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Key Points

- There is a vital need for climate finance narratives to focus on the qualitative aspects of money flowing in, along with increasing the quantum of financial flows.
- The varied financial requirements to support climate targets of developing G20 countries shed light on the differing contexts and needs as far as the sectoral allocation of the finances is concerned.
- The data indicate a marked imbalance between funds channeled toward mitigation as compared to adaptation sectors. They also highlight a general predominance of financial flows taking the form of concessional loans as opposed to grants.
- There are underlying risk-return profiles associated with climate-relevant projects (both mitigation and adaptation). The choices of instruments and sources are determined based on how these match with the return expectations and risk appetites of international climate finance sources.
- Similar to the heterogeneity of sectors from which climate needs emanate, the instruments of climate finance are also dissimilar. Therefore, when talking about funds flowing to developing countries, broad-brushing all instruments (grants, loans, and venture capital/equity) to be the same is erroneous.

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Financing Climate Targets: A Study of Select G20 Countries

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Introduction

Foreign investments are generally accompanied by transfers of technical know-how, organizational and managerial skills, access to new markets, and so on. The ability to transform economies via innovation, enhancing productivity, and generating employment are some of the positive spillover effects of such investments (World Bank 2018). There exists a body of literature that has investigated the links between capital flows and economic growth (Berthélemy and Démurger 2000; Hermes and Lensink 2003) and the former's impact on productivity gains (Girma 2005; Suyanto and Salim 2010), on technology diffusion (Balasubramanyam, Salisu, and Sapsford 1996; Keller 2004), and much more. Owing to benefits that accrue from such foreign investments, emerging economies and developing countries have been known to liberalize their respective trade regimes and create environments conducive for them (OECD 2002).

Given the critical role international climate finance sources are expected to play in augmenting total flows, this policy brief explores how they can be optimally raised through public and private sources using various instruments. With specific reference to G20 developing countries, the brief provides an overview of the financing requirements with respect to their Nationally Determined Contributions (NDCs). It also explores the trends and patterns of climate fund financial flows into these countries and builds an econometric model to understand the underlying risk-return profiles associated with climate-relevant projects in various sectors.

What Makes Climate Flows Different?

Developing countries have limited financial resources at their disposal and as such struggle to balance economic growth with sustainable development. As countries across the world transition to a low-carbon economy, continuous occurrences of climate-induced events warrant the need for sizeable financial resources. Climate finance amalgamates local, national, and international financing from public or private sources that are channeled toward mitigation and adaption strategies for climate change. The United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement call upon developed countries to provide financial assistance to other economies that are more vulnerable and less wealthy (UNFCCC, n.d.). The notion of "Common but Differentiated Responsibilities" lies at the heart of the aforementioned agreements that acknowledge the varied roles that both developed and developing countries must play in combating the effects of climate change.

The Intergovernmental Panel on Climate Change (IPCC) defines co-benefits as "positive effects that a policy or measure aimed at one objective might have on other objectives, thereby increasing the overall benefits for the society or the environment" (IPCC 2018a). In the context of climate change, this would mean taking action while also advancing development objectives. To give an example, curbing the health impacts of air pollution has been a top priority for several developing countries. The burning of fossil fuels and biomass-based energy sources (fuelwood, crop residue, animal dung, etc.) is the primary cause of such pollution, resulting in emissions from the transport sector, coal power plants, and traditional cookstoves. There exists a strong relationship between exposure to air pollution and cardiovascular diseases, respiratory diseases, and chronic pulmonary diseases. In addition to increasing the burden of diseases, air pollution also impacts the economy through reduced productivity and premature deaths (IISD, ODI and ICF 2017). Investing in renewable energy projects and reducing dependence on fossil fuels will thus not only help reduce greenhouse gas (GHG) emissions, but will also facilitate employment creation, improve air quality, and ensure energy access, thereby creating co-benefits.

Global Status of Climate Finance

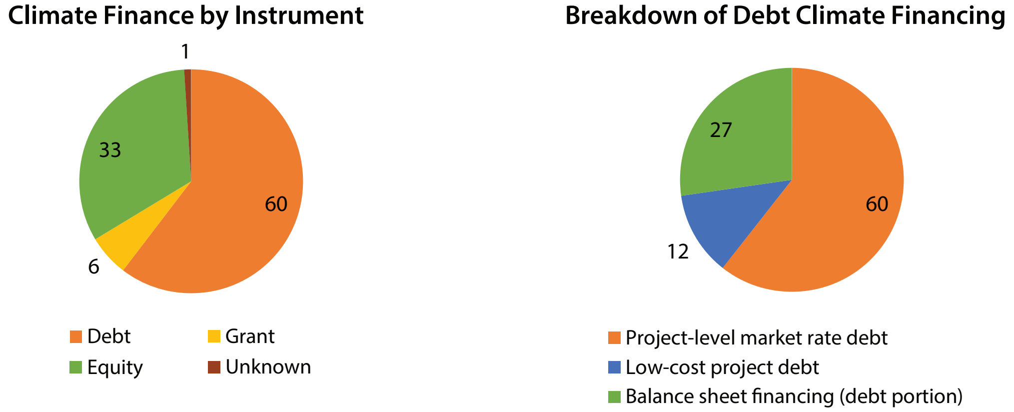
The 2009 Paris Agreement saw the famous "$100 billion by 2020" climate finance mobilization commitment by the developing set of countries (UNFCCC 2015). This formed a crucial step for the developed west to understand the predicament of developing nations towards balancing their developmental and climate goals. However, this international finance commitment has not been met yet. The 2021 United Nations Climate Change Conference (COP26) saw a climate finance delivery plan by the developed countries for achieving the $100 billion goal by 2025. While the plan acknowledges that donor countries fell short of timely achievement of the goal, based on an analysis by the Organisation for Economic Co-operation and Development (OECD) of recent climate finance pledges and historical levels of climate finance, the delivery plan highlights a positive outlook. It provides reassurance that the $100 billion goal will be met in 2023 by the developed nations, with renewed confidence in the ability to mobilize more annually thereafter (UK COP26 2021).

