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Understanding the World Bank's role in climate finance

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Abstract
As the most well-resourced multilateral development bank, the World Bank is expected to play a central role in international climate finance (CF). However, systematic analysis of its CF projects remains limited, raising key questions such as what qualifies as a CF project, how the Paris Agreement has influenced the Bank's CF, and whether CF projects are directed to areas of greatest need. Utilizing statistical analysis and natural language processing, this study offers a novel examination of the Bank's CF projects. To provide a nuanced and detailed picture, we uniquely distinguish between the Bank-financed "pure" CF projects—those dedicated exclusively to climate objectives—and "mixed" CF projects, which combine climate aims with other priorities. Although there has been a significant increase in the Bank's CF post-Paris, this rise is primarily driven by mixed CF projects with low climate components. Furthermore, while vulnerable countries and large emitters have received more mixed CF projects following the Paris Agreement, they have not received more pure CF projects. The findings indicate that the Bank incorporates climate goals when and where it can. The study provides insights into the pressing issue of CF flows from wealthier to poorer countries.

Keywords Climate finance · World Bank · Multilateral development banks · Paris agreement · Mitigation · Adaptation

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1 Introduction

Climate finance (CF) refers to the financial resources that countries use, need, and acquire to address climate change. CF is needed both to reduce greenhouse gas emissions, that is, mitigation, and for adaptation and resilience to the impacts of climate change. The need for CF is particularly acute in developing countries (Roberts and Weikmans 2017; Khan and Munira 2021; Roberts et al. 2021; Toetzke et al. 2022). According to a recent estimate, these countries, excluding China, require $2.4 trillion annually to meet their climate goals by 2030 (Bhattacharya et al. 2023). Their need for adaptation finance alone is around $200 billion in 2021–2030 (UNEP 2022).[1]

Given this urgent need, countries have negotiated international climate finance goals.[2] In 2009, richer economies agreed to mobilize $100 billion CF annually (by 2020) to less wealthy countries, a number subject to much controversy (Roberts et al. 2021; A. Michaelowa and Michaelowa 2011).[3] The watershed 2015 Paris Agreement has further accentuated the importance of CF (Khan and Munira 2021).[4] It has called for increased flows with a balance between mitigation and adaptation finance (Agreement 2015). Paris also foresees developed countries reporting their climate finance contributions. In the process of implementing Paris, in November 2024, countries negotiated a new annual goal for climate finance of $300 billion by 2035. This New Collective Quantifiable Goal updates the $100 billion target, amplifying the importance of international CF.

The need for international CF in the developing world has also underscored the role of multilateral development banks (MDBs) as CF providers (Kaul 2017; Miller et al. 2019; Murphy and Parry 2020; Michaelowa et al. 2020). MDBs typically use their capital to finance (through loans or grants) projects in the developing world.[5] Climate change impedes economic development through various effects, such as floods and droughts, and growth driven by greenhouse gas emissions fuels more climate change (World Bank 2010; IPCC 2022). Thus, with expertise in economic development assistance, MDBs are well placed to play a central role in CF. In turn, these banks have engaged in a “massive sales pitch to persuade ministers and heads of state” to channel climate funds through their organizations (Schalatek et al. 2010). Since 2011, MDBs have been releasing “joint reports” that underscore their aggregate contributions to global CF flows. MDBs have also declared to make their financial flows Paris-aligned, though at differing degrees (Gebel et al. 2022).

However, the lack of a systematic understanding of climate-related projects funded by MDBs makes it unclear whether these organizations are actually effective conduits for (public) international CF (Kaya 2024). On the one hand, thanks to the joint reports and international tracking, *aggregate flows* of climate finance flowing from MDBs altogether or individually, can be ascer-

[1] While the private sector may also be involved in the provision of CF, our focus is on international (public) climate finance.

[2] States negotiate multilateral climate change agreements under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC).

[3] Michaelowa and Michaelowa (2011) note that the climate component of bilateral environmental aid may be exaggerated.

[4] All UNFCCC members have signed Paris and have pledged nationally determined contributions (NDCs), which are revised every five years, with some countries explicitly indicating the implementation of their NDCs to be conditional upon having adequate CF (Overholt et al. 2024).

[5] Generally, member states pay in some of this capital, making the rest callable upon need. Relying on this sovereign capital, MDBs issue bonds to borrow cheaply in capital markets, which they then lend to developing countries.

tained (Gebel et al. 2022). Beyond this aggregate data, some recent studies have used country-level data (Xie et al. 2023) for select MDBs to assess whether climate finance flows are meeting needs. These new analyses are crucial in improving our understanding of CF from MDBs. On the other hand, project-level analysis, which differentiates between different types of climate finance projects, is still lagging.[6] Understanding which *projects* financed by the MDBs count toward their climate finance targets, and whether these projects promise a meaningful contribution to climate finance, is a necessary step in advancing the understanding of the MDBs' role in CF flows.

We contribute to this question by examining the best-resourced MDB and one of the most important global economic institutions with near-universal membership. The World Bank (WB) is often identified as a key vessel for climate finance from richer to poorer countries (Patrick 2023; Morris 2024). Recently, it led the way for other MDBs in pledging to increase climate lending to meet the new international CF target (World Bank 2024). In 2023, nearly 40% of the CF reported by MDBs came from the World Bank.[7] Despite the importance of the Bank, however, we have scant understanding of its CF to its member countries.[8] What does the Bank consider a CF project? What has been the impact of the monumental Paris Agreement on the WB's CF? Do WB-financed CF projects occur in places where these funds are most needed?

In addressing these questions, we provide a novel and systematic analysis of the Bank's own accounting of each project's contribution to alleviating climate change (through mitigation or adaptation) through its two traditional (sovereign) lending arms.[9] Our compiled dataset comprises 2,743 projects the WB has financed between 2010–2021.[10] To capture the variation within the broad category of Bank-financed CF projects, we differentiate the projects by the extent of their climate component (as recorded by the Bank). In particular, we distinguish *pure climate finance projects* funded by the Bank from *mixed climate finance projects*. *Pure CF projects* are solely dedicated to mitigation or adaptation, whereas *mixed CF projects* combine mitigation or adaptation with other project aims.[11] Furthermore, we analyze the diversity within the category of mixed CF projects: some projects have as little as 5% of a climate component, while other projects are primarily about climate.

Our initial analysis, shown in Fig. 1, reveals an important empirical pattern that forms the core of our econometric analysis: the Paris Agreement appears as a clear turning point. Compared to their pre-Paris levels, the Bank's average annual number of CF projects has increased by 675% in the post-Paris era (from an annual average of 22 projects to 170.5 projects). Although the fraction of committed loans has also increased, this increase is not as remarkable (Fig. 1).[12]

[6] While (Xie et al. 2023) includes project-level analysis, it does not encompass the World Bank.

[7] This number only accounts for the IBRD and the IDA, which are next explained. Calculations are based on Bank et al. (2023).

