risk management in the financial sector and mobilize mainstream finance to support the transition toward a sustainable economy.” The NGFS, which by now has 141 members and 21 observer organizations, had initially given priority to the first of these two goals, issuing six recommendations for central banks and financial supervisors (NGFS, 2018). Most of these recommendations focus on improving data collection, on internationally consistent disclosures of climate- and environment-related risks, and on integrating these risks into financial stability monitoring and microprudential supervision. In its Glasgow Declaration on the occasion of COP26, NGFS reconfirmed this priority (NGFS, 2021a). But since the NGFS’s 2019 “call for action” (NGFS, 2019), the understanding of the nature and magnitude of climate-related financial risks, as well as of the implications for financial regulators, has become more nuanced—thanks in part to the work of the NGFS itself.

Climate-related risks for the financial sector are unique and their modeling poses fundamental challenges. Their long time horizon, radical (Knightian) uncertainty about the possible climate pathways and their probability distribution, and their unprecedented and potentially catastrophic consequences mean that well-established risk management tools in the financial industry, such as Value-at-Risk models and stress tests, cannot readily be used to measure these risks; exploratory scenario-based impact assessments must be used instead. Although these are methodologically different,⁷ they are often also referred to as “stress tests”—and in the rest of this chapter, these two terms are used interchangeably. In addition, if climate-related risks materialize, they would affect the economy and the financial system as a whole and may be amplified by the pro-cyclical behavior of market participants, self-reinforcing reductions in bank lending and insurance provision, the bank-sovereign nexus, feedback loops with the real economy, and network and cross-border effects (BCBS, 2021a). Finally, the data required to perform climate-based stress tests are not always available or sufficiently granular.⁸

More than 20 jurisdictions have by now conducted climate-related stress or scenario analyses.⁹ Though not a regulatory agency, the International Monetary Fund (IMF) has also started including climate-related risks in its Financial Sector Assessment Program.¹⁰ The experience thus far has highlighted the limitations of these analytical approaches as guides for policy.¹¹

First, the time horizons typically used in these analyses exceed by far the average maturity of bank loans, which, for syndicated loans, is estimated at three to five years at origination in the US (Blickle et al., 2022) and closer to five years in Europe (Berg et al., 2017). While loan rollovers are common, it is doubtful that banks will continue for decades to roll over loans to firms or sectors that are negatively affected if climate shocks start to materialize. Indeed, there is some evidence that banks already *shorten* loan maturities in order to lower their exposure to possible transition risk (Ivanov, Kruttli, and Watugala, 2023). It is therefore hard to take at face value future loss estimates derived on this assumption, and even harder to justify

imposing capital charges on banks today for unexpected losses on loans that have not been made yet—and may never be made.

Second, over such time horizons, many of the routine working assumptions underpinning stress tests systematically overestimate the impact of climate risk on loan portfolios. For one thing, bank balance sheets need to be modeled dynamically, allowing banks to adapt their exposures to changes in climate risk. It is obvious that over the course of several decades, banks will reduce loan exposures to carbon-intensive sectors if transition risk materializes (e.g., if carbon taxes are increased). Yet despite the importance of incorporating dynamic lending responses, the large majority of climate-related stress tests undertaken so far have adopted the standard static balance sheet assumption, thereby substantially overestimating future climate-related credit losses (FSB and NGFS, 2022). This, together with many other such drastic simplifying assumptions, increases model risk: seemingly minor technical decisions about functional forms and parameter values can dominate the results. In situations like this, “economists should be less confident [...] and adopt a more modest tone that befits less robust policy advice” (Weitzman, *op. cit.*).

Third, current scenario-based analyses tend to treat the mitigation pathways as exogenous (typically derived by IAMs that do not model the financial sector), thus missing the feedback loop between the financial system and those pathways (Battiston et al., 2021). But to fully understand the effect of climate risk on banks’ profitability over such long time horizons, one needs to take into account the effect of this risk not only on banks’ balance sheets but also on loan demand. However, most climate-related stress tests so far do not incorporate such macro-financial feedback loops (FSB and NGFS, *op. cit.*).

Fourth, the time horizon raises issues of prioritization since, over the long term, climate is just one of many uncertainties facing the economy and the financial system, from geopolitical upheavals to technological disruption to pandemics. Additional arguments are therefore needed to justify policymakers’ and supervisors’ focus on this particular one (Stiroh 2020).

Fifth, in the exercises that have been completed so far, the estimates of the impact of climate scenarios in terms of losses, regulatory capital, solvency ratios, and so on span a very wide range, from negligible to severe. One such exercise concluded, for example, that

between 3.8 percent to 29.9 percent of the available Common Equity Tier 1 (CET1) capital of the banking system is wiped out in first-round losses following the implementation of a sizeable carbon tax of €100, depending on the geographical scope of application and abruptness of the policy.

(Reinders, Schoenmaker, and Van Dijk, 2020)

The 2021 European Central Bank (ECB) exercise concluded that even in the most severe (“hot house”) climate scenario, the increase in probabilities of default (PDs) for banks’ portfolios would range from 5 to 30 percent over the 30-year test horizon (Alogoskoufis et al., 2021). Such a wide range of results does not provide a firm basis for policy action today.

Of course, future climate-related shocks may affect bank balance sheets not only through credit losses but also through market losses in their trading books. If climate risk is substantially underpriced, changes in investor perception can lead to re-pricing of assets—and thus to market losses for asset holders, including banks—even if the true underlying probability of risk realization is unchanged. The empirical literature has shown that climate risk is at least partially priced across a wide range of asset classes.¹² Assessing the magnitude of any residual climate risk underpricing (for example, as a result of not incorporating a future acceleration of

the decarbonization process) and thus the size of the related market risk requires understanding how different assets' state-dependent cash flows are affected by climate change and climate policies. Given the radical uncertainty regarding climate and decarbonization pathways, as well as the fact that investors have heterogeneous climate beliefs and there is evidence of sorting between the climate beliefs of investors and the climate exposure of assets (Bakkensen and Barrage, 2021), this question remains very much open.

Some commentators have argued that the current risk assessment models used by central banks and financial regulators systematically underestimate climate-related risk because they do not account for "double materiality." "Double materiality" in this context is the idea that banks are not only affected by the "inward" risk arising from climate change and energy transition policies, but also the "outward" risk that their own activities generate for the climate through contributing to GHG emissions and rising global temperatures. Capturing this feedback loop, the argument goes, would lead to better (higher) loss estimates and strengthen the case for regulatory action.

Unfortunately, there is no basis for this claim. Even if, despite the lack of reliable estimates, one is convinced that the "inward" impact of climate risk on banks' future losses is certain and sizable, the incremental "outward" impact of current lending by each individual bank on global temperatures would be negligible—except, at the margin, for the largest global banks (Demekas and Grippa, 2024; Stiroh, 2022). Attempting to estimate the feedback of individual bank loans on future climate risk through "double materiality" and using this estimate to calibrate bank capital requirements today does not seem a promising way forward.

"Double materiality" may be a useful device to sensitize—through their disclosure obligations—financial and non-financial corporates to the broader social and environmental impact of their business decisions. This is the goal of the EU's Corporate Sustainability Reporting Directive (CSRD), although, given that the CSRD is being gradually phased in, it is too early to judge its effectiveness. However, "double materiality" is of no practical value for the capital regulatory framework, and we are not aware of any financial regulators, including in the EU, seriously considering incorporating it in their risk assessment toolkit.