Climate financing requirements are going to increase further, demanding greater commitment and fewer broken promises from the international community. The recent IPCC (2018b) study revealed that developing countries' climate finance requirements stood at $600 billion per year between 2020–50 in additional investments for the energy sector alone. The 2021 Global Climate Finance Landscape report further elaborates on the latest climate finance flows in 2019–20, totaling $632 billion. The report, however, reveals that the required increase in annual climate finance flows would need to be at least 590%. The analysis describes this huge requirement as necessary for fulfilling the internationally agreed climate objectives by 2030 and averting the impacts of climate change.

With the mounting requirement of climate finance, the focus on the quantum of financial flows is growing. New numbers pop up in multiple assessments, sparking debates on the credibility of estimated numbers or on the responsibility of channelizing that amount. However, the narratives of the climate finance story also require the need to focus on other qualitative aspects of the money involved. The delivery plan on achieving $100 billion also recognizes the need to address issues of climate finance quality, including the deficient focus on adaptation financing, lower shares of climate finance grants, and difficulties in accessing climate finance by poor and vulnerable countries (Bhattacharya and Stern 2021). The mode of financing has long been an overlooked topic with respect to quantum flows. With its global nature and expanding scope, climate finance flows from multiple sources and for diverse purposes. These equally require attention in the climate change debate.

The most favored mode of climate financing is still the conventional instrument of debt financing. Of the total climate finance flows in 2019–20, about 61%, or $385 billion was raised as debt. Further, most of this debt was formed by project-level market rate debt, with a meagre share of $47 billion, or 12%, being extended at low-cost project levels. Such debt-infused investments are often combined with conditionalities, putting debt distress on developing countries. On the other hand, the other modes of financing, equity, and grants formed a small share of 33% and 6% of the total climate finance mobilized in the year, respectively (Climate Policy Initiative 2021), as depicted in Figure 1. In the aftermath of the pandemic, developing countries are already struggling to strike a balance between developmental

Figure 1: Patterns of Climate Financing Flows, 2019–2020 (%)



Source: Authors' construction using data from Climate Policy Initiative (2021); Global Landscape of Climate Finance 2021.

goals and climate sustainability. If the worrisome trend of debt financing continues, it could lead to further complications for these countries. Apart from the mode of finance flowing in, another key question is formed by the diversity of sectors receiving that finance. Trends show that the preferred destination of climate finance flows still remains the mitigation sector. Forming a meagre share of 7.4%, adaptation financing continues to be funded by the public sector and still lags (Climate Policy Initiative 2021).

Ensuring greater accountability for not just the amount financed, but the mode adopted for the same should form a crucial aspect of climate change negotiations. The need to track and monitor international finance in order to not only ensure greater transparency but also to hold developed countries and other sources more accountable for their climate commitments has already been acknowledged. In fact, India has stressed the topic for a long time. A discussion paper by the Department of Economic Affairs (DEA) not only highlighted the need for scaling up climate finance for climate justice to prevail for Least Developed Countries and emerging economies but also emphasized monitoring of actual progress made in climate finance delivery. Highlighting the differences in commitments and actual climate finance flow, the paper shed light on the fact that the 2017 climate finance flows saw only about 12% of total pledges to multilateral climate funds materialize into actual disbursements (DEA 2018).

Climate Finance Requirements by G20 Developing Countries[1]

Moving from supply-side issues, another question that needs tackling is what the demand for finance would look like. As far as the adequacy of $100 billion is concerned, the issue is clear: the developing world as a whole needs much more than what $100 billion could provide. Additionally, it has been widely recognized that the developmental contexts of developing countries vary widely. This section provides a brief overview of the financial needs of some of the G20 developing countries for meeting their respective NDC targets. As can be seen, even while looking at individual countries in a small group like the G20, the needs are rather varied.

According to the estimates by the International Finance Corporation, the quantum of cumulative investments (2015–30) required by **South Africa** for achieving its NDC targets is R8.9 trillion ($697.55 billion[2]). As per the study by Cassim et al. (2021), financial flows comprising public, private and blended finance for 2017 and 2018 were equivalent to R62.2 billion. This was spread across clean energy (76%), general eco-system (6%),

1 Owing to limited/lack of data availability for Republic of Korea and Saudi Arabia, estimates for these countries have not been included in this section.
2 Assuming 2015 prices and exchange rate of $1 = R12.759.

cross-sectoral (5%), low-carbon transport (4%), water (3%), agriculture, forestry, and other land use (3%), energy efficiency and demand-side management (2%), circular economy (2%) and material substitution (1%) sectors. The report also identified critical sectors for climate-resilient development, i.e., clean energy, low-carbon transport, smart water, circular economy, and smart agriculture.