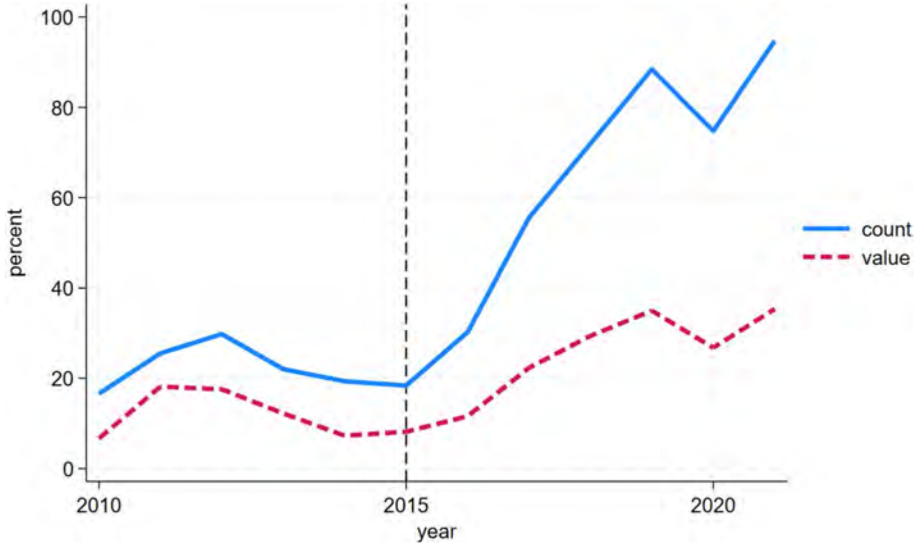
[8] Michaelowa et al. (2020) analyzes donor-funded trusts in the Bank, which are bespoke arrangements. The authors also note the dearth of studies on this topic.

[9] The bank does its lending to members states through the International Bank for Reconstruction and Development (IBRD), which generally lends to middle-income countries, and the International Development Association (IDA), which typically lends to low-income countries.

[10] Although these data are publicly available, collecting and cleaning the data is labor intensive, as Appendix B explains.

[11] There are many themes, ranging from economic policy, to private sector development, to finance, to urban and rural development, among others.

[12] To calculate the loan fraction, we multiplied the percentage of adaptation or mitigation component assigned to each project by the project's loan amount and summed the values by year. In the next section, we explain why analyzing loan amounts is not a sound approach.



Notes: The figure plots the number and the value of climate projects as a fraction of the total number and committed value of World Bank projects. The vertical line is located at 2015, the year Paris agreement was signed

Fig. 1 Climate projects as a fraction of total World Bank projects

We subject this basic finding to econometric analysis, while also explaining the nature of the post-Paris increase. Our results show that the post-Paris increase in CF comes largely from *mixed CF projects*–projects that integrate a mitigation or adaptation component along with other goals–much more than projects focused exclusively on climate goals, namely *pure CF projects*. Furthermore, most of these mixed CF projects have climate as a minority focus (that is, less than 50% of the project) (Fig. 3). We also find that CF projects in countries where the "bang for the buck" might be the highest in terms of addressing climate change–those that emit more and are more vulnerable to climate impacts–do not receive more pure CF projects. For high emitters, pure mitigation projects, which can contribute significantly to emissions reductions, promise the biggest impact. Similarly, for more climate-vulnerable countries, pure adaptation projects would be expected to alleviate the impact of climate change relatively more. Instead of receiving pure projects, however, the post-Paris increase in these particular countries results from the increase in mixed CF projects.

In expanding our core findings, we also explore the question of whether the increase in mixed CF projects is more consistent with "mainstreaming", whereby any project integrates a climate dimension, versus "green washing", whereby *the appearance of* distributing more CF is greater than a meaningful increase in CF. Although our results here are suggestive (since smoking-gun evidence on this issue will be elusive), we provide novel insights. Our examination of the Bank's CF project descriptions using natural language processing techniques shows that mixed CF projects with a higher climate component are not necessarily more like pure climate projects. Furthermore, we show that after Paris, more mixed CF projects contain non-climate, or even non-environment, adjacent sectors relative to pre-Paris.

The findings raise questions about the promised climate impact of some projects, which the Bank marks as contributing to addressing climate change.

This novel systematic analysis of the World Bank's CF projects suggests that the Bank is inserting climate goals where it can when it can, as it is scrambling to increase its CF. There is a significant quantitative increase in the Bank CF projects, which aim for mitigation or adaptation, following Paris. However, our analysis shows that most of this post-Paris increase comes from mixed CF projects with low climate components, whereas pure CF projects are relatively stagnant in growth following Paris. Moreover, these pure projects do not necessarily go where they are most needed.

Our study has important policy implications beyond advancing disaggregated analyses on global climate finance flows. The kind of detail that this study provides is also important for those who wish to utilize the Bank for climate finance provision– without focusing on the project level, it is difficult to grasp the actual nature of the Bank's climate finance. If the WB has managed to increase the quantity and quality of its climate finance, to spur mitigation, and to boost adaptation, then scarce funds have been well allocated towards the intended goal.[13] If, however, the WB has gaps in its climate finance allocation, then progress toward collective goals is lagging, and vulnerable communities do not benefit. Our analysis suggests that shareholders and stakeholders could utilize the Bank more fruitfully if they could avoid a quantity-quality tradeoff in the Bank's climate finance provision.

2 Empirical analysis

2.1 Dataset overview

Our dataset on WB project finance is based on the Bank's reported data to the International Aid Transparency Initiative (IATI) and covers 2010–2021. The first year in our sample, 2010, is when the Bank started marking its financed projects' contributions to mitigation and adaptation. The timeline also gives us an equal number of years pre- (2010–2015) and post-Paris (2016–2021), which allows for a systematic assessment of the importance of Paris. That said, the Paris Agreement also serves as a helpful identification strategy. Appendix B details our choice of IATI, which has a rigorous process of quality checks, and our data extraction via Python.[14] As we emphasize, IATI is the preferred choice for data on World Bank project investment finance for others as well. However, we also confirm that the primary trends in the data remain the same if we rely on the Bank's own data instead of the Bank's reported data to IATI (see Appendix E.2).

We base our calculations on the Bank's own thematic coding for each project–the Bank has a "climate" theme with "mitigation" and "adaptation" as its subthemes. Often, the World Bank assigns a single project multiple themes, as a project can be deemed to serve multiple purposes. Hence, the two climate change subthemes (mitigation and adaptation) can intersect with other themes, say, social development and protection. Moreover, each project receives a relative percentage based on that theme's centrality to project goals. The Bank's own documentation notes that "[t]ask teams are required to articulate the considerations of

[13] The U.S. has been a leading prominent of this policy (Yellen 2021, 2022).

[14] All Appendices can be found in the online Supplementary Information.