Finally, it has been pointed out that even if financial institutions' potential long-term losses from climate-related risk were conclusively shown to be high, this would not necessarily imply risks to financial stability nor, by itself, suffice as an argument for pre-emptive supervisory action today, since the mission of supervisors is not to prevent losses for the financial institutions they supervise (Cochrane, 2021).

Growing awareness of the limitations of these exercises helps explain why central banks and regulators have so far proceeded cautiously in incorporating climate-related risks into the supervisory process, as discussed in the next section.

Nevertheless, there is a more modest but still important role that these risk assessment exercises can play. This is succinctly summarized in the Bank of England's description of the goal of the 2021 climate-related exploratory stress test: this exercise will

focus on sizing risks, rather than testing firms' capital adequacy or setting capital requirements [and] will allow the Bank to examine how major financial firms expect to adjust their business models, and what the collective impact of these responses on the wider economy might be.

(Bank of England, 2022)

By translating, however imperfectly, the long-term and highly uncertain climate-related risks into quantitative losses and by illustrating the channels of transmission and contagion, these exercises raise awareness of these risks in the industry; provide incentives for improving risk management in individual financial firms; and help supervisors strengthen their own supervisory frameworks.

3. CLIMATE-RELATED FINANCIAL RISK AND THE PRUDENTIAL FRAMEWORK

Researchers have proposed a number of ways in which the (micro- and macro-) prudential framework could, in theory, be used to mitigate climate-related risks in the financial system. As regards the microprudential framework, there have been many proposals for “greening” all three Pillars of the Basel III capital framework (see, for example, Bolton et al., 2020; Berenguer, Cardona, and Evain, 2020; and Nieto, 2019). However, as these proposals were examined more closely, initial enthusiasm has given way to skepticism.

A key question that must be answered before deciding what, if any, prudential tools can be used to mitigate climate-related risk is how exactly climate-related risk affects the loss-generating process. To illustrate, if historical losses are determined by the business cycle and idiosyncratic factors as a variable X with a mean $E(X)$ and a variance $V(X)$, and climate-related losses reflect a new variable Y with its own mean and variance, then future losses are determined as:

$$\text{Expected Losses} = E(X) + E(Y)$$

$$\text{Variance of losses} = V(X) + V(Y) + 2 \text{cov}(X, Y)$$

Consistent with the Basel capital framework, expected losses should be covered by loan loss provisions, while capital should cover unexpected losses. Hence, it is important to understand in what way the correlation between climate-related losses and historical (business cycle and idiosyncratic) losses is going to change the distribution of future total losses. Regulators would also need to decide which specific component of the capital “stack”¹³ should cover the additional future unexpected losses (for a more detailed discussion, see Holscher et al., 2022). Without answers to these empirical questions—which, unfortunately, are not at hand—regulators cannot decide whether and by how much loan loss provisions or bank capital should increase as a result of climate risk and, if the latter, which specific component of the capital “stack.”

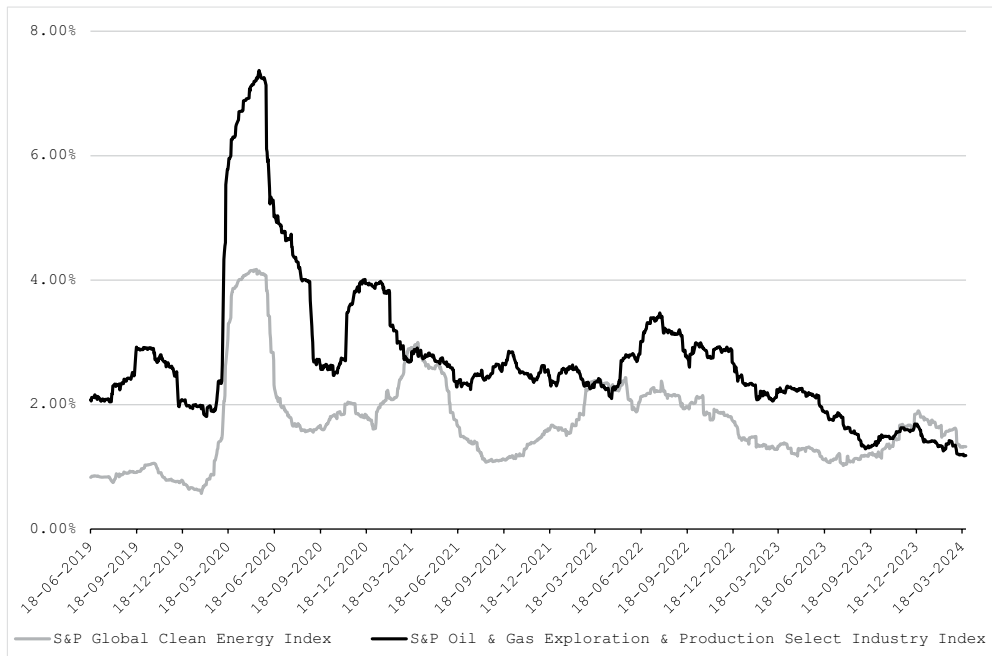
It should be stressed that these questions are unrelated to the time horizon: they reflect the fundamental design of the Basel capital framework. Even if regulators managed to tackle the intractable analytical challenges of extending their risk assessment models several decades into the future, they would still need to address these questions before using Pillar I to mitigate climate risk.

One proposal that initially seemed to gain some traction was to incorporate environmental impacts into the calculation of risk-weighted assets (RWA). This could be done by adjusting risk weights through a “green supporting factor” (GSF) and a “brown penalizing factor”

(BPF). The latter would require banks to hold more capital for loans to “brown” sectors, thus discouraging them from lending to those sectors, while the former would lower capital requirements in order to encourage lending to “green” sectors. EU policymakers, in particular, seriously considered this step (Dombrovskis, 2017; European Union High Level Expert Group, 2018), as the capital framework for EU banks already includes similar “SME supporting” and “infrastructure supporting” factors, although there was no consensus on whether the GSF and a BPF should both be used.¹⁴

Adjusting RWA would be appropriate only if climate risk changes the relative riskiness of specific asset classes, and assuming that there is an empirically driven approach for calibrating these changes. However, there is no conclusive evidence that “green” assets are less risky than “brown” assets.¹⁵ In fact, in the current environment of increasing interest rates and energy insecurity, the volatility of “green” asset prices has been increasing and, at least for some asset classes, is now identical to that of “brown” assets (Figure 22.1) (Gardes-Landolfini et al., 2023).

In addition, calibrating BPF/GSF for each asset class to account for transition risk requires a comprehensive taxonomy of economic activities. However, the experience with “green/brown” taxonomies has demonstrated their limitations: their static nature, lack of transparency and consistency, openness to political interference, and evidence of pervasive “greenwashing” make them unlikely to provide a credible basis for calibrating BPF/GSF. This experience, and the attendant lessons, are discussed in the next section.



Source: Authors' calculations based on S&P Dow Jones index data.

Figure 22.1 Volatility of daily returns (60-day moving window)

At a more fundamental level, the Institute for International Finance, among others, has argued that risk weights should reflect evidence-based and quantifiable economic risks and questioned the wisdom of using the regulatory capital framework, which is supposed to protect the soundness of the financial system, to finance the transition to a low-carbon economy (Institute of International Finance, 2021; Samtani, 2021; Manninen and Tiililä, 2020). Regulators also need to carefully ponder the potential unintended consequences of any revision of microprudential capital requirements for climate-related risks, especially those that reach beyond the financial sector. For example, increasing risk weights on low-rise properties in flood-prone areas could cause a significant drop in house prices in these areas, with significant social and political repercussions that go beyond the scope of financial regulation and become the responsibility of other policymakers.

