7 Transforming the finance system to enable the achievement of the Paris Agreement

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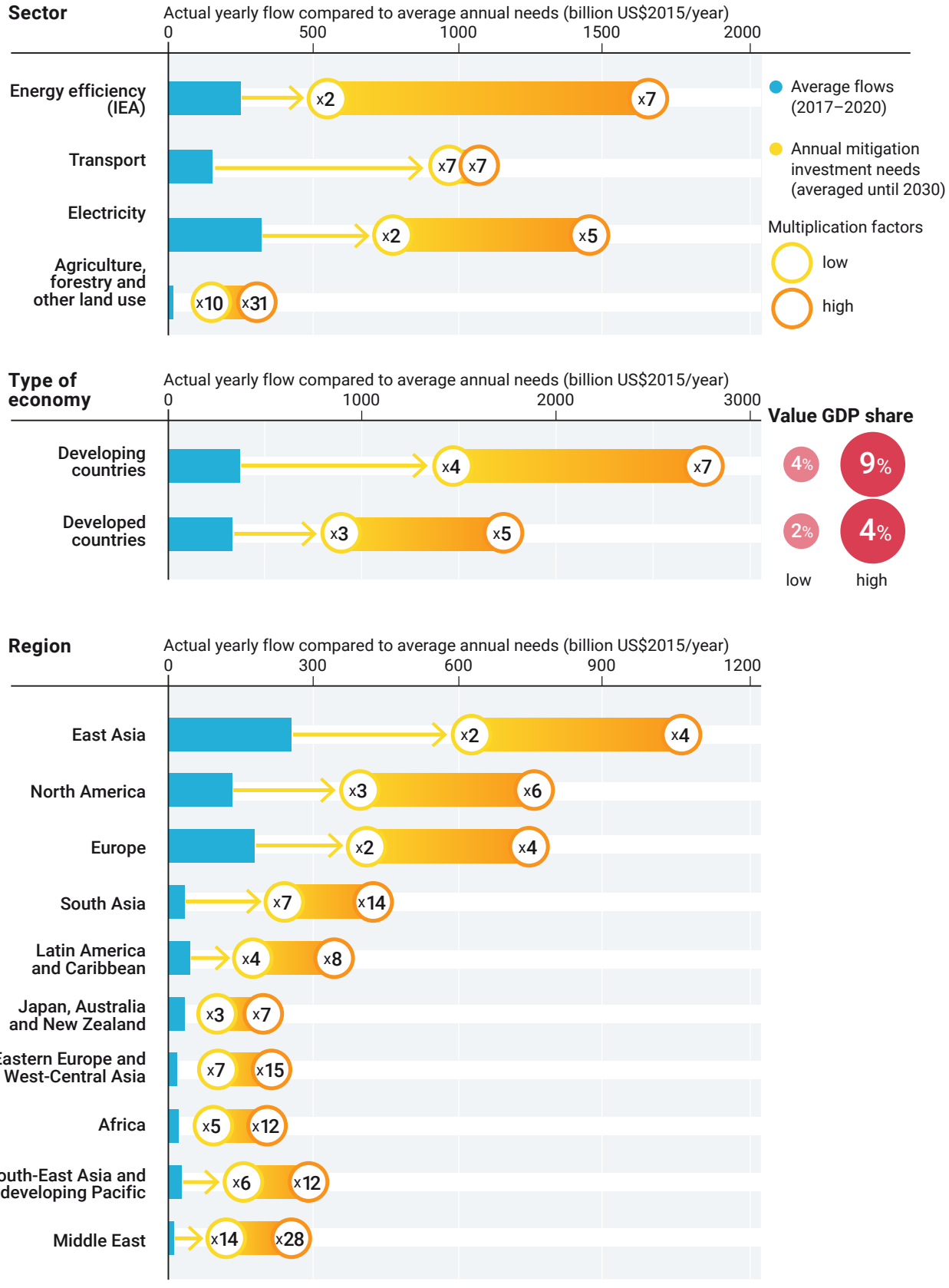
7.1 Introduction: The need for a transformation of the financial system

A realignment of the financial system is a critical enabler of the sectoral transitions required to address the current climate crises. Article 2.1(c) of the Paris Agreement calls for this and establishes a new objective for all countries to make finance flows consistent with low-carbon and climate-resilient development pathways (United Nations Framework on Climate Change Convention [UNFCCC] 2015). In contrast to the mobilization of climate finance for developing countries under the UNFCCC (article 9), another key goal, the climate consistency of finance flows represents a new purpose that relies on support and action to transform the global financial system (Zamarioli *et al.* 2021). This chapter therefore focuses on a transformation of the financial system that engages all relevant actors, including governments, central banks, commercial banks and institutional investors. The success of the transformation can ultimately be measured based on two indicators: a rapid increase in investments in low-carbon assets worldwide and a rapid decrease in investments in greenhouse gas (GHG)-intensive assets. Although this has significance for all sectors, examples in this chapter focus on the energy sector, where literature on finance and transformation is emerging (Steffen and Schmidt 2021).

Investments in low-carbon assets need to rapidly increase. Tracked climate-related investments in mitigation rose significantly to about US$571 billion per year in 2019–2020 (Buchner *et al.* 2021).[1] However, the Intergovernmental Panel on Climate Change (IPCC) estimates that global mitigation investments need to increase by the factor of 3 to 6. In developing countries, this gap is even larger (see figure 7.1) (Kreibiehl *et al.* 2022). Access to capital in developing countries is more difficult and financing costs much higher, reflecting perceived cross-border investment risks and international capital market inefficiencies (see box 7.1).

1 Methodological issues and data limitations persist. Limited data availability prevents a full accounting of domestic government expenditures on climate finance and of private sector investments in energy efficiency, transport and land use (Buchner *et al.* 2021).