Table 1 Examples of the World Bank's climate finance projects

Pure Mitigation Projects	
P122028	"The development objective of the Project is to support the Borrower (the Moroccan Solar Agency MASEN) in the development of the 500Megawatt Ouarzazate solar power plant by financing the first phase (160 Megawatt gross) through a public private partnership (PPP),to increase power generation from solar power and mitigate greenhouse gas emissions and local environment impact."
P162149	"The objective of the proposed Project is to help: a) diversify the domestic power generation mix in Dominica by integrating clean, renewable geothermal energy; and b) demonstrate the potential of larger development of the geothermal resource."
P160379	"The Project Development Objectives (PDO) are to demonstrate the operational and economic feasibility of utility-scale innovative renewable energy technologies and battery energy storage solutions, and to strengthen institutional capacity to facilitate scale-up of such technologies on a commercial basis in India."
Pure Adaptation Projects	
P125999	"The project's main objective is to improve productivity of water use in irrigated agriculture. This will be achieved through improved physical delivery efficiency and irrigation practices, crop diversification and effective application of inputs that will translate into greater agricultural output per unit of water used. The project's objectives would contribute to increased agricultural production, employment and incomes, higher living standards and positive environmental outcomes."
P146965	"The Project Development Objective is to enhance Jamaica's resilience to disaster and climate risk."
P167382	"To improve the climate resilience of the Recipient's road network, with emphasis on the selected project road, and in the event of an Eligible Crisis or Emergency, to provide an immediate response to the Eligible Crisis or Emergency."
Mixed Projects	
P176447	"The Development Objective of the proposed operation is to strengthen the capability of the state and national governments in India to respond to the needs of informal workers through a resilient and coordinated social protection system."
P125999	"The project's main objective is to improve productivity of water use in irrigated agriculture. This will be achieved through improved physical delivery efficiency and irrigation practices, crop diversification and effective application of inputs that will translate into greater agricultural output per unit of water used. The project's objectives would contribute to increased agricultural production, employment and incomes, higher living standards and positive environmental outcomes."
P173982	"The program's development objectives are to (i) strengthen the regulatory and institutional framework to build back better and greener and (ii) enhance systems and regulations to protect the most vulnerable and support sustainable business growth."

The table provides examples of WB climate finance projects across different categories

climate change incorporated in their project design in project documents" (World Bank n.d). Hence, even if the project is (hypothetically) about strengthening public administration, task teams need to consider its relevance for the two climate goals. Of course, the project may also be directly focused on a climate goal, such as a renewable energy project.

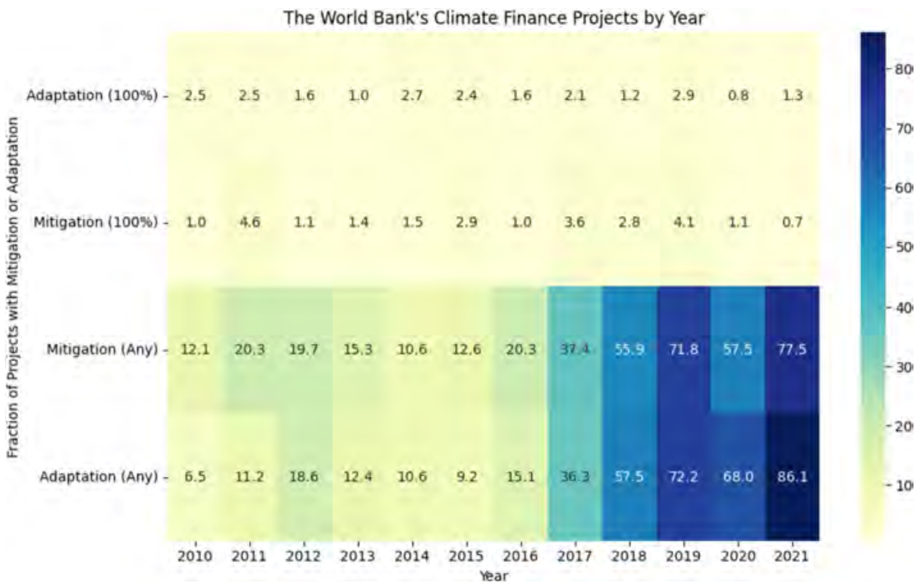
These project thematic additions can exceed 100%, which makes it difficult to precisely ascertain the monetary value of the climate component. Hypothetically, a project can simultaneously be assigned a theme of 40% climate, plus a theme of 75% social development and protection. When the total thematic additions to a single project exceed 100%, it becomes difficult to accurately determine the commitment of the project (i.e., the amount of dollars) devoted to climate change. Since this is a common problem for WB projects (see Appendix C), we focus our analysis on the number of Bank projects that contain a climate component.

In this context, the Bank counts as a CF project *any* project that contributes *any* amount to mitigation or adaptation. Hence, in the aggregate, WB's CF includes both projects that contribute a little (say, a project marked as having a 5% mitigation component) and a lot (consider a project that is solely dedicated to mitigation) to climate goals. Therefore, we create three analytical categories to trace the change in CF projects over time. First, *pure CF projects* are those that have a 100% mitigation or adaptation component. Second, when the climate objectives coexist with other thematic goals in a project, we designate the project as a *mixed CF project*. Third, non-CF projects have a zero climate component (adaptation or mitigation), as marked by the WB. Later, we also differentiate within the mixed CF category. To provide examples from projects that fall under "pure" versus "mixed", Table 1 provides the project descriptions for select World Bank climate finance projects.

2.2 Descriptive analysis

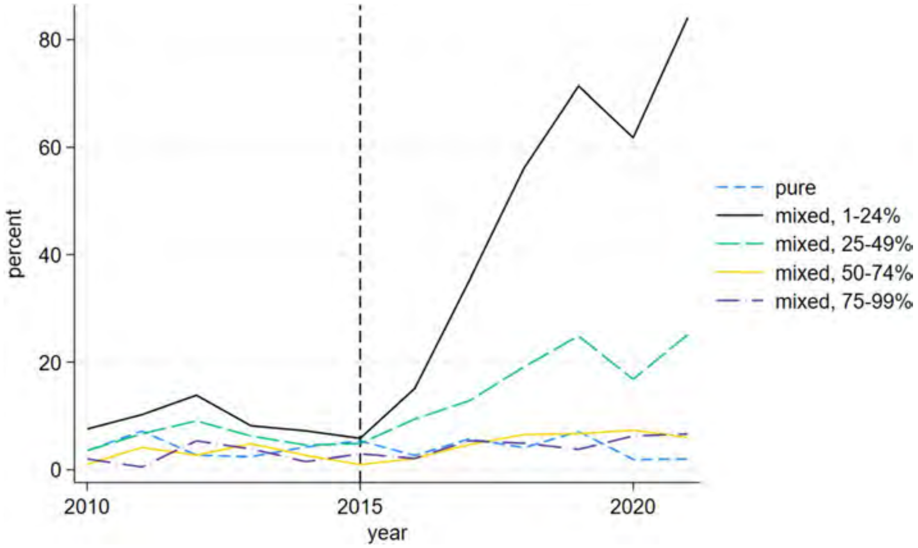
How has the Bank's financing of CF projects changed over time? To begin answering this question, we provide a heatmap in Fig. 2 that captures the shifts in Bank projects marked with a climate, i.e., mitigation or adaptation, component. The figure tracks both projects that contain *any* mitigation or adaptation component, i.e., mixed CF projects, as well as "pure" CF projects dedicated only to one or the other of these climate goals. Again, for reasons explained, the heatmap tracks the number of CF projects as a fraction of total WB projects.

Figure 2 shows that although the Bank's pure mitigation or adaptation projects have remained the same from pre-Paris to post-Paris (with averages steadily around 2% for both



Notes: The heatmap shows the fraction of Bank projects (as a % of the total number of Bank projects) that are entirely devoted to mitigation and adaptation, i.e. projects with a 100% climate compoent, as well as projects that contain just *any* mitigation and adaptation component (i.e., greater than 0%).

Fig. 2 Shift in the World Bank's mitigation and adaptation projects over time



Notes: In addition to pure climate projects, the figure differentiates mixed projects by the extent of their climate component. The mixed CF categories are projects with 1–24%, 25–49%, 50–74%, and 75–99% climate components.

