

University of Groningen

Public Financial Institutions and Climate Change

Xie, Lina; Scholtens, Bert; Homroy, Swarnodeep

Published in:
The Routledge Handbook of Green Finance

DOI:
[10.4324/9781003345497-7](https://doi.org/10.4324/9781003345497-7)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2023

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Xie, L., Scholtens, B., & Homroy, S. (2023). Public Financial Institutions and Climate Change. In O. Lehner, T. Harrer, H. Silvola, & O. Weber (Eds.), *The Routledge Handbook of Green Finance* (pp. 75-86). Routledge. <https://doi.org/10.4324/9781003345497-7>

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

5

PUBLIC FINANCIAL INSTITUTIONS AND CLIMATE CHANGE

Lina Xie, Bert Scholtens, and Swarnodeep Homroy

Introduction

Climate finance is at the heart of addressing climate change. To limit the temperature rise to 1.5 degrees Celsius, more than 4 billion USD of climate finance is required annually by 2030 (see Climate Policy Initiative, 2021). Raising such amounts is challenging given the already high and rapidly increasing levels of public debt in relation to the impact of the Covid-19 pandemic and rising inflation worldwide. The UN Climate Change Conference 2021 (COP26) reinforced the importance of taking climate into account in every financial decision for both public and private financial actors. As significant asset owners, public financial institutions (PFIs) provide similar amounts of international climate finance as private institutions. Their investment allocation (e.g., shifting from carbon-intensive to low-carbon infrastructure) can substantially affect the climate system and emission trajectories (Steffen & Schmidt, 2019). However, those PFIs are underappreciated in the academic debate about their engagement in climate actions. To understand the role and potential of PFIs in addressing climate change, we provide the basics about these institutions and why and how they might help address climate change.

A commonly used definition of PFIs is that they are financial institutions initiated/owned by governments with official missions to serve the public interest as defined by national, regional, or international policy objectives (Cochran et al., 2014; Xu et al., 2021). As such, development-oriented PFIs, for example, multilateral development banks (MDBs) such as the World Bank and the African Development Bank, are the most typical PFIs in the financial system. They have explicit investment mandates to support industrial development, structural change, regional development, and innovation (De Aghion, 1999; Fry, 1988; Mazzucato & Penna, 2016). Some PFIs are set up to help achieve specific policies, such as export-import lending and insurance (the EXIM banks), society-wide transition financing, and climate financing (the green banks). Furthermore, they can act as a catalyst in bringing private financial institutions to certain projects (Fleta-Asín & Muñoz, 2021; OECD, 2016). In this chapter, we extend the scope of PFIs to all banks and asset owners in the public sphere (with government ownership), which can be public banks owned by local authorities, public funds, and public insurers. They are on the rise and account for a significant fraction of the financial system with their substantial assets under management (AUMs). More specifically, it shows that the 27 trillion USD AUMs of public

pension and sovereign wealth funds make them the third-largest group of asset owners globally (Megginson et al., 2021).

Figure 5.1 illustrates various financial institutions in both the public and private sectors and their involvement in providing climate finance and conventional finance. PFIs are in quadrants II and III. PFIs that focus on facilitating and mobilizing climate finance, such as climate funds and green banks, occupy quadrant II. They are established to provide capital via different financing mechanisms (e.g., in partnership with private investors) for climate change adaptation, mitigation, and capacity-building activities in different sectors and regions (Chaudhury, 2020; Michaelowa et al., 2020a). Adaptation aims to improve the vulnerable country’s resilience to climate change and reduce risks of economic damage from climate incidents. Mitigation is to reduce emissions and shift to a low-carbon development path. Capacity-building activities help enhance a country’s technical and institutional capacity and ability to respond to climate change. PFIs typically focus on underserved markets, where perceived barriers and lack of private investment slow the adoption of clean energy and related technologies (OECD, 2016, 2017).

The development-oriented PFIs operate in highly diverse fields, such as promoting national and local economic development, small and medium-sized enterprises growth, and addressing societal challenges like climate change. The significant international climate finance providers, MDBs, are committed to increasing their activities’ share of climate finance (MDBs, 2019, 2021). More and more national development banks (NDBs) and state investment banks (SIBs) are integrating climate change into their investment decisions and promoting low-carbon and climate-resilient (LCR) development (Geddes et al., 2018). The investment portfolios of those PFIs consist of both climate finance and conventional finance. Therefore, they are positioned in the middle of quadrants II and III.

Furthermore, other public banks and state-owned investors (SOIs, e.g., public pension funds, sovereign wealth funds, and public insurance companies) are more oriented toward providing conventional finance. They take deposits or manage households’ retirement plans

