Governance and Climate Finance in the Developing World*

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Abstract

We investigate the relationship between governance and climate finance, particularly in the context of the energy transition in developing countries. Our aim is to examine how governance qualities in developing countries impact financial contributions from contributor countries that intend to fund mitigation projects in the energy sector. We have compiled a dataset of yearly climate finance contributions at the project level spanning from 2011 to 2019. Our analysis, which utilizes random forests and LASSO estimations, reveals that climate finance contributions, particularly those for energy-related projects, are significantly linked to good governance, including a robust legal system, rule of law, and accountability. Ultimately, this study provides valuable insights into the dynamics between governance and climate finance in developing countries and informs policy decisions to support effective climate action in the energy sector.

1 Introduction

Climate change has a global impact, and requires being tackled globally. To feasibly reach the goal of net-zero by 2050, international climate finance must increase by a factor of six by 2030 (CPI, 2021). Considering the existing income disparities in the world, climate finance flows from developed to developing economies are crucial.

However, this effort requires that finance is effectively used to secure decarbonization and a just transition. On the other hand, since mitigation projects tend to target the energy sector, which is characterized by important sunk costs and long-term high rents, energy related projects within countries with poor governance can be subject to increasing asymmetric information problems. This may include moral hazard from contract parties by renegotiations (Choe, 2020) or increased corruption.

Governance factors are relevant for climate finance effectiveness, given for example that a strong correlation between climate change vulnerability and perceived corruption exists at the country level. Moreover, Nest, Mullard, and Wathne, 2020 identifies other risk factors such as inadequate monitoring, multiplicity of actors, and unclear and evolving rules in renewable energy projects,

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which increases developing countries' vulnerability to corruption. Thus, it is crucial to assess the impact of climate finance in the developing world, since developing countries are the most vulnerable to climate change and to weak institutions and poor governance. Low governance levels can be significant barriers to emissions reductions within these countries. For that reason, we conduct a study to characterize climate finance, particularly those that flows from developed to developing countries, to identify potential hindrances to the effectiveness of climate finance allocation.

Under our analysis, accounting for the governance dimension can help to improve funding allocation mechanisms. Thus, our study contributes to the literature by including such dimension, which has not been fully studied yet (Kouwenberg, 2023, Nest et al., 2020). We use publicly available information from the UNFCCC Climate Finance Data Portal, 2023, Global Environment Facility, 2023, IMF, 2023, and country governance indicators from The PRS Group, 2023 and The World Bank, 2023. We use machine learning methods on a data set for climate finance funds during the period 2011-2019 at the project level to evaluate how developing countries' governance qualities impact developed countries' financial contributions.

Thus, we study the determinants of funding contribution for climate change projects, particularly for energy-related ones. We find that governance, energy, and the environment factors in developing countries determine the size of funding contribution for their climate finance projects in their countries, particularly for energy-related projects.

A good governance allows for greater economic stability and predictability, which favors investment flows. Developing countries need to work more to improve their governance, but bigger efforts need to be done considering the rapid climate change. This includes to urgently improve climate finance access, by simplifying and standardizing administrative processes, and providing with capacity building support and higher participation of local stakeholders in the decision of climate change projects. It is also crucial to have more clarity between climate finance and development aid, they should not be treated as same, and actually the incentives for each case are different.

Our study briefly discusses on climate change and the global sustainable goals in Section 2, then focuses the discussion on climate finance, types of instruments, its differences from development aid, and on the different incentive in each case, in Section 3. Section 4 presents a brief analysis of clean energy markets and its relation with climate finance, then the following section presents the factors for climate finance. The empirical analysis is presented and discussed in section 6 and finally the conclusion remarks are presented in section 7.

2 Climate change and sustainability goals

Climate change is manifesting more often with extended heat waves or unexpected cold seasons in usually warm areas, which is affecting humanity and the ecosystem in several ways. The adverse effects of climate change – such as water stress, reduced food security, forced climate migrations, and increased morbidity are in the developing world than in developed countries, even though developing countries contribute the least to climate change (IPCC, 2023). According to IPCC, 2023, global surface temperature for the period 2011-2020 was 1.1 degrees Celsius higher than the levels recorded in the mid-19th century. Greenhouse gas (GHG) emissions which are mostly CO2 emissions [1], have been consistently increasing decade by decade. Global GHG emissions grew 25.4% between 2000 and 2010 and 11% between 2010 and 2019. These increases are explained mainly by upper-middle income countries (China included) (see Figure 1). For low income and lower-middle income countries jointly, GHG emissions grew by 69% in the last 20 years. Low-income countries are significantly de-accelerating their emissions, where emissions from these countries increased by 4% from 2010 to 2019 in contrast to 21% from 2000 to 2010.

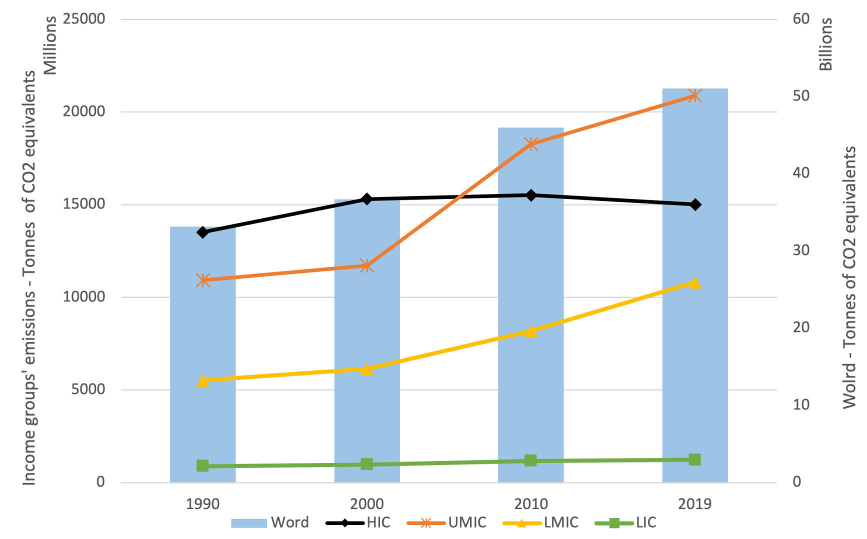

Figure 1: Evolution of total GHG emissions by income group, tonnes of CO2e (1990-2019)
Notes: HIC= High income countries, UMIC=Upper middle income countries, LMIC= Lower middle income countries, and LIC= Low income countries.
Source: Our World in Data based on the Global Carbon Project 2022

GHG emissions are largely caused by extensive global energy use; additionally energy consumption, and therefore CO2 emissions, is strongly associated to industrialization and economic growth. This explains why historically high income countries were and are still among the high emitters (see Figure 2). Recently during the last decade big emerging economies, such as China, surpassed the share of high income emitters to the global GHG emissions.

By 2019, 51 million tonnes of greenhouse gas (GHG) were emitted worldwide. The top four economic sectors that jointly explain 57% of global high GHG emissions are electricity and heat, transport, manufacturing and construction, and agriculture (see Figure 3). Although such or-

[1] According to the World Resource Institute, CO_2 emissions in 2019 represented around 75% of GHG emissions (see https://www.wri.org/insights/4-charts-explain-greenhouse-gas-emissions-countries-and-sectors).

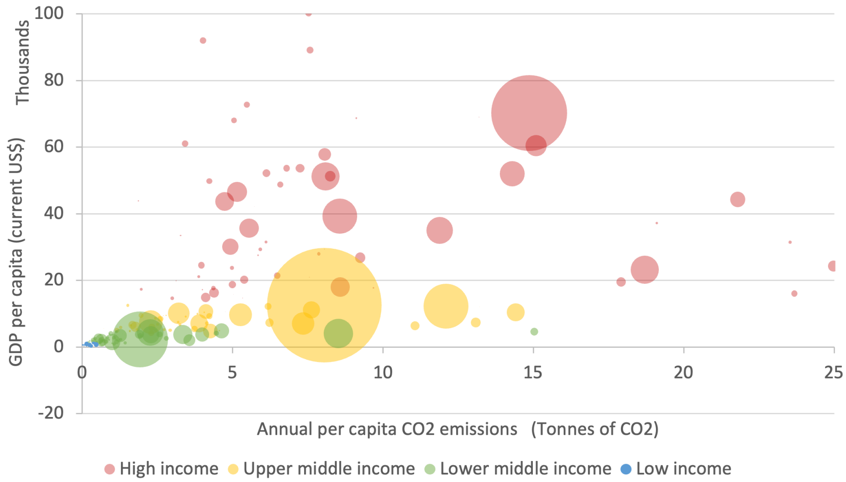

Figure 2: Emissions of CO2 and GDP per capita (2021)
Notes: Bubble size indicates country's annual CO2 emissions
Source: Our World in Data, World Bank Dataset

dering is preserved for higher income countries, the scheme changes for low and lower-middle income countries, where agriculture accounts for a larger emissions share. Electricity and transportation are still important for lower middle income countries (See Figure 4).

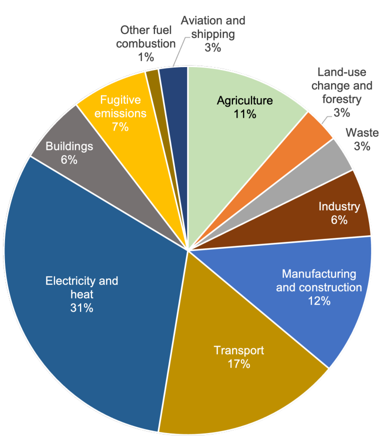

Figure 3: Greenhouse gas emissions by sector, 2019
Source: Our World in Data based on the Global Carbon Project 2022

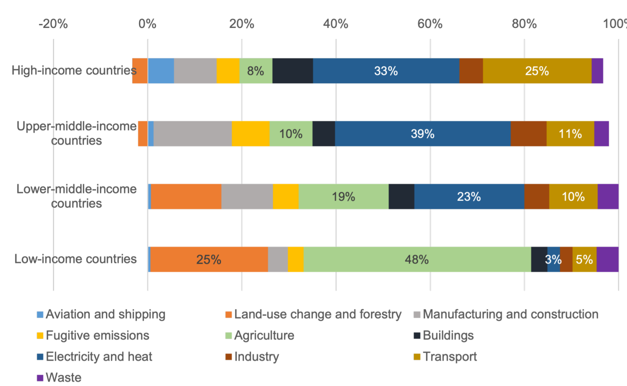

Figure 4: Share of per capita greenhouse gas emissions by sector, 2019
Source: Our World in Data based on the Global Carbon Project 2022

The task to reduce global emissions is difficult since it also deals with large disparities. Since emissions increase with economic growth, it is reasonable to expect increasing emissions from lower income countries (also the least emitters) in their path to economic growth. It is also expected that low reductions will occur in high income countries because they may want to keep their high-income life standards (Tirole, 2017).

Climate change is a global phenomenon, and tackling it requires global climate policy solutions. Currently, two are the main policies to address climate change and its adverse effects: (i) Mitigation policies that aim to reduce emissions and decarbonize economies, and (ii) Adaptation policies that aim to adjust socioeconomic systems and enhancing resilience to current and future climate change impacts.