Fig. 3 World Bank's mixed climate finance projects over time

types of projects), projects with *any* mitigation or adaptation components have skyrocketed in the post-Paris era. The increase is so spectacular in mixed CF projects that in 2021, the last year under analysis, more than 80% of the Bank's projects contained a mitigation or adaptation component. Furthermore, in line with Paris' call for a balance between mitigation and adaptation, the Bank's adaptation finance has increased over time.[15] However, the figure also shows that pure CF projects, those with a 100% climate component, do not increase after Paris.

To provide a more nuanced understanding of these shifts in WB CF projects over time, Fig. 3 plots the number of "pure" versus "mixed" CF projects over time. Furthermore, to display the variation within mixed CF projects, the figure differentiates "mixed CF projects" into four subgroups: projects with a climate component of 1–24%, 25–49%, 50–74%, or 75–99%, as marked by the Bank.

Figure 3 shows that most of the increase in mixed projects over time, and particularly after Paris, comes from the lowest percentage group of projects with a 1–24% climate focus. Mixed projects with a 25–49% CF component also show an increase. Differences in means tests (for each category, before and after Paris) confirm this pattern: means are statistically different only for mixed projects with 1–24% and 25–49% climate components.[16] The figure thus, shows that most of the increase in the Bank's CF over time comes from projects where climate is not the major focus of the project. The stagnancy in pure CF projects again pro-

[15] We note that the Bank's post-Paris adaptation projects average to 55.9%, and the same number for mitigation projects is 53.4%. We are, however, unable to assess (with six observations for each series) whether these numbers are statistically significant in a proper way.

[16] The p-values for the means tests (assuming equal variance) for the 1–24% and 25–49% categories are 0.013 and 0.026, respectively, but all other tests have p-values greater than 0.10.

vides a contrast to the shift in low-component mixed CF projects. These descriptive patterns are important to further investigate with inferential statistics.

2.3 Regression analysis

Before we detail our preferred estimation equation, we flesh out some of the considerations that motivate the specification. First, given the aforementioned importance of Paris, we treat it as a "shock" to the Bank's lending and test its importance empirically. Our empirical strategy, therefore, relies on the reasonable notion that the Paris Agreement affects climate-related project financing significantly more than non-climate project financing.

Second, for each borrowing country i in year t, we differentiate CF from non-CF projects (that is, projects without a climate component). Specifically, for each country i in year t, we record two observations that count the number of CF and the number of non-CF projects. Our dataset, hence, accounts for all projects the country has received from the Bank. Initially, we identify CF projects as those with *any* (i.e., a positive percentage assigned) adaptation or mitigation components. In extensions, we switch to a more detailed classification following Fig. 3 to capture the varying levels of climate goals in CF projects.

Third, we also need a flexible model that integrates "zeros", i.e., country-year observations (for each country i in year t), where there are no WB projects (CF or non-CF).[17] These zero observations provide important information on which countries receive WB financing, so ignoring them would lead to biased estimates. With these considerations, we start our analysis at the *project type-recipient country-year* level as captured in Eq. 1:

$$N_{ijt} = \boldsymbol{\gamma}\mathbf{X_{it-1}} + \alpha_0 Climate_j + \alpha_1 Climate_j * Paris_t + \omega_i + \tau_t + \epsilon_{ijt}, \tag{1}$$

where:

N_{ijt} denotes the number of WB projects of type j, in country i, and year t;
ω_i denotes recipient country fixed effects;
τ_t is year fixed effects to be able to capture common shocks to all countries;
$Paris_t$ a dummy variable that takes the value of one starting in 2016 to trace the differences before to after Paris[18];
X_{it-1} country-level covariates.

The time effects capture the impact of all annual shocks, including the common effects of Paris, on both climate and non-climate World Bank projects. Because we include year fixed effects, τ_t, we are not able to identify the impact of Paris on non-CF projects separately. As we just discussed, Paris should have a differential impact on climate projects, which we identify with the interaction term between the climate indicator and the Paris dummy, i.e., $Climate_j * Paris_t$. And, through these variables, we can estimate the change in the number of CF projects and compare the difference between CF and non-CF projects before and after Paris. Hence, in the ensuing analysis, we measure the change in CF projects relative to non-CF, and technically, we discuss how the gap between CF versus non-CF shifts pre- to post-Paris. In addition to being statistically sound, this

[17] Notably, the WB does not make available which projects it considers for financing, which enhances the importance of the zeros.

[18] Since Paris was signed at the end of 2015, this approach is reasonable.

approach conceptually makes sense as well, since one has to locate the changing importance of CF projects in the broad context of WB lending.

With this set-up, in Eq. 1, the coefficient α_0 for $Climate_j$ informs about the average difference between the number of CF and non-CF projects prior to Paris. The interaction term $Climate_j * Paris_t$ shows the average change in the number of CF projects after Paris. A negative estimate of α_0 suggests that before Paris CF projects are fewer than non-CF projects, while a positive estimate of α_1, the coefficient of $Climate_j * Paris_t$, shows that the number of climate projects increases after Paris. Hence, the pre-Paris gap between (the number of) CF and non-CF projects is captured by α_0, whereas, the post-Paris gap is captured with $\alpha_0 + \alpha_1$.[19]

Finally, Eq. 1 also includes country-specific covariates (in vector X_{it-1}) that are common in the literature (for a recent work, see Kilby and McWhirter 2022). We control for GDP per capita (deflated, logged), population (logged), voting affinity with the U.S. at the UNGA (Bailey et al. 2016),[20] temporary membership to the UNSC (Dreher et al. 2009),[21] regulatory quality (Kaufmann et al. 2011), which proxies the country's strength of governance,[22] and Freedom House Index to capture the country's level of democracy.[23] The literature finds that more populous countries and those that are relatively poorer but also better governed tend to receive more WB funds. The literature also finds evidence consistent with US influence in that countries aligned with the US receive more WB funds, although we do not anticipate this kind of alignment to necessarily affect countries' receipt of CF projects.[24] Similarly, UNSC members appear to have privileged access to international financial institutions. The description of the variables, including their sources, and a set of summary statistics, can be found in Appendix A.

We estimate Eq. 1 for our count dependent variable (DV) using Poisson Pseudo-Maximum Likelihood (Silva and Tenreyro 2010) with multi-way fixed effects employing the methodology in Correia et al. (2020). This algorithm for estimating Poisson regressions with high-dimensional fixed effects is robust to convergence issues, which are typical in count regressions that involve many observations with zeroes. We show the robustness of the baseline results using a negative binomial model and OLS. In all specifications, we estimate standard errors that are robust to heteroskedasticity and clustered at the country level to account for the possibility of serial correlation in the number of WB projects received within a country over time.

Table 2 presents the baseline results from Eq. 1. Column (1) presents the results for the specification that only includes the indicator variable for CF projects. Column (2) addition-

[19] Because in our preferred model we estimate a Poisson model with indicator variables that take on a value of zero or one, the pre-Paris gap between (the number of) CF and non-CF projects is calculated as $exp(\alpha_0) - 1$, and the post-Paris gap is calculated as $exp(\alpha_0 + \alpha_1) - 1$.

[20] Following extant studies (Section 2), this variable measures ideal point difference with the United States at the Assembly.