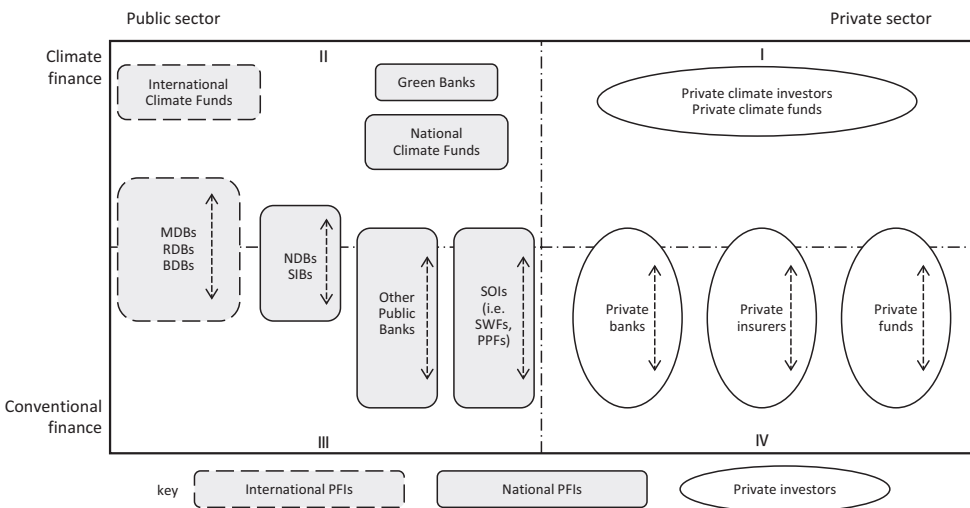


Figure 5.1 Public financial institutions in the financial system. **Note:** MDBs: multilateral development banks; RDBs: regional development banks; BDBs: bilateral development banks; NDBs: national development banks; SIBs: state investment banks; SOIs: state-owned investors; SWFs: sovereign wealth funds; PPFs: public pension funds. Source: authors’ construction.

and transform them into loans, equity investments, and other financial vehicles. Given their government ownership, they operate with public interest mandates and stakeholder engagement (DSGV, 2018; Marois, 2021). Regarding climate change, some front runners have started to align their investment portfolios with climate goals and actively promote environmental and climate-related policies in their investee companies (Driouich et al., 2020). For instance, the Environment Agency Pension Fund (UK) targets getting to net zero by 2045, and the California Public Employees' Retirement System (US) actively engages its portfolio companies to encourage them to consider climate-related factors in their operations. However, the majority of them are less proactively engaged in providing climate finance. This suggests the substantial potential for the public financial sector to address climate change.

Private investors are positioned in quadrants I and IV of Figure 5.1. Here, climate funds are initiated by the private sectors in quadrant I and are purely focused on providing climate finance. For example, Bloomberg New Energy Finance (2022) tracked 2.8 billion USD in capital raised by climate-focused venture capital and private equity funds between December 2021 and February 2022. In addition, private banks and asset owners are raising their awareness of climate change, assessing and managing climate risks, and integrating climate into their financial decisions (e.g., participating in climate-related initiatives such as Principles for Responsible Investment, Principles for Responsible Banking, and Climate Action 100+).

In the societal and academic debate, many studies focus on private investors in terms of their motivations for considering climate factors and related impact on financial performance (Bolton & Kacperczyk, 2021; Hartzmark & Sussman, 2019; Mazzucato & Semieniuk, 2018; Reboledo & Otero, 2021; Riedl & Smeets, 2017; Trinks et al., 2018). Though private investors pursue the maximization of shareholder value, they also can collaborate with PFIs to fund low-carbon technology and innovation and to help turn the billions of public climate finance into trillions of total climate investments. It is because, here, private and social interests align.

The Role of PFIs in Addressing Climate Change

PFIs play a crucial role in meeting the urgent need for upscaling global climate finance, given their public features and climate-related market failures. They facilitate climate finance in two ways: by providing their own resources and by mobilizing climate finance from private investors (see Figure 5.2) (Migliorelli & Dessertine, 2019; NRDC, 2016). Left to the market alone, there will be underinvestment in LCR projects. Market failures, presented with the externalities of climate change, information asymmetry, and structural barriers in green innovation financing, decrease the attractiveness of climate projects (Polzin, 2017). Especially private investors and corporations with short planning horizons and prioritizing financial profits are reluctant to bear related risks and engage in LCR investments (Egli et al., 2018; Le et al., 2020; Schmidt, 2014).

Government ownership allows PFIs to primarily pursue their policy objectives while trying to break even financially, which sets them apart from private investors. The explicit or implicit government guarantee enables PFIs to raise a substantial volume of stable capital and transfer it to LCR projects at a lower cost (see Figure 5.2, capital provision), especially for projects which are not able to access capital from the private sector (Mazzucato & Penna, 2016; Steffen & Schmidt, 2017). The basic funding means include concessional loans, intermediated loans, equity investments, guarantees, etc. Yet, given the already high public debt and the scope of LCR investments in need, it is difficult for PFIs to provide sufficient climate finance on their own. Therefore, mobilizing capital from private investors becomes the other important role for PFIs in addressing climate change (OECD, 2016).