India's intended NDC document that was submitted to UNFCCC in 2015 provides a preliminary estimate of $2.5 trillion (calculated in 2014–15 prices) as the cost of meeting its climate change actions till 2030 (Government of India 2015). As per the report prepared by the DEA (2020), the cumulative cost of financing India's NDCs till 2030 under the scenarios envisaged, specifically for the energy, adaptation and forestry sectors stands at Rs245.61 trillion ($5.26 trillion),[3] Rs85.6 trillion ($1.83 trillion), and Rs7555.83 billion ($161.90 billion), respectively. This brings the estimated total requirement to Rs118.685 trillion (after discounting) in 2030 (Ministry of Finance 2020). With the country having recently announced its plans of turning carbon-neutral by 2070, the cost requirements are expected to increase further. India's Third Biennial Update Report identifies a few technologies which would require investments; these consist of technologies specific to the hard-to-abate sectors of cement and iron and steel, as well as the agricultural sector (MOEF & CC 2021). In addition to industrial deep decarbonization, some of the key sectors for India include renewable energy (including offshore wind and green hydrogen), pump and battery storage, climate-smart mobility, space cooling, carbon capture, utilization and storage, etc.

With reference to the **People's Republic of China's** (PRC) previously submitted NDC targets, a report by COMMIT (2018) estimates the country's cumulative financing needs for 2016–30 to be close to CNY55.95 trillion ($8.42 trillion).[4] In terms of annual requirements, the country will need roughly CNY3.73 trillion ($561.36 billion) per year with CNY2.12 trillion and CNY1.61 trillion ($319.06 billion and $242.3 billion) spread across mitigation and adaptation, respectively. Some of the key sectors the country is likely to be focusing its attention on include energy efficiency in buildings and transport sectors, energy storage, smart grids, sustainable infrastructure, non-hydropower renewable energy, and disaster prevention. In light of the recently revised NDC targets, the aforementioned figures are expected to increase further. In fact, as per a study undertaken by the Institute of Climate Change and Sustainable Development of Tsinghua University and others (2022), it has been estimated that between 2020 and 2050, the PRC's dual target of peaking carbon emissions before 2030 and carbon neutrality by 2060 will require CNY138 trillion ($22.16 trillion),[5] in the energy sector alone (Nedopil & Boer 2020).

As per the Second Biennial Update Report, **Indonesia** had submitted an initial estimate of financial requirement of Rp3,461 trillion ($247 billion) for 2018–30. With regard to sectoral requirements, the bulk (~96%) is taken up by the energy and transport sector, in particular renewable energy deployment and clean technologies. Other sectors such as forestry, Industrial Processes and Product Use (IPPU) (cement and steel industries), waste management, and agriculture (efficient irrigation, use of biogas etc.) account for 2.25%, 1.18%, 0.88%, and 0.15% of the funding needs, respectively (Republic of Indonesia 2018). In 2019, Indonesia carried out another round of estimation and arrived at the funding requirement of roughly Rp4,520 trillion (or $322.86 billion). However, it is important to mention that this figure only covers the mitigation sector (Republic of Indonesia 2021).

In the context of **Brazil**, several studies have attempted to calculate the resource requirement for the mitigation sector. For instance, the IES Brasil (2018) study designed two scenarios for estimating cumulative costs for 2015–30, one indicating the requirement to be R$99 billion ($40.67 billion) and the other indicating R$372 billion ($152.81 billion).[6] Similarly, another study quotes $41.2 billion as the required investment amount for achieving the NDC target. Owing to the multitude of financial estimates calculated by numerous entities, the Brazilian Ministry of Environment and Inter-American Development Bank provided an indicative range between R$890–R$950 billion ($278.88–$297.68 billion)[7] as its investment requirement (Lima et al.). In terms of priority sectors, climate finance flows have been primarily directed toward energy and transport as far as national development banks are concerned. However, most of the country's GHG emissions accrue from the

3 Using exchange rate $1 = Rs46.67 (for 2011).
4 Assuming 2016 prices and using the exchange rate $1 = CNY6.64.
5 Using exchange rate $1 = CNY6.39 (in 2015).
6 Using exchange rate $1 = R$2.434 (for 2005).
7 Using Exchange rate $1 = R$3.191 (for 2017).

land use, agricultural, and livestock sectors. Some of the other strategic areas of focus include energy efficiency, advanced biofuels, climate risk management, water security, etc. (Abramskiehn et al. 2017; SAIN 2018).

A report by the National Institute of Ecology and Climate Change (INECC) (2018) calculated the cost of implementing unconditional pledges of **Mexico** for 2014–30 and found it to be equivalent to $126 billion (calculated in 2017 values). This amount corresponds to GHG reduction activities via 30 sectoral measures that have been stated as part of the country's NDC. The eight sectors across which the investment requirement will be distributed include electricity generation (54%), transport (23%), land use, land use change, and forestry (9%), waste (2%), oil and gas (4%), industry (6%), agriculture and livestock (0.22%) and residential and commercial (1%) (Averchenkova and Luna 2018; GGGI 2021).