[21] We record China and Russia as zero, since they are permanent members to the UNSC.

[22] The regulatory quality is highly correlated with two other variables from that dataset, the rule of law and the control of corruption, but has fewer missing variables.

[23] Bättig and Bernauer (2009) shows that democracies have stronger commitments toward tackling climate change. Furthermore, democracies may have more transparent and accountable institutions, preferred by lenders.

[24] There is no reason why influential member states, like the U.S, would use their sway over climate projects specifically– not only would such an intervention require micro-management by the U.S., these projects may not also necessarily be the ones U.S.-aligned countries are pleased to receive.

Table 2 World Bank's climate finance before and after Paris

Dependent variable: number of World Bank projects (N_{ijt})				
Estimation method	PPML	PPML	OLS	N-binomial
	(1)	(2)	(3)	(4)
$Ln(GDPpercapita)_{it-1}$	−0.095	−0.095	0.127	−0.136
	(0.399)	(0.399)	(0.310)	(0.412)
$Ln(Population)_{it-1}$	1.561**	1.561**	1.411***	1.595**
	(0.703)	(0.703)	(0.398)	(0.705)
$UNGA_{it-1}$	0.102	0.102	0.037	0.102
	(0.134)	(0.134)	(0.113)	(0.135)
$UNSC_{it-1}$	0.146*	0.146*	0.169*	0.178**
	(0.078)	(0.078)	(0.086)	(0.084)
$Regulatoryquality_{it-1}$	0.173	0.173	0.095	0.178
	(0.188)	(0.188)	(0.130)	(0.189)
$FreedomHouseIndex_{it-1}$	−0.044	−0.044	−0.025	−0.048
	(0.116)	(0.116)	(0.092)	(0.115)
$Climate_j$	−0.131***	−1.387***	−0.863***	−1.392***
	(0.046)	(0.093)	(0.085)	(0.093)
$Climate_j * Paris_t$		2.176***	1.514***	2.178***
		(0.095)	(0.140)	(0.097)
Observations	3,052	3,022	3,074	3,074

The dependent variable N_{ijt} is the number of WB projects of type j (CF or non-CF) in country i and year t. Standard errors are clustered at the recipient country level. *, **, *** respectively denote significance at the 10%, 5%, and 1% levels

ally integrates the interaction term between the CF projects indicator and the Paris indicator, which allows us to capture the difference between CF and non-CF projects before and after Paris. Columns (3) and (4) provide evidence that the findings in our preferred specification in Column (2) are robust to estimating Eq. 1 using the Ordinary Least Squares (OLS) or the negative binomial model. Note that in all models, the control variables are in line with the existing literature (Dreher et al. 2009; Kilby 2013; Vreeland and Dreher 2014): more populous countries receive more WB projects, and having a temporary seat at the UNSC increases the chances of receiving a WB project. Although GDP per capita is not significant, the negative coefficient unsurprisingly suggests that poorer countries receive more WB projects. Voting proximity with the U.S. at the UNGA, regulatory quality, and the Freedom House index, which proxies the level of democracy in the country, are insignificant.

The estimates from our preferred specification in Column (2) show that the number of CF projects lags behind non-CF projects by 12% on average throughout the sample period. However, Paris strikingly reverses this gap between CF and non-CF projects.[25] After Paris, the number of CF projects exceeds that of non-CF by 120%– a distinct reversal.[26]

Having shown the striking increase in CF projects (relative to non-CF) post-Paris, we now delve more deeply into the nature of this increase. To that end, we alter the threshold

[25] Because this is a Poisson model with indicator variables that take on a value of zero or one, the coefficient of -1.387 on Climate is evaluated as exp(-1.387)-1 = -0.75.

[26] This impact is calculated as exp(-1.387 + 2.176)-1 = 1.20. Furthermore, Figure A1 in the Appendix demonstrates the dynamic effect of Paris, showing that CF projects increase steadily after 2015, without a pre-trend, and only Covid-19 interrupts this steady increase.

for what constitutes a CF project using $Climate_j$. Recall that a climate project may have a low or a high climate component, and that the results so far illustrate the difference between non-CF projects (0% mitigation and 0% adaptation component) and projects with *any* positive degrees of the climate component (mitigation or adaptation) before and after Paris. In our next analysis, we begin by defining a CF project as one with a greater than zero climate component, as before, and then progressively increase the threshold for constituting a CF project in 5 percentage points. Formally, for each categorization, we define a CF project as having a climate component greater than x%, where x takes on a value in 5 percentage point increments, i.e. {0, 5, 10,…,95}. Throughout, we group projects with climate components less than x% with non-CF projects.[27] For each of these increments, we re-estimate Eq. 1 and calculate the difference between the number of CF and non-CF projects pre- and post-Paris.

Figure 4 plots each of these estimates with the confidence intervals. The first tick in the figure shows projects with *any* positive climate component, and the last tick denotes CF projects with an at least 95% climate component.[28] The figure shows that there is no discernible change in the gap between CF and non-CF projects pre- to post-Paris when we define a CF project as one with a majority (more than 50%) climate component. Moreover, the number of CF projects surpasses the number of non-CF projects post-Paris, only when we adopt a very generous categorization of CF by counting projects with *any* or a *very minor* climate goal ($x > 0\%$ or $x > 5\%$, the first two ticks). As soon as we define CF as a project with a climate component of at least 10%, we find that CF projects lag behind the non-CF ones even after Paris. Figure 4 confirms the descriptive findings that the change in the Bank's post-Paris projects comes from projects with a small climate component (see Fig. 3).

To further probe the observed rise in mixed CF projects and to identify whether these projects go to where they are most needed, we expand Eq. 1 as follows:

$$\begin{aligned}N_{ijt} = \alpha_0 Pure_j + \alpha_1 Pure_j * Paris_t + \alpha_2 Pure_j * Z_{it} + \alpha_3 Pure_j * Z_{it} * Paris_t + \\ \beta_0 Mixed_j + \beta_1 Mixed_j * Paris_t + \beta_2 Mixed_j * Z_{it} + \beta_3 Mixed_j * Z_{it} * Paris_t + \\ \eta_0 Z_{it} + \eta_1 Z_{it} * Paris_t + \gamma \mathbf{X_{it-1}} + \omega_i + \tau_t + \epsilon_{ijt}.\end{aligned} \tag{2}$$