In addition to these reservations, it is worth recalling that it took regulators decades to agree on a shared standard of risk-based microprudential requirements, and ad hoc departures from this standard—such as the EU’s “SME supporting factor”—are already contentious (BCBS, 2014). While some elements of the microprudential framework could be adjusted to differentiate between “green” and “brown” exposures when this is supported by concrete, risk-based considerations—such as, for example, exposures secured by assets in high carbon-intensive sectors at risk of becoming “stranded” in the face of a sharp increase in carbon prices—the international regulatory community may be reluctant to countenance introducing generic, non-risk-based factors for differentiating risk weights. Further divergence of individual jurisdictions from the global standard, on the other hand, risks increasing fragmentation and disincentivizing supervisory cooperation.

Against this background, it is not surprising that the idea of adjusting RWA for climate risk seems to have been abandoned, at least for now. The Basel Committee’s recent guidance on climate risk does not call for any changes in RWA and, more broadly, in Pillar I standards (BCBS, 2022). Even in the EU, the European Banking Authority explicitly recommends avoiding both BPF and GSF in Pillar I capital requirements (EBA, 2023).

Although financial regulators have—understandably—been so far reluctant to make ad hoc adaptations to the microprudential framework for climate-related risk, they have nonetheless acted to build awareness of climate issues among the firms they supervise through publicly signaling their concern, undertaking surveys, organizing conferences, or convening industry fora. One such example is the Climate Financial Risk Forum, formed in 2019 in the UK, co-chaired by the Prudential Regulation Authority and the Financial Conduct Authority.

A number of supervisors have taken a step further and have issued—or indicated that they are preparing—supervisory guidance on how financial institutions should monitor and manage climate-related risks. Supervisory guidance is not always legally binding but often principle-based guidelines or interpretations of existing rules. The type of guidance that has been issued—or is in the process of being developed—usually takes one or more of the following forms: (i) outlining supervisory plans on deliverables and activities related to climate-related risks; (ii) encouraging financial institutions to strengthen risk management and the disclosure of climate-related exposures; and (iii) providing guidance on how to properly integrate climate-related financial risks within risk management (BCBS, *op. cit.*; see also the case studies in NGFS, 2020). Some regulators have also introduced standards for the incorporation of ESG risks in banks’ financial disclosures under the third Pillar of the Basel framework (see, for example, EBA, 2022).

Such efforts are relatively more advanced in the insurance industry, where the liability risk of climate change-related weather events (physical risk) is most pressing. A comprehensive issues paper published by the International Association of Insurance Supervisors (IAIS) discussed climate-related risks for the sector, identified gaps in current supervisory practice, and put forward “preliminary insights from practice and initial conclusions relating to the supervision of climate change risks to the insurance sector” (IAIS, 2018). National insurance supervisors have started taking this agenda forward. The Bank of England’s PRA, for example, expects insurers to include in their Own Risk and Solvency Assessment (ORSA) “all material exposures relating to financial risks from climate change, and an assessment of how firms have determined the material exposure(s) in the context of their business” (PRA, 2019). The European Commission launched a “sustainable finance package” that includes regulatory measures on sustainability risks and factors to be considered by insurance and reinsurance companies and other non-bank financial institutions; as well as a “comprehensive review package” of Solvency II rules that would introduce sustainability risks into insurance prudential regulation. The latter is currently under consideration by EU legislators (European Commission, 2021a and 2021b).

Work is also ongoing in banking, where a number of supervisors, notably the ECB and the Bank of England, have set out supervisory expectations for banks to understand and analyze climate-related risks, incorporate them into their risk appetite framework and overall business strategy, report data that reflect their exposures to environmental and climate-related risks, and take these risks into account in all relevant stages of the credit-granting process, as well as in their operational risk management framework (PRA, *op. cit.*; and ECB, 2020). The European Banking Authority (EBA) has also published an Action Plan outlining its “high-level policy direction and expectations,” in which “institutions are encouraged to consider taking steps (strategy and risk management, disclosure, and scenario analysis) before the EU legal framework is formally updated and the EBA regulatory mandates delivered” (EBA, 2019).

Regulatory and supervisory action in this area requires striking a fine balance between opposing risks: at one end of the spectrum (“deferential transition”), supervisors could simply push banks to develop better internal capacities to manage climate-related risk, while limiting their own role to enforcement of the rules—at the risk of limited effectiveness; at the other end (“guided transition”), regulatory authorities could prescribe in detail what types of investments are compatible with the climate mitigation objectives—but at the risk of getting drawn into a more political role, as discussed in more detail below, without the necessary democratic legitimization to do so (see, for example, the discussion in Smoleńska and van ’t Klooster, 2022).

Efforts in securities supervision are relatively less advanced at this stage. In a report covering 145 European issuers, the European Securities and Markets Authority (ESMA) concluded that only a few sectors and companies incorporate climate-related elements in their corporate reporting and proposed that the European Commission support the creation of a single set of international standards for ESG disclosures (ESMA, 2020). Along similar lines, the US Commodity Futures Trading Commission (CFTC), noting that material climate risks must be disclosed under existing US law, called for financial regulators to clarify the definition of materiality for disclosing medium- and long-term climate risks; support the availability of consistent, comparable, and reliable data to advance the effective measurement and management of climate risk; and, on this basis, require banks and non-bank financial firms to address

climate-related financial risks through the existing risk management frameworks (CFTC, 2020).

On the face of it, the macroprudential toolkit might appear at first blush to be more appropriate for mitigating climate-related risk, given its systemic nature. As with the microprudential framework, a number of proposals have been put forward in this area: for example, adjusting the systemic risk buffer through a “climate-related add-on,” or incorporating climate-related risks into the cross-sectional dimension of macroprudential policy through exposure or concentration limits to “brown” sectors of the economy and/or sovereigns with elevated environmental risk (Gruenewald, *op. cit.*; Schoenmaker and van Tilburg, 2016; European Systemic Risk Board (ESRB), 2016). But again, turning these ideas into policy is challenging. Increasing the systemic risk buffer would, other things being equal, increase the resilience of the financial system to all systemic shocks, including climate-related shocks. However, as the preceding discussion has made clear, there is no reliable way to calibrate a systemic buffer add-on to the size of prospective system-wide losses from climate risk. Moreover, such a—presumably permanent—add-on would create trade-offs with elements of the microprudential capital framework and interfere with other macroprudential buffers, such as, for example, sectoral buffers for real estate lending. More importantly, for a climate-related systemic risk buffer (or for concentration limits/surcharges) to go beyond resilience and start reducing system-wide climate risk by changing bank exposures, the application would need to be differentiated by bank, be dynamic over time, and its scope narrowed to the firm or project level (Coelho and Restoy, 2023). This, however, would make these tools hostage to the shortcomings of taxonomies mentioned above. This is discussed in more detail in the next section.

Finally, from a more general perspective, incorporating climate-related risks into micro- and macroprudential policy also requires a shift in the supervisory approach. Short-termism does not only afflict financial institutions’ boardrooms. Financial policymakers and regulators also face the challenge of reconciling the long-term effects of climate change with the short-to-medium-term horizon of their current risk assessment and supervisory frameworks. This challenge is not only analytical and practical but also a matter of mindset.

4. CLOSING INFORMATION GAPS AND IMPROVING DISCLOSURE

In parallel with efforts to measure climate-related risk and the ongoing debate on the potential role of financial regulation in mitigating this risk, major initiatives have been launched to address data gaps—brought out in sharp relief by the attempts to assess climate-sensitive financial exposures and run climate-related stress tests—and, relatedly, to improve the disclosure and dissemination of climate-relevant information by financial (and non-financial) institutions.