The case of **Turkey** represents a unique example since it is classified as a developing country as per the World Bank, the International Monetary Fund and the United Nations Development Program, despite falling under the category of Annex-I countries within the Convention. Given the fact that the cornerstone of the 2015 Paris Agreement is the distinction between developed and developing countries and that it does not reflect the special circumstances of Turkey, this has resulted in some uncertainty that has limited the financial assistance it can rely on. For instance, it cannot tap resources from the Green Climate Fund, which was constituted in 2010 under the aegis of the UNFCCC (Ministry of Environment and Urbanization 2019). According to a report by the SHURA Energy Transition Center (2019), specifically for renewable energy and energy efficiency, Turkey would require average annual investments of $5.3–$7 billion between 2019–30.

While **Argentina** has submitted its updated NDC document in December 2020, the country is yet to specify its financial requirements and sectoral targets (WWF 2020).

Table 1 summarizes the aforementioned financial requirements.

Climate Finance Analysis

Given the larger climate finance narrative and the needs of various developing countries, the next step is to analyze the current flow of climate funds to derive trends

Table 1: Summary of Financial Requirements for G20 Developing Countries

Country	Period of Study	Sectors Covered	Base Year	Amount in $ (Cumulative Requirement)
South Africa	2015–30	Energy, Waste and Agriculture, IPPU, Forestry and other land use	Not specified; Assuming 2015 values	$697.551 billion
India	2018–30	Energy, Forestry and Adaptation	2011	$5.25 trillion (Mitigation); $1.83 trillion (Adaptation); $161.898 billion (Forestry); Cumulative requirement after accounting for time value of money Rs118.685 trillion
PRC	2016–30	Mitigation and Adaptation	Not specified; assuming 2016 values	$8.42 trillion
Indonesia	2018–30	Energy and Transport, Forestry, IPPU, Waste and Agriculture	Not specified	$247 billion
		Mitigation	Not specified	$322.86 billion
Brazil	till 2030	Mitigation and Adaptation	2017	$278.88–$297.68 billion
Mexico	2014–30	Electricity generation, transport, LULUCF, Waste, Oil and Gas, Industry, Agriculture and Livestock and Residential and Commercial	2017	$126 billion
Turkey	2019–30	Renewable energy and energy efficiency	Not specified	$63.6–$84 billion

PRC = People's Republic of China, IPPU = Industrial Processes and Product Use, LULUCF = land use, land use change, and forestry.

Source: Authors' compilation.

and patterns of flows. The Climate Funds Update (CFU) dataset (Heinrich-Böll-Stiftung and ODI 2022) was used to gather information regarding the flow of funds into these countries. The dashboard provides cumulative data on pledges, deposits, and project approvals by multilateral funds. It also provides details in terms of broad sectors and subsectors of a particular project, the name of the fund, the modality via which finances were received (i.e., concessional loans, guarantees, equity or grants), recipient institution and so on. The dashboard has been updated for the latest available data as of January 2022. Specifically, for the countries included as part of the study, a total of 432 projects were covered, pread across broad sectors as indicated in Table 2.

For a deeper understanding of the financial flows, this study made use of the sub-sectoral classification of projects, with some realignments and subsectors collapsed into fresh categories. In addition, out of the 432 projects, there was no defined specification available for subsectors for 23 projects. These were thus allocated to the relevant sub-sectoral category based on the project description provided in the database.[9]

Table 2: Sectors Included in the CFU Data

S. No.	Name of Sector
1.	Agriculture
2.	Agriculture, forestry, and fishing
3.	Banking and financial services
4.	Business and other services
5.	Disaster prevention and preparedness
6.	Energy
7.	Energy generation, non-renewable sources
8.	Energy generation, renewable sources
9.	Energy policy
10.	Fishing
11.	Forestry
12.	General environment protection
13.	Government and civil society
14.	Industry
15.	Other multisector
16.	Transport and storage
17.	Water and sanitation
18.	Unallocated

CFU = Climate Funds Update.

Source: Climate Funds Update. https://climatefundsupdate.org/ (accessed 20 March 2021).

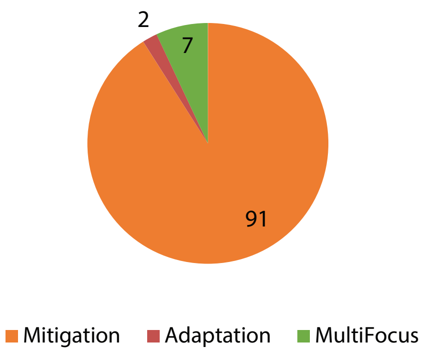
For the purpose of this study, G20 developing countries have been selected based on the categorization provided by the report "World Economic Situation and Prospects (2020)", by the United Nations Department of Economic and Social Affairs. The set of countries includes Argentina, Brazil, the PRC, India, Indonesia, Mexico, South Africa, and Turkey.[8]

The CFU data are available for different projects centered around three major categories, namely mitigation, adaptation, and multiple foci or cross-cutting, which includes both mitigation as well as adaptation objectives. It adopts the IPCC (2007) definition of adaptation and mitigation categories. Broadly, this defines adaptation as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities," and mitigation as "technological change and substitution that reduce resource inputs and emissions per unit of output."