In the case of mitigation actions, any individual effort to reduce emissions will have a positive impact that is shared by everyone. This means that mitigation can be seen as a public good, as it provides benefits to society as a whole. However, this also creates incentives for individuals to wait for others to reduce their emissions, as they can enjoy the benefits of mitigation without having to bear the costs. That is what is known as the free-rider problem in Economics. Climate policy (understood as policies to fight against climate change) can be understood as a typical tragedy of the commons situation where although reducing emissions is beneficial for everyone and their future generations, there are little to no individual incentives to incur in such effort due to the free-riding problem (Bracking & Benjamin, 2021). Another crucial characteristic is that reducing emissions requires collective actions; isolated efforts may be insufficient to prevent the greater adverse impacts of emissions. The Kyoto Protocol, by which in 1997 the signatory parties (developed countries) agreed to reduce their emissions by 2012 and created tradable emissions permits system, did not work as incentives to keep up the agreement were lessened by free-ride problem (Tirole, 2017).

On the other hand, adaptation actions which is focused on preparing vulnerable population – mostly concentrated in developing countries – to the adverse effects of climate change, does not fit well under the public good definition. Adaptation measures tend to be localized and benefit countries that incur in such effort; and although they are urgently needed to avoid suffering from populations (that contributed the least to the emissions problem), the incentives to incur in the efforts to alleviate such vulnerability are high for affected countries but very low or null for other not-so affected countries.

The implementation of climate policies requires of both, political will and finance access, which are crucial particularly for developing countries. As for political will, two key events happen in years 2000 and 2015. In 2000, the United Nations named climate change as its seventh Millennium Development Goal and in 2015 as one of its 17 Sustainable Development Goals. The thirteenth goal explicitly calls to "take urgent action to combat climate change and its impacts," while related references are implicit within other goals such as those that aim for affordable and clean energy (goal 7), access to clean water and sanitation (goal 6), sustainable cities and communities (goal 11).[2] In December 2015, the Paris Agreement set the ambitious target of limiting global temperature rise to 1.5°C or, at most, 2°C by 2050. Currently 194 parties (193 countries and the European Union) have joined this, legally binding, Paris Agreement. Parties agreed to submit their national climate action plan (National Determined Contributions NDC) to their re-

[2]See United Nations website https://sdgs.un.org/.

duce GHG emissions and actions to adapt to climate change impacts.

In terms of climate finance, an important boost was given by the Paris agreement because of the commitment (although voluntary) of developed countries to provide financial assistance. The agreement also included climate-related capacity-building support to developing countries, as well as support for enhancing technology development and transfer to mitigate and adapt to climate change. An Enhanced Transparency Framework (ETF) was also established, to which – starting from 2024– all countries are expected to report all their actions and progress on climate-related mitigation and adaptation measures and the support given or received for the climate goals.[3]

3 Climate Finance

Climate finance refers to funds mobilized to climate change mitigation and adaptation activities around the world, and it includes climate finance flows from developed countries to less developed countries as in the context of the Paris Agreement.[4] In the Paris Agreement of 2015, developed countries committed to jointly mobilize USD 100 billion per year in climate finance by 2020, and to continue this level of annual spending through 2025. This funding would come from a variety of sources, including public and private, bilateral and multilateral – including the U.N.'s Green Climate Fund –, and would be used to support developing countries in their efforts to mitigate and adapt to climate change.

According to UNFCCC, 2022, global climate finance reached an annual average USD 803 billion between 2019 and 2020, 12% higher than the 2017-2018 period. Likewise, least developed countries received roughly 20% of total global climate finance. In general, between 2016 and 2020, developing countries received around USD 66 billion in private climate finance (mobilized via bilateral and multilateral channels). Around 86% of these climate funds were given for mitigation projects, and 53% of those mitigation projects were energy related (mostly for renewable energy).

The high emphasis on financing energy projects, particularly related to renewable and clean energy projects, is associated to the strong role the energy sector plays on global carbon emissions. Collectively, there are higher incentives and urgency to decarbonize the energy sector, where implementation costs has reduced significantly over the years because of technological advancements (IEA & IFC, 2023). In the same line, transportation would be the next sector that climate finance would target.

Despite the increasing trend of climate finance, current climate finance flows are very far from being sufficient given the net-zero goals: according to some estimates, the current amount may

[3]Based on information available in the UNFCCC website. For more see https://unfccc.int/process-and-meetings/the-paris-agreement .

[4]A more precise definition is given en UNFCCC, 2022: "Climate finance aims at reducing emissions, and enhancing sinks of greenhouse gases and aims at reducing vulnerability of, and maintaining and increasing the resilience of, human and ecological systems to negative climate change impacts." (Climatic Change, 2020).

need to increase at least five-fold to reach an annual climate investment of USD 4.35 to 5 trillion by 2030 (CPI, 2021, Boehm et.al.(2021) cited in Kouwenberg, 2023). The situation is even more concerning when we observe that the climate-related annual financing for period 2019-2020 (USD 803 billion per year) is still even below the annual global investment in fossil fuels for the same period (USD 892 billion) and annual fossil fuel subsidies are equivalent to more than half of climate finance flows, USD 450 billion (UNFCCC, 2022). Such significant gap between current and needed levels of investment can be explained in part by the free rider problem; however, it is also important to understand how climate finance and its incentives mechanism work.

3.1 Types of financing

Funds can be provided by the public sector, private sector or by a combination of both. Funds can come from direct national and sub-national governments, private financial institutions and philanthropy foundations, multilateral institutions. Funds also can come from through intermediaries such as development financial institutions (DFI) – development banks– that comprises national, non-profit organizations, multilateral and bilateral funds to promote and finance economic development projects on a non-commercial basis.

DFIs are important since they enable the financing of public and private sector investments for projects that would otherwise not be developed due to high financial risk. There are also climate-specific funding mechanisms, such as the UNFCCC funds, non-UNFCCC funds, and national climate funds. These include the Global Environment Facility (GEF), the Green Climate Fund (GCF), the Adaptation Fund (AF), and the Climate Investment Funds (CIF)). In addition, there are green bonds and green, social, and sustainability bonds (GSS) issuers. From these, the GEF, the World Bank's CIF, and the GCF jointly constitute the main pillars of public finance via multilateral channels (Bracking & Benjamin, 2021).

According to the type of financial instrument, climate finance is similar to economic development finance in that it is given through grants, debt through loans (including concessional or soft loans), equity and guarantees. Below we briefly define each instrument.

- Grants are given free of interest and with no repayment obligation.
- Loans are provided under an interest rate and a repayment schedule; when the interest rates are significantly lower than commercial loans, the instrument is known as concessional loan.
- Equity finance refers to early stage investment or capital provided for developing a project in exchange for a portion of ownership, and
- Guarantees that cover borrowers' obligations in the case of default reducing the risk faced by the lenders.

Incentives for recipient countries may vary according to the financial instrument. Loans present stronger incentives to borrowers to perform well since there is a commitment for repayment and there is an interest rate for the loan; the incentives can be higher for repetitive interaction. Equity finance, on the other hand, provides stronger incentives to lending parties to improve monitoring and project assessment. Guarantees are important to reduce the investment risk, which can promote higher investments; but also for repetitive interactions they may be available for more credible and stable borrower parties.

Optimal use of climate finance instruments can accelerate climate action and improve climate finance allocation. Achieving net-zero goals requires widespread climate action, which in turn requires abundant and accessible climate finance.

3.2 Climate finance access

Access to climate finance has been challenging particularly for Least Developed Countries (LDCs) and Small Island Developing States (SIDS). The challenges are associated with different requirements to various sources of climate finance, which are summarized by UNFCCC, 2022 (p. 124), and slightly modified by us as two factors:

- Project adequacy and predictability conditions: involves the level of funding available relative to needs (mitigation-adaptation balance), nature of funding available relative to needs (financial instrument and time horizon), and nature of macro-economic conditions and impact on capital access. Likewise, this should include an enabling environment such as policies and regulations governing sectoral transitions.
- Technical and administrative skill set: involves capacity and capability to identify and articulate financial needs and priorities, to prepare projects; and procedural capability to deal with eligibility criteria, and accreditation and financial approval processes. [5]

Argueta, Chhetri, Eckstein, and Köhler, 2021 particularly analyze the accessibility to climate finance by LDCs and SIDS. According to this source, multilateral climate funds have been less accessible to developing countries than other sources, such as private and bilateral sources, and DFIs and multilateral development banks MDBs.

Identified access barriers are related to some high requirements that countries may not be able to comply. For example, Argueta et al., 2021 found that the requirement of historical climate data (for the last 30 years) to support climate change-related rationale of projects has been preventing recipient countries, which are often low-income countries that lack such data or the means to obtain it. Other access barriers found by same authors are the requirements related to recipient countries' characteristics –such as size or income level– which may make them more likely to reach required levels of co-finance, or private sector-investment. This is relevant for countries highly indebted with low fiscal resources, particularly after COVID-19 pandemic, which may make them ineligible for non-concessional loans.

Another detected obstacle is the lack of standardization and simplification of requirements, criteria and/or processes to access climate finance across financial sources, and multilateral and bilateral sources. Processing costs and inefficiencies may increase considering the low or marginal

[5] In summary, capacity building, which was also highlighted as important during the IMF 2023 Spring Meetings.

capacity building and administrative skills of some recipient countries. There is also a lack of clarity between development finance and climate finance for adaptation actions, which adds confusion and inefficiencies in the process and in funds allocation. These lacks of clarity stand as an obstacle for multilateral climate finance, where coordination problems may also arise between the multilateral MDB's Climate Investment Fund (CIF), and the Green Climate Finance (GCF) administered by the UNFCCC.[6] Moreover, this ambiguity can be detrimental at the domestic level, where coordination failures between assigned agencies with overlapping functions may prevent or slow project developments (Skovgaard et al., 2023).

Finally, one aspect highlighted in Argueta et al., 2021's analysis is that bilateral channels tend to be less transparent and more discretionary. Since most of the climate finance flows to these countries are given by bilateral channels, recipient countries' perceive that finance would often be linked to contributors' interest and policy goals, such as geopolitical ties and proximity. This is consistent to the finding of Burnside and Dollar, 2000 for development aid.

In sum, recipient countries' economic conditions that facilitate project predictability and existence of adequate regulatory environments are crucial to enable project development. Such conditions favor country's institutional capacity and maturity to deal with climate finance requirements and comply with accreditation standards more efficiently. These factors are indeed highly related to country's governance. Moreover, repetitive interactions given by finance sources and recipient countries would lead to a learning process for procedural matters, while highlighting governance issues as enablers or obstacles to further climate finance. Nest et al., 2020, for example, poses corruption as a crucial governance issue that may undermine the climate-related achievements. The authors observe that countries that received around 40% of climate related ODA are among the riskiest countries to corruption. We will discuss these issues later in the paper in section 5.