Figure 7.1 Finance flows and mitigation investment needs by sector, type of economy and region



Source: Adapted and modified from Figure TS.25 from Pathak, M., Slade, R., Shukla, P.R., Skea, J., Pichs-Madruga, R., Ürge-Vorsatz, D. *et al.* (2022). Technical summary. In *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change. Geneva. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_TS.pdf.

Box 7.1 Financing the low-carbon transformation in developing countries

Developing economies account for 83 per cent of global population, one half of global GDP (in purchasing power parity terms), and 36 per cent of global GDP (at market-based exchange rates) (World Bank 2020). Given their development needs and low per capita consumption of energy, virtually the entire future increase in global primary energy demand is expected to occur in these economies (International Energy Agency 2021). An 'efficient' global financial market would mobilize flows from capital abundant high-income economies for investment in faster-growing and capital-scarce developing economies in theory (see section 7.3), but this mobilization is missing in practice (Agenor 2001; Gourinchas and Jeanne 2006; Obstfeld 2021).

There are at least three 'frictions' that prevent capital markets from investing more in developing countries. First, the perceived high risks of investing (Koepke 2018), sometimes attributed to weaker policy settings and compounded by credit rating agency risk assessment and their observed bias or tendency to assign higher credit ratings to firms and enterprises located in financial centres (Ioannou, Wójcik and Pažitka 2021). Exchange rate risks can be an additional deterrent in contexts where local capital markets are not well developed and the risks cannot be hedged because of limited risk markets. In marked contrast, investments in fossil fuel sectors in many developing countries are considered less risky because such investments, as globally traded primary energy sources, have greater asset backing and liquidity. For example, the single biggest private investment in sub-Saharan Africa in 2020 was in fossil fuel (liquefied natural gas [LNG]) export investment (Pekic 2022).

Second, persistent 'home-bias' of investors in high-income markets to invest within their own borders, contravening efficient capital markets functioning (Hau and Rey 2008) (Ardalan 2019).

Finally, observed procyclical volatility of capital flows (larger inflows in 'good times' and faster outflows in 'bad times') can exacerbate the problem and lead to periodic economic crises, debt defaults and exchange rate volatility (Dadush, Dasgupta and Ratha 2000).

These three frictions can potentially worsen with increasing climate vulnerability and unsustainable debt burdens (Volz *et al.* 2020) or lead to a "climate investment trap", especially for least developed countries, as in sub-Saharan Africa (Ameli *et al.* 2021).

Multilateral development banks (MDBs) and regional development banks can play a larger and countercyclical role, but their overall role in global capital markets is relatively small and decreasing (see section 2). Strategic international positioning and growing financial resources have led to alternative South-South financing in recent years (Chen, Dollar and Tang 2016). Some developing countries have also benefited from new market instruments, such as green bonds (see section 2), but this has not provided a solution to the financing difficulties.

Investments in fossil fuel assets need to decline rapidly, because they work against the clean energy transition now and lock in GHG emissions for decades to come, leading to stranded assets in the future (Campiglio *et al.* 2018; Mercure *et al.* 2018; Kreibiehl *et al.* 2022). The financial sector has historically funded and is highly exposed to GHG-intensive assets (see section 7.2), including fossil fuel extraction and GHG-intensive industrial sectors (e.g. steel and cement). For example, of the equity holdings portfolios of the European Union's 50 biggest banks, 4–13 per cent is directly in the fossil fuel sector and 36–48 per cent is in climate-relevant sectors such as fossil fuels, utilities and energy-intensive industries (Battiston *et al.* 2017).

Across all portfolios in the energy sector, renewable power generated higher returns than fossil fuel investments (Fomicov *et al.* 2020). Additionally, current returns in fossil fuel investments are only possible because of the continued absence of clear government policies to counteract rising climate risk (Griffin *et al.* 2015) and because of continued public fossil fuel subsidies. Explicit fossil fuel-related subsidies (US$340 billion annually)[2] are estimated to be much greater than for renewable energy (US$170 billion) (IPCC 2022).

It is also in the long-term interest of the financial system to reduce investments in fossil fuel assets, because a considerable share of fossil fuel assets is likely to become stranded (Campiglio *et al.* 2018; Mercure *et al.* 2018; Kreibiehl *et al.* 2022). Based on ongoing low-carbon technology trends, global estimates of potential stranded fossil fuel assets amount to at least US$1 trillion. When more stringent policies to limit global warming to well below 2°C are adopted, these can increase to US$4 trillion (Mercure *et al.* 2018). Together with societal and litigation risks, these technological and policy risks cause a "transition risk" that

2 Parry, Black and Vernon (2021) estimate that implicit fossil fuel subsidies (undercharged environmental costs, including climate change, and foregone consumption taxes) amount around US$5.9 trillion per year.