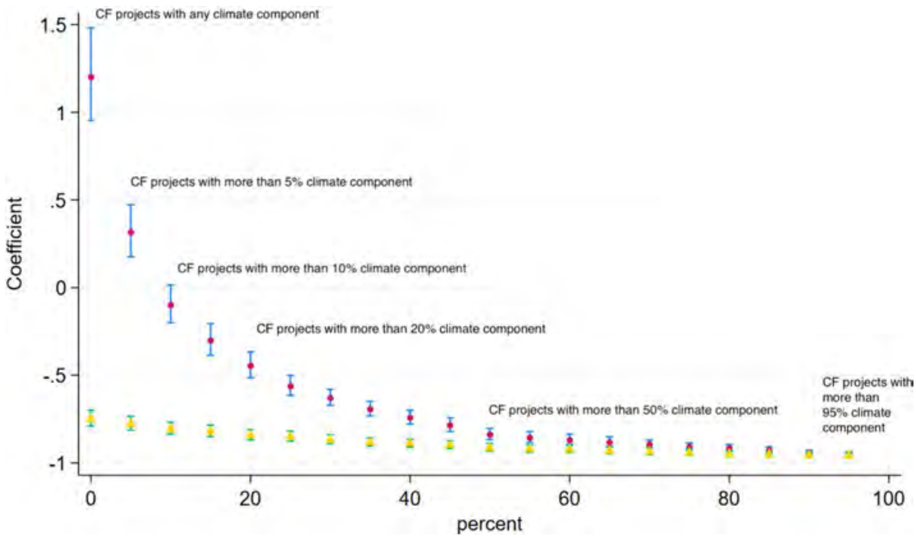
Equation 2 replaces $Climate_j$ with two indicators $Pure_j$ and $Mixed_j$ and augments the set of covariates and fixed effects in Eq. 1 with interaction terms between these project category indicators and $Paris_t$ as well as two alternative country trait indicators Z_{it}. These country traits allow us to examine whether CF projects go to places where the "bang for the buck" is higher. For CF projects to have the greatest impact, pure CF projects (those with a 100% climate component) should go to countries that are relatively more vulnerable to climate change or emit more. The same renewable energy project (mitigation) will have a greater impact where emissions are higher. Similarly, the same adaptation project will have a greater impact where the vulnerability to climate change is higher.[29]

In Eq. 2, we define an indicator variable for being a "more vulnerable" country by calculating the average number of disasters in our sample and defining a country as more vulnerable if the number of disasters they experience in a year is greater than the sample

[27] For example, when we define CF projects as those with a threshold climate component of at least 5%, we categorize projects with 0–4% climate component as non-CF projects.

[28] Essentially, the first tick in Fig. 4 corresponds to the results shown in Column 5 of Table 2.

[29] This is akin to the logic of MDBs lending more to more populous developing countries as the same project can impact relatively more people.



Notes: Each coefficient plotted in the figure shows the estimate of the difference between the number of CF and non-CF projects, where a project is defined CF if the climate component is greater than a particular percentage (represented on the x-axis). Estimates from several of the CF categories are labeled for ease. The triangles represent the difference pre-Paris, and the circles represent the estimated difference post-Paris. 95% confidence intervals are provided.

Fig. 4 Change in the number of climate projects: varying climate components

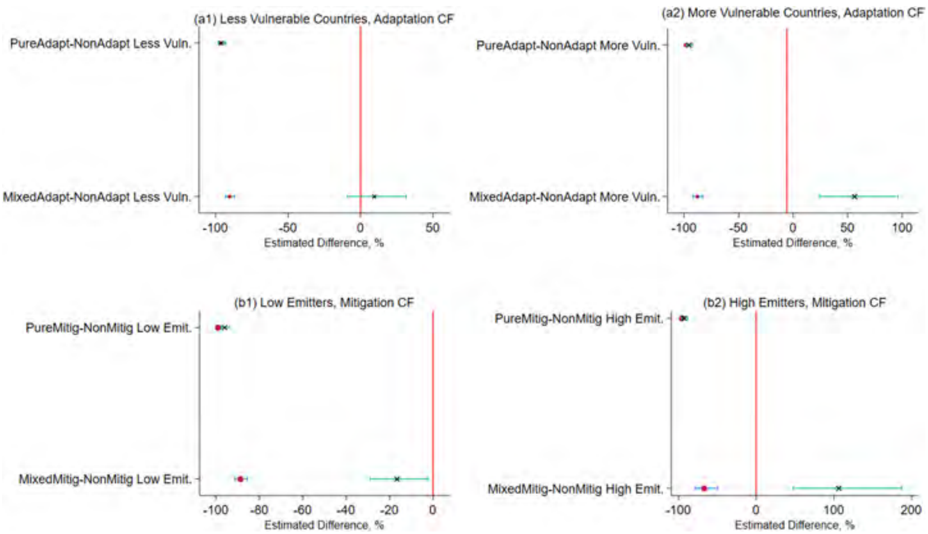
average.[30] Similarly, we construct a high emitter indicator by comparing the emissions of a country in a given year with the sample average.[31] To explore whether larger emitters have received more pure mitigation projects, and more vulnerable countries have received more pure adaptation projects following Paris, we estimate Eq. 2 alternating between mitigation CF and adaptation CF.[32]

Our core results based on Eq. 2 are presented in Fig. 5. By differentiating between less and more climate-vulnerable countries, as well as higher and lower emitters, the Figure provides a holistic picture of the change in pure and mixed projects across these different types of countries (Z_{it}) over time. For example, the low emitters in the figure refer to all countries that are not identified as high emitters. Similarly, low-vulnerability countries capture all countries that are deemed relatively less vulnerable by the aforementioned metrics. Panels (a1) and (a2) of Fig. 5 present the results for pure versus mixed adaptation CF, before and after Paris, based on the vulnerability indicator. Panels (b1) and (b2) present the estimated change in the pure and mixed mitigation CF for low and high emitters, respectively.

[30] These disasters include droughts, floods, wildfires, and extreme temperatures, which makes this variable particularly suited to climate analyses. The alternative variables from the ND-GAIN vulnerability index are missing for many developing countries.

[31] Appendix A contains all variable descriptions.

[32] Put differently, we differentiate CF into mitigation or adaptation CF by separating projects along these two climate components. By contrast, our previous CF measures counted the projects with mitigation *or* adaptation components.



Notes: Each coefficient plotted in the figure shows the estimate of the difference between the number of CF (pure or mixed) and non-CF projects. Panels (a1) and (a2) focus on adaptation CF and show the change for less and more vulnerable countries, respectively. Panels (b1) and (b2) focus on mitigation CF and show the change for low and high-emission countries, respectively.

Fig. 5 Pure versus mixed climate finance projects in more vulnerable countries and high emitters

The results show that there are no discernible changes in pure adaptation CF or pure mitigation CF for either sets of countries.[33] Figure 5 suggests, however, that mixed adaptation and mitigation CF, going to more vulnerable countries and larger emitters (respectively), has increased over time. Panels (a1) to (a2) show that mixed adaptation CF has increased for both less and more vulnerable countries, though this increase in adaptation CF is more pronounced for more vulnerable countries (a2). Post-Paris, adaptation CF significantly surpasses non-adaptation CF for these countries. Panels (b1) and (b2) display that mixed mitigation finance in the high emitters has increased following Paris, but, again, there is no significant change in pure mitigation finance going to these countries. Taken altogether, the results suggest that, quantitatively, more CF is going to places where it is needed, but qualitatively, most of this CF is embodied in other types of projects that do not have climate as an exclusive focus. Pure CF failing to find its way to the most vulnerable and highest emitters raises questions as to whether communities at the frontline of climate change are adequately served or whether the emissions reductions from relatively low emitters are enough to limit global warming.

Finally, our results hold up if we do not rely on the IATI dataset, which has quality checks as explained in Appendix B, but on the data from the Bank's website. As shown in Appendix D, using this alternative data source for the Bank's CF projects, we find that after Paris, the increase in CF projects from mixed projects, particularly from mixed projects, where the climate component is in the non-majority. This confirmatory result, however, is not surpris-

[33] The pre- and post-Paris estimates and confidence intervals for the difference between non-CF and the pure adaptation (panels a1 and a2) or pure mitigation CF (panels b1 and b2) are almost identical for both sets of countries CF.

ing because the IATI is a quality-checked version of the World Bank data submitted by the organization itself.