3.3 Stylized facts about climate finance

Based on UNFCCC, 2022 and CPI, 2021, some important facts for the period 2019/2020 can be highlighted:

Global climate finance flows

- Public sector finance, through mostly DFIs, accounted for more than half (51%) of climate finance during the period 2019-2020. Roughly 37% of total public finance was given by national DFIs, and around 20% of it came from multilateral DFIs.
- Private sector – comprised mainly by corporations, commercial financial institutions, and

[6] According to Skovgaard et al., 2023 under CIF would treat climate finance as development finance, where MDBs develop projects and the decisions are shaped by the "contributors" criteria, while under GCF, climate finance is seen different from development aid so its mechanisms are intended to be different, funds are provided by "contributors" and recipient country with other stakeholder will take active part on the decision-making of the project development. CIF also tends to provide moderately concessional lending and few grants, whereas GCF tends to provide more concessional loans and grants.

households and individuals – contributed with 49% of the annual climate finance.[7] Corporations contributed with 40% of the total private finance, but commercial banks accounted 39% of the private finance, showing a significant increase from the previous period as more commercial banks are financing clean energy projects.

- Global climate finance grew 12% from period 2027/2018 driven mainly by investments in energy efficiency of buildings, sustainable transport and adaptation finance.
- Global climate finance was given through loans (debt), 61% of the total, followed by equity investments (33%), according to CPI, 2021. Only 6% was raised as grants, from which 55% correspond to international flows.
- Around 90% of the global climate finance went to mitigation projects.
- Geographically, global climate finance is concentrated in East Asia and Pacific (43%), Western Europe (20%), and US & Canada (20%)

A great expansion of global climate finance is needed to reach net-zero goals, and there is room for expansion of private finance, which according to IEA and IFC, 2023 are highly concentrated in projects of the developed world leaving the emerging and developing world behind. This also would require develop carbon markets, as well as standards and certification to leverage on Environmental, Sustainable and Governance (ESG) practices as a way to mobilize capital.

Flows from developed to developing countries

- The commitment, made with the Paris agreement to jointly mobilize USD 100 billion per year in climate finance by 2020 was not fully met.
- Most climate finance flows from developed to developing countries (79%) were provided by bilateral, regional and other channels. The rest (21%) was given by multilateral DFIs and multilateral climate funds.
- According to UNFCCC, 2022, there is not a clear estimate of private climate finance to developing countries. However, the total private climate finance mobilized by multilateral funds to developing countries may amount USD 66.8 billion, where 86% was provided for mitigation projects. Half of the 86% specifically went to funding the energy sector. Private climate finance for adaptation targeted projects for industry, mining and construction.
- A large share of climate finance flows are directed to mitigation projects. 57% of funds from bilateral channels were for mitigation activities, only 28% for adaptation projects.
- Climate finance flows channeled by multilateral means. Likewise, more than 90% of multilateral finance are given to adaptation and cross-cutting and other general projects.
- Public finance for mitigation projects were mostly given by loans, while public finance for adaptation projects was predominantly given by grants (UNFCCC, 2022).

[7] Households contributions would come basically from their spending on electric vehicles, estimated to be around USD 25 billion per year in the period 2019/2020.

- In geographic terms, most of the climate finance for developing countries were provided to Asia (36%), followed by Africa (27%) and then Latin America (16%).
- Out of the USD 13.6 billion committed finance for climate-related projects from the GCF, only USD 5.1 billion (37.5%) was disbursed.

Below in table 1, a distribution of public climate finance provided by bilateral and multilateral channels is presented by area of support and type of financial instrument. It is visible that climate finance given by multilateral development banks are funding mitigation projects via loans.

Table 1: Public climate finance flows to developing countries by channel, area of support and type of instrument (2019/2020)

	Annual average	**Area of support**				**Financial instrument**		
	(USD billion)	Mitigation	Adaptation	cross-cutting	REDD+	Grants	Loans	Other
Bilateral climate finance	31.6	57%	28%	15%	-	49%	49%	1.5%
Multilateral climate funds	3.1	37%	19%	35%	9%	62%	34%	4%
MDB climate finance	38.3	62%	36%	2%	-	8%	78%	13%

Source: Taken from UNFCCC, 2022 (p. 106).

3.4 Climate finance, foreign aid and incentives

Traditionally, financing economic development projects –which includes a variety of projects to improve economic development and social welfare of recipient countries – has been provided to developing countries under the figure of foreign aid that has been defined as official development assistance (ODA) by the OECD's Development Assistant Committee. In this case, contributor countries are basically OECD country members, and ODA recipients are developing countries including upper-middle income countries. [8]

Climate finance has been widely allocated to the developing world through ODA means, more likely due to the experience accumulated in aid resource allocation by the ODA system. Likewise, climate finance to developing countries and aid are both mostly given by bilateral channels. Approximately 89% of the climate finance flows from developed to developing countries was given through bilateral, regional and other channels in the period 2019-2020 (UNFCCC, 2022). In the case of foreign aid, in 2020, 71.4% of the total aid under ODA (USD 162.27 billions) was given also through bilateral channels, while 28.6% was given under multilateral.[9]

Although development aid and climate finance may share some similarities as the way they are provided, some key differences are worth mentioning the nature of climate finance in contrast to foreign development aid:

i climate finance entails all financial flows used for climate-related projects everywhere. Aid is basically restrained to funds provided to help less developed countries.

[8]The list of recipient countries is updated every three years based on per capita income. See OECD website for more information: https://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/official-development-assistance.htm.

[9]By 2022, that share changed to 74.6% and 25.4%, respectively (of a total of USD 204 billions). For more information see https://stats.oecd.org/Index.aspx?QueryId=65072.

ii climate finance has the global objective of fighting against and adapting to climate change, which constitutes a public good so any improvement is shared by everyone. Foreign aid has fewer incentives as the project advances, which are not easily shared. Browne, 2022 argues that climate finance should be seen as restitution rather than aid, since most affected countries by climate change tend to be poorer and are indeed the least emitter countries.

iii the sense of urgency is higher for climate finance than in traditional foreign aid, due to the climate and net-zero goals to which most of the countries have committed.

Given that climate finance is mostly using ODA-like system to allocate funding, it is important to review how these aid traditional mechanisms work, so as to learn from them and improve them for climate finance.

Despite expectations, foreign aid has not been very successful in bridging the investment gap in poor countries or increasing growth rates. Empirical evidence suggests that aid increases consumption rather than investment (Easterly, 2007), which is likely due to political variables in recipient countries. Politicians in these countries may be more likely to use aid to maximize the welfare of elites rather than the welfare of society as a whole (Boone, 1996). Aid would enrich corrupt elites, and incentivize corruption and violence (Fisman & Miguel, 2008). These findings have important implications for foreign aid and for climate finance. For effective allocation of these resources in reaching their goals, it is important to address the political factors that can lead to their misuse.

Empirical studies have found that aid was not necessarily directed towards countries in greater need, due to strategic or political interests that influence contributor's incentive to allocate aid (Boone, 1996; Alesina and Dollar, 2000, Burnside and Dollar, 2000, Kuzienko and Werker, 2006). In particular, Burnside and Dollar, 2000 find, in a sample of 56 countries, that strategic factors are strong determinants of aid allocation in the specific case of bilateral aid. However, unlike aid, they found that private flows –namely foreign direct investment– respond correctly to economic incentives (economic conditions such as openness and property rights protection).

It is worth mentioning that aid provided by ODA was traditionally given through grants, but currently grants account for a small share of overall ODA finance, while debt-financing is more popular (Bracking & Benjamin, 2021). International public climate finance consist mostly on loans –debt-financing made roughly 64% of the joint total provided by bilateral, multilateral development banks and multilateral climate funds–. Interestingly, adaptation climate finance was largely provided by grants, while mitigation finance, by loans (UNFCCC, 2022). Adaptation climate finance seems to be closer to aid, in fact, Argueta et al., 2021 find that there is not a clear definition or separation on what qualifies as climate adaptation project or as aid for financing purposes.

It is clear then that aid is driven by both, contributors' own interest and recipients' needs, so the effectiveness may depend on how committed recipient governments are to efficiently address aid. In the context of climate finance contributors' interest might be heightened by the Paris Agreement commitments and also by the expected impact of climate projects, particularly mitigation projects which has shareable and non-excludable benefits if successful (Choe, 2020). This also explains why bilateral climate finance is mostly directed to mitigation actions, and why adaptation projects are left behind.

In aid and climate finance, there exist important principal-agent problems that need to be analyzed to align objectives and give the right incentives. Contrary to the belief that multilateral finance can be more effective and efficient –and able to make conditional aid less political–, most aid and climate finance is given bilaterally. In the context of aid, Milner, 2006 researches the asymmetric information problem in the first stage – from the public to contributor's government – in order to explain the trend to delegate aid provision to multilateral agencies. According to the author, evidence shows that the multilateral scheme might be used by contributors as a signal of the right use of money paid by the public (taxpayers), especially when public opinion is negative about aid. Thus, when people are not informed about aid effectiveness, then governments are biased to use bilateral scheme, since they can exert more control.

Although, the bilateral scheme reduces the principal-agent problem by avoiding the inclusion of an extra agent (multilateral agency), it is often driven according to donor/contributor's strategic and political interests.[10] In the context of climate finance, to accelerate the energy transition and guarantee energy security, it is possible that bilateral climate finance may be influenced by the strategic existence of extractive critical resources in the recipient country (minerals for example).

From a theoretical approach, a way to solve the principal agent problem between donors/contributors and recipients is by implementing conditional projects (instead of direct transfer of money), which would help align interests of donors/contributors and receivers (Jain, 2007). Another way would be improving monitoring of the financed project, in this regard bottom-up approach such as community engagement and community reporting may help, broadening the participation of stakeholders, local and indigenous communities, is taken as relevant factors for the delivery of effective finance. Thus, there is an increasing presence of 'country ownership' scheme in climate finance and project development, for example under UNFCCC financial mechanism such as the GCF (Argueta et al., 2021, UNFCCC, 2022, Browne, 2022).

Climate finance, as same as aid, implies higher rents for governments. Because governments' objective function might differ from social welfare, under no monitoring or supervision, a risk of rent-seeking behavior (private consumption of rent-seekers) of those in power would adversely affect the project's positive outcomes. Thus, more funds should be allocated to less corrupt countries; but as long as funds allocation is discretionary, contributors do not systematically allocate finance or aid to less corrupt countries. Thus, political equilibrium is key for project finance and/or aid's positive effect. Democracies have been shown to diminish the corruption counter-effect (perverse incentives) of these funds in recipient countries (Svensson, 2000, Economides, Kaluvitis, and Philippopoulos, 2008).

Corruption is perhaps the main reason for foreign aid's failure, a characteristic that is not only

[10]This would partially explain why aid does not show a positive effect on growth and development.

present in recipients' governments, but also within contributors' aid agencies.[11] Although corruption is difficult to fight against and it may not be possible to eliminate it, it is possible to limit its scope:

- One way would be increasing debt financing rather than grants; Quazi, 2006 argues that loans finance investment projects, while grants usually are wasted in public consumption or unproductive projects. Grants would be easier to be stolen by corrupt governments than loans. Unlike grants, loans need credit assessment and need to be paid back. Thus, loans would induce lenders to pursue outcomes of their funded projects, and would diminish perverse incentives to steal money.

- Another way consists of increasing enforcement and post-evaluations of financed projects or aid's uses. Fisman and Miguel, 2008 argue that increased enforcement severally reduces corruption. This is particularly important in climate finance given that there is a lack of evaluation of funds usage (Bracking & Benjamin, 2021).