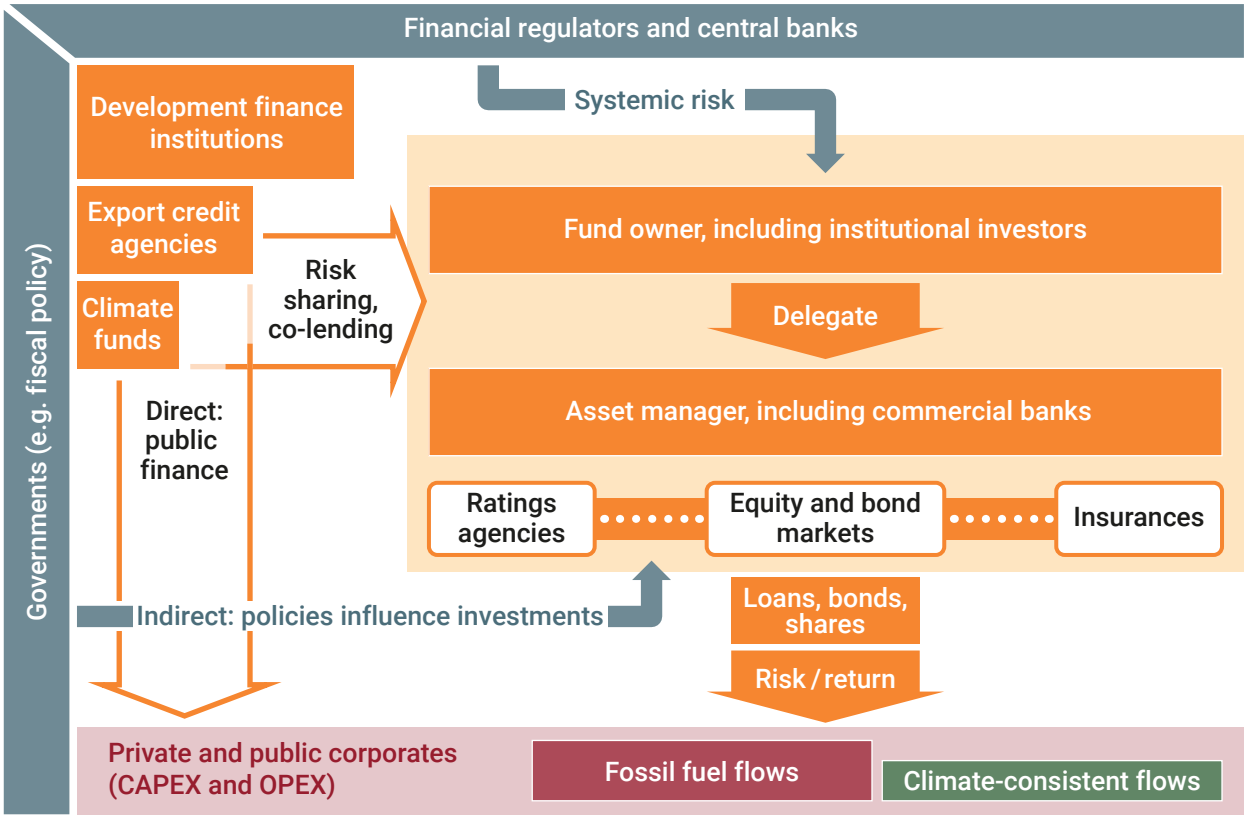
should be managed to avoid financial instability (Campiglio *et al.* 2018). The bursting of a carbon bubble cannot be ruled out (Griffin *et al.* 2015).

7.2 Aligning financial system actors with climate change

The core function of the large and complex global financial system is "to facilitate the allocation and deployment of resources, spatially and across time, in an uncertain environment" (Merton 1990). The financial system is a network of private and public institutions such as banks, institutional investors and public institutions that regulate the safety and soundness of the system but also co-lend or finance directly. Financial systems are regulated as they influence the economic system, and their capabilities facilitate the growth and productivity of real assets (see figure 7.2 for more insight into key roles and relations of actors in the financial system).

The size of assets held by a myriad of financial actors in global capital markets is very large: recent estimates indicate US$128 trillion in global bond markets (International Capital Market Association 2020), US$83 trillion in banking credit (Bank for International Settlements 2021), and US$124 trillion in equity markets (Securities Industry and Financial Markets Association 2021), totalling some US$225 trillion in credit to the non-financial sector (Bank for International Settlements 2021) and growing by about 7 per cent (US$15 trillion) annually. Given rapidly changing economic opportunities, risks and returns, decisions by actors in capital markets to change their allocation of assets even modestly, or not, have an enormous bearing on economic transitions (see box 7.2).

Figure 7.2 The financial system, its actors and their roles and relations



Source: Authors' illustration, based on Climate Finance Leadership Initiative (2019)

Box 7.2 Complexity of financial system, policy and climate finance progress

Climate-related investments have increased considerably over recent years and so has the interest in climate action of various actors in the financial system. Nevertheless, progress on the alignment of financial flows towards the goals of the Paris Agreement remains slow (Kreibiehl *et al.* 2022). This box therefore puts the climate-related finance flows in a broader macrofinancial economic perspective.

Tracked climate-related finance flows fall consistently short of the levels needed. Their share in total credit to the non-financial sector (core debt) during 2012–2021 remained very low (rising from 0.23 per cent in 2012 to 0.32 per cent in 2021) (IPCC 2022; Bank for International Settlements 2022). In equity markets (reported from public data), the market capitalization of the top-ten listed renewable energy companies globally was a small 0.2 per cent (US$215 billion) of global equity markets in 2021. To put this in perspective, market capitalization of major technology stocks was bigger and rose faster (US$600 billion in 2012 to over US$9 trillion by 2021). Even highly speculative cryptocurrency stocks (with energy-intensive 'mining' operations) reached higher peak valuations (US$2 trillion in 2022), before sliding recently. In the wake of the 2008 financial crisis, the re-emergence of the real estate and housing sector as a reinvigorated global asset class, after its earlier market collapse, has been remarkable (Fields 2017; Ghent, Torous and Valkanov 2019; Christophers 2021).

Between 2012 and 2021, a period that saw a surge in debt and equity markets, there was no significant increase in the relative scale of climate finance, despite large technology gains as seen in renewable energy. In contrast, other sectors, many highly speculative, saw extremely rapid growth, attracting bigger investment and financing support. The share of 'zombie' firms, for example, defined as firms unable to even cover debt servicing costs from current profits, rose from 4 per cent in late 1980s to 15 per cent by 2017. Such misallocation in financial markets can be attributed to low nominal interest rates and quantitative easing policies as well as a rise in central bank balance sheet assets, which hit creditworthy firms (Acharya *et al.* 2019). A consensus on cutting wealth taxes emerged in public finances (Lierse 2022) while fossil fuel financing remained unabated (Kirsch *et al.* 2022). Whether such broader macroeconomic policy and finance directions carried significant negative effects on the slow, observed progress of climate finance is a complex question (van 't Klooster and Fontan 2020), but the relative magnitudes confirm that climate finance has not been significant in the financial system nor in the overall macrofinancial setting globally.