Looking at the data, some clear results emerge. For example, a classification of the estimated approved route of funding for the G20 developing countries reveals that mitigation projects dominate, with 91% of the total approved funding (Figure 2). Corroborating what has been highlighted by the Climate Policy Initiative (2021) report, adaptation projects are observed to lag, with a meagre share of about 2%. Even multiple focus projects seem to garner a higher share, standing at 7% of the climate finance pie. The mismatch between the channeling of funds toward mitigation and adaption sectors has been a longstanding debate. Recent assessments of climate finance flows have shown that the adaptation sector is significantly dependent on public sector funds. One of the main reasons for this difference is perhaps that the benefits of adaptation are more local and involve a greater risk appetite, restricting the movement of private players in the sector. The lack of bankability of adaptation projects, as well as limited internal capacity for private players to assess, identify, and develop an adaptation activities pipeline,

8 While Saudi Arabia and Republic of Korea also fall under the category of developing countries, due to limited/lack of data for projects in the aforementioned countries, they have not been included in the analysis.
9 Details of this classification exercise can be provided by the authors on request.

Figure 2: Thematic Division of Multilateral Climate Finance (%)



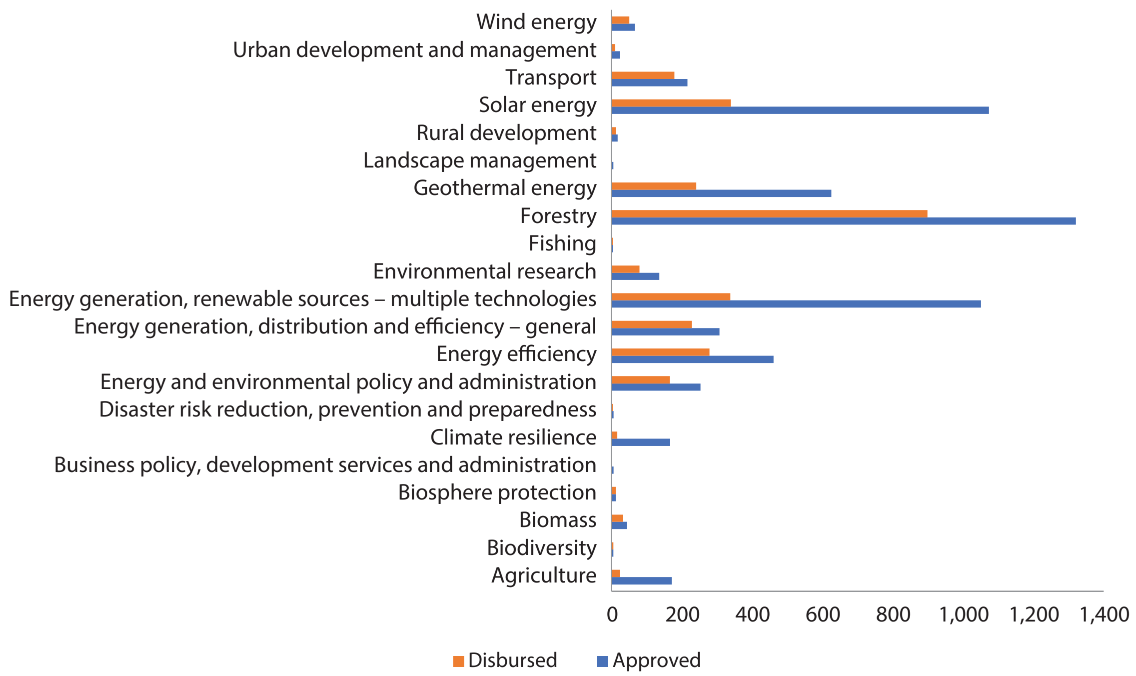
Source: Authors' construction using CFU data (2022).

serves to widen the "adaptation gap" further. With the combination of smaller shares of finance and significant dependence on public sector sources, countries most vulnerable to climate-induced changes suffer the most.

With regard to climate finance flows from multilateral climate funds, there exists a stark difference between the amounts approved and those actually disbursed. If one focuses on the quantum of total finance approved and disbursed for the countries in question (for all sectors), the figures stand at $5.968 billion and $2.918 billion, respectively. The mismatch between approved and disbursed amounts is true across the board, barring a few exceptions of subsectors such as *fishing*, *biodiversity* and *biosphere protection* wherein the two amounts actually match. Otherwise, most of the popular sectors receiving climate finance "commitments" exhibit a shortfall. For instance, for the category of *Energy generation, renewable sources – multiple technologies*; *agriculture,* and *forestry* the gap is $713.08 million, $146.4 million, and $422.23 million, respectively. In fact, for a few subsectors such as *Business policy, development services and administration* (which focuses on the crucial need for environmental research and policy frameworks) and *landscape management*, the data suggest that no amount has been disbursed thus far (Figure 3).

Focusing on the mode of climate financing flows, the data support the global trend, highlighting the crucial requirement of a differently focused approach. As depicted in Table 3, for the G20 developing countries as a whole, concessional loans (51%) represent the most commonly used mode of financing, followed by grants (47%) and equity (2%). The latter is likely an

Figure 3: Climate Finance Amounts Approved and Disbursed ($ million)



Source: Authors' construction using CFU data (2022).

Table 3: G20 Developing Countries and Mode of Investment Received

Country	Mode of Financial Flows (in $ million)			Total
	Concessional Loans	Grant	Equity	
Argentina	100	146.0888		246.0888
Brazil	127.48	1,051.53		1,179.01
PRC	100	404.84		504.84
India	881.46	463.339	132.5	1,477.799
Indonesia	478.25	373.22		851.47
Mexico	366.62	188.02		554.64
South Africa	557.43	90.31		647.74
Turkey	425.34	81.56		506.9
Total	**3,036.58**	**2,798.91**	**132.5**	**5,968.49**

PRC = People's Republic of China.