Governance factors such as perceived corruption, lack of rule of law (or low level of private property protection), lack of political stability (less predictability), or lack of accountability may affect climate finance allocation, since these factors increase the project risks particularly if the project is financed by loans. Specifically, governance factors increase their relevance in the context of energy-related projects that are capital intensive and require important investment.

4 Energy-related projects

As mentioned previously, climate finance for energy-related projects accounts for a significant share of total mitigation finance contributions. Indeed, for the period 2019/2020, renewable energy generation projects accounted for the largest sector of global climate finance (UNFCCC, 2022). This pattern has been shown last decades, which coincides with the sharp decline of the costs of non-conventional renewable energy (wind and solar power) which made these technologies accessible and cost-competitive in the electricity generation market (IRENA, 2022).

The Paris Agreement in 2015 stimulated climate finance commitments, and although actual disbursements were minimal, energy projects could get funding. As shown in Figure 5, climate finance commitments increased almost exponentially for non-energy projects after 2015, but disbursed funds were significantly reduced. Among provided funds, energy projects received relatively larger amounts than non-energy projects, specifically through mitigation finance.
Clean energies such as renewable energy from solar and wind sources are being implemented in several countries, but the deployment of such projects face important barriers in emerging economies. Low clean energies projects deployment might be due to the nature of the investment: unlike fossil fuels extractive activities, solar and wind projects require high upfront costs and low operating costs, therefore investors face significant capital investment; risks are higher

[11] Studies on the membership structure of the Security Council (SC) of the United Nations (UN) have shown evidence of bribery among rotating members of the SC, influencing the amount of aid allocated by the US through the UN (Kuzienko & Werker, 2006).

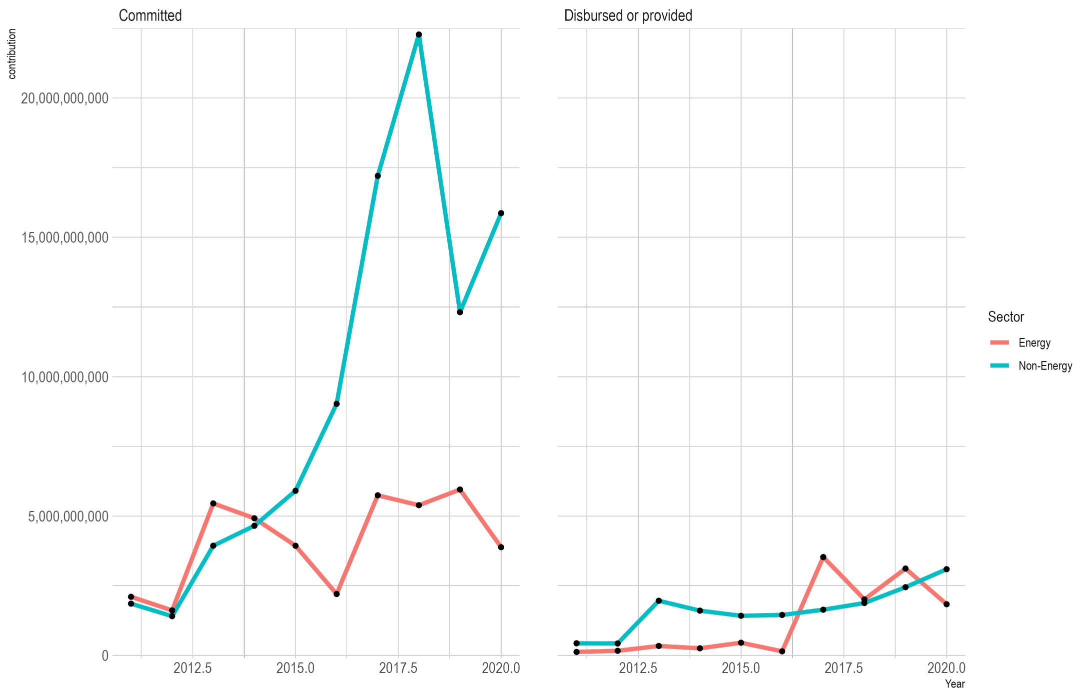

Figure 5: Climate finance contributions to projects by sector and by status
Source: UNFCCC Climate Finance Data Portal, 2023

under country's economic instability and uncertainty. Investment risk will be reduced under a secured demand (via power purchase agreements, for example) and a stable economy with reliable institutions, which lowers the risk of renegotiation (Choe, 2020), and, even, the risk of expropriation.

Figure 6 shows how the total contribution during the period from year 2011 to 2020 varies by grant status and whether the project is related to energy. For the energy projects, the more contribution comes from non-grant (loans), while it is the opposite for the non-energy project. This difference might be due to the significant by the investment characteristics within the energy sector, but it could also be due to other several factors.
WorldBank, 2023 identifies two barriers for low income and middle income countries to mobilize required finance: (i) limited affordability or limited fiscal flexibility of governments to incur in clean energy public investment, and (ii) limited access to private capital and the high capital cost, that are associated with weak or underdeveloped financial markets (usually not aligned to international financial markets standards), poor or weak policy and regulatory frameworks, and lack of adequate institutional capacity.

A key factor that impedes many LIC and MIC is the prevalence of fossil fuel subsidies, which is a cause of fossil fuels dependency. Governments are under pressure from society to keep subsidies

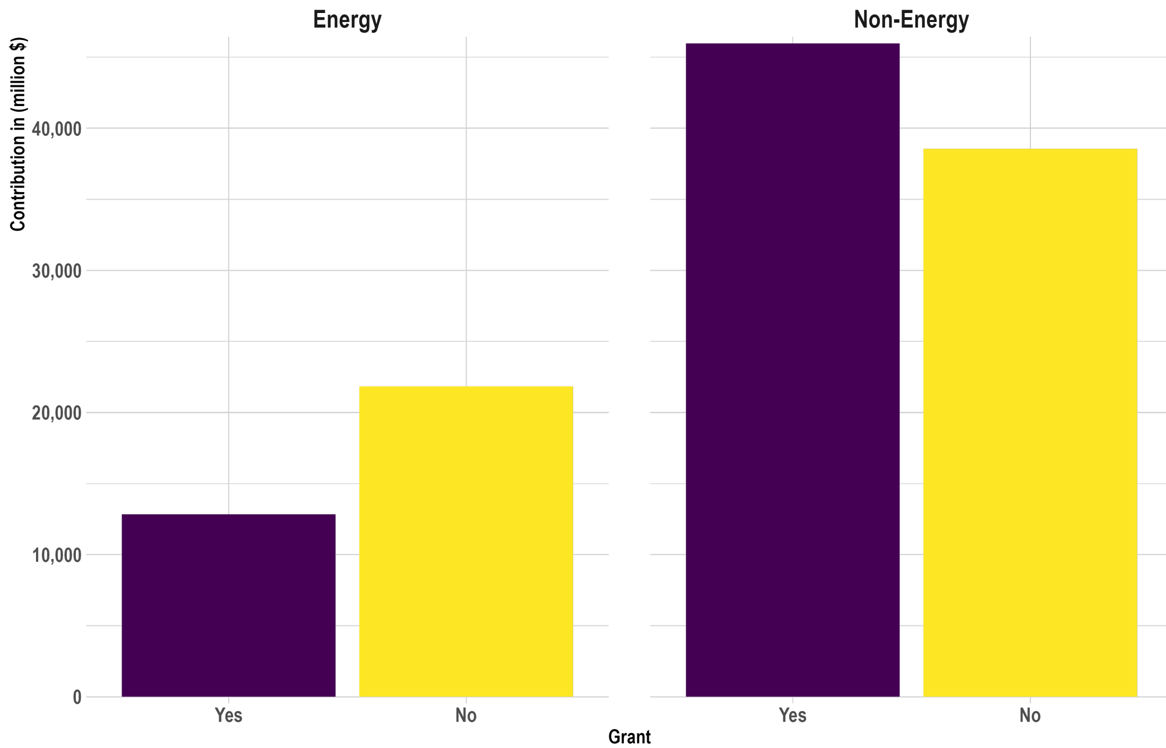

Figure 6: Climate finance contributions to projects by sector and by grant
Source: UNFCCC Climate Finance Data Portal, 2023

on transport and cooking fuels, which are essential for the mass population. However, they also lack the fiscal resources to promote and invest in renewable energy projects, which require high up-front costs (WorldBank, 2023). In order to speed the energy transition, and expand mitigation projects Nest et al., 2020 proposes climate finance to be optimized for impact and effectiveness, strengthening anti-corruption efforts particularly on renewable energy, low carbon transport and energy efficiency projects.

Countries' market and economic conditions, regulatory framework, capacity building, governance quality and political risk are crucial for clean energy investment. Given the characteristics of the investment, its is reasonable to expect that clean energy project investments will be higher in places with favorable conditions. We can observe such relationship thanks to the renewable energy indicator – a proxy for progress in the investment climate for investment in renewables –, developed by the World Bank and ESMAP's Regulatory Indicators for Sustainable Energy (RISE), and governance indicators provided by the World Governance Indicators (Kaufmann & Kraay, 2023). Figures 7 and 8 show a positive relationship between the government effectiveness indicator (GGE) [12] and the RISE sub-indicator of incentives and regulatory support for renewable

[12]The higher, the better.

energy, and the same indicator with the overall renewable energy pillar indicator. The relationship trend is preserved across income level groups, such that lower GGE is observed for lower income level countries that also have lower renewable energy investment climate.

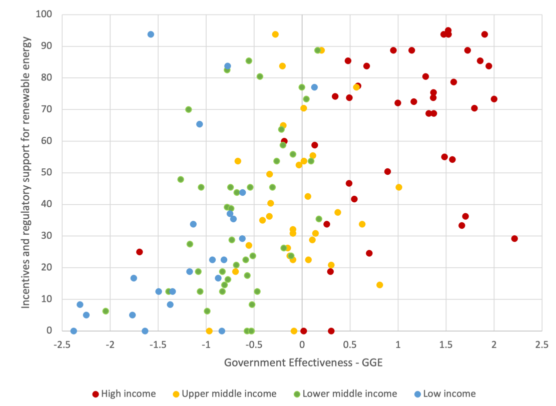

Figure 7: Incentives and regulatory support indicator vs Government effectiveness, 2019
Source: RISE 2019 and World Governance Indicators

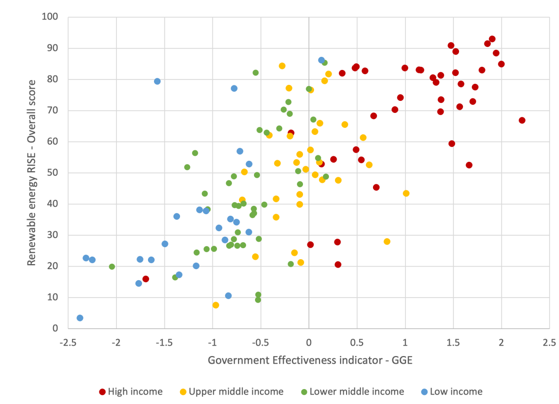

Figure 8: Renewable energy indicator vs Government effectiveness, 2019
Source: RISE 2019 and World Governance Indicators

5 Factors influencing climate finance allocation

Following our analysis and based on the theory and literature, we identify some factors that may influence climate finance in developing countries.