A global transformation from a heavily fossil fuel energy-dependent economy to a low-carbon economy is expected to require investments of at least US$4–6 trillion a year, a relatively small (1.5–2 per cent) share of total financial assets managed, but significant (20–28 per cent) in terms of the additional annual resources to be allocated. While the size of the global financial system is clearly sufficient to close funding gaps, there is a qualitative mismatch between available and required types of capital (Polzin and Sanders 2020; IPCC 2022).

Table 7.1 Actors in the financial system relevant to climate change

Actor	Role in financial system
Governments	Set out policies and regulations, especially to manage public goods externalities, such as climate. In addition, governments influence investments through fiscal policy levers (including green procurement), public finance (including grants, loans and sovereign guarantees) and information instruments (Whitley *et al.* 2018). Furthermore, governments own and operate financial institutions such as development finance institutions (DFIs), 'green' banks, climate funds, export credit and aid agencies (see below).
Central banks and financial regulators	Primary mandate to ensure price stability and financial stability in the economy. Institutional settings vary between countries, but many central banks also have a mandate to support government policies. Dikau and Volz (2021) found that 114 central banks consider curbing climate change as part of their existing mandate. Besides, climate change poses risks to financial stability and has implications for prudential regulation.

DFIs (bilateral and multilateral)	Provide financial and technical support to developing countries public and private sectors, thereby filling gaps where governments and other financial actors cannot deploy needed investments in critical sectors of the economy. Backed by their shareholders, DFIs have recognized the need to play an essential role through initiatives (e.g. green bond programmes by the International Finance Corporation, African Development Bank and European Investment Bank; mainstreaming climate in financial institutions' initiatives) in addressing global development challenges such as climate change.
International climate funds	Channel international public finance to mitigation and adaptation projects in developing countries. The funds vary in size, geographic coverage, aims and governance.
Export credit agencies (ECAs)	Official or quasi-official government agencies that provide government-backed support for the international operations of corporations from their home country. Such support can either take the form of credits (financial support) or credit insurance and guarantees (pure cover) or both, depending on the ECA's mandate. This way, ECAs can crowd in billions of dollars of private investment.
Insurance industry	Provides insurance as a risk management instrument to hedge against the risk of contingent or uncertain (financial) loss. Insurance payouts for catastrophes have increased significantly over the last 10 years, and this trend is expected to continue (Kreibiehl *et al.* 2022).
Commercial banks	Commercial banks are financial institutions that accept deposits from the public and give loans for the purposes of consumption and investment to make profit. Loans from commercial banks are the most important source of external finance for firms.
Institutional investors	Institutional investors, such as mutual funds, pension funds and insurance companies invest money on behalf of others. They have large assets under management (US$84 trillion) in Organisation for Economic Co-operation and Development (OECD) countries in 2017 (OECD 2018) and long timescales of their liabilities, which can potentially match the timescales of climate change (Ameli *et al.* 2020).
Equity markets	Compared to other financial instruments (e.g. debt instruments, guarantees and grants), equity investments require enhanced assessment and governance (OECD 2021) because of increased investors' ownership of a company or asset class.
Credit rating agencies	Credit rating agencies (CRAs) are crucial actors for access to finance on international and domestic capital markets. CRAs rate the creditworthiness of debt and equity securities based on quantitative and qualitative analyses (Mathiesen 2018).

Notes: See also figure 7.2.

The actors within the financial system can play key roles in shaping its transformation (see Hölscher, Wittmayer and Loorbach 2018). Some of the actors in the financial system have an explicit mandate or aim to enable action on climate change (table 7.1). However, it is not the primary objective of any of them, except for the climate funds, to address climate change. Furthermore, successful integration of climate risks into financial decision-making requires a time-horizon of multiple decades, but most actors in the climate finance system typically have time-horizons of 1–5 years (Chenet 2019). Aligning the actors of the financial system with the goals of the Paris Agreement is therefore challenging.

Public sector actors

Public sector authorities are most strongly linked to climate change, in particular governments, central banks and regulators, DFIs and climate funds. Governments, as signatories to the Paris Agreement, have a responsibility to implement its article 2.1(c), but they are also important to give climate policy signals to address macroeconomic uncertainty and to help guide investment decisions (Kreibiehl *et al.* 2022).

Central banks and financial regulators recognize that climate change can impact the macroeconomic aggregates that they are required to stabilize, such as inflation and employment (Robins, Dikau and Volz 2021). Furthermore, climate impacts and the transition to net zero will affect financial markets (key for the monetary transmission), financial institutions (often supervised by central banks) and the broader financial system, for which central banks have

a macroprudential mandate (Chenet, Ryan-Collins and van Lerven 2021; Svartzman *et al.* 2021).

Central banks must choose how to react to climate change: by trying to maintain the status quo by focusing purely on climate risk assessment, which is more easily framed within their primary mandate of financial stability, or proactively by addressing climate change and transition risks by including climate risk criteria, e.g. in their asset purchase programmes, adjusting collateral frameworks and capital requirements (see Bolton *et al.* 2020). The former will pose a barrier to the transformation of the financial system because risk disclosure alone does not ensure the expected shift in financial decision-making (Ameli *et al.* 2021).

Bilateral and multilateral DFIs have recognized their role in addressing climate change. For example, some European DFIs have committed to ending lending to fossil fuel projects by 2030 as well as immediately ceasing the financing of new oil and coal projects (e.g. European Investment Bank, Investment Fund for Developing Countries [IFU], and Swedfund, which has invested in renewables only since 2014). Using instruments such as loans, guarantees and equity acquisitions, many DFIs leverage their financial resources to mobilize and scale up finance to address climate change in developing countries (Lemma 2015; Attridge, te Velde and Andreasen 2019). However, despite their potential significance in climate finance, the eight largest international DFIs only mobilized US$50 billion in mitigation finance in 2020 (African Development Bank *et al.* 2020). This may reflect their preference for direct project finance operations (Hourcade, Dasgupta and Ghersi 2020) over de-risking and crowding in private capital (African Development Bank *et al.* 2015) as well as limits on their capital exposure (single-country exposure limits).