Note: The CFU database did not include entries for the category of "Guarantees" for the countries in question.

Source: Authors' computation using CFU Data (2022).

underreported figure. It is suggested that future work on this topic be made to improve this figure using actual foreign direct investment (FDI) data emerging from business deals. However, if one investigates country-specific finances, countries such as Argentina, the PRC, and Brazil receive more funds in the form of grants rather than loans, while the converse is true for countries such as India, Indonesia, Mexico, South Africa, and Turkey.

Going beyond aggregates, Table 4 provides greater details in terms of the financing modalities across the subsectors for the bloc of countries selected as part of the study. This granularity allows us to make some nuanced observations. In particular, it becomes evident how certain sectors have received specific forms of investments. For instance, in the case of the *forestry* sector, investments primarily take the form of grants, whereas sectors such as *energy generation, renewable sources – multiple technologies; solar energy and geothermal energy* received more concessional loans. This particular issue is discussed in greater detail in the following section.

Table 4: Finance Modalities and Subsectors

	Concessional Loans	Grants	Equity	Total
Agriculture	65	106		171
Biosphere protection		12		12
Biomass		44		44
Biodiversity		5		5
Business policy, development services and administration		6		6
Disaster risk reduction, prevention, and preparedness		6		6
Energy generation, distribution, and efficiency – general	100	207		307
Energy generation, renewable sources – multiple technologies	712	206	133	1,051
Solar energy	988	85		1,073
Wind	57	9		66
Environmental research		135		135
Energy and environmental policy and administration	100	153		253
Energy efficiency	281	180		461
Forestry	54	1,267		1,321
Fishing		4		4
Geothermal energy	517	108		625
Landscape management		5		5
Transport	62	154		216
Rural development		17		17
Urban development and management		24		24
Climate resilience	100	67		167

Note: Figures have been rounded up.

Source: Authors' computation using CFU data (2022).

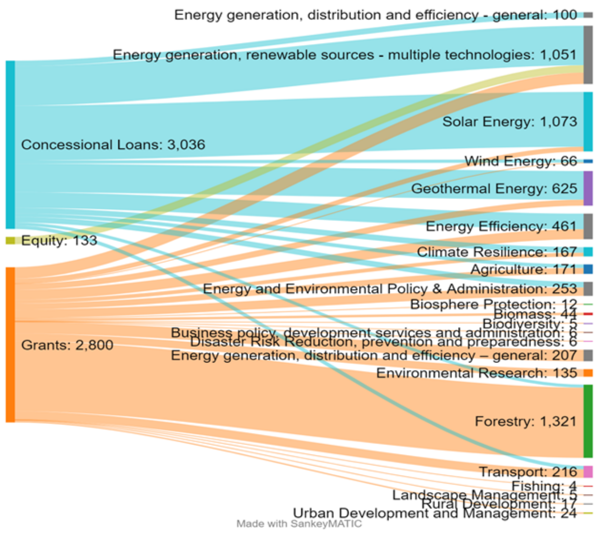
The loans versus grants debate has been a longstanding one in the climate financing landscape. The developed world continues to extend loans, mostly at non-concessional rates. The Glasgow Climate Pact and the recent Delivery Plan emphasize the need to favor greater concessional funding; however, the numbers show a lack of such commitments (Johnson and West 2021). It is important to note that debt financing is particularly damaging for low- and lower-middle-income countries. An overdependence on loans makes them more vulnerable, overemphasizing the actual value of climate financing provided since the loan needs to be repaid as well as serviced through interest, which should be in turn subtracted from the total "financing provided". Furthermore, the terms of such loans tend to be more expensive for low and lower middle-income countries, pushing them into climate-related debt traps when a calamity strikes (Chowdhury and Jomo 2022). However, a question that may be asked while looking at the data is could the stage of technology development or the nature of the sector itself dictate the mode in which funds flow?

A graphical representation of the data presented in Table 4 has been provided in Figure 4.

Analyzing Choice of Instruments: A Methodological Framework

There have been many papers in the past that have taken an empirical route toward understanding climate flows. There have been studies that have looked at whether

Figure 4: Sankey Diagram for Financial Flows



Source: Authors.

public funds crowd in private climate funds (Haščič et al. 2015), the role domestic climate policies play in attracting climate funds (Azarova and Jun 2021; Wall et al. 2018; Ragosa and Warren 2019), and catalyzing innovation (Ang, Röttgers, and Burli 2017).

However, the issue of choice of instruments remains a largely underexplored area. As has been depicted in the Sankey diagram (Figure 4), it is clear that certain instruments have been relied on more frequently for funding climate projects in particular sectors. The lack of empirical papers for this is due to two factors:

- While it is widely understood that climate finance is flowing to specific projects rather than systemic interventions (World Bank 2020), project-level information is hard to come by. Moreover, project-based funding typically has additional diktats than just emissions abated. Before making the funding commitments, entities located within the source country look at the risk-return profiles of technologies or sectors that the funds would go to, much like any other investment decision-making. Despite the availability of project-level data on the CFU website, it is not possible to verify the risk-return profile of each of these projects to make a verifiable claim.

- Additionally, the nature of technology, i.e., country-specific technology readiness, as well as technology risks vary widely. This also has an implication for the choice of instrument. For example, a recent IRENA and CPI report (2018) states that project-level equity was the most widely used financial instrument for renewable sector investment till 2016. However, after that, it was overtaken by project-level conventional debt. This transition, one could argue, could be because of the technology maturity attained by the renewable sector that improves its risk profile. Similarly, based on biofuel technology readiness, funds have a greater likelihood of going to Brazil than other nations.