- **Global climate change factors**: a distinctive characteristic of climate finance is the sense of urgency, motivated by increasing global GHG emissions or rising temperatures. Thus, indicators of worsening climate conditions may increase greater climate finance mobilization.
- **Project level factors**
  - **Type of support**: Taking into account the objectives of climate finance, and the non-excludability of emissions reductions, mitigation projects would be provided by more climate finance.
  - **Sector of the project**: In the same line, due to its role on emissions, energy-related projects, and transport-related projects are expected to be more likely to get funded.
  - **Type of finance instrument**: From the literature and our analysis, given that climate finance is provided mostly by debt-financing (loans), then project finance should respond correctly to economic conditions such as economic openness, economic risks and property rights protection. Also, there would be fewer incentives to funds misuse and higher monitoring should be expected.
  - **Status of funds**: since climate finance commitments are not binding by design, contributor countries would tend to commit to fund more projects and at higher amounts.

If commitments were binding, we would see a smaller gap between committed and disbursed projects.

- **Recipient country's factors**:
  - **Economic factors**: we summarize some of these factors below:
    - Size of the economy: income level is actually part of the criteria to access climate finance, therefore climate projects of lower income countries are expected to be recipient of climate finance. Also, despite the income classification, income stability and a balanced budget that indicates fiscal discipline can encourage higher project investments. On the other hand, size of the population is another factor to consider since the impact of projects can be greater in larger populations. Also –in the case of energy-related projects – because bigger population increase the need for energy consumption so the demand for clean energies projects is expected to increase. Indeed, a study on the determinants of firms' green investments finds a positive effect of GDP and population size in green investment levels (Barabanov, Basnet, Walker, Yuan, & Wendt, 2021) .
    - Economic risk factors, which includes macroeconomic factors, that bring economic stability and predictability can incentivize private investment as economic stability lowers the investment risk. This is more relevant for debt financing projects. Moreover, governments with stable budget or fiscal balances are associated with fiscal discipline, lower default risk and higher reliability; thus we expect lower climate finance for countries with budget imbalances. On the other hand, economic openness (or openness to trade) of recipient countries signal higher interest in aligning to international standards, therefore it may increase reliability and attractiveness for climate investment or finance.
    - Strong financial markets can help to mobilize funds more easily through new financial instruments –for example blended finance or corporate financial instruments–, therefore, countries with better financial markets may be more likely to get climate finance.
  - **Socioeconomic factors**: Countries with impoverished populations vulnerable to climate change disasters may get more climate finance, at least in terms of funds for adaptation. Likewise, high unemployment levels and low consumer confidence usually lead to social and economic instability, which can adversely affect project investments.
  - **Energy environmental factors**:
    - Countries with higher GHG emissions and/or higher levels of energy intensity (i.e. low energy efficiency), may receive higher funds to help them reduce faster such emissions. Also, countries with higher rates of nature depletion are expected to be more likely to get funded.
    - Countries may have higher incentives to promote renewable energy projects (solar photovoltaic projects) when facing higher population with low access to electricity, aiming to increase electricity access.

* The role of renewable/clean energy in their energy matrix on climate finance is expected to be positive. Having relatively clean energy matrices may show higher commitment towards cleaner energy technology and therefore may be more likely to foster clean energies. However, we should expect that higher penetration of renewable energy in one period reduces the likelihood to get finance for renewable energy projects in the following period.
* From the openness to trade perspective, higher trade flows of low carbon energy products may show higher readiness of countries to foster clean energy projects, therefore higher funding is expected in this case.
* Finally, since bilateral climate finance may be influenced by the strategic interest of contributors, the existence of natural resources in the recipient country (extractive resources such as minerals for example), in a way to secure future use of those resources to cover their energy transition needs.

– **Governance factors**: Investment decisions are long term decisions, that is why factors such as stability and predictability of policies and regulations – shielded from political biases– are crucial to attract them. For instance, countries with clear rules, with a system protective of property rights, and an effective legal system and enforcement, offer a favorable environment for investments and the private sector to thrive. Effective governance includes then strong and stable institutions, with high capacity building, and low bureaucracy, such that governments facilitate market interactions by minimizing transaction costs and contract costs. On the contrary, perceived corruption that usually flourish in the absence of transparency and accountability, weak rule of law (or low level of private property protection), and lack of political stability (less predictability) may affect climate finance allocation, since these factors increase the project risks particularly if the project is financed by loans. We should expect that projects in more corrupt countries may get less funding in terms of quantity, and funding in the form of loans.

In the next session, based on real data for period 2011-2019, we empirically test whether the expected relationships of these factors with climate finance happen in the real world.

6 Empirical analysis

6.1 Data

For our empirical analysis, we construct a dataset on global climate finance, governance, various indicators for energy, the environment, and the economy, and various indicators for financial and economic risks from various sources including UNFCCC Climate Finance Data Portal, 2023, IMF, 2023 , The World Bank, 2023, Global Environment Facility, 2023, Food and Agriculture Organization, 2023, Kaufmann and Kraay, 2023, The PRS Group, 2023, and Climate Watch, 2023. [13] We restrict our analysis to the period 2011-2019, and exclude year 2020 from our analysis to avoid

[13] Another data source that we initially considered is the regulatory indicators for sustainable energy (RISE) created by the Energy Sector Management Assistance Program (ESMAP) form the World Bank. RISE indicators are constructed to assess energy policy and regulatory framework that support investment in clean energy and access to

distortions due to the Covid-19 pandemic in climate finance trends.

The dataset consists of various determinants for funding contribution for a climate change project, denoted as $Contribution_{p,s,r,n,c,y}$ and given in US dollar. Subscripts p, s, r, n, c, and y on the variables in this Section represent observation units for a climate change project (p) in a sector (s) in a recipient country (r) in a continent (n) contributed by a contributor country/organization (c) in year (y).[14]

Table 2 provides a summary statistics for $Contribution_{p,s,r,n,c,y}$ by $Energy_s$, a dummy variable for the energy sector.[15]

Table 2: Summary statistics for $Contribution_{p,s,r,n,c,y}$

Variable	$Energy_s$	Mean	Std.Dev.	Min	Q1	Median	Q2	Max
$Contribution_{p,s,r,n,c,y}$	Yes	5723235.24	23554437.7	-38382142	42779.5	410000	2100000	551380000
	No	1807144.37	10410810.8	-33924246	16832	102631.12	530000	398300584

$\mathbf{Governance}_{r,y-2}$ is the vector of two-year lagged governance-related indicators, which encompasses several aspects of governance including (1) control of corruption, (2) voice and accountability, (3) regulatory quality, (4) government effectiveness, (5) rule of law, and (6) political stability and absence of terrorism/violence.[16] The indicators for these six categories, provided by Kaufmann and Kraay, 2023 (WGI), are described in Table 9; the WGI indicators vary within the $[-2.5, 2.5]$ range such that higher values mean better governance. The vector $\mathbf{Governance}_{r,y-2}$ also includes the additional indicators for more details in each category of the WGI provided by The PRS Group, 2023, and described in Table 10. PRS indicators vary in range, but for all of them, higher values indicates better situations. Table 3 provides a summary statistics for the selected variables in vector $\mathbf{Governance}_{r,y-2}$.

$\mathbf{EnergyEnvironment}_{r,c,y-1}$ is the vector of one-year lagged environment- and energy-related indicators for the recipient country r. The vector $\mathbf{EnergyEnvironment}_{r,c,y-1}$ includes (1) energy intensity, (2) exports and imports of low carbon technology products between the recipient and the contributor countries,[17] (3) greenhouse gas emissions from various sectors, (4) access to elec-

it. RISE depend on four pillars: access to electricity, access to clean cooking, energy efficiency, and renewable energy. For our study, we did not get access to such dataset, so instead we used available energy sector indicators that may capture some of RISE's information.

[14]Note that one climate change project can involve multiple sectors (i.e., (1) the agricultural sector and (2) the water sector), except for the energy sector. For climate change projects involving multiple sectors, we assume that the funding contribution is equally allocated across all the involved sectors. The number of such climate change projects is 2,174, while the number of all the projects is 16,804. In particular, for the energy sector, we use observations with climate change projects that involve solely the energy sector. Additionally, we also assume that if the project encompasses multiple countries, the funding contribution for such project is equally allocated. The number of the projects that were in multiple countries is 1,535.

[15]Out of 52,833 observations, 738 exhibit a negative $Contribution_{p,s,r,n,c,y}$. The empirical analysis presented in this Section is anticipated to remain robust, even when incorporating these observations with negative contributions.

[16]We consider the two-year lagged governance variables, because one country's governance quality tends to evolve slowly.

[17]Products based on low-carbon technology generate fewer greenhouse gas emissions than traditional energy solu-

Table 3: Summary statistics for $\textbf{Governance}_{r,y-2}$

Variable	$Energy_s$	Mean	Std.Dev.	Min	Q1	Median	Q2	Max
$Contract\_Viability_{r,y-2}$	Yes	2.5617	0.2989	0.5	2.4203	2.5	2.6667	4
	No	2.5291	0.3241	0.5	2.4203	2.5	2.6205	4
$Control\_of\_Corruption_{r,y-2}$	Yes	-0.544	0.334	-1.7698	-0.7088	-0.5598	-0.4375	1.6366
	No	-0.5799	0.3367	-1.7698	-0.7088	-0.5598	-0.4535	2.0705
$Ethnic\_Tensions_{r,y-2}$	Yes	3.4198	0.7794	1	3.022	3.3292	4	6
	No	3.4462	0.8149	1	3	3.3473	4.0147	6
$Government\_Cohesion_{r,y-2}$	Yes	2.7681	0.3069	1.875	2.5938	2.7378	2.9142	4
	No	2.7461	0.2994	1.7083	2.5417	2.7378	2.9142	4
$Law\_and\_Order_{r,y-2}$	Yes	3.0872	0.6498	0.5	2.5	3.0285	3.5	5
	No	2.9666	0.7134	0.5	2.4167	3.012	3.375	6
$Legislative\_Strength_{r,y-2}$	Yes	2.3991	0.3268	1.5	2.2311	2.344	2.4583	4
	No	2.3686	0.2997	1.5	2.2256	2.3333	2.44	4
$Rule\_of\_Law_{r,y-2}$	Yes	0.0769	0.937	-4.80	-0.520	-0.130	0.504	7.67
	No	-0.0115	1.01	-5.17	-0.485	-0.130	0.414	9.60
$Popular\_Support_{r,y-2}$	Yes	2.085	0.2651	0	2	2.0579	2.1595	3.6667
	No	2.065	0.2641	0	2	2.0564	2.1355	3.6667
$Voice\_and\_Accountability_{r,y-2}$	Yes	-0.3495	0.4723	-2.2592	-0.5749	-0.3825	-0.0463	1.2134
	No	-0.3727	0.4795	-2.2592	-0.5858	-0.3325	-0.0408	1.3875

tricity in urban and rural areas, (5) fuel imports and exports, (6) depletion of energy and natural resources, (7) rents from natural resources, and (8) access to basic drinking water. The details on these variables are provided in Table 11 in Appendix. Table 4 provides a summary statistics for the selected variables in vector $\textbf{EnergyEnvironment}_{r,c,y-1}$.