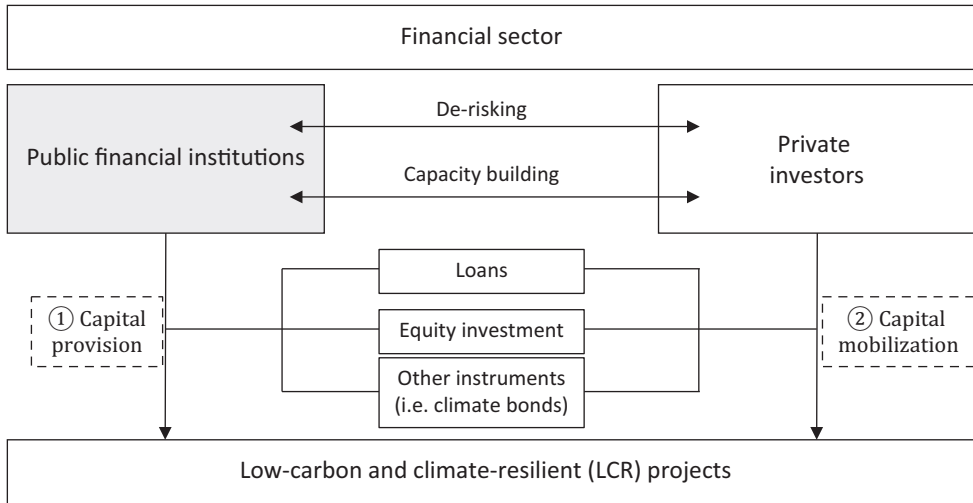


Figure 5.2 PFIs’ role in channeling climate finance to LCR projects. Source: authors’ construction

Mobilizing private climate finance can be achieved through two channels. First, the involvement of PFIs in LCR projects performs a de-risking role, namely decreasing the downside risk of LCR projects (OECD, 2021; Schmidt, 2014). The relatively high risks and financing costs of LCR projects form significant barriers to accessing capital from private investors. PFIs’ involvement brings explicit or implicit risk insurance or guarantees (that cover potential losses) that make LCR projects financially attractive for private investors. PFIs signal to the market that those projects are commercially viable and, in turn, leverage private climate finance to LCR investments (Geddes et al., 2018). In addition, with specific financing structures and arrangements, PFIs’ involvement either shares or transfers the risk of LCR projects at different stages among investors with different risk-return portfolios and then leverages more private climate finance (Cochran et al., 2014). OECD (2021) analyzed 328 projects funded by institutional investors with public interventions and recorded 19 de-risking instruments (the three most used instruments are co-investment as an equity fund, loan, and stake cornerstone at the fund level).

Meanwhile, the public actors need to be aware of the potential crowding-out effect of public climate finance. PFIs are expected to provide additional finance for climate projects lacking sufficient funds due to market failures. Their investments in already bankable LCR projects compete with private investors and, as such would crowd out private climate finance (Geddes et al., 2018). It seems many institutional investments and public interventions flow to mature technologies (OECD, 2021). PFIs might focus on higher-risk low-carbon technologies and climate-resilience projects to provide additional climate finance.

Secondly, PFIs play a role in providing and building capacity and expertise regarding climate investment. Though the awareness and understanding of climate change and related risks increase among both public and private investors, expertise in LCR investments and assessing and managing climate-related risks are far from mature (Krueger et al., 2020; Stroebel & Wurgler, 2021). Building capacity and fostering expertise become crucial for PFIs to attract additional capital. Technical assistance is one of the typical financing types of development banks for climate-related projects, especially essential for adaptation projects. Such assistance aims to improve the ability of project developers regarding project preparation and strategic planning

and strengthen the technical capacity of the capital market so that LCR projects have better access to financing (United Nations, 2020).

PFI also invest in researching and developing innovative financial tools and standards for climate investments which are public goods that benefit all investors. Relying on the PFI's platforms and initiatives, climate investment expertise and knowledge are disseminated to more project developers and investors (Driouich et al., 2020). Given the government ownership and stakeholders' engagement, PFI can also be a bridge between governments and market actors, advocating climate-related policies and regulations and promoting climate-related responsibility. For example, the water bank in the Netherlands (a national promotional bank) set up a water innovation fund to innovate sustainable water-related projects in the pilot phase (NWB Bank, 2022). It also actively funds sustainable energy projects supported by the government, such as projects that received government grants and projects raised from public-private partnerships.

Many LCR projects are funded with traditional forms of loans and equity investments. PFI also developed many other financial instruments that leverage private climate finance, for instance, mezzanine finance, quasi-equity, and off-balance sheet instruments (Cochran et al., 2014; NRDC, 2016). In the green bond market, public sector actors take the lead. They issued 230 billion USD of green bonds in 2021, which accounted for 40% of the overall amount of this type of bond issue. Issuance by PFI like development banks and government-backed entities accounted for more than 22% (Climate Bonds Initiative, 2021).

Geographic Dimension of PFI's Climate Finance

What is the destination of PFI's climate finance? As of today, an accurate answer is unavailable due to data limitations. On the one hand, there are no consensus and systematic studies identifying PFI of all countries. An exhaustive database of PFI worldwide is still missing. Xu et al. (2021) build the first database of over 500 public development banks and development financial institutions worldwide, but many public banks and SOIs are not included. On the other hand, only a few PFI start tracking and reporting climate finance in their portfolio, and these data are unavailable for most PFI. Moreover, without a harmonized and jointly agreed accounting and reporting methodology, the data cannot be aggregated and compared across countries (Shishlov & Censkowsky, 2022; Weikmans & Roberts, 2019).