In theory, better data and broader disclosure of information can play a useful role in achieving environmental, social, or other goals by disseminating certain relevant but not readily observable characteristics—such as GHG emissions—to influence the allocation of capital toward less polluting activities without direct policy intervention through regulation or taxation.¹⁶ The direct benefit is that rational investors receive superior information with which to make decisions in line with their preferences. There is also an indirect benefit, since greater transparency about the impact of a company’s activities—in this case, on climate—may help

better quantify related risks on the balance sheets of lenders. The combination of these effects would, in theory, induce a shift in capital supply toward “green” activities. In practice, however, the effectiveness of information disclosure is limited by several factors. In the case of climate- or environmental-related disclosures, the magnitude and timing of this shift in capital supply would depend on how heterogeneous investor preferences translate into aggregate demand for “green” assets; how quickly issuers, in turn, respond; and—since most real-world investment transactions involve financial intermediaries—on the agency conflicts and collective decision-making problems affecting those intermediaries, which are typically large, complex organizations. Nevertheless, international organizations and regulatory networks have launched a number of initiatives aimed at closing data gaps and improving disclosure:

- The FSB launched the private sector-led Task Force on Climate-related Financial Disclosures (TCFD) to develop “voluntary, consistent climate-related financial disclosures that would be useful to investors, lenders, and insurance underwriters in understanding material risks.” Its initial report includes four recommendations on the collection, analysis, reporting, and governance of climate-related data and risk metrics (TCFD, 2017).
- The International Association of Securities Commissions (IOSCO) established a Sustainable Finance Network (SFN) and announced its intention to work toward “robust sustainability reporting standards, interconnected with financial reporting standards” that would “lay the foundations for mandatory corporate reporting on sustainability internationally” (IOSCO, 2020).
- Five global organizations—CDP (formerly the Carbon Disclosure Project), the Climate Disclosure Standards Board (CDSB), the Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC), and the Sustainability Accounting Standards Board (SASB)—published in 2020 a vision document for a comprehensive corporate reporting system that would include both financial accounting and sustainability disclosures and complement generally accepted financial accounting principles (GAAP), as well as a prototype of a climate-related financial disclosure standard.¹⁷
- The NGFS issued a “Final Report on Bridging Data Gaps” that, while acknowledging the persistent and significant challenges in data collection, introduces a living catalog of available climate-related data sources for the financial sector (the “directory”) and provides specific NGFS policy recommendations for improving the availability, quality, and comparability of climate-related data, thus further advancing progress on three building blocks: (i) rapid convergence toward a common and consistent set of global disclosure standards; (ii) efforts toward a minimally accepted global taxonomy; and (iii) development and transparent use of well-defined and decision-useful metrics, certification labels, and methodological standards (NGFS, 2022).
- In 2022, in the context of its 2018 Action Plan on Financing Sustainable Growth,¹⁸ the European Commission drafted the Corporate Sustainability Reporting Directive (CSRD, Directive 2022/2464/EU), which entered into force in January 2023 and, since January 2024, replaces the Non-Financial Reporting Directive (NFRD, Directive 2014/95/EU). The CSRD has a broader scope than the NFRD (covering ~50,000 vs. ~11,000 companies) and embeds in regulation the principle of *double materiality*, i.e., the notion that corporate disclosures should provide information necessary for understanding not only the impact of environmental and climate-related risks on a company but also the impact of its activities on the environment and society.

In view of these overlapping global initiatives, the International Financial Reporting Standards (IFRS) Foundation announced at COP26 the formation of an International Sustainability Standards Board (ISSB). The ISSB is meant to build on the work of existing investor-focused reporting initiatives—including the CDSB, the TCFD, the Value Reporting Foundation's Integrated Reporting Framework and SASB Standards, and the World Economic Forum's Stakeholder Capitalism Metrics—to become the global standard-setter for sustainability disclosures for financial markets. In 2023, the ISSB published the first two standards (S1—General Requirements for Sustainability-related Disclosure of Financial Information, and S2—Climate-related Disclosures).¹⁹ As the G20 has welcomed this initiative, the ISSB looks likely to eventually yield a broadly accepted disclosure standard.

While all these initiatives are voluntary, two major jurisdictions have taken the step to introduce statutory frameworks for classifying and mandating sustainable or “green” investment and related disclosures.

- The EU introduced in 2020 a Framework to Facilitate Sustainable Investment—the so-called “Taxonomy Regulation” (Regulation (EU) 2020/852). This Regulation, which followed and amended the Sustainability-Related Disclosures Regulation (Regulation (EU) 2019/2088), establishes an EU-wide classification system intended to provide businesses and investors with a common language to identify what economic activities can be considered environmentally sustainable. While the bulk of the Regulation applies to asset managers making available financial products that are marketed as “environmentally sustainable” or promote other environmental characteristics, the Regulation also states that financial market participants who do not consider criteria for environmentally sustainable investments should provide a statement to this end. This effectively means that *all* asset managers—including non-EU asset managers offering financial products in the EU—are in scope.
- The Chinese authorities issued in 2019 a “Guiding Catalogue for the Green Industry” to help promote sustainable development through clarifying the definition of “green industry” and harmonizing standards for sustainability. In addition, in June 2020, the People's Bank of China (PBoC), the China Securities and Regulatory Commission (CSRC), and the National Development and Reform Commission (NDRC) released a draft “Green Bond Endorsed Project Catalogue” to update PBoC's 2015 green bond guidelines and harmonize them with the “Guiding Catalogue.”²⁰

In parallel, the explosion in investor and shareholder interest in ESG issues and the growth in “green” bonds have spurred the development of a bewildering array of standards and taxonomies for “green” or “sustainable” financial products in the private sector. Most of them have been developed by industry associations, environmental advocates, or “ESG ratings” advisers and are voluntary. Already back in 2020, IOSCO had identified more than 45 such initiatives (Table 22.1), and since then, the number has likely increased. Most of these have major shortcomings in the areas of transparency, coherence, governance, and accountability. Many financial products are labeled by their issuers or managers as “ESG,” “green,” or “sustainable” without a clear link to how the product is contributing to environmental objectives. Most of these classification schemes make no provision for an independent external evaluation of compliance or for a process for certifying that self-reporting has been prepared in accordance

Table 22.1 *ESG-related initiatives for companies, investors, issuers, and asset managers*

Categories	No. of initiatives
Disclosure and reporting principles and frameworks used by companies and issuers	12
Principles and frameworks applicable to asset managers	4
Green bond principles and taxonomies	7
Coalitions and alliances related to ESG	17
Other initiatives	8

Source: IOSCO (2020).

with any particular standards. As a result, different providers often come up with different ratings for the same companies (Murray, 2021). The lack of consistency and rigor in defining and applying “green” criteria risks undermining the credibility of these classifications (NGFS, 2021b; Organisation for Economic Co-operation and Development (OECD), 2020b). This is underscored by emerging evidence of extensive “greenwashing” (Amenc, Goltz, and Liu, 2021), followed by regulators’ heightened scrutiny of potential greenwashing practices (Rudgard, 2023, and Warren-Smith, Valenstein, and Page, 2024), which has already led to fines against some financial institutions for ESG-related violations.²¹

What are the lessons from this experience? Do better data, taxonomies, and disclosure standards—whether voluntary or statutory—live up to the theoretical arguments? Do they have a sizable impact on capital allocation?