Table 4: Summary statistics for $\textbf{EnergyEnvironment}_{r,c,y-1}$

Variable	$Energy_s$	Mean	Std.Dev.	Min	Q1	Median	Q2	Max
$Access\_to\_Electricity\_Urban_{r,y-1}$	Yes	89.2881	13.9612	7.2	76.6907	97.3018	99.6732	100
	No	88.2863	15.429	7.2	75.3419	97.2573	99.0926	100
$Electricity\_Capacity\_Renewable\_excluding\_Hydro_{r,y-1}$	Yes	7.3442	5.7644	0	2.8122	6.6415	10.614	63.2237
	No	8.015	6.5885	0	3.3301	7.508	10.7074	63.2237
$Exports\_of\_Low\_Carbon\_Tech.\_Products_{r,c,y-1}$	Yes	74.25	321.1643	0	0.9737	1.6765	2.364	1572.3721
	No	54.2598	274.4348	0	0.917	1.6147	2.2001	1572.3721
$GHG\_Emissions\_LUCF_{r,y-1}$	Yes	35.2789	120.5791	-707.6	-0.6823	37.1175	55.5414	1147.43
	No	48.7781	117.7534	-707.6	0.0907	39.0036	57.54	1147.43
$GHG\_Emissions\_Manufacturing\_Construction_{r,y-1}$	Yes	88.8133	320.6468	0	2.5687	8.6653	31.32	3111.27
	No	56.1213	202.722	0	2.3496	5.78	18.8135	3111.27
$GHG\_Emissions\_Other\_Fuel\_Combustion_{r,y-1}$	Yes	8.1768	23.1904	0	0.4674	1.2285	5.43	208.9
	No	5.6401	15.0632	0	0.42	1.09	4.0806	208.9
$Fuel\_Exports_{r,y-1}$	Yes	11.9092	12.0131	0	7.2097	9.9273	13.878	99.9865
	No	11.754	11.5476	0	5.522	9.9273	15.4025	99.9865
$Natural\_Resources\_Rents_{r,y-1}$	Yes	5.1691	4.2225	0	2.2553	3.8902	7.4886	56.3427
	No	5.3757	4.5415	0	2.4374	3.9687	7.6629	79.4309

tions, serving a critical function in transitioning to a low-carbon economy. Examples of such low-carbon technologies encompass mechanisms such as wind turbines, solar panels, biomass systems, and carbon capture equipment.(IMF, 2023)

$\mathbf{EconomicRisks}_{r,y-1}$ is the vector of one-year lagged economy-related risk indicators for the recipient country r. The vector $\mathbf{EconomicRisks}_{r,y-1}$ includes risks associated with (1) budget balance, (2) debt service, (3) exchange rate stability, (4) foreign debt, (5) inflation, (6) international liquidity, (7) current account, (8) GDP growth, and (9) GDP per capita. The details on these variables are provided in Table 13 in Appendix. Table 5 provides a summary statistics for the selected variables in vector $\mathbf{EconomicRisks}_{r,y-1}$.

Table 5: Summary statistics for $\mathbf{EconomicRisks}_{r,y-1}$

Variable	$Energy_s$	Mean	Std.Dev.	Min	Q1	Median	Q2	Max
$Risk\_for\_Budget\_Balance_{r,y-1}$	Yes	5.636	0.8243	1	5.2251	5.6736	6.1039	10
	No	5.6728	0.8702	0	5.2276	5.6736	6.25	10
$Risk\_for\_Current\_Account\_as\_percentage\_of\_XGS_{r,y-1}$	Yes	10.4698	1.5968	0	9.1712	10.9167	11.5	15
	No	10.4015	1.6914	0	9.3333	10.875	11.439	15
$Risk\_for\_Debt\_Service_{r,y-1}$	Yes	9.4513	0.5888	0	9.25	9.5534	9.7918	10
	No	9.4607	0.6349	0	9.25	9.5496	9.8039	10
$Risk\_for\_International\_Liquidity_{r,y-1}$	Yes	2.5993	0.9963	0	1.947	2.5833	3.2959	5
	No	2.6148	1.0765	0	1.947	2.7266	3.3362	5
$Risk\_for\_Per\_Capita\_GDP_{r,y-1}$	Yes	0.7711	0.7155	0	0.1359	0.6336	1.3288	5
	No	0.7447	0.702	0	0.1216	0.5984	1.3383	5

$\mathbf{SocioeconomicFactors}_{r,y-1}$ is the vector of one-year lagged socioeconomic indicators for the recipient country r. The vector $\mathbf{SocioeconomicFactors}_{r,y-1}$ includes (1) GDP per capita based on purchasing power parity (GDP PPP), (2) the size of population, (3) unemployment, (4) consumer confidence, and (5) poverty. The details on these variables are provided in Table 12 in Appendix.

$\mathbf{X}_p$ is the vector of project characteristics. The vector $\mathbf{X}_p$ includes (1) whether the funding contribution is grant; (2) whether the funding for the project p is only committed or disbursed/provided; (3) whether the funding contributor for the project p is a single country or a multilateral fund/organization such as the Special Climate Change Fund and the Global Environmental Facility; (4) whether the project p is adaptation, mitigation, or cross-cutting; and (5) whether the project is aimed at lowering carbon emissions through the prevention of deforestation and forest degradation in developing countries, all while supporting the climate - specifically through sustainable forest management and the preservation and increase of forest carbon stocks (known as REDD+).

6.2 Empirical model

In this Subsection, we use the panel dataset described in the previous Subsection to estimate the climate funding decisions on climate change projects in recipient countries, particularly for the projects in the energy sector, provided in equation (1).

$$
\begin{aligned}
Contribution_{p,s,r,n,c,y} = \big(\, & \boldsymbol{\beta}_G \cdot \mathbf{Governance}_{r,y-2} + \\
& \boldsymbol{\beta}_E \cdot \mathbf{EnergyEnvironment}_{r,c,y-1} + \\
& \boldsymbol{\beta}_F \cdot \mathbf{EconomicRisks}_{r,y-1} + \\
& \boldsymbol{\beta}_R \cdot \mathbf{SocioeconomicFactors}_{r,y-1} \big) \times Energy_s + \\
& \gamma \cdot \mathbf{X}_p + \alpha + \mu_s + \psi_r + \kappa_n + \chi_c + \phi_{c,r} + \eta_y + \epsilon_{p,s,r,n,c,y} \,. \qquad (1)
\end{aligned}
$$

In principle, equation (1) could be estimated by applying simple ordinary least square (OLS) models with pooled cross-sections in the dataset. However, there might be several unobserved factors that persistently affect the funding decisions. Even after controlling for the effects of governance, environmental, energy, and economic factors, and economic and political risks, some funding decisions are made for other reasons that we are not directly observing. For example, we do not directly observe private information about the relationship between the contributor and the recipient countries that can influence their funding decisions. Therefore, we should consider controlling for a contributor-recipient-specific unobserved effect.

Fixed-effects (FE) estimators are often considered to control individual-specific unobserved effects. Some of the countries' or sectors' unobserved factors, for example, private information over the two countries' relationships for funding contracts, can be correlated to variables of partisanship or social media and might not be randomly distributed.

Equation (1) assumes that the relationship between $Contribution_{p,s,r,n,c,y}$ and each of the variables in the vectors, $\mathbf{Governance}_{r,y-2}$, $\mathbf{EnergyEnvironment}_{r,c,y-1}$, $\mathbf{SocioeconomicFactors}_{r,y-1}$, and $\mathbf{EconomicRisks}_{r,y-1}$ varies by whether the project p is related to energy. Considering the special characteristics of the energy sector, this assumption is valid. However, this assumption of the interaction leads to 2,714 independent variables in the model. Accordingly, the simple linear FE estimator will suffer from the consequences of multicolinearity.

To robustly perform variable selection, we estimate the bootstrapped cross-validation (CV) LASSO (Least Absolute Shrinkage and Selection Operator) regression model, quantifying the uncertainty regarding variable selection. We also estimate the bootstrapped Random Forests model to determine variable importance, which indicates the variables that are more important than others. This combination is beneficial because the Random Forest may capture complex interactions and non-linear relationships between $Contribution_{p,s,r,n,c,y}$ and each of the variables in the vectors $\mathbf{Governance}_{r,y-2}$, $\mathbf{EnergyEnvironment}_{r,c,y-1}$, $\mathbf{SocioeconomicFactors}_{r,y-1}$, and $\mathbf{EconomicRisks}_{r,y-1}$ that the LASSO can miss.

Furthermore, the LASSO can help control for overfitting and provide a more parsimonious model, especially when the model has high-dimensional controls. The bootstrapped CV LASSO selects only a small subset of variables ranging from 4 to 36 out of 2,714, excluding the fixed effect dummies.[18] Additionally, we estimate the bootstrapped Random Forests model to deter-

[18]The number of the independent variables selected by the LASSO depends on the size of the penalty parameters,

mine variable importance, which provides an indication of which independent variables might be more important than others.

6.3 Results

Figure 9 shows the 20 most important variables excluding variable $Grant_p$ and the fixed-effect dummies, selected by the metric of variable importance in the Random Forests estimation.[19] Variable importance from the random forest estimation provides insights into how strongly these variables in the vectors – $\mathbf{Governance}_{r,y-2}$, $\mathbf{EnergyEnvironment}_{r,c,y-1}$, $\mathbf{SocioeconomicFactors}_{r,y-1}$, and $\mathbf{EconomicRisks}_{r,y-1}$ – are likely to be associated with the funding contribution, $Contribution_{p,s,r,n,c,y}$. This is because changes in a variable with higher importance tend to result in significant changes in the outcome variable.

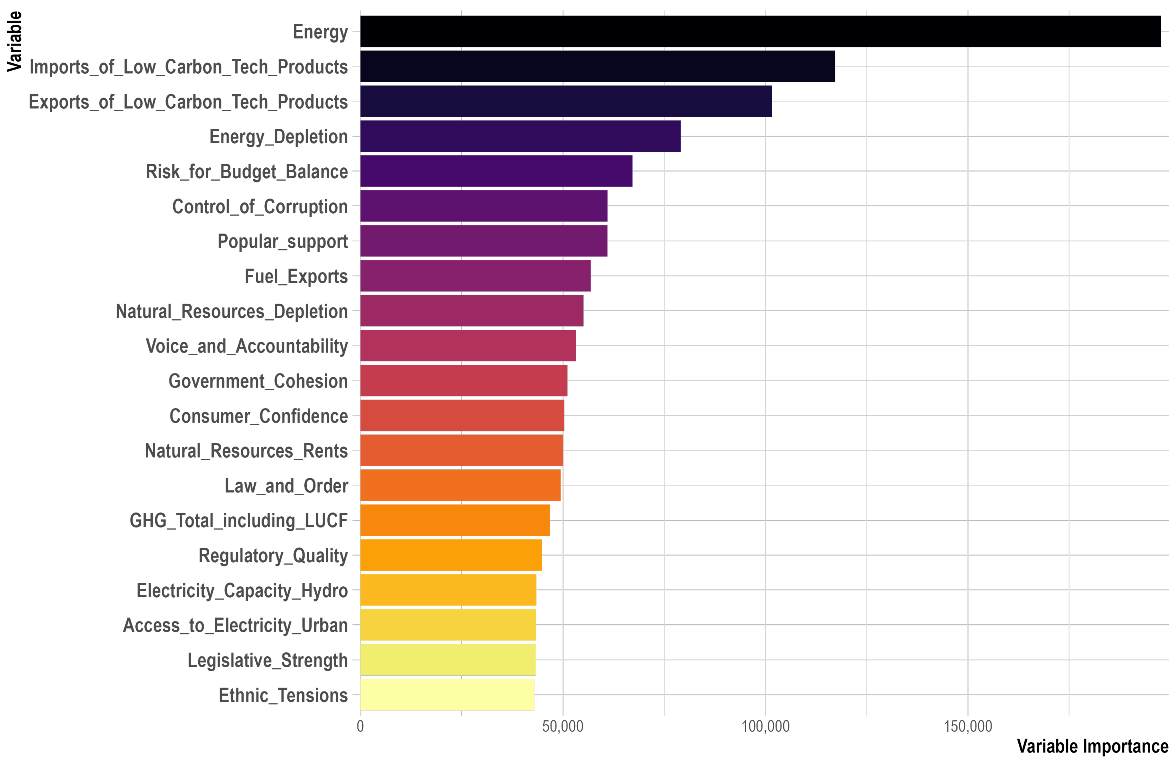

Figure 9: Top 20 Most Important Variables from the Random Forests Estimation

lambdas. For the penalty parameters lambdas, the minimum mean CV error and the CV error that is within one standard error of the CV error.