In this chapter, we adopt public climate finance data from Climate Policy Initiatives (CPI) and eight leading MDBs to illustrate the geographic flows of climate finance from the public sector. CPI aggregates international climate finance from all public actors (e.g., PFI, government budget, and state-owned enterprises) on the regional level (Climate Policy Initiative, 2021). In 2019–2020, more than half of public climate finance (180 billion USD) went to Asia Pacific Region. CPI estimates most public climate finances were concentrated in China because of its strong government involvement in public spending and policies. Western Europe, which consists of developed economies, has sourced 13.8% of global public climate finance (43 billion USD). The other economically advanced regions, namely the United States, Canada, and Oceania, have sourced only 1.3% and 0.3% of all public climate finance. In those regions, climate finance primarily comes from the private sector. Moreover, regions with the most vulnerable countries, such as sub-Saharan Africa, the Middle East, and North Africa, sourced limited public climate finance for their LCR projects (5.5% and 2.9%). Countries in those regions find it difficult to obtain climate finance from the private sector (see Figure 5.3, panel A).

Data from the MDBs enable us to go deeper into the climate finance flows across countries. Eight MDBs¹ developed common principles for finance to mitigate and support adaptation to climate change and reported their climate finance commitments across countries

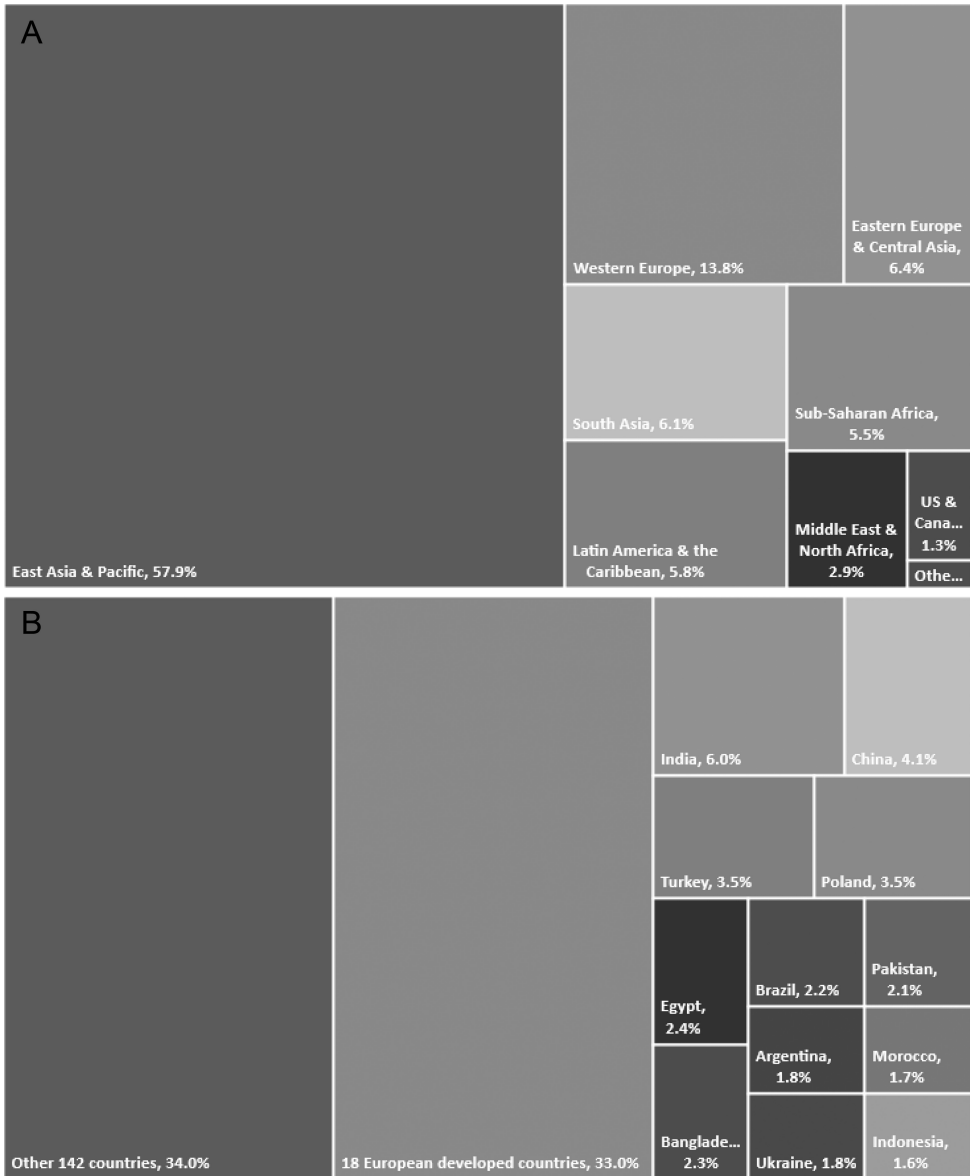


Figure 5.3 Geographic flows of PFIs' climate finance. **Panel A: Public climate finance across regions (2019–2020 annual average); Panel B: MDBs' climate finance commitments across countries (2015–2020 annual average).** Note: transregional public climate finance is not illustrated in this figure. The bottom-right box of Panel A is other Oceania countries, 0.3%. Source: Global Landscape of Climate Finance 2021, Joint Report on Multilateral Development Banks' Climate Finance 2021.

between 2015 and 2020 (MDBs, 2021). MDB climate finance only includes the proportions of project funds that directly contribute to or promote adaptation and/or mitigation. The annual climate finance commitments made by MDBs between 2015 and 2020 were 51.4 billion USD, allocated to 172 countries. The geographic distribution of MDBs' climate finance is highly skewed. For example, EIB provided one-third of the climate finance to 18

European developed countries (17 billion USD per year). Climate finance from EIB constitutes a significant source of public climate finance for Western European countries. The rest was allocated to 154 developing and emerging countries in transition. Among them, the 12 largest recipients and the other 142 countries received a similar proportion (around 33%) of climate finance from MDBs.