3 Mainstreaming or greenwashing?

The seemingly opportunistic integration of climate goals into projects could suggest "mainstreaming" or "greenwashing" or, more realistically, a combination of the two. Mainstreaming means that climate objectives become so commonplace that they get integrated into any project financed by the World Bank, whereas greenwashing suggests an exaggeration of the assigned climate goal in mixed CF projects. We refer firmer answers to this question to future studies, since this study intends to provide the first deep dive into the WB's CF. Crucially, completed projects should be evaluated for climate impact–even mainstreaming does not necessarily mean that the desired climate impact is achieved. This said, we nonetheless provide two different types of preliminary analysis that commence answering this question, with the caveat that intentions as well as smoking gun evidence will be elusive.

3.1 Content analysis of project descriptions of pure and mixed CF projects

First, as a starting point to the question of mainstreaming or greenwashing, we compared project descriptions of different types of projects, using cosine similarity. Specifically, we used natural language processing techniques, utilizing Python, to compare project descriptions of pure (100% mitigation or 100% adaptation) versus mixed CF projects, differentiated into the percentiles previously used in the paper (see Fig. 2). Our intuition here is that as the mixed CF projects' climate component increases, this mixed CF project should resemble more a pure CF project (with consistent recording of meaningful climate component in each project).

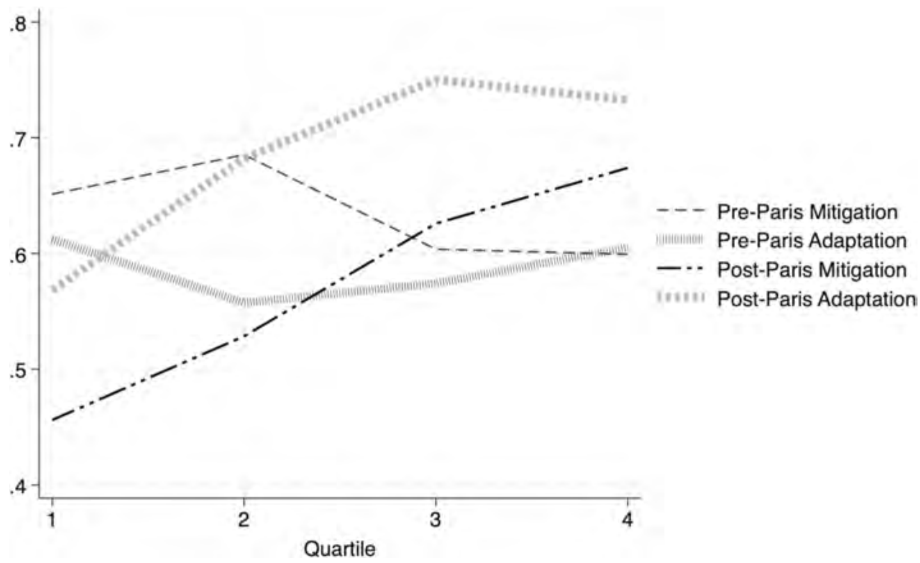
Cosine similarity essentially measures the angle between any two vectors. If the vectors of words in the two sets of projects (e.g., pure mitigation and pure adaptation) are completely orthogonal with no shared words, the angle between them will be 90 degrees, and their cosine will be 0. If the vectors of words in the two sets of projects are identical, the angle between them will be 0 with a cosine of 1. Hence, the more similar the content, i.e., the language in the descriptions of the two sets of projects, the higher the value of the cosine similarity measure in the range of 0 to 1.[34]

Before conducting the cosine similarity analysis, we adopted standard procedures of cleaning and preparing the data of project descriptions, including lemmatization, removal of common stop words (such as a, the, and) and elimination of generic terms with no content value (such as the standard beginning for WB project descriptions– the "objective of this project"). We then performed national language processing using Python, which gave us words and associated relative frequencies (frequencies normalized as the percentage frequency for a given dataset) for each word. Importantly, these words were meaningful, such as resilience or energy.

[34] Cosine similarity is particularly preferred for text analysis where zero vectors are expected–here no occurrence of a word (Han et al. 2022).

To conduct the cosine similarity analysis, we created different vectors of word frequencies using in Python for the following sets of projects: pure mitigation, pure adaptation, mixed mitigation, and mixed adaptation, with the mixed CF projects differentiated into pre- and post-Paris and subsequently further divided into the quartiles presented in Fig. 2. These quartiles group mixed CF projects based on the degree to which they have a WB-ascribed climate content: projects with a climate component that is in the 1st-25th percentiles are followed by projects in the 26th-50th percentiles, then 51st-75th, with the final category being 76th-99th. To recall, in each dataset, we use the project descriptions provided by the Bank, which highlight the main content and goals of the project.

The results are presented in Fig. 6. While one would expect that as the climate component of the mixed project increases, the project resembles more a pure CF project (mitigation or adaptation), we do not always find this to be the case. For example, in some categories, projects with higher climate components are less similar to pure projects than projects with lower climate components (e.g., see third versus fourth quartiles of adaptation projects post-Paris in Fig. 6). This major takeaway from our textual data analysis of project descriptions withstands robustness checks. For example, we analyze the top word similarity between pure and mixed CF projects, again differentiating the latter by the degree of its climate goals, reaching a similar conclusion (see Appendix Table A4). This finding, at the very least, suggests that the Bank could make more transparent how it decides on the climate contribution of different projects.



Notes: The figure plots cosine similarity between pure CF projects (mitigation or adaptation) and mixed CF projects (mitigation or adaptation), pre- and post-Paris. Higher numbers indicate greater similarity between two sets of project descriptions. Quartiles 1, 2, 3, 4 indicate climate content for the project at 1st-25th, 26th-50th, 51st-75th, 76th-99th quartiles.

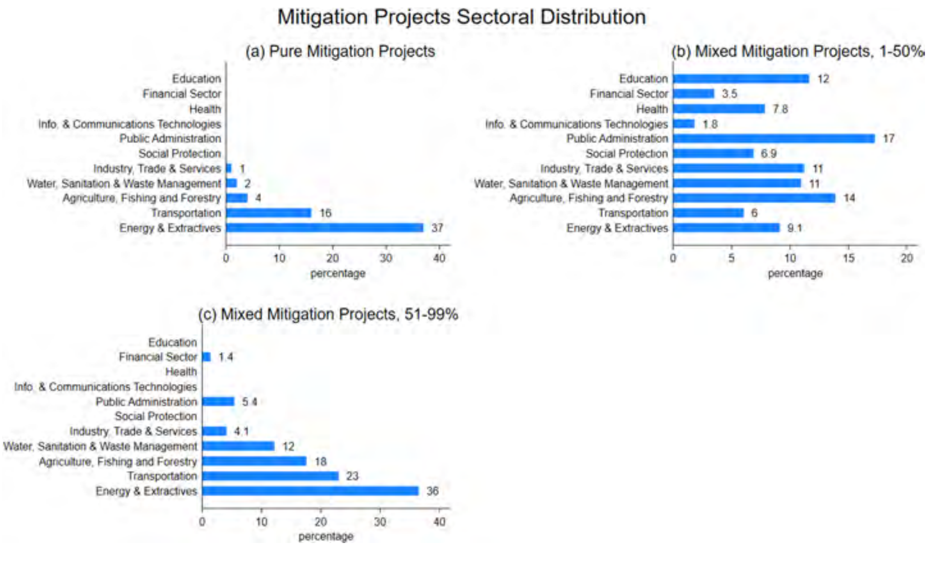
Fig. 6 Comparison of pure and mixed climate project descriptions (Cosine Similarity)