[19] Figure 9 omits variable $Grant_p$, which is selected to be the most important variable in the random forest estimation. Variable importance of $Grant_p$ is 10.18 times greater than variable $Energy_s$. This ranking is determined by the relative contribution each variable makes to the predictive power of the model. When the values of these variables change, the model's predictions are most affected. Hence, they appear higher in a variable importance ranking.

Table 6 presents estimated beta coefficients for the selected variables in $\mathbf{Governance}_{r,y-2}$ in equation (1) from the bootstrapped CV LASSO. The LASSO selects those governance-related variables that interact with $Energy_s$. Columns (1)-(6) contain the estimates depending on what FEs are controlled. Table 14 in Appendix provides the counterpart from the OLS.

Overall, the estimated coefficients on variable $Energy_s$ in Table 6 are all with relatively small bootstrap standard errors, implying reliable estimates. The estimated coefficients on variables $Legislative\_Strength_{r,y-1} \times Energy_s$, $Popular\_support_{r,y-1} \times Energy_s$, and $Voice\_and\_Accountability_{r,y-1} \times Energy_s$ are all positive with relatively small standard errors. Variable $Rule\_of\_Law_{r,y-1} \times Energy_s$ is selected only when all the FEs are controlled.

Table 7 presents estimated beta coefficients for the selected variables in $\mathbf{EnergyEnvironment}_{r,c,y-1}$ in equation (1) from the bootstrapped CV LASSO. Columns (1)-(6) contain the estimates depending on what FEs are controlled. Table 15 in Appendix provides the counterpart from the OLS.

Overall, the estimated coefficients on variable $Energy_d$ in Table 7 are all with small bootstrap standard errors, implying the reliable estimates. The estimated coefficients on variables $Access\_to\_Electricity\_Urban_{r,y-1} \times Energy_s$ and $Exports\_of\_Low\_Carbon\_Tech\_Products_{r,y-1} \times Energy_s$ are negative and positive, respectively, with relatively small standard errors. Variable $Fuel\_Exports_{r,y-1} \times Energy_s$ is selected only when all the FEs are controlled. Most GHG emissions variables interacting with $Energy_s$ are not selected when controlling the contributor FE and the contributor-recipient FE.

Table 8 presents estimated beta coefficients for the selected variables in $\mathbf{EconomicRisks}_{r,y-1}$ as well as $Population_{r,y-1}$ in equation (1) from the bootstrapped CV LASSO. Columns (1)-(6) contain the estimates depending on what FEs are controlled. The estimated coefficients on variables $Risk\_for\_Budget\_Balance_{r,y-1} \times Energy_s$ is negative with relatively small standard errors. Table 16 in Appendix provides the counterpart from the OLS.

6.4 Discussion

Based in Random Forest and LASSO estimations, our analysis show that indeed, governance factors play a crucial role in climate finance allocation. Additionally, we find that energy, environmental, and socioeconomic factors are associated with funding contribution for energy projects in developing countries. Below we discuss some of the highlighting findings:

As expected, a strong legal system, paired with clear rules, reliable enforcement, and solid social accountability are not only found to be important factors for climate finance, but particularly relevant for energy-related projects. On the other hand, higher popular support of the government in place, and higher control of corruption levels are associated to more political stability and reliability, therefore, they bring favorable conditions for higher climate finance contributions, with special emphasis in energy sectors, which involve mostly renewable energy projects. Good governance reduce uncertainty and investment risks, making project investment relatively more

Table 6: Bootstrapped CV LASSO estimates for **Governance** $_{r,y-2}$

Interaction w/ Energy LASSO	(1)	(2)	(3)	(4)	(5)	(6)
Contract_Viability	.	.	.	.	.	.
	.	.	.	.	.	.
Contract_Viability:Energy	-438134.76	-453127.89	-454461.12	-434525.2	-492357.5	.
	(9618.37)	(8255.11)	(8389.78)	(4304.1)	(0)	.
Control_of_Corruption	11762.31	19399.11	16992.94	.	.	.
	(1186.23)	(168.32)	(74.73)	.	.	.
Control_of_Corruption:Energy	582911.1	592918.8	593335.75	592595.79	361260.5	.
	(6297.5)	(4599.4)	(4641.52)	(1239.07)	(0)	.
Ethnic_Tensions	.	.	.	.	.	.
	.	.	.	.	.	.
Ethnic_Tensions:Energy	.	.	.	.	-4772.47	-302109.7
	.	.	.	.	(0)	(125966.2)
Law_and_Order	.	.	.	.	.	.
	.	.	.	.	.	.
Law_and_Order:Energy	203360.5	196393.22	199595.08	137202.16	168677.5	.
	(8403.2)	(7780.82)	(8104.24)	(7648.42)	(0)	.
Legislative_Strength	.	.	.	.	.	.
	.	.	.	.	.	.
Legislative_Strength:Energy	490787.77	390372.72	392227.09	436696.87	594191.5	748536.5
	(3537.34)	(3078.77)	(3266.08)	(3216.28)	(0)	(295523.1)
Popular_support	206317.4	180663.21	182251.47	163337.1	166903.8	.
	(1579.97)	(1297.89)	(1458.32)	(1087.1)	(0)	.
Popular_support:Energy	451151.04	470173.77	469465.62	448819.99	505163.4	95208.68
	(5883.64)	(4346.29)	(4274.76)	(2518.11)	(0)	(53034.54)
Rule_of_Law	54696.1	3290.11	3411.88	.	.	.
	(951.18)	(1560.13)	(1547.83)	.	.	.
Rule_of_Law:Energy	.	.	.	.	.	194095.82
	.	.	.	.	.	(72990.15)
Voice_and_Accountability	18567.26	.	.	.	.	.
	(623.38)	.	.	.	.	.
Voice_and_Accountability:Energy	830354.3	793857.6	791048	751479.7	939435.3	692649.8
	(13548.4)	(10806.6)	(10522.8)	(10651.04)	(0)	(303641.1)
Year FE	No	Yes	Yes	Yes	Yes	Yes
Continent FE	No	No	Yes	Yes	Yes	Yes
Recipient FE	No	No	No	Yes	Yes	Yes
Contributor FE	No	No	No	No	Yes	Yes
Contributor-Recipient FE	No	No	No	No	No	Yes

Estimates are the mean value of estimates from the bootstrap.
Bootstrapped standard errors are in the parentheses.

attractive.

- Legislative strength: The estimated coefficients for variable $Legislative\_Strength_{r,y-1} \times Energy_s$ implies that all else being equal, an increase in $Legislative\_Strength_{r,y-1}$ score by one standard deviation (0.33) is associated with an increase in $Contribution_{p,s,r,n,c,y}$ for the energy-

Table 7: Bootstrapped CV LASSO estimates for **EnergyEnvironment**$_{r,c,y-1}$

Interaction w/ Energy LASSO	(1)	(2)	(3)	(4)	(5)	(6)
Access_to_Electricity_Urban	-141992.37	-168463.15	-166600.47	.	.	.
	(4993.34)	(2696.49)	(2508.34)	.	.	.
Access_to_Electricity_Urban:Energy	-1896060.7	-1862315.6	-1860602.9	-1812734	-1593928	-1089217
	(13933.1)	(10753.6)	(10580.6)	(7140.4)	(0)	(432877)
Electricity_Capacity_Renewables_excluding_Hydro	.	.	.	.	.	.
	.	.	.	.	.	.
Electricity_Capacity_Renewables_excluding_Hydro:Energy	-49413.63	.	.	-95519.25	-212452.4	.
	(4991.28)	.	.	(1842.21)	(0)	.
Exports_of_Low_Carbon_Tech_Products	-792.7	-472.08	-473.42	-650.79	-723.14	-529.42
	(15.37)	(10.51)	(10.65)	(8.56)	(0)	(244.25)
Exports_of_Low_Carbon_Tech_Products:Energy	690.46	713.85	713.96	788.2	1162.02	836.18
	(9.76)	(8.34)	(8.36)	(5.22)	(0)	(355.12)
GHG_Land_Use_Change_and_Forestry	.	.	.	.	.	.
	.	.	.	.	.	.
GHG_Land_Use_Change_and_Forestry:Energy	31681.08	40874.47	42928.9	1045.06	.	.
	(3200.11)	(4128.73)	(4336.25)	(105.56)	.	.
GHG_Manufacturing_Construction	.	.	.	.	.	.
	.	.	.	.	.	.
GHG_Manufacturing_Construction:Energy	-96053.59	-74702.88	-75330.37	-41299.64	.	.
	(9702.38)	(7545.75)	(7609.13)	(4171.68)	.	.
GHG_Other_Fuel_Combustion	.	.	.	.	.	.
	.	.	.	.	.	.
GHG_Other_Fuel_Combustion:Energy	.	.	.	-75002.37	-18410.82	.
	.	.	.	(7576)	(0)	.
Fuel_Exports	.	.	.	.	.	.
	.	.	.	.	.	.
Fuel_Exports:Energy	.	.	.	.	.	-104045.64
	.	.	.	.	.	(73300.47)
Natural_Resources_Rents	283561.64	188055.44	188586.97	51879.36	22940.64	40072.62
	(890.57)	(957.58)	(1011.27)	(202.31)	(0)	(20184.63)
Natural_Resources_Rents:Energy	195693.32	256816.45	255788.13	258552.2	82848.16	.
	(637.21)	(94.46)	(198.33)	(86.04)	(0)	.
Year FE	No	Yes	Yes	Yes	Yes	Yes
Continent FE	No	No	Yes	Yes	Yes	Yes
Recipient FE	No	No	No	Yes	Yes	Yes
Contributor FE	No	No	No	No	Yes	Yes
Contributor-Recipient FE	No	No	No	No	No	Yes

Estimates are the mean value of estimates from the bootstrap.
Bootstrapped standard errors are in the parentheses.

related climate change project by $748,536.