PFIs' Climate Finance Priorities: Mitigation Versus Adaptation

PFI

s' climate finance is the primary source for developing countries to mitigate and adapt to climate change, while developed countries mainly source funding from the private sector, especially the United States, Canada, and countries in Oceania. The data also confirm the highly skewed distribution of PFIs' climate finance. Moreover, this skew exists not only among countries but also between mitigation and adaptation purposes. Mitigation finance accounted for 86% of all CPI-tracked public climate finance and 75.6% of the eight MDBs' climate finance. Though adaptation projects heavily rely on funding from the public sector, they receive limited funds from PFIs (see Figure 5.4).

Adaptation to climate change that improves economic and social resilience is imperative because of the growing hazardous impacts of climate incidents (e.g., extreme weather events, floods and droughts, and rising sea levels). Even if we achieve net-zero emissions immediately, climate change impacts will last for the next few decades. Adaptation is unavoidable and urgent in the short term, especially for least developed and most vulnerable countries (Klein et al., 2007). Mitigation is to reduce sources or enhance the sinks of greenhouse gases (GHGs), which

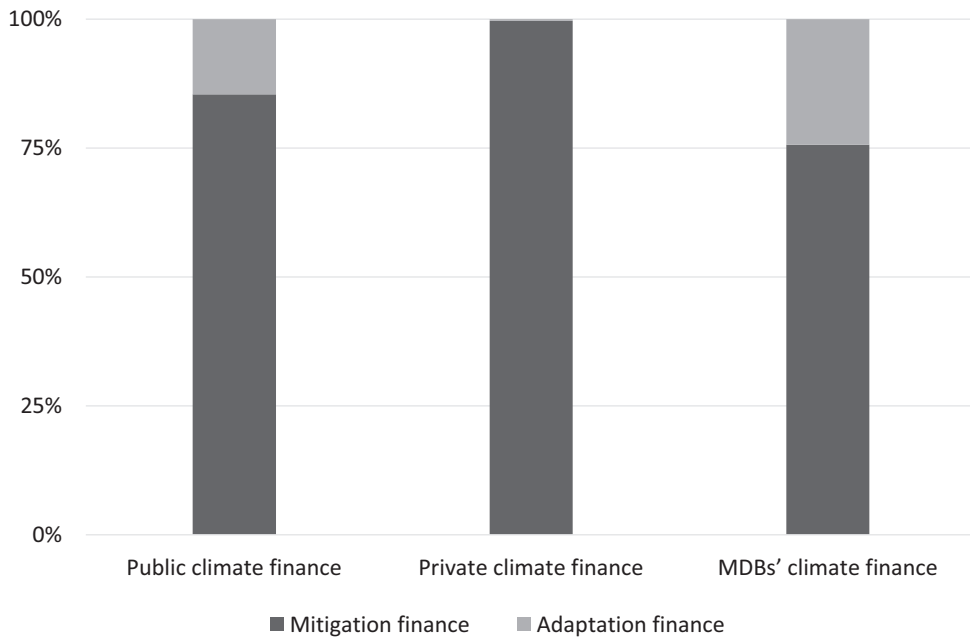


Figure 5.4 Public climate finance by mitigation and adaptation. Source: the two left bars use data from CPI, indicating CPI-tracked climate finance (2019–2020 average) by mitigation and adaptation from public and private actors. The right bar uses data from MDB-reported climate finance from their own resources (2021).

requires significant efforts from major GHG emitters. Mitigation limits the concentration of GHGs in the atmosphere and generates global benefits in the long term. Without mitigation, adaptation will be impossible for some natural systems associated with tremendous social and economic costs. However, because of the long duration of mitigation measures to take effect on the actual climate, this implies that many people have to face increasing climate risks and significant economic damages for a prolonged time. This seeming paradox reflects the real nature of the climate crisis: the urgent need to protect vulnerable societies and ecosystems and the pressure to cut emissions simultaneously.

The Paris Agreement brings the importance of the balance between mitigation and adaptation finance to the table. Article 9 of the Paris Agreement states that the

provision of scaled-up financial resources should aim to achieve a balance between adaptation and mitigation, and the allocation of climate finance should consider country-driven strategies, and the priorities and needs of developing country Parties, especially those that are particularly vulnerable to the adverse effects of climate change and have significant capacity constraints.

(United Nations, 2015)

Whether this Article is implemented in the climate finance allocation, many studies investigate the allocation of international climate funds and MDBs' climate finance.

Garschagen and Doshi (2022) track and analyze the allocation of the World Bank's Green Climate Fund (GCF) and find it allocates its funds largely to vulnerable countries as it aims to prioritize. They observe that the most vulnerable countries with weak institutional governance cannot access project funding. Halimanjaya (2016) connects the recipient country's carbon sink with the mitigation finance allocation and finds discrepancies in the mitigation finance allocation of different donor countries. Michaelowa et al. (2020a) find that mitigation trust funds allocate their funding according to recipients' certified emission reductions, while adaptation trust funds do not prioritize the most vulnerable countries.