Identifying and closing data climate-related gaps have clear benefits. They allow financial (and non-financial) institutions to evaluate their exposures, both in terms of the climate-related risk they imply for their balance sheet and—assuming these institutions are interested—their broader environmental impact. They also allow regulators to monitor climate-related risks in the financial system. Whether the explosion of “green” taxonomies and various disclosure standards has had a positive impact on capital allocation, however, is less clear. In the absence of empirical studies measuring their impact, controlling for all other factors, one is limited to theoretical considerations and speculation. On one hand, the rapid growth of the market for “green” assets during the last decade was the result of many factors on the demand side, notably increased investor interest. Without “green” taxonomies and disclosure standards, this increased demand for “green” assets would arguably have had less of an impact. At the same time, increasing concerns about “greenwashing” have dented the credibility of these taxonomies and have probably dented demand, especially more recently. In addition, “green” and “sustainable” bonds have been the children of the low interest rate environment during the last decade, and it is less clear how they will fare in an environment of higher rates, energy insecurity, and geopolitical tensions.

In addition, the experience has highlighted a number of pitfalls of “green” taxonomies (OECD, 2020a; Ogus, 2021; Hentov, 2021; and Caldecott, 2019).

- First, they are backward-looking: they reward currently established “green” assets and activities and penalize “brown” ones. As such, they may not provide adequate incentives

for investment and technological innovation in “brown” activities today that could help make these more environmentally sustainable in the future. For example, climate investment funds—which represent a subset of the “sustainable funds” category—tend to hold portfolios with slightly higher carbon intensity levels than conventional funds, as these are the ones with the highest decarbonization potential if supported by credible decarbonization plans (IMF, 2021a). This type of fund would be penalized under a green taxonomy.

- Second, they tend to be binary (“green”/“brown”), thus failing to adequately reflect the more nuanced reality of the transition to a low-carbon economy. This has been brought into full evidence by the intense controversy that surrounded the decision by the European Parliament to include nuclear energy and gas in the EU Taxonomy. Nuclear energy is a low-carbon technology whose revamping some consider a crucial ingredient of any realistic decarbonization strategy (International Energy Agency (IEA), 2022a), while others see it as fundamentally incompatible with the principle of “do no significant harm” (to environmental objectives other than climate change mitigation) that lies at the foundation of the taxonomy (Khan, 2022). Natural gas is seen by some as a “bridge fuel” between coal (which is almost twice as carbon-intensive) and renewables (IEA, 2022b), but by others as a way to perpetuate the economy’s carbon addiction (Muttitt, 2021). A binary framework, such as the EU Taxonomy, fails to reconcile these opposite views, while amplifying the influence of mutually incompatible ideological stances in what should be an essentially pragmatic decision.
- Third, they tend to be static, which could make them obsolete as technology advances. Instead, the distinction should ideally be dynamic, by establishing a target path over time that an activity must follow to satisfy the taxonomy’s criteria, for example, a declining GHG emissions pathway for power generation—the approach taken by the EU.²² However, translating reliably and transparently these dynamic pathways for specific activities to targets for individual corporations, which often operate many different activities, is a major conceptual and practical challenge.
- Fourth, taxonomies can be applied to two different types of information about the environmental impact of economic activities: unevaluated quantitative or qualitative information (“raw data”) and a summary normative assessment (“label”) (Steuer and Tröger, 2022). In ideal, frictionless markets, where rational agents can process complex information costlessly, disclosure of raw data would be sufficient; in real-world markets, bounded rationality and transaction costs mean that labels are more useful. However, to be effective as tools to reallocate capital, labels must be accurate, consistent, and credible—a condition that is clearly not met by the multitude of taxonomies today.
- Fifth, taxonomies can be applied to three different levels of economic activity: an individual product (e.g., car production); a company (issuer); and an asset portfolio that combines instruments from different issuers. Applying environmental or other taxonomies to an individual product or activity is the most coherent and transparent approach. Unfortunately, it is fraught with measurement problems (extent of coverage of supply chains, impact on the product life cycle, estimate of recyclability, etc.). Applying them to the company or issuer level (as with green or social bond taxonomies) runs into the problem that, according to standard corporate finance theory, debt instruments are issuer-financing devices and cannot be interpreted as funding a specific activity (this is a problem that use-of-proceeds bonds are trying to address). And applying them to a portfolio

(e.g., an investment fund) further obscures the true environmental or other impact of the multitude of underlying economic activities.

- Sixth, these taxonomies can be applied to publicly traded equities and funds, but not to direct investments into privately held assets through venture capital and private equity. These continue to invest in oil, gas, and coal (Private Equity Stakeholder Project, 2021). As a result, despite the regulators' best intentions, mandatory disclosure requirements and, more broadly, regulatory actions to promote "green" investments may simply push heavy GHG emitters to shift their financing sources to private equity, diminishing their effectiveness.
- Finally, like old-fashioned industrial policies, which they resemble, mandatory taxonomies could be swayed by industry lobbying or be used to promote political agendas (on the latter, see, for example, Kyriakopoulou, Marsh, and Sobel, 2021).

Despite these limitations, in the absence of "first-best" policies for climate change mitigation (notably carbon taxes), it can be argued that a disclosure-based regulatory strategy could make a positive contribution. Against this background, researchers at the Bank for International Settlements (BIS) have put forward five principles for the design of effective sustainable finance taxonomies (Ehlers, Gao, and Packer, 2021). Effective taxonomies should ensure:

- Alignment not only with the high-level policy objective but also with measurable interim targets, since the high-level objective (e.g., achieving net zero or providing sustainable alternative employment to laid-off workers) may be beyond the time horizon of investors.
- Focus on one single objective ("one taxonomy, one objective"): otherwise, investors would be uncertain about exactly what information the "label" conveys.
- Focus on outcome-based, simple, and measurable performance indicators, rather than on abstract principles. This would allow low-cost, independent verification of the process and the certification.
- Incorporation of both activity-level and company-level information to avoid the potential for "greenwashing" in the case of classification of issuer-based instruments.
- Sufficient granularity, covering both high and low sustainability performance, to allow differentiated ("shaded"), rather than just binary ("green-brown") classifications.

5. SHOULD FINANCIAL POLICY AND REGULATION BE GIVEN THE OBJECTIVE OF PROMOTING THE LOW-CARBON TRANSITION?

All the initiatives discussed thus far share an underlying preoccupation: they seek to safeguard the established goals of financial policy and regulation in the face of a new reality: climate change and the concomitant imperative to transition toward a low-carbon economy. For the last five years or so, policymakers and regulators have been trying to identify what changes they need to make in their data requirements, analytical models, policy toolkit, and global standards in order to continue doing their job in this new environment: ensuring financial stability, the safety and soundness of financial institutions, market integrity, investor protection, or whatever other goals they are mandated to pursue.

Recently, several critics have been questioning this focus. They have pointed out that in the face of climate change, which in their view represents an urgent threat to humanity, continuing to focus on financial stability is akin to rearranging tables on the deck of the Titanic while doing little to “make finance flows consistent with a pathway toward low GHG emissions and climate-resilient development” as laid out in the Paris Agreement.