Looking at this phenomenon from a theoretical framework, Markowitz's Modern Portfolio Theory (1959) talks about the criteria for portfolio selection and the fact that investors should value securities as a function of returns and systematic risk. Taking this idea forward and applying it to the case of climate investment, the following econometric model seeks to understand the underlying risk-return profiles associated with climate-relevant projects in various sectors. *The key hypothesis* *being that the choice of instruments is determined based on how they match with the return expectations and risk appetites of international climate finance sources.*

To prove the above hypothesis is tricky since, as stated, data on project-specific risk returns are not available. However, if it is assumed that these are embodied in the choice of instruments as far as sectoral flows are concerned, a modelling framework is possible. Choosing the Heckman Sample Selection model or Heckit, it is possible to look at factors governing the choice of a particular instrument as well as the flow of funds coming via that route.

The Heckman sample selection model is composed of two separate equations. The first focuses on the selection choice, i.e., whether the outcome is observed or not. The second equation is the linear model of interest that links the outcome with the covariates of interest (Adkins and Hill 2011). Details of the model applied have been provided in Appendix I and the data sources have been presented in Appendix II.

Modelling Results

Using the above framework and data, the Heckman Sample Selection model was run to better understand the underpinnings of climate flows. Unfortunately, the data for equities were extremely limited. Therefore, the hypothesis was primarily applied to the case of loans. To reiterate the framework detailed earlier, the model estimated two sets of equations: factors determining the choice of loan and thereupon the quantum of loans disbursed. The results from the econometric modelling exercise paint a very interesting picture.

As can be seen from Table A3.1 (Appendix III), there were very strong causalities between sector dummies and the choice of loans. It was specifically seen that the probability of funds being sent in the form of loans for energy efficiency, renewable energy, and solar energy sectors was highly statistically significant. Gross domestic product (GDP) per capita was also found to be mildly important in dictating the choice of instrument.

As regards the other part of the model, i.e., factors determining the quantum of loan flow, political stability and climate risk were the most significant. In addition, existing renewable capacity was also found to be statistically significant. Interestingly, the sector dummies were not significant in determining the quantum of loan flows. It would thus seem that country-specific factors predominate the sector-specific factors while determining the loan amounts being given.

In sum, the hypothesis that the choice of instruments is largely driven by a sectoral perspective is not rejected as per the analysis. While the risk-return profiles are unobserved for these fund flows, the fact that they went to sectors known anecdotally to be profitable 'sunrise' sectors seconds the assumption.

Conclusion

Climate finance is very often, in both literature and negotiations, thought to be a homogenous set. The fact that countries need this finance to fund individual projects and programs comes as an afterthought. This brief argues that, similar to the heterogeneity of sectors from which climate needs emanate, the instruments of climate finance are also dissimilar. Therefore, when talking about funds flowing to developing countries, broad-brushing all instruments (grants, loans and venture capital/equity) to be the same is erroneous.

There are, like all other investment decision-making processes, some core attributes such as risk-return profiles, the timeframe of investment, etc. However, one interesting feature is that, unlike investments made in other sectors, outcomes achieved with respect to abated emissions or vulnerabilities drive the agenda. This study contributes to the existing literature by saying that there are higher propensities for some types of funds to go to specific sectors, specifically for developing countries. While data for equity flows were extremely inadequate, the Heckman Sample Selection Model run for climate loan flows coming into G20 developing countries found this hypothesis to be true.

This result, when applied to the developing country context, means that for all climate funding needs assessments, especially in keeping with elevated NDC commitments, it is necessary to do a thorough scan of the instruments that they have at their disposal. As the results also show, most of the funds coming into the sectors of renewable energy and energy efficiency come with an interest burden. While planning for their climate-related expenditure, developing countries need to take note of that. Additionally, as technologies mature, the nature of fund flows also changes. This has been observed in the case of renewable energy historically. The same could be true for new-age adaptation technologies that are entering the market.

In light of the above, it is important that G20 developing countries be a part of the investment rulemaking. It is understood that higher climate ambitions would necessitate a concomitant rise in finance. While many new fund sources and financial instruments to source the same are on the anvil, there is a lack of globally accepted standards, frameworks and rulemaking on these sustainable finance avenues. G20 developing countries, as part of the Standing Committee on Green Finance, can assume a more active role, rather than the hitherto passive one, to lead this discussion. As stated above, the choice of instruments would have an important implication on the total cost of finance.

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Appendix 1: Model

The model has been applied in the present study in the following way:

a. The selection equation for the choice of sending funds via loans is expressed in terms of a latent variable z^*_i which depends on an explanatory variable set w_i. The equation is given by

$$z_i^* = \gamma_i + \sum_{j=1}^{n} \gamma_j w_{ij} + \mu_i \; i = 1, \dots, N$$

The latent variable is not observed but rather the binary variable is observed wherein

$$z_i = \begin{cases} 1 \; if \; z_i^* > 0 \\ 0 \; otherwise \end{cases}$$

In other words, the outcome variable (in this case, climate loans) is only observed if the latent selection propensity exceeds zero.

b. After the selection, the expected value of the outcome in the main equation is given by:

$$E[y_i \,| z_i^* > 0] = \beta_1 + \sum_{j=1}^{n} \beta_j x_{ij} \, x_i + \beta_\gamma \gamma_i \; i = 1, \dots., n$$

Heckman postulates that it is rather likely that unobservable or unmeasured factors may affect both the outcome "y" and the probability of selection "z", and that these unmeasured factors would be contained in the residuals of both equations. Heckman shows that this bias can be corrected with estimators being obtained through maximum likelihood by jointly estimating the first selection equation with a Probit model, and then the outcome equation by including the expected value of the selection equation residuals (Kone et al. 2019).