Climate funds have a stronger focus on climate change than DFIs but they are relatively small: together, they held US$34.8 billion in deposits from donors and committed US$28.4 billion in approved projects by January 2022 (Climate Funds Update 2022). Some funds function exclusively through grants, as in the case of the Adaptation Fund, while others, such as the Green Climate Fund (GCF), use a variety of financial instruments to engage public and private actors to implement and co-finance projects. Since 2020, the GCF also intends to support mainstreaming of climate considerations in developing countries' national financial systems, by developing climate investment capacities of national institutions or by formulating supportive policy/regulatory frameworks (GCF 2020).

Finally, export credit agencies: between 2016 and 2018, ECAs from OECD members reported US$5.7 billion of climate finance through export credits (OECD 2021). In the same period, the ECAs of the G20 provided at least US$120.3 billion in support for fossil fuel projects (excluding the Export-Import Bank of the United States) (Tucker and DeAngelis 2020). ECAs thus currently tend to work against the implementation of article 2.1(c) and the low-carbon transformation (see Shishlov, Censkowsky and Darouich 2021).

If the public sector-backed financial system actors would work in an aligned way towards shifting financial flows away from high-GHG investments to low-GHG ones, they could multiply each other's impact and increase the viability of low-GHG projects.

Private sector actors

Private actors in the financial system include commercial banks, insurance companies, institutional investors and private equity (equity markets).

Commercial banks are simultaneously an important source of debt financing for low-carbon investments (Polzin, Sanders and Täube 2017) and a source of fossil fuel financing. As an illustration, the world's 60 largest banks alone provided US$4.6 trillion in fossil fuel financing in the six years since the adoption of the Paris Agreement, with no sign of decline (see Kirsch *et al.* 2022). Macroprudential regulation, such as Basel III,[3] promotes short-termism and hence negatively affects the already problematic access to finance of low-emission sectors (Campiglio 2016).

For the insurance industry, climate change is a threat because losses limit the affordability (through increased premiums) and availability of coverage (when insurers withdraw from particular perils and geographical areas) (Collier, Elliott and Lehtonen 2021). Financial instruments are being developed by private insurers and other financial services entities to price in climate risks, but a majority of the companies does not integrate climate change into their risk management practices (e.g. Thistletwaite and Wood 2018). Furthermore, internal conflicts may arise when an insurer's underwriters advise against issuing insurance in areas with increasing climate risk, while doing so would decrease the value of the insurer's real estate investments in that same area (Riedl 2022).

Institutional investors (including insurers) accounted for just 0.2 per cent of total climate-related finance flows in 2016 (Ameli *et al.* 2020). The very broad current permissive classifications of environmental, social and governance (ESG) investments obscures rather than promotes scaled-up climate finances (Berg, Kölbel and Rigobon 2019). More significant action has also been limited by the priorities of institutional investors on short-term returns, lack of climate expertise and their lingering scepticism about climate risk exposure.

3 The Basel accords provide recommendations on banking regulations issued by the Basel Committee on Banking Supervision. Basel III introduces stricter standards for banks on both the liquidity of their assets and the robustness of their capital.

In equity markets, private equity expansion (e.g. corporate financing or early-stage investors into a portfolio of start-ups) is essential for riskier tranches of low-carbon investments (Hourcade *et al.* 2021), but private equity energy investments continue to be dominated by GHG-intensive activities. The higher cost of equity capital for GHG-intensive production activities provides still a relatively weak market disincentive mechanism (Trinks *et al.* 2022).

While still predominantly a barrier to addressing climate change, private actors in the financial system demonstrate a willingness to act on climate change. For example, the United Nations-convened Net-Zero Banking Alliance brings together a global group of 117 banks, currently representing about 39 per cent of global banking assets (UNEP Finance Initiative 2022). Insurance companies and institutional investors are increasingly aware of the risk climate change is posing as well as increasing ESG pressures from shareholders and stakeholders. However, effects have been limited so far.

This is where CRAs may contribute. Climate and ESG risks are increasingly integrated into CRAs' rating methodologies (Mathiesen 2018; Angelova *et al.* 2021) and climate risks have started to negatively affect credit ratings (Cevik and Jalles 2020). Especially in developing countries, higher-risk premiums have already raised costs of public (sovereign) capital (Beirne, Renzhi and Volz 2021; Kling *et al.* 2021). However, climate risks tend to materialize with high uncertainties and on longer time-horizons (Network for Greening the Financial System [NGFS] 2020; Coelho and Restoy 2022), while ratings issued by CRAs are relatively short-term-oriented. The limited response by CRAs to the growing scientific and economic evidence of climate-related risks may cause markets and investors to struggle to correctly identify, price and manage their investments (Agarwala *et al.* 2021).

In summary, most actors in the financial system only align their activities with the aims of the Paris Agreement to a limited extent compared to the total scale of their activities. For actors to do more and move faster to address the climate crisis, both individually and as a system, external forces of climate policy-setting by governments as well as financial regulators and supervisors are necessary.

Box 7.3 Gender responsive transformation of the financial system

A growing number of recent studies (e.g. Bosone, Bogliardi and Giudici 2022; Clancy *et al.* 2020; Robino and Jackson 2022) have consolidated the importance of a gender lens and gender responsiveness in investments and financial policies for low-carbon transitions, both in terms of equity and increased impact. A gendered approach should ensure that women will gain equally in the emerging opportunities from a green economy, while also improving effectiveness to decarbonize through, for example, girls' education. Women are inordinately affected by climate change, creating strong links between gender and adaptation. Yet evidence has shown the relevance of gender and gender-smart investments also for most mitigation-related areas, from renewable energy to agriculture and forestry, infrastructure and waste. The practice is developing to boost women's financial inclusion in climate finance/investment, with the example of climate funds (Kreibiehl *et al.* 2022). Overall, however, practice and literature remain deficient, particularly in advancing the business case to mainstreaming gender in the broader context of shifting finance flows.