According to this view, central bankers and financial regulators have a duty to play a more active, “promotional” role in the transition to a low-carbon economy. The actions discussed in the previous section—measuring and raising awareness of climate-related risk and enhancing transparency and disclosure of relevant information to the market—are helpful but insufficient. In addition to those, central banks and regulators should (i) lead by example, taking steps to make their own operations “greener”; and (ii) use all tools at their disposal to influence private investment and credit allocation decisions so as to promote decarbonization in the economy. This would involve, *inter alia*, directing credit to “green” investments through differentiated capital requirements or rediscount facilities; setting ceilings to (or banning outright) lending to “brown” activities; and requiring all supervised entities to submit decarbonization plans and holding them accountable for their implementation.²³

The first proposal—leading by example—is uncontroversial and a number of central banks have embraced it: the Banca d’Italia has been publishing since 2010 annual “Environment Reports” monitoring its ecological footprint through a series of environmental indicators, such as energy and resource consumption, waste production, and so on (Banca d’Italia, 2024); the Banque de France published a “Responsible Investment Charter” in 2018, followed by annual “Responsible Investment Reports” (Banque de France, 2018, 2023); the Sveriges Riksbank published a sustainability strategy (Sveriges Riksbank, 2020); the Bank of England started publishing a climate-related financial disclosure report in line with the recommendations of the TCFD (Bank of England, 2024); and the Dutch central bank started including this information in its Annual Report (De Nederlandsche Bank, 2021). In 2023, the ECB and the central banks of the euro area started publishing climate-related financial disclosures on a harmonized methodology consistent with the TCFD recommendations.

In contrast, the proposal to use regulatory tools actively to promote decarbonization in the economy is more controversial. For one thing, it appears to be inconsistent with the current legal mandates of central banks and financial regulators. Against this, however:

- Advocates of a “promotional” role for central banks and financial regulators have argued that in many cases, it is indeed consistent with their existing mandates. While only a few have an explicit mandate to promote sustainable growth, many are tasked to support their governments’ policy objectives, often as a subordinate goal conditioned on not interfering with their primary goals (Dikau and Volz, 2021). Since many governments have adopted climate mitigation targets, advocates argue that central banks and regulatory authorities in many jurisdictions do not need additional or modified mandates to play a “promotional” role in the transition to a low-carbon economy.
- Moreover, in cases where a “promotional” role is not permitted by the existing mandates, these can be updated. Historically, central bank and regulatory agency mandates have evolved considerably, and often in response to crises: for example, the global financial crisis prompted an expansion of these mandates to cover systemic stability. Whether this took the form of a revised legal framework or a reinterpretation of the existing one is immaterial. Likewise, the argument goes, in the face of a climate emergency, mandates

of central banks and financial regulators should be expanded to enable them—indeed compel them—to contribute to the transition to a low-carbon economy.²⁴

In practice, however, using regulatory tools to promote climate transition would complicate the conduct of policy, while, based on the available evidence, it is unlikely to be effective. At a minimum, it would need to address the “Tinbergen” constraint of correspondence between objectives and tools: if the same tools are used to pursue different objectives, policy inconsistencies will inevitably arise. For example, if a GSF were used to adjust RWAs, a “promotional” objective for the prudential regulator would dictate that RWAs for “green” activities be adjusted downward; but if a certain activity presents a certain level of risk from the Basel III perspective, its climate-adjusted RWA should not be lower than the unadjusted one. In situations like this, regulators would be forced to make uneasy choices between their standard and “promotional” roles. In addition, regulatory measures are unlikely to achieve the massive shift in credit and investment flows required for decarbonization. The evidence shows that the EU’s “SME supporting factor,” which was supposed to promote SME lending in a similar fashion, has had no material influence on lending prices or volumes to SMEs (EBA, 2016). This is corroborated by model estimates that show that even a massive GSF (effectively halving the capital requirement for “green” projects) would have a negligible impact on overall credit growth and a very low impact on financing for the targeted transition projects (Chamberlin and Evain, 2021). In addition, a sudden and sizable differentiation of capital requirements between “green” and “brown” projects could increase financial stability risks (Dafermos and Nikolaidi, 2021). Last, it has been shown that the anticipation by the market of such “promotional” interventions by regulators may create risky imbalances in the balance sheets of financial intermediaries (Diluiso et al., 2020).

In conclusion, the merits of the proposal to task financial regulation with promoting the transition to a low-carbon economy are highly doubtful. Advocates of a “promotional” role for central banks and financial regulators sometimes like to present their case as a struggle against old-fashioned “traditionalists,” in which “the only barrier is orthodox thinking” (Schoenmaker and Jourdan, 2020). But this oversimplification overlooks a much more complex reality. The fundamental problem is not legal: agency legal mandates are often flexible enough and, if necessary, can indeed be reinterpreted or updated. This, of course, is not something that central bankers and regulators can (or should) do by themselves: it has to be done through the political process and be accompanied by appropriate political oversight and accountability arrangements for the central banks and other agencies that would be given these expanded responsibilities. The fundamental problem, rather, is that in practice, “green”-promoting regulatory action would raise major governance and operational challenges for regulators, while it is unlikely to have a real-world impact.

Not surprisingly, central banks and financial regulators seem so far reluctant to adopt a more active “promotional” role. Far from timidity and lassitude, as their critics sometimes allege, this shows justified caution and an appreciation of the limitations of their analytical tools. They continue to approach the consequences of climate change primarily through the lens of risk management for the financial sector.²⁵ As the Bank of England has concluded, regulatory tools—the capital framework, in particular—should be used to address the consequences of climate change for the financial sector in terms of increased risk, not its causes (PRA, 2021).

6. RISKS AND UNINTENDED CONSEQUENCES

In adapting their policies to the new challenges created by the effects of climate change and the transition to a low-carbon economy, central banks and financial regulators need to carefully weigh the potential pitfalls. These fall broadly into two groups: (i) unintended consequences their policies may have on markets and the financial system, and (ii) risks that these policies may fail to achieve their stated objectives owing to poor design or lack of coordination with other policymakers. In both cases, there could be negative repercussions on the central bankers' and regulators' reputation for competence and independence and, ultimately, on their credibility. And if this were to happen, it would undermine their ability to achieve not just their climate-related but *all* their policy goals.

One potential unintended consequence of regulatory action to favor “green” or penalize “brown” assets or activities is inadvertently exacerbating financial market volatility. This potential exists regardless of whether the intention of the regulator is to mitigate climate-related risks for the financial sector or to promote decarbonization in the economy. Although market volatility per se is not a concern for financial policy and regulation, it can trigger financial instability and have broader repercussions.

- There is already evidence of a certain price exuberance in the “green” energy sector, although this may to some extent reflect normal market dynamics (Nauman, 2021). The MSCI Global Alternative Energy Index reached a market cap of about 15 percent of the global energy sector in 2021, up from 6.4 percent in 2010. Alternative energy equity ETFs have shown similar growth.²⁶ These dynamics are, at least to some extent, an inherent aspect of market adjustment to new information. As awareness of climate-related risks grows, but—due to data gaps, cognitive lags, or other reasons—these risks are only slowly being priced in, stocks of “green” companies (or companies with higher ESG scores) should initially have a return advantage over “brown” stocks (with lower ESG scores). As ESG investing becomes more widely adopted and these risks are gradually priced in, “brown” stocks would decline relative to “green” until they have a higher expected return that compensates for their higher environmental risk. During an initial period, “green” stocks would outperform “brown” stocks, creating a “green” bubble, but once a new equilibrium has been reached where ESG risks are fully integrated into the analysis of most investors, “brown” stocks should have higher returns. The evidence suggests that the market is currently in this initial period (Bolton and Kacperczyk, 2020; Klement, 2020; Goergen et al., 2020).
- Since many of the “green” companies in sectors such as renewables or energy storage tend to be more capital- and technology-intensive, their stock prices are more sensitive to increases in interest rates. For a gas-fired power plant, for example, a large part of the total operating cost over its lifetime is the cost of fuel, but for a solar or wind power plant, almost all costs are fixed and borne upfront at the time of construction and installation. Such “long duration” stocks, whose valuations are based on high expected earnings in the future (like those of technology companies), are, at least in theory, more sensitive to changes in the cost of finance. Therefore, the higher interest rate environment is already aggravating volatility in the prices of these stocks.