We examine the allocation of MDBs' climate finance and connect it to the country's CO₂ emissions and vulnerability to climate risks (Homroy, Xie, and Scholtens, 2021). From project-level data of ADB, EIB,² and IDBG, MDBs' mitigation finance and adaptation finance are positively correlated with countries' CO₂ emissions, while their adaptation finance is not positively correlated with countries' vulnerability to climate risks (see Table 5.1). Furthermore, we simulate and predict future emissions and vulnerability under different scenarios of climate finance distribution between mitigation and adaptation. We find that a more evenly balanced allocation

Table 5.1 Correlation coefficients matrix of MDBs' mitigation finance and adaptation finance, and countries' CO₂ emissions and vulnerability

	<i>ADB</i>		<i>EIB</i>		<i>IDBG</i>	
	<i>Mitigation</i>	<i>Adaptation</i>	<i>Mitigation</i>	<i>Adaptation</i>	<i>Mitigation</i>	<i>Adaptation</i>
CO ₂ emissions	0.559***	0.530***	0.172**	0.488***	0.709***	0.326***
Vulnerability	-0.074	-0.044	-0.151**	-0.053	-0.149*	0.056

Source: mitigation and adaptation finance data are drawn from project-level data of ADB, EIB, and IDBG. CO₂ emissions data are the country's total emissions from World Development Indicators. Vulnerability data are the country's vulnerability index from Notre Dame Global Adaptation Index.

between adaptation and mitigation finance (from 30:70 to 60:40) could substantially reduce vulnerability to climate change for around 1.9 billion people.

Adaptation is one of the core topics juxtaposed with *mitigation, collaboration, and climate finance* at the UN Climate Change Conference 2021. Adaptation projects face more barriers than mitigation projects to obtain funding from the private sector, therefore rely to a great extent on the public financing source. However, adaptation finance only accounts for a small fraction of the public climate finance portfolio. Studies show that adaptation finance hasn't reached the most vulnerable countries (Garschagen & Doshi, 2022; Michaelowa et al., 2020b). To align its finances with the investment portfolio with Paris Agreement Articles, PFIs must balance mitigation and adaptation finances and take the country's climate priority into account. The COP26 Presidency (2021) also requests developed-country parties to consider doubling adaptation finance to balance mitigation and adaptation.

Conclusion

The transition to a low-carbon and climate-resilient development path is increasingly urgent. The sheer scale and risky funding on mitigation, adaptation, and capacity-building require significant participation from public financial institutions. The public characteristics of PFIs enable them to be used as an atypical climate policy instrument by governments, providing authorities with more policy tools other than conventional regulations, subsidies, emissions trading schemes, and carbon taxes. With implicit or explicit government guarantees, PFIs support specific climate policies with specific financing tasks and fund cheaper than private institutions. They play a crucial role in facilitating sufficient funds for climate projects. Besides traditional development-oriented PFIs, such as MDBs and NDBs, we should also shed light on public banks owned by local authorities and state-owned investors, which have substantial AUMs and great potential to scale up climate finance.

Closing the climate financing gap is challenging for both public and private investors. We have seen an increasing awareness of climate change and the related risks of PFIs. More and more instruments and expertise are developed and accumulated. The balance between mitigation and adaptation finance must be highlighted during this process. Adaptation is not only to protect against negative climate impacts but also to avoid long-term damage to communities and ecosystems and to provide lasting support for climate policies. Similarly, mitigation is important to achieve the objectives of the Paris Agreement. Future emissions will exacerbate vulnerabilities of communities and ecosystems consequently. Therefore, a more balanced allocation between mitigation and adaptation and human health and well-being dimension needs to be considered by PFIs in their investment decisions.

Abbreviations and Acronyms

ADB	Asian Development Bank
AfDB	African Development Bank
AIIB	Asian Infrastructure Investment Bank
AUMs	assets under management
BDBs	bilateral development banks
COP	Conference of the Parties
CPI	Climate Policy Initiative
EBRD	European Bank for Reconstruction and Development

EIB	European Investment Bank
EXIM banks	export–import banks
GCF	Green Climate Fund
GHG	greenhouse gas
IDBG	Inter–American Development Bank Group
IsDB	Islamic Development Bank
LCR	low–carbon and climate–resilient
MDBs	multilateral development banks
NDBs	national development banks
OECD	Organization for Economic Co–operation and Development
PFIs	public financial institutions
RDBs	regional development banks
SIBs	state investment banks
SOIs	state–owned investors
SWFs	sovereign wealth funds
PPFs	public pension funds
UK	United Kingdom
UN	United Nations
US	United States
WBG	World Bank Group

Notes

- 1 They are Asian Development Bank (ADB), African Development Bank (AfDB), Asian Infrastructure Investment Bank (AIIB), European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB), Inter–American Development Bank Group (IDBG), Islamic Development Bank (IsDB), and the World Bank Group (WBG).
- 2 We only include EIB’s climate finance to developing and emerging countries here.