7.3 Transforming the financial system: Six approaches to public policy

Inspired by the innovation system literature (Bergek *et al.* 2008; Geels 2002), the financial system can be viewed as a complex constellation of actors, interactions and institutions with a specific internal dynamic, as well as a relation to the real economy of projects, assets and policy instruments. When a system is influenced by external pressures or by social, technological or institutional innovations within the system, it can change rapidly. This has been extensively documented for technological innovation systems (Blanco *et al.* 2022) and recently scholars started applying the concept to finance (Hafner *et al.* 2020; Naidoo 2020; Steffen and Schmidt 2021). Processes to shape transitions are necessarily about interactions between technology, policy/power/politics, economics/business/markets, and culture/discourse/public opinion (Geels 2011).

There are multiple approaches to reach inflection points that lead to a financial system capable of supporting actions to limit warming to 1.5°C:

- **Increase the efficiency of financial markets.** In well-developed financial markets, markets function efficiently, but in their 'weak' form, markets are inefficient, especially in the context of uncertainty. However, agents can correct this with time and better information (Krueger *et al.* 2020). Financial innovations through 'engineering' of new financial

products to address special needs are a mark of such relatively efficient markets. The main policy prescription is better information, including taxonomies for sustainable economic activities and transparency through disclosure of climate risks (Carney 2015; Dietz *et al.* 2016; Zenghelis and Stern 2016; Campiglio *et al.* 2018). In developing country contexts (Bond, Tybout and Utar 2015; Hamid *et al.* 2017), priorities will include capacity-building and strengthening institutions (Banga 2019). Relying solely on the efficient markets and information disclosure can hide imperfections that are inherent to financial markets' structure and practices (Ameli, Kothari and Grubb 2021; Bolton and Kacpercyzk 2021) and depend on the uncertain (behavioural) responses of boards, stockholders and markets to such disclosures.

Examples of increasing the efficiency of financial markets can be found in both developed and developing countries. For example:

- through voluntary disclosures (e.g. recommendations from the Task Force on Climate-Related Financial Risk Disclosures) and mandatory rules (e.g. European Union Corporate Sustainability Reporting Directive) on enterprises' observed emissions and projected risks from climate change
- the definition of low-carbon consistent or transition activities via taxonomies and classification systems (e.g. Chinese Green Bond Catalogue and Green Industry Guiding Catalogue; Bangladeshi Green Taxonomy; European Union Taxonomy for sustainable activities)
- the protection of consumers of ESG-related services against 'greenwashing' (e.g. by the United States of America Securities and Exchange Commission or the German Federal Financial Supervisory Authority)

► **Introduce carbon pricing.** In the presence of strong externalities and missing or incomplete futures markets, this approach suggests that the most important response is to price carbon explicitly and high enough for it to provide signals for investors to alter decisions (Aghion *et al.* 2016). This can be done through carbon taxes or through cap-and-trade systems (Haites 2018). Carbon taxes have practical appeal because they provide more certainty over future emissions prices, helping encourage low-carbon investments and lower energy use. Emissions trading schemes, on the other hand, provide certainty over future emission levels. They can be designed to mimic some of the advantages of taxes, including through carbon price floors (Newbery, Reiner and Ritz 2019).

An increasing number of countries are putting carbon pricing in place. Emission trading schemes and carbon taxes now cover 30 per cent of all global emissions, with a global average price of US$6 per ton of CO_2 (Black, Parry and Zhunussova 2022). Both the coverage and the price are insufficient to transform the financial system: the International Monetary Fund (IMF) (Black, Parry and Zhunussova 2022) suggested a global average price of US$75 as required by 2030. Similarly, the High-Level Commission on Carbon Prices (2017) concluded that an explicit carbon price level should be at least US$50–100/tons of CO_2 (tCO_2) by 2030 to limit global warming to between 1.5°C and 2°C warming above pre-industrial levels, provided a supportive policy environment is in place. The report proposed that this goal can also be achieved with lower near-term carbon prices, but that this would require stronger action through other policies and instruments and/or higher carbon prices later (Stern and Stiglitz 2017). Currently, there are proposals for higher near-term international carbon price floors (Chateau, Jaumotte and Schwerhoff 2022), differentiated between high-, medium- and low-income countries (US$75, US$50 and US$25, respectively).

In jurisdictions without explicit carbon pricing, shadow pricing is a tool for firms, development banks and governments to internalize a carbon price in investments and take more informed decisions. Rising (minimum) carbon price floors can strengthen such future investment decision-making (Stern and Stiglitz 2017).

► **Nudge financial behaviour.** Climate finance markets are subject to deep information asymmetry, risk-aversion and herd behaviour (contagion and bandwagon), all of which result in inefficient choices, status quo and deter actions. In addition, the financial system is characterized by the existence of strong and complex networks, nodes and inter-linkages among financial institutions (Battiston *et al.* 2016), (Hüser 2015). While this might create hard-to-change behaviour and inertia, they can be addressed through credible public signals directed at such financial networks and nodes. Routines are strongly determined by networks and are relatively easily adaptable: imitation of other actors' new routines can result in herding effects towards transformation (Steffen and Schmidt 2021).