- Moreover, a new commodity cycle appears to be forming, with potentially broader economic ramifications. At present, the technological transformation required for the transition to a low-carbon economy depends on the supply of a small group of minerals, such as graphite, lithium, and nickel, used in energy storage; palladium for hydrogen fuel cells; and molybdenum for wind turbines. Because clean energy technologies are much more material-intensive than fossil fuel-based electricity generation, the World Bank has estimated that in a scenario that would keep the global temperature rise below 2°C from pre-industrial levels, as called for by the Paris Agreement, demand for 17 specific minerals would quadruple by 2050 (World Bank, 2020). And these estimates do not include the demand from the additional infrastructure needed to support the deployment of these technologies, such as new transmission lines or the chassis of newly built electric vehicles. Prices of these minerals have already started reflecting these trends, which some see as the start of a new commodity super-cycle (Home, 2021). Last but not least, although most of these minerals are abundant in nature, supply chain dependencies can choke their provision. The batteries used in electric vehicles, for example, require a number of critical minerals for which substitutes are limited or non-existent and supplies are geographically concentrated (Elkind, Heller, and Lamm, 2020). Volatility in such a context could have ramifications that extend well beyond the financial system.
- Finally, looking beyond financial markets, as the recent spike in energy prices demonstrates, the road toward a low-carbon economy is going to be bumpy. The scale of the economic transformation required to achieve the Paris Agreement goals is unprecedented. Given the delicate balance that has to be maintained throughout the long process of replacing fossil fuel resources with sustainable ones, volatility in energy markets is likely to remain high.

In such a complex environment, central banks and financial regulators have to tread a fine line. While they should not necessarily aim at dampening volatility in financial, commodity, or energy markets or preventing overstretched valuations in the “green” sector, measures that unintentionally amplify this volatility (for example, if central banks’ asset purchases are tilted toward “green” securities while their supply is still limited) can be destabilizing and ultimately counterproductive: excessive volatility of “green” asset prices could temporarily dampen investment flows into the sector and delay urgently needed progress toward decarbonization. Moreover, as the discussion of commodity and energy markets highlights, such measures could have repercussions that extend well beyond the financial system.

Another set of challenges that central banks and financial regulators face in this new environment relates to their own governance. Prior to the global financial crisis, central banks were by and large focused on price stability: as one of the leading central bankers of the day put it, their “ambition was to be boring” (King, 2000). The crisis and the Great Recession that followed prompted an overhaul of central banking and regulatory frameworks. In almost all cases, central banks were given substantial additional responsibilities, notably for financial stability. Because these did not fit well within the governance model that had been established for monetary policy, they created frictions—and, in some cases, a political backlash against central bank power—and necessitated a set of new governance and accountability arrangements (Tucker, 2018; Balls, Howat, and Stansbury, 2018; Bean, 2017). The new expectations that are now being placed on central banks and regulators as a result of climate-based considerations, especially if they include playing an active role in decarbonization, fit even less well

within existing governance arrangements. Like financial stability (Demekas, 2019), climate mitigation is not a task that can—or should—be delegated to technocratic agencies, like a central bank or a regulator, as it does not meet the conditions for such delegation (Alesina and Tabellini, 2007, 2008). A collective effort of such magnitude and far-reaching economic and distributional repercussions should be mediated by the political process.

Central banks and regulators taking on—or being tasked with—supporting the transition to a low-carbon economy are already facing renewed criticism for “mission creep” and unchecked power in some jurisdictions. For some academic advocates of a “promotional” role in climate mitigation, such “mission creep” cannot happen fast enough (Robins et al., *op. cit.*; Mazzucato et al., *op. cit.*). But for real-life central bankers and regulators, it is a major risk: it would divert attention and resources from the pursuit of their core mandates; it would raise difficult technical trade-offs in the targeting of their tools, as illustrated in the previous section; and it would create a pressing need for greater accountability for achieving the new objectives, as well as the specter of greater political and public scrutiny of their activities (Mackintosh, 2019; Somerset Webb, 2021).

Failures of broader policy coordination also create risks for the financial system that could reflect back on central bankers and financial regulators. Financial policy and regulation cannot deliver the transition to a low-carbon economy by themselves: broader policy efforts and investments are needed to meet climate and environmental objectives, and most of these are in the hands of governments, notably carbon pricing and other policies that are necessary to deliver the governments’ own Paris Agreement commitments (IMF, 2020b; Group of Thirty, 2020). If central banks and regulators move ahead on their own, but, despite their stated intentions, governments fail to follow, these efforts will not only prove fruitless but could have negative repercussions. Financial firms could end up incurring losses if they move—in anticipation of or prompted by regulators—toward “green” finance but governments fail to follow through with changes in carbon pricing. Such an outcome would prevent the change in relative prices needed to sustain the transition (Pisani-Ferry, 2021a) and would deprive the market of the “critical signal for re-directing private investment and innovation to clean technologies, and to incentivize energy efficiency” (Georgieva, 2021). Asset managers and pension funds could be seen as compromising their fiduciary responsibilities as these are currently defined, a risk that is acknowledged even by advocates of a more active role for financial policy and regulation (Vaccaro and Barmes, 2021). And the inevitable backlash would be directed toward central banks and financial regulators (King and Katz, 2021).

7. CONCLUDING OBSERVATIONS

The reality of climate change and the increasing political support for moving toward a low-carbon economy mean that financial policy and regulation have to grapple with new challenges. The required large-scale, long-term economic transformation generates new risks—as well as opportunities—for financial firms and for the stability and orderly functioning of the financial system. Central bankers and financial regulators need to understand the implications for the firms they supervise, as well as assess and, if possible, take action to mitigate these new risks. Given the current state of development of their diagnostic and policy tools, however, none of these tasks is easy. In addition, at least in some jurisdictions, they are increasingly pushed to play a more active role in promoting the transition to a low-carbon economy. And

because central bankers and regulators are not immune to the political environment in which they operate, some of them may be tempted to take on these additional responsibilities.

Engaging central banks and regulatory agencies to achieve specific climate transition goals is not consistent with their current legal mandates, governance arrangements, or the risk-focused approach they have adopted so far. To be sure, these mandates and approaches can be reinterpreted or expanded, if necessary. But in order to avoid criticism of “mission creep,” this has to happen through the political process, not by the central bankers themselves. Governance arrangements would have to be amended and political oversight and accountability of central banks and regulators strengthened considerably if they are given a new goal that is essentially political and has far-reaching social, distributional, and intergenerational implications. Moreover, the evidence suggests that their tools are unlikely to be effective in bringing about the massive reorientation in financial flows required for the transition. Last but not least, pursuing this new goal alongside their existing goals will create difficult operational trade-offs and risk compromising their ability to achieve any of their goals.

As with any other policy, there is also the risk of unintended consequences for the financial system and the broader economy. Instead of safeguarding market integrity and stability, central banks and financial regulators may find themselves inadvertently fueling market volatility, overstretched asset valuations, or even a commodity super-cycle—which appears to be already underway. To be sure, an economic transformation of such a magnitude can be expected to generate large-scale re-pricing of financial assets, and market volatility per se should not be a concern for policy. But excessive volatility or, at the limit, the bursting of a “green” bubble could be destabilizing. And given the complexities of the economics of climate transition, this could have repercussions well beyond the financial system.