References

- Bloomberg New Energy Finance. (2022). *Climate funds heat up raising \$2.8 billion in three months*. Bloomberg NEF. <https://about.bnef.com/blog/climate-funds-heat-up-raising-2-8-billion-in-three-months/>
- Bolton, P., & Kacperczyk, M. (2021). Do investors care about carbon risk? *Journal of Financial Economics*, 142(2), 517–549. <https://doi.org/10.1016/j.jfineco.2021.05.008>
- Chaudhury, A. (2020). Role of intermediaries in shaping climate finance in developing countries—Lessons from the green climate fund. *Sustainability*, 12(14), 5507. <https://doi.org/10.3390/SU12145507>
- Climate Bonds Initiative. (2021a). *Sustainable debt: Global state of the market 2021*. https://www.climatebonds.net/files/reports/cbi_global_sotm_2021_02h_0.pdf
- Climate Policy Initiative. (2021b). *Preview: Global landscape of climate finance 2021*. <https://www.climatepolicyinitiative.org/wp-content/uploads/2021/10/Global-Landscape-of-Climate-Finance-2021.pdf>
- Cochran, I., Hubert, R., Marchal, V., & Youngman, R. (2014). Public financial institutions and the low-carbon transition: Five case studies on low-carbon infrastructure and project investment. OECD Environment Working Papers, No. 72. <https://doi.org/10.1787/5jxt3rhpgn9t-en>
- COP26 Presidency. (2021). *Priorities for public climate finance in the year ahead*. <https://ukcop26.org/wp-content/uploads/2021/01/PRIORITIES-FOR-PUBLIC-CLIMATE-FINANCE-IN-THE-YEAR-AHEAD.pdf>
- De Aghion, B. A. (1999). Development banking. *Journal of Development Economics*, 58(1), 83–100. [https://doi.org/10.1016/S0304-3878\(98\)00104-7](https://doi.org/10.1016/S0304-3878(98)00104-7)
- Driouch, R., Ralite, S., Stein, E., & Ghirardi, T. (2020). On the road to Paris? A review of financial institutions’ climate-related commitments. In *2 investing initiative (2DII)*. <https://2degrees-investing.org/wp-content/uploads/2020/12/On-the-Road-to-Paris.pdf>

- DSGV. (2018). *Inside the savings banks finance group*. [https://www.dsgv.de/bin/servlets/sparkasse/download?path=%2Fcontent%2Fdam%2Fdsgv-de%2Fenglische-inhalte%2FSavings_Banks_Group_2018_EN.pdf&name=Inside the Savings Banks Group.pdf](https://www.dsgv.de/bin/servlets/sparkasse/download?path=%2Fcontent%2Fdam%2Fdsgv-de%2Fenglische-inhalte%2FSavings_Banks_Group_2018_EN.pdf&name=Inside%20the%20Savings%20Banks%20Group)
- Egli, F., Steffen, B., & Schmidt, T. S. (2018). A dynamic analysis of financing conditions for renewable energy technologies. *Nature Energy*, 3(12), 1084–1092. <https://doi.org/10.1038/s41560-018-0277-y>
- Fleta-Asin, J., & Muñoz, F. (2021). Renewable energy public–private partnerships in developing countries: Determinants of private investment. *Sustainable Development*, 29(4), 653–670. <https://doi.org/10.1002/sd.2165>
- Fry, M. J. (1988). *Money, interest, and banking in economic development*. Johns Hopkins University Press.
- Garschagen, M., & Doshi, D. (2022). Does funds-based adaptation finance reach the most vulnerable countries? *Global Environmental Change*, 73, 102450. <https://doi.org/10.1016/j.gloenvcha.2021.102450>
- Geddes, A., Schmidt, T. S., & Steffen, B. (2018). The multiple roles of state investment banks in low-carbon energy finance: An analysis of Australia, the UK and Germany. *Energy Policy*, 115, 158–170. <https://doi.org/10.1016/j.enpol.2018.01.009>
- Halimanjaya, A. (2016). Allocating climate mitigation finance: A comparative analysis of five major green donors. *Journal of Sustainable Finance and Investment*, 6(3), 161–185. <https://doi.org/10.1080/20430795.2016.1201412>
- Hartzmark, S. M., & Sussman, A. B. (2019). Do investors value sustainability? A natural experiment examining ranking and fund flows. *Journal of Finance*, 74(6), 2789–2837. <https://doi.org/10.1111/jofi.12841>
- Homroy, S., Scholtens, B., & Xie, L. (2021). Climate consequences of rebalancing official climate finance: Analyzing multilateral development banks’ allocation practices. Available at SSRN 3972261.
- Klein, R., Huq, S., Denton, F., Downing, T., Richels, R., & Robinson, J. (2007). Inter-relationships between adaptation and mitigation. In *Climate change 2007: Impacts, adaptation and vulnerability. contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change* (pp. 745–777). Cambridge University Press. <https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg2-chapter18-1.pdf>
- Krueger, P., Sautner, Z., & Starks, L. T. (2020). The importance of climate risks for institutional investors. *Review of Financial Studies*, 33(3), 1067–1111. <https://doi.org/10.1093/rfs/hhz137>
- Le, T. H., Nguyen, C. P., & Park, D. (2020). Financing renewable energy development: Insights from 55 countries. *Energy Research and Social Science*, 68, 101537. <https://doi.org/10.1016/j.erss.2020.101537>
- Marois, T. (2021). *Public banks: Decarbonisation, definancialisation and democratisation*. Cambridge University Press. <https://doi.org/10.1017/9781108989381>
- Mazzucato, M., & Penna, C. C. R. (2016). Beyond market failures: The market creating and shaping roles of state investment banks. *Journal of Economic Policy Reform*, 19(4), 305–326. <https://doi.org/10.1080/17487870.2016.1216416>
- Mazzucato, M., & Semieniuk, G. (2018). Financing renewable energy: Who is financing what and why it matters. *Technological Forecasting and Social Change*, 127, 8–22. <https://doi.org/10.1016/j.techfore.2017.05.021>
- MDBs. (2019). *High level MDB statement*. <https://www.adb.org/sites/default/files/page/41117/climate-change-finance-joint-mdb-statement-2019-09-23.pdf>
- MDBs. (2021). *Joint report on multilateral development banks’ climate finance*. 64. https://www.miga.org/sites/default/files/2021-08/2020-Joint-MDB-report-on-climate-finance_Report_final-web.pdf
- Meggison, W. L., Lopez, D., & Malik, A. I. (2021). The rise of state-owned investors: Sovereign wealth funds and public pension funds. *Annual Review of Financial Economics*, 13(1), 247–270. <https://doi.org/10.1146/annurev-financial-110420-090352>
- Michaelowa, A., Michaelowa, K., Shishlov, I., & Brescia, D. (2020a). Catalyzing private and public action for climate change mitigation: The World Bank’s role in international carbon markets. *Climate Policy*, 21(1), 120–132. <https://doi.org/10.1080/14693062.2020.1790334>
- Michaelowa, K., Michaelowa, A., Reinsberg, B., & Shishlov, I. (2020b). Do multilateral development bank trust funds allocate climate finance efficiently? *Sustainability*, 12(14), 5529.
- Migliorelli, M., & Dessertine, P. (2019). *The rise of green finance in Europe*. https://doi.org/10.1007/978-3-030-22510-0_7
- NRDC. (2016). *Green & resilience banks*. <https://www.nrdc.org/sites/default/files/green-investment-bank-model-emerging-markets-report.pdf>
- NWB Bank. (2022, December). *The sustainable water bank: NWB Bank*. <https://www.nwbbank.com/en/public-finance/sustainable-water-bank>
- OECD. (2016). *Green investment banks: Scaling up private investment in low-carbon, climate-resilient infrastructure, green finance and investment*. <http://doi.org/10.1787/9789264245129-en>