On the demand side, solutions to reduce consumption of GHG-intensive uses can be significant, reducing 40–70 per cent of the gap in low-carbon transition (Creutzig *et al.* 2016; Creutzig *et al.* 2022; IPCC

2022) and can enhance household welfare. Current demand-side policy strategies, however, still rely heavily on individual self-responsibility. Governments need to steer more actively, through taxes, subsidies, regulations, standards, labelling and public infrastructure, especially in sectors such as mobility, food, housing and urban transitions (Moberg *et al.* 2019). In the case of electric vehicles, for example, in addition to subsidies and tax rebates, charging density, fuel prices and road priority incentives are increasingly important across countries (Ingeborgrud and Ryghaug 2019; Wang *et al.* 2019). Green finance institutions additionally play a critical role (Polzin and Sanders 2020; Song, Xie and Shen 2021) in nudging investor and financial behaviour (Zhang, Li and Ji 2020; Koutsandreas *et al.* 2022).

Institutions and local governments pledging to divest from carbon-intense assets, for example coal and oil companies, can help. Building on climate awareness and its associated moral claims, shareholders and activists create uncertainty among institutional investors about the future stability of the fossil fuel industry and its reliability as a continuing source of profitable investment (Ayling and Gunningham 2017). The effectiveness of divestment has been criticized, for example because entities that are divesting do not account for a large share of investors, the effects might only be temporary (Ansar, Caldecott and Tilbury 2013), or because investment funds are not mandated to operate based on ethics but on rules that protect them from the forces of politics (Mercure 2019). However, the stigmatization and reputational damages impact the fossil fuel companies (Ayling and Gunningham 2017). Based on a divestment campaign by 350.org, about 1500 institutions in 71 countries representing US$40 trillion in assets are divesting (Lipman 2021). Divestment also takes place outside of this movement. For example, Europe's biggest pension fund, ABP of the Netherlands, pledged to divest US$17.4 billion worth of fossil fuel assets by 2023 (Marsh 2021) and stated that it reduced the CO_2 footprint of its portfolio by 40 per cent in 2022 compared with 2015 (ABP 2022).

- **Create markets.** Public policy can accelerate new product markets for low-carbon technology, replacing the older, inefficient (fossil fuel-based) technology. Public policy actions include: (a) financial and product market regulations (such as fuel or energy-efficiency standards), (b) altering the risk-reward profiles of investment classes through public policies, taxes and subsidies and (c) directly engaging in public financing through public financial institutions, green banks and innovation funds, public financial guarantees to private investments, and by public contracting and guaranteed purchase agreements. All actions lower the risks of new technology and can lead the financial system to follow and shift financial flows accordingly. The most important recent example of swift public actions to rapidly develop a product market using a blend of indirect and direct instruments was the development of COVID-19 vaccines. In the case of low-carbon product markets, an example is the rapid uptake of LEDs in India's lighting market from negligible to a dominant share in five years (annual sales grew 130 times between 2014 and 2018) (Kamat *et al.* 2020), attributable to a programme aimed at lowering prices through at-scale public agency procurement.

  Industrialized countries can support the creation of markets in developing countries. Development banks, including green banks, can play a more active role to stimulate financial markets as newer product markets are being accelerated. These banks are at the nexus of the public and private sectors and the developed and developing worlds, and with their ability to provide concessional public financing, alongside technical and policy expertise, and working with domestic financial institutions, they can lower risks in new low-carbon asset markets (e.g. accelerated solar rooftop power in India). MDBs can support market creation through shifting financial flows, stimulating innovation and helping to set standards (e.g. for fossil fuel exclusion policies, GHG accounting and climate risk disclosure).

  Consistency of public policy is, however, essential: signals must go in one direction. Alignment of public policies towards creating new markets in low-carbon energy transition also requires exiting from subsidies and other support to fossil fuel sectors, such as guarantees from ECAs. Steering in other directions prolongs the status quo, and is expensive and ineffective. It also prevents norms and practices from changing, because signals towards the actors in the financial system are unclear.

- **Mobilize central banks.** Central banks are increasingly addressing the climate crisis, and have different tools at their disposal (see section 7.2). In December 2017, eight central banks and supervisors established the NGFS, which has now grown to 116 members and 18 observers. Mandates of central banks in developing countries are often broader than those of central banks in developed countries; More concrete action towards this approach can therefore be observed. For example, the Reserve Bank of India requires that commercial banks allocate a certain proportion of lending to a list of 'priority sectors', including renewable energy, and Bangladesh Bank has introduced a minimum credit quota of 5 per cent that financial institutions must allocate to green sectors (Campiglio *et al.* 2018).

Furthermore, prudential regulations are increasingly starting to include climate change. Prudential regulation aims at ensuring that banks and other financial institutions (the micro level) and the whole of the financial system (the macro level) are robust against market risks. Apart from stress testing, central banks could also consider green quantitative easing and making transition plans, or transition pathways, mandatory for commercial banks, for example through science-based net-zero targets with interim emissions reduction targets every five years, sectoral decarbonization trajectories for the entire portfolio, and minimizing the use of offsets (Pinko and Pastor 2022). The European Central Bank, for example, announced the incorporation of climate criteria in their asset purchase programmes in 2022. The prioritization of which bonds to purchase, or to keep in their portfolio, is crucial. By choosing to release high-emitting assets first, central banks send a strong signal to the market for firms and financial institutions. The same is true for changing capital requirements and collateral frameworks.

Another important recent development is that the IMF has set up a special Resilience and Sustainability Trust Fund (special drawing rights [SDR] 33 billion, equivalent to US$45 billion) as part of the recent SDR issuance of US$650 billion in August 2021. Aim is to help low-income and vulnerable middle-income countries access long-term funding (up to 20 years) for climate change and other structural challenges, at low interest rates, using a part of new SDR reserves (IMF 2022).

- **Set up climate clubs and cross-border finance initiatives.** This approach draws from game theory literature, and suggests a strong advantage of smaller 'clubs' of cooperating countries (Nordhaus 2015), to move faster on commitments to shifting financial flows (since global climate agreements have greater difficulties in coordinated actions). Because of the smaller size and leverage of participating countries, such clubs could alter policy norms and change the course of finance through credible financial commitment devices, such as sovereign guarantees on cross-border financial flows.