Appendix 2: Data Sources

The dependent variable for the analysis is the financial flows to a particular sector located in a particular country through a particular instrument. As mentioned above, the analysis has been done in a two-step process. In the first step, determinants for the choice of instruments were examined, while, in the second one, the quantum of flow by each instrument was looked at.

The explanatory variables used as part of the analysis can be grouped into multiple buckets, i.e., factors determining the choice of country, choice of sector, and choice of instruments. Similar to other studies looking at factors determining FDI or other capital flows internationally, the set for the choice of country looks at macroeconomic, socio-economic, and environmental parameters. Factors determining the choice of sector relate to existing natural resources and infrastructural endowments, needs determined by existing vulnerability, or other requirements. Table A2.1 lists the variables with the sources from which the data have been collected.

Table A2.1: Variables and Data Sources

Variable	Units	Source
Average losses per GDP	% of GDP	Global Climate Risk Index Reports (2012–2021)
CO_2 emissions	Kt	World Bank
Control of corruption	Percentile rank	WGI World Bank (World Governance Indicators)
Crude oil prices	$ per barrel measured in 2020 prices	BP Statistical Review of World Energy
Deposit interest rate	%	World Bank
Domestic credit to the private sector	% of GDP	World Bank
EPI score	Range from 0 to 100	Socioeconomic Data and Applications Center (SEDAC)
Exchange rate	Local currency unit per $, period average	World Bank
FDI Regulatory Restrictiveness Index	Restrictions evaluated on a 0 (open) to 1 (closed) scale. The overall restrictiveness index is the average of sectoral scores.	OECD.Stat
FIT	Dummy variable	Renewables Global Status Reports (2011–2021)
Forest area	% of land area	World Bank
GDP	Constant 2015 $	World Bank
GDP growth	%	World Bank
GDP per capita	Constant 2015 $	World Bank
Government effectiveness	Percentile rank	WGI World Bank (World Governance Indicators)
Inflation	GDP deflator, annual %	World Bank
Installed renewable electricity capacity	MW	IRENA Renewable Energy Statistics database
Land area	Sq. km	World Bank
Lending rate	%	World Bank
Natural resource rent	% of GDP	World Bank
People using at least basic drinking water services	% of population	World Bank
PNG bonds	Net financial flows, current $	World Bank
Political stability	Percentile rank	WGI World Bank (World Governance Indicators)
Population	Total population	World Bank
Population with access to electricity	% of population	World Bank
Portfolio investment bonds	Net financial flows, current $	World Bank
Poverty headcount ratio at national poverty lines (% of population)	% of population	World Bank
PPG bonds	Net financial flows, current $	World Bank
Real interest rate	%	World Bank
Regulatory quality	Percentile rank	WGI World Bank (World Governance Indicators)
Rule of law	Percentile rank	WGI World Bank (World Governance Indicators)
Voice and accountability	Percentile rank	WGI World Bank (World Governance Indicators)

GDP = gross domestic product, FIT = feed-in tariff.

Source: Authors compilation.

Appendix 3: Stata Results

Table A3.1: Heckman Selection Model Results

	Coefficient	Jacknife Std. Error	T Statistic
Dependent Variable: ln_loan_total			
Explanatory Variables			
gdp_pc	0.000	0.0014453	–0.26
dep_int_rate	–0.401	0.3016777	–1.33
dom_credit_pvt	–0.040	0.0382684	–1.04
inflation	–0.110	0.526534	–0.21
pol_stability	8.197**	3.855669	2.13
co2emissions	0.000	8.65E-06	–0.2
climate_risk	10.865**	5.355812	2.03
renew_capacity	0.000*	0.0000172	1.65
exch_rate	0.000	0.0004026	–0.22
sectordum3	2.599	6.870404	0.38
sectordum6	4.821	9.157876	0.53
sectordum8	6.926	18.28751	0.38
sectordum10	6.320	13.82834	0.46
_cons	7.484	21.80095	0.34
Dependent Variable: loan dummy			
Explanatory Variables			
sectordum3	0.987*	0.6004352	1.64
sectordum6	1.481**	0.7202438	2.06
sectordum8	3.458	7.274018	0.48
sectordum10	2.401**	1.093986	2.19
lending_rate	–0.017	0.0585432	–0.28
rule_law	0.016	0.0263866	0.62
gdp_pc	0.000	0.0001689	1.24
inflation	–0.107	0.0923469	–1.16
ren_capacity	0.000	0.0000165	0.24
co2emissions	0.000	2.13E-06	–0.2
_cons	–2.781	2.328516	–1.19

Notes:

1. ** and * indicate significance at 1% and 5%, respectively.
2. Sectordum3 = Energy efficiency, Sectordum6 = Renewable Electricity, Sectordum8 = Geothermal Energy, and Sectordum10 = Solar Energy.

Source: Authors computation

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