3.2 Analysis of sectoral distributions of pure and mixed CF projects

Second, to preliminarily explore the question of mainstreaming versus greenwashing, we have also examined the sectors for mixed CF projects in the post-Paris era, comparing them to the sectors of pure projects. Figures 7 and 8 show the post-Paris sectoral distribution of mixed and pure mitigation and adaptation projects, respectively. On the one hand, by definition, mixed CF projects should be more diffused across sectors. On the other hand, we find that post-Paris, a good portion of mixed CF projects belong to non-climate adjacent sectors, such as “education", “health”, “public administration”, “social protection”, “industry, trade, and services. To be sure, some projects, particularly those with a higher climate component, are also in related climate-sectors, such as “agriculture, fishing, and forestry.”

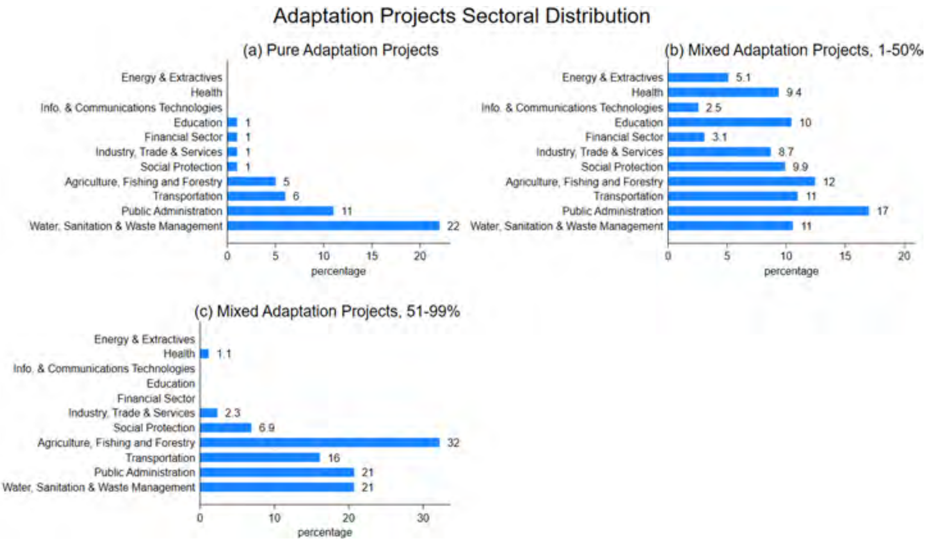
However, to give examples of the marked increase in climate goals in non-climate adjacent sectors, before Paris, only 1% of pure adaptation projects belonged to the education and health sectors. In contrast, post-Paris, about one-fifth of the mixed adaptation projects belonged to these two sectors (Fig. 8). In a parallel trend, prior to Paris, no pure mitigation projects belonged to the “public administration” sector, but after Paris, about a fifth of mixed mitigation projects belonged to this sector (Fig. 7). To recall, most of the Bank’s post-Paris increase in CF comes from mixed projects where climate goals are 1–49% of the project. These results show that a good portion of these projects are in general sectors, such as education or public administration. This trend raises the question of whether as much climate impact can be expected from some of these projects. For example, how much impact can we realistically expect from a general education project that also integrates a climate change awareness goal?

While we invite future work to further probe the question of mainstreaming or greenwashing, in this section, we have shown that there is a distinct probability that the Bank



Notes: This figure shows the sectoral distribution of post-Paris mitigation projects.

Fig. 7 Sectoral distribution of post-Paris mitigation projects



Notes: This figure shows the sectoral distribution of post-Paris mitigation projects.

Fig. 8 Sectoral distribution of post-Paris adaptation projects

is too generous in its estimate of the expected climate impact of some of its projects. Both when we examine project descriptions of climate-assigned projects and the sectoral distribution of post-Paris projects, our results raise questions about why *some* Bank projects have a relatively high climate component. To be sure, nuance here is important because the Bank aims to systematically record the climate contribution of its projects. However, greater transparency and detail on the Bank's part regarding the climate promise of its project finance appears appropriate. This point is all the more important considering most of the increase in the Bank's CF in recent years comes from projects with a low climate component.

4 Conclusion

The World Bank is the central global economic development organization called upon by its member states and stakeholders to tackle a number of challenges, including climate change. Yet, we have a limited sense of the details in the Bank's climate finance, including what actually comprises the Bank's climate finance, how this dispensation has changed over time, and what the impact of the Paris Agreement has been. These questions are vital for coordinating strategies to meet internationally agreed-upon climate finance goals.

Our empirical analyses demonstrate that the Bank's CF levels have responded to Paris with a striking increase in CF projects as Paris' climate goals are being implemented. However, the findings also suggest that the Bank appears to be inserting climate goals into the projects it finances when it can and where it can. We show the wide range of projects that count as CF– from a project that can have less than 5% dedicated to mitigation or adaptation, to pure CF projects, which totally aim to support these twin climate goals. The results reveal that "mixed" CF projects, where climate and other goals co-exist, account for the bulk of the post-Paris increase in the Bank's CF. But in over 80% of the projects that "mix" mitigation and adaptation with other thematic goals, the two climate goals are in the minority. We also show that pure CF projects are not only relatively stagnant over time, they also do not significantly go where they are most needed, such as to countries that are more vulnerable to climate change.

Moreover, we raise the additional question of how much climate impact the mixed CF projects promise. Naturally, we defer a fully-fledged answer to this question to the actual impact assessment of completed projects in future analyses. However, plausibly, when projects are financed to address climate change, they *estimate* an anticipated impact. Particularly, as a project's assigned climate component increases, so should its promise for alleviating climate change. Based on our textual analysis of the project descriptions, we fail to find systematic evidence that a higher climate component in the Bank's mixed CF projects means that the project is more like a pure CF project dedicated solely to mitigation or adaptation. Moreover, we show that the sectoral distribution of mixed CF projects is increasingly in non-climate adjacent sectors with broad goals, such as health, education, or public administration. These results raise questions about whether the promised impact of these climate projects is *always* as high as the accounting suggests.

These results also offer considerations for policy and research. First, instead of an emphasis on quantity, shareholders could emphasize quality in CF projects, such that more pure CF projects are funded through organizations like the World Bank. Second, as others have also emphasized (Gebel et al. 2022), future research, or the Bank, can re-categorize all of the Bank's climate finance in terms of its Paris alignment. Third, the Bank itself can provide further transparency to assigned climate percentages and link these percentages to outcomes for climate. Future research can also extend our project-level analysis to other MDBs. That global public resources are well measured, well allocated, and rigorously analyzed remains key to addressing global problems through multilateral organizations.

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Data availability The datasets generated during, and or analysed during the current study are available through the World Bank's website, but the authors' code or other analyses will be available on the corresponding author's website upon publication of this piece. The publicly available data can be downloaded from:
https://documents.worldbank.org/en/publication/documents-reports/api

Declarations

Competing interests The authors have no competing interests to declare.

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