These challenges are neither unprecedented nor insuperable, but they are significant. The scope of financial policy and regulation has always been adapting to new exigencies, most recently after the global financial crisis. In the process, mandates had to be redefined, accountability strengthened, institutions reformed, technical problems tackled, resources increased, and risks taken. The same has to happen today in order to enable financial policy and regulation to play their role in the transition to a low-carbon economy. At the same time, these challenges are real and cannot be wished away. Recognizing and debating them should not be seen as an excuse for inaction but as a necessary step to developing appropriate solutions.

Ultimately, there is nothing that financial regulators can do about the energy transition that an appropriately designed carbon tax cannot do better.²⁷ It was not the withdrawal of bank financing from the tobacco industry that deterred smoking, but the high taxes imposed on cigarettes. The problem is that governments are unwilling or unable to impose carbon taxation, and when they do, it is unambitious, riddled with exemptions, and accompanied by fuel subsidies for certain sectors. This is largely self-inflicted: instead of being transparent about the costs and dislocations it will cause, politicians have presented the energy transition to voters “if not as pathways of roses, at least as a rather benign endeavor,” making unpopular measures even more difficult to implement (Pisani-Ferry, 2021b). Against this background, shifting some of the responsibility for unpopular measures to unelected bureaucrats in central banks must appear very appealing to politicians.

It is not the first time this has happened. In the aftermath of the global financial crisis, the eurozone crisis, and the COVID-19 pandemic, central bankers and financial regulators were pushed, cajoled, and in some cases volunteered to take on additional responsibilities of an essentially political nature. But no matter how appealing certain solutions may appear

under urgent political or popular pressure, they need to prove practical and viable in the long term from an economic, social, and political perspective—especially for processes spanning decades, like the transition to a low-carbon economy. Otherwise, central banks and regulators would be exposed to accusations of overreach and political attacks, undermining their independence and ultimately constraining their ability to make even modest contributions to the transition that are within their power.

NOTES

1. See, for example, United Nations Environment Program Finance Initiatives (UNEPFI) (2002); Dlugolecki and Loster (2003); Association of British Insurers (2004); Allianz Group and World Wildlife Fund (2006); and Lloyd's of London (2006).
2. In 2020, “green” bond issuance reached a record of US\$270 billion, continuing a rising trend of nine consecutive years (Climate Bonds Initiative, 2021)—although the pace of growth has declined since then, especially once interest rates started increasing worldwide. “Sustainable investments,” a broader category that includes all investments that integrate ESG factors in asset selection and management, is estimated to have reached US\$35.3 trillion in five major markets, more than one-third of global assets under management (Global Sustainable Investment Alliance, 2021).
3. G20 Finance Ministers and Central Bank Governors’ Communiqué (2015).
4. Liability or litigation risk is sometimes identified as a separate climate-related risk. Since in most cases this arises as a result of climate change, it is included in physical risk for the purposes of this chapter.
5. See, for example, Villeroy de Galhau (2015), Signorini (2017), and Lane (2017).
6. See the summary in IAIS (2018).
7. The methodological differences between “traditional” stress tests and scenario-based assessments in relation to climate-related risks have been analyzed extensively in the literature. For an in-depth discussion, see Thomä and Chenet (2016) and Chenet, Ryan-Collins, and van Lerven (2019).
8. For a discussion of the various methodological and other challenges facing climate-related scenario-based assessments, see Basel Committee on Banking Supervision (BCBS) (2021b), Covas (2020), Gruenewald (2020), Dépoues et al. (2019), and Campiglio et al. (2018).
9. For a comprehensive survey, see Acharya et al. (2023).
10. IMF (2021b); Grippa and Mann (2020); IMF (2022); and Adrian et al. (2022).
11. For a detailed discussion, see Demekas and Grippa (2022) and (2024).
12. For an extensive review covering equities, sovereign, municipal, and corporate bonds, and real estate, see Giglio, Kelly, and Stroebe (2021). For a more recent survey, as well as a discussion of the analytical challenges involved in pricing climate risk, see Eren, Merten, and Verhoeven (2022).
13. Minimum requirement, capital conservation buffer, countercyclical buffer, systemically important buffer, or Pillar II add-on.
14. Some have argued that the GSF and BPF are complementary and should be used in tandem, perhaps combined into a “green weighting factor” (GWF) (Berenguer et al., *op. cit.*), while others felt that a GSF may result in an unwarranted weakening of banks’ capital positions and preferred to use the BPF alone. See, for example, Villeroy de Galhau (2018), Boot and Schoenmaker (2018), and Ford (2018).

15. See Giglio, Kelly, and Stroebe (op. cit.). Overall, there is limited evidence that broader market prices incorporate risk premia commensurate with the scale and nature of climate-related risks across different sectors (IMF, 2020a). In addition, risk reductions that may appear linked to the “green” nature of an exposure could be the result of other factors, such as government subsidies or tax advantages.
16. For the standard economic theory of dealing with activities that entail environmental externalities, see Baumol (1972), Deewes (1983), and Deewes, Mathewson, and Trebilcock (1983).
17. “Five global organisations, whose frameworks, standards, and platforms guide the majority of sustainability and integrated reporting, announce a shared vision of what is needed for progress towards comprehensive corporate reporting—and the intent to work together to achieve it.” Press Release, September 11, 2020, <https://bit.ly/35qx8KH>.
18. See https://finance.ec.europa.eu/publications/renewed-sustainable-finance-strategy-and-implementation-action-plan-financing-sustainable-growth_en.
19. See <https://www.ifrs.org/issued-standards/ifrs-sustainability-standards-navigator/#sustainability-standards>.
20. The Climate Bonds Initiative and the International Platform on Sustainable Finance (IPSF)—founded in 2019 by the EU, China, and six other countries, and now counting 20 members—have published comparisons of the EU and Chinese standards. See Climate Bonds Initiative (2020); and International Platform on Sustainable Finance (2022).
21. Like the charges by the US Securities and Exchange Commission (SEC) on Goldman Sachs Asset Management (SEC, 2022a), BNY Mellon (SEC, 2022b), and Deutsche Bank Subsidiary DWS (Mooney and Flood, 2021, and SEC, 2023).
22. The EU taxonomy tries to address this issue by setting thresholds for “contributing to environmental objectives” that are to be updated by the European Commission in line with technological advances.
23. See, for example, Schoenmaker and van Tilburg (2016); Volz (2017); Finance Watch (2020); Mazzucato, Ryan-Collins, and Voldsgaard (2020); Robins, Dikau, and Volz (2021).
24. The EU, for example, has extended the mandates of its supervisory agencies to include sustainability by obliging them to consider ESG factors in the course of their duties. See De Arriba-Sellier (2021).
25. See, for example, Elderson (2021). Other central bankers and regulators have also cautioned against adopting a “promotional” role, for example, Weidmann (2019); and Laca (2021).
26. Data from MSCI Global Alternative Energy Index (<https://www.msci.com/documents/10199/40bd4fec-eaf0-4a1b-bfc3-8ed5c154fe3c>), MSCI World Energy Index (<https://www.msci.com/documents/10199/de6dfd90-3fcd-42f0-aaf9-4b3565462b5a>), and ETF Database (https://etfdb.com/etfdb-category/alternative-energy-equities/#etfs_returns%26sort_name%3Dassets_under_management%26sort_order%3Ddesc%26page%3D1).
27. For an exposition of these arguments specifically in relation to “green central banking,” see Tirole (2023). See also the excellent review in Blanchard, Gollier, and Tirole (2023).

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