- Popular support: The estimated coefficients for variable $Popular\_Support_{r,y-1} \times Energy_s$ implies that all else being equal, an increase in $Popular\_support_{r,y-1}$ score by one standard deviation (0.27) is associated with an increase in $Contribution_{p,s,r,n,c,y}$ for the energy-related climate change project by $95,209.

- Rule of law: The estimated coefficients for variable $Rule\_of\_Law_{r,y-1} \times Energy_s$ implies that all else being equal, an increase in $Rule\_of\_Law_{r,y-1}$ score by one standard deviation (1.00) is associated with an increase in $Contribution_{p,s,r,n,c,y}$ for the energy-related climate change project by $194,095.

Table 8: Bootstrapped CV LASSO estimates for $\textbf{EconomicRisks}_{r,y-1}$ and $Population_{r,y-1}$

Interaction w/ Energy LASSO	(1)	(2)	(3)	(4)	(5)	(6)
Population	-8.14	.	.	.	.	.
	(0.82)	.	.	.	.	.
Population:Energy	3026.76	3141.89	3135.34	3134.85	2969.48	1724.26
	(32.46)	(25.97)	(25.31)	(22.35)	(0)	(662.65)
Risk_for_Budget_Balance	.	.	.	.	60126.16	.
	.	.	.	.	(0)	.
Risk_for_Budget_Balance:Energy	-776515.25	-762734.14	-759797.6	-766949.11	-602339.6	-450639.5
	(10027.54)	(8137.59)	(7840.97)	(4859.94)	(0)	(187599.1)
Risk_for_Current_Account_as_percentage_of_XGS	.	.	.	.	.	.
	.	.	.	.	.	.
Risk_for_Current_Account_as_percentage_of_XGS:Energy	637407.43	625703	625932.76	675757.97	667225.8	196206.6
	(21392.72)	(17508.2)	(17531.41)	(14032.28)	(0)	(125966.2)
Risk_for_Current_Account_as_percentage_of_XGS	.	.	.	.	.	.
	.	.	.	.	.	.
Risk_for_Current_Account_as_percentage_of_XGS:Energy	637407.43	625703	625932.76	675757.97	667225.8	196206.6
	(21392.72)	(17508.2)	(17531.41)	(14032.28)	(0)	(144567.2)
Risk_for_Debt_Service	9237.52	49604.49	49588.22	89409.12	133336.9	.
	(933.08)	(1531.41)	(1529.76)	(1438.46)	(0)	.
Risk_for_Debt_Service:Energy	.	.	.	.	.	-38817.7
	.	.	.	.	.	(29100.71)
Risk_for_International_Liquidity	.	.	.	.	.	.
	.	.	.	.	.	.
Risk_for_International_Liquidity:Energy	709195.55	658733.02	655567.6	765431.92	526185.4	92210.33
	(21401.54)	(16488.77)	(16169.03)	(17309.82)	(0)	(68710.91)
Risk_for_Per_Capita_GDP	.	.	.	.	.	.
	.	.	.	.	.	.
Risk_for_Per_Capita_GDP:Energy	-367619.08	-320923.9	-320044.34	-376630.4	-319745.6	-17535.13
	(21463.25)	(16603.4)	(16514.56)	(16141.01)	(0)	(14091.55)
Year FE	No	Yes	Yes	Yes	Yes	Yes
Continent FE	No	No	Yes	Yes	Yes	Yes
Recipient FE	No	No	No	Yes	Yes	Yes
Contributor FE	No	No	No	No	Yes	Yes
Contributor-Recipient FE	No	No	No	No	No	Yes

Estimates are the mean value of estimates from the bootstrap.
Bootstrapped standard errors are in the parentheses.

- Voice and accountability: The estimated coefficients for variable $Voice\_and\_Accountability_{r,y-1} \times Energy_s$ implies that all else being equal, an increase in $Voice\_and\_Accountability_{r,y-1}$ score by one standard deviation (0.47) is associated with an increase in $Contribution_{p,s,r,n,c,y}$ for the energy-related climate change project by $692,650.

Regarding the energy and environment factors, we find that, as expected, higher access to electricity leads to lower contribution, particularly in energy. Let's remember that a significant portion of the climate finance projects are mitigation projects that consist mostly of energy projects. For low income countries, higher electricity service coverage would allow them to focus on solving problems in other sectors or perhaps on adaptation projects.

GHG emissions of recipient countries' were expected to influence in climate finance contributions. According to our results, the effect may not be evident with the emitter sector whenever the attention is focused on energy-related projects. For example, if there is no unobserved hetero-

geneity between the contributor and the recipient countries (i.e., strategic relationship between these countries), higher emissions from land use change and forestry are associated to higher contribution for energy projects. Also, energy projects may be funded as a quick way to mitigate country emissions given the difficulty of lower income countries to lower emissions from their land use. On the other hand, higher emissions coming from manufacturing and construction sector tends to diminish contributions to energy projects, we may expect that climate finance would flow towards mitigation actions for manufacturing and construction. However, these expected effects do not seem to be significant if there exists the contributor-recipient relationship that is associated with variables the model consider, for example, the bilateral trade pattern in low carbon technology products.
Additionally, according to our data, countries with higher natural resources rents seems to receive more climate change contributions, a pattern that is kept when we account for fixed effects on contributor countries, but loose significance when contributor-recipient fixed effect is used.

Contributions for energy projects seems to decrease with the recipient country's installed capacity of renewable energy, however the effect disappears when we control for contributor-recipient fixed effect. Likewise, trade flows of low carbon technological products, specifically export flows, are also positively associated with increasing contributions for energy-related projects.

- Access to electricity in urban areas: The estimated coefficients for variable $Access\_to\_Electricity\_Urban_{r,y-1} \times Energy_s$ implies that all else being equal, an increase in $Access\_to\_Electricity\_Urban_{r,y-1}$ by its one standard deviation is associated with a decrease in $Contribution_{p,s,r,n,c,y}$ for the energy-related climate change project by $1,089,217.[20] Countries with low access to electricity, particularly in urban areas, have strong incentive to invest in energy infrastructure such as electricity grids.

- Exports of low carbon technology products: The estimated coefficients for variable $Exports\_of\_Low\_Carbon\_Technology\_Products_{r,y-1} \times Energy_s$ implies that all else being equal, an increase in $Exports\_of\_Low\_Carbon\_Technology\_Products_{r,y-1}$ score by one standard deviation (353.44) is associated with an increase in $Contribution_{p,s,r,n,c,y}$ for the energy-related climate change project by $836.18. This result is intuitive in the sense that contributor countries have strong incentive to invest in countries producing a large amount of low carbon technology products to promote a transition to low carbon economy around the globe.

Besides the previous results, we find some counter-intuitive results regarding a governance indicator – ethnic tensions– and the macroeconomic factor risk of budget balance. We discuss each lines below.

- Ethnic tensions: The estimated coefficients for variable $Ethnic\_Tensions_{r,y-1} \times Energy_s$ implies that all else being equal, an increase in $Ethnic\_Tensions_{r,y-1}$ score, meaning less ethnic tensions, by one standard deviation (0.78) is associated with a decrease in $Contribution_{p,s,r,n,c,y}$ for the energy-related climate change project by $302,110. This result might be counter-intuitive in the sense that less ethnic tensions would be positively associated with improving in tackling social problems such as climate change. One

[20] In the estimation, we standardize the numeric-type of the independent variables.

possible explanation for this result is that some countries with low ethnic tensions might be dependent upon fossil fuel rents. These countries have less incentive to switch from fossil fuel to renewable energy sources. Figure 10 visualizes the relationship between ethnic tensions and fossil fuel consumption. Regardless of

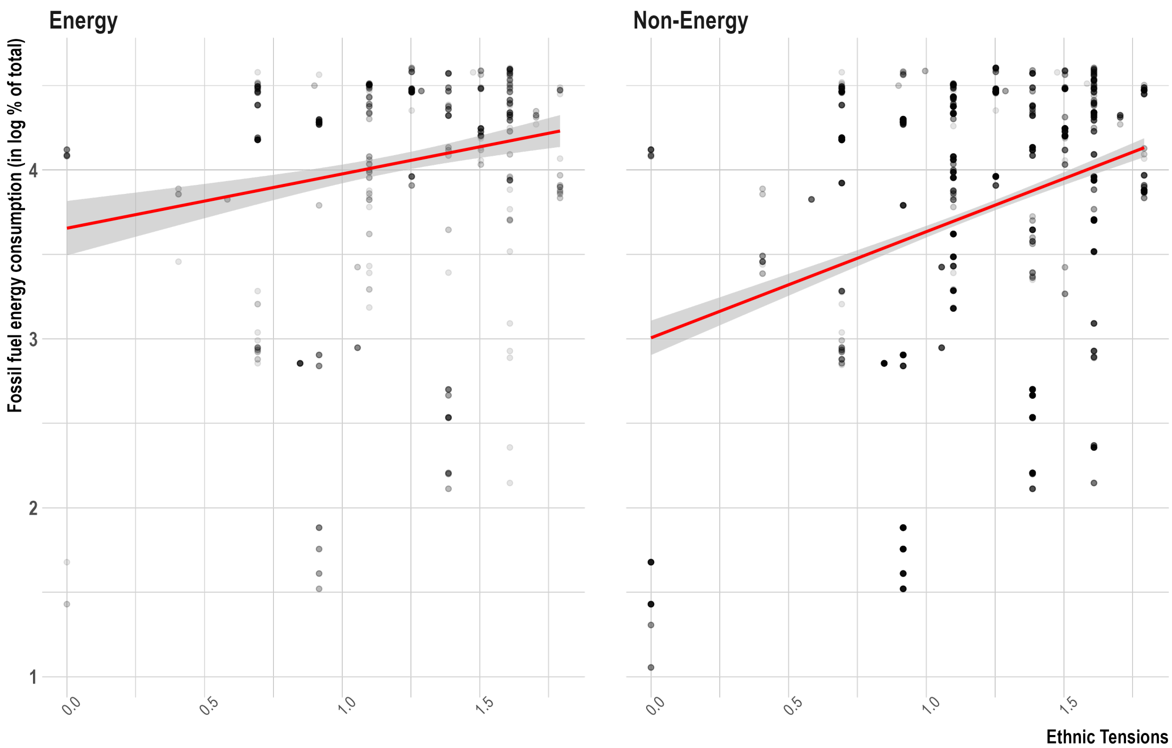

Figure 10: Ethnic tensions and fossil fuel consumption

- Risk for budget balance: The estimated coefficients for variable $Risk\_for\_Budget\_Balance_{r,y-1} \times Energy_s$ implies that all else being equal, an increase in $Risk\_for\_Budget\_Balance_{r,y-1}$ score, meaning less risk for budget balance, by one standard deviation (0.82) is associated with a decrease in $Contribution_{p,s,r,n,c,y}$ for the energy-related climate change project by $450,640. This result is also counter-intuitive in the sense that a contributor country would more likely to invest in countries with low risks for government budget balance. One possible explanation for this result is that some countries with low risks for budget balance might be dependent upon fossil fuel rents. These countries have less incentive to switch from fossil fuel to renewable energy sources.