For example, at COP 26 in Glasgow, a group of 34 countries signed an agreement to end new direct public support for the international unabated fossil fuel energy sector by the end of 2022, except in limited and clearly defined circumstances that are consistent with a 1.5°C warming limit and the goals of the Paris Agreement (United Nations Climate Change Conference of the Parties 2021). This agreement directly targets ECAs. For the transition of the financial system, it is crucial that this agreement is fully implemented and that additional countries join the agreement, as Japan did in the context of the G7 meeting in 2022. The International Just Energy Transition Partnership initiative was also announced at COP 26, and could be enlarged and operationalized. Climate clubs are more effective and could do more; they currently primarily act as information-sharing and voluntary arrangements among small groups of influential cooperating countries (such as at the G20) (Unger and Thielges 2021).

Another example is fossil fuel subsidy reform, an emerging norm (Skovgaard and van Asselt 2019) that is advocated by climate clubs. For example, after earlier commitments by the G20 and the Asia-Pacific Economic Cooperation to reform fossil fuel subsidies, this was also mentioned in the UNFCCC Glasgow Climate Pact. A demonstration effect caused by deepening these initiatives domestically would have an important impact.

Evidence on the effectiveness of the six approaches above suggests that there is no single 'silver bullet' that will transform the financial system, and that multiple instruments, institutions and actors under different approaches need to be mobilized (see table 7.2). For example, while institutional investors are making markets more efficient by applying exclusionary screens (or not), they have done so solely on the basis of scope 1 emissions intensity, and only for the industries with the highest CO_2 emissions (oil and gas, utilities, and motor industries) (Bolton and Kacperczyk 2021). It will take time and more reliable data to overcome such shortcomings. Similarly, when governments postpone ambitious climate policy, the transition risks are downplayed, which makes the short-term effects for financial stability less problematic, thus limiting action by central banks with the mandates they have (even if long-term risks are aggravated). Instead, nested and coordinated approaches are likely to work better in transforming climate finance (Schmidt and Sewerin 2019; Bhandary, Gallagher and Zhang 2020): the ensure that action is implemented in the same direction, tailored to contexts and pursued across major groups of countries, with equity and a just transition within and between countries. The institutional challenges to achieving such coordinated and cooperative actions, however, ultimately depend on public support and pressures to avert the significant risks of inaction.

Adopting multiple approaches in the same direction ultimately helps address a variety of different binding constraints to accelerate the pace of change. Low-carbon transitions are undertaken by a wide range of actors with differing interests, resources, capabilities and beliefs about their preferred solutions (Geels, Berkhout and van Vuuren 2016; Edomah *et al.* 2020). The other reason is that a multiplicity of approaches may signal a stronger 'whole of

society' commitment. For example, combinations of carbon taxes, use of pooled green bond markets and supportive state fiscal policies have worked in some contexts (Hoff 2017; Nassiry 2018; Andersen 2020; Hans *et al.* 2022). These, in turn, help drive faster movement up the typical S-curves observed in the uptake of large system/technological/finance transitions where such transitions are typically non-linear (Dasgupta 2015; Grubb, Drummond and Hughes 2020).

Table 7.2 Accelerating climate finance flows for emissions gap reduction and low-carbon transition: Multiple approaches, instruments and actors

	Instruments	Institutions and actors
Increase the efficiency of financial markets	• Financial transparency rules and protection of investors and consumers • Climate-related financial risk disclosure (voluntary and mandatory) • Taxonomies and classification systems • Financial engineering (structured finance, asset-backed non-recourse debt, venture capital, private equity etc.) • Definitions and disclosure/recognition of risk of stranded assets • Green bonds and bond market classifications and standards, including ESG standards • Capacity-building	• Financial regulatory institutions • Central banks • Credit rating and related agencies • Banks and institutional investors • Bond market regulators
Introduce carbon pricing	• Carbon taxes • Emissions trading schemes • Fossil fuel subsidy reduction • Carbon credit instruments	• Ministries of finance and treasuries • Financial regulatory agencies • Ministries of power/ environment • International agreements (e.g. UNFCCC)
Nudge financial behaviour	• Nudges to address herd behaviour and behavioural and system inertias, and to provide benefits from switching to low-carbon alternatives • Divestment movements • Tax benefits to accelerate low-carbon investments • Product taxes, subsidies, regulations, standards, labelling and public infrastructure • Carbon taxes and regulations on GHG-intensive activities	• Ministries of finance and treasuries • Ministries of environment • Large corporates, supply chains • MDBs, DFIs, ECAs
Create markets	• Public bonds and guarantee issuances for domestic, early-stage research and development investment and direct investment support, green banks • Innovation intermediaries and investment • Public-private partnerships • Enabling policy support (feed-in tariffs, reverse auctions etc.) • Product market regulations and standards • Public procurement contracts and purchase guarantees • Taxes and subsidies	• Ministries of finance and treasuries • National and regional development banks and green banks • Cities and regions • Private equity investors

Mobilize central banks	• Priority sector lending and credit quotas • Prudential lending standards and bank supervision, collateral requirements • Stress testing and financial stability prudential requirements • Enhanced liquidity support to financial system • Creating new asset classes for climate in banking/ investment regulation • Quantitative easing and central bank balance sheet activities • Low-carbon climate remediation assets • IMF SDR issuance funding for climate investment support in low-income contexts	• Central banks • Financial regulators • IMF • Banks and institutional investors
Set up climate clubs and international cross-border financial initiatives	Instruments depends on type of initiative, but include: • Voluntary standards and agreements on fossil fuel subsidy reductions • Agreement on ECA norms • Just transition initiatives and financial support structures • Multilateral and bilateral climate funds • Multi-sovereign and other guarantee support to de-risk and leverage private investment	• Climate funds • MDBs, ECAs • Multi-sovereign guarantee mechanisms • CRAs • G7/G20 agreements • Larger private institutional actors

Notes: There are significant overlaps between categories, and only a limited exercise has been conducted to net out these overlaps.