- OECD. (2017). *Green investment banks: Innovative public Financial Institutions scaling up private, low-carbon investment*. <https://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2017/01/Green-Investment-Banks-OECD.pdf>
- OECD. (2021). *De-risking institutional investment in green infrastructure*. <https://doi.org/10.1787/357c027e-en>
- Polzin, F. (2017). Mobilizing private finance for low-carbon innovation – A systematic review of barriers and solutions. *Renewable and Sustainable Energy Reviews*, 77, 525–535. <https://doi.org/10.1016/j.rser.2017.04.007>
- Reboredo, J. C., & Otero, L. A. (2021). Are investors aware of climate-related transition risks? Evidence from mutual fund flows. *Ecological Economics*, 189, 107148. <https://doi.org/10.1016/j.ecolecon.2021.107148>
- Riedl, A., & Smeets, P. (2017). Why do investors hold socially responsible mutual funds? *Journal of Finance*, 72(6), 2505–2550. <https://doi.org/10.1111/jofi.12547>
- Schmidt, T. S. (2014). Low-carbon investment risks and de-risking. *Nature Climate Change*, 4(4), 237–239. <https://doi.org/10.1038/nclimate2112>
- Shishlov, I., & Censkowsky, P. (2022). Definitions and accounting of climate finance: Between divergence and constructive ambiguity. *Climate Policy*, 22(6), 798–816. <https://doi.org/10.1080/14693062.2022.2080634>
- Steffen, B., & Schmidt, T. S. (2017). The role of public investment & development banks in enabling or constraining new power generation technologies. *International Conference on the European Energy Market, EEM*, 1–6. <https://doi.org/10.1109/EEM.2017.7981949>
- Steffen, B., & Schmidt, T. S. (2019). A quantitative analysis of 10 multilateral development banks' investment in conventional and renewable power-generation technologies from 2006 to 2015. *Nature Energy*, 4(1), 75–82. <https://doi.org/10.1038/s41560-018-0280-3>
- Stroebel, J., & Wurgler, J. (2021). What do you think about climate finance? *Journal of Financial Economics*, 142(2), 487–498. <https://doi.org/10.1016/j.jfineco.2021.08.004>
- Trinks, A., Scholtens, B., Mulder, M., & Dam, L. (2018). Fossil fuel divestment and portfolio performance. *Ecological Economics*, 146, 740–748. <https://doi.org/10.1016/j.ecolecon.2017.11.036>
- United Nations. (2015). *Paris agreement*. https://unfccc.int/sites/default/files/english_paris_agreement.pdf
- United Nations. (2020). *Implementation of the framework for capacity-building in developing countries*. <https://unfccc.int/documents/210528>
- Weikmans, R., & Roberts, J. T. (2019). The international climate finance accounting muddle: Is there hope on the horizon? *Climate and Development*, 11(2), 97–111. <https://doi.org/10.1080/17565529.2017.1410087>
- Xu, J., Marodon, R., Ru, X., Ren, X., & Wu, X. (2021). What are public development banks and development financing institutions?—Qualification criteria, stylized facts and development trends. *China Economic Quarterly International*, 1(4), 271–294. <https://doi.org/10.1016/j.ceqi.2021.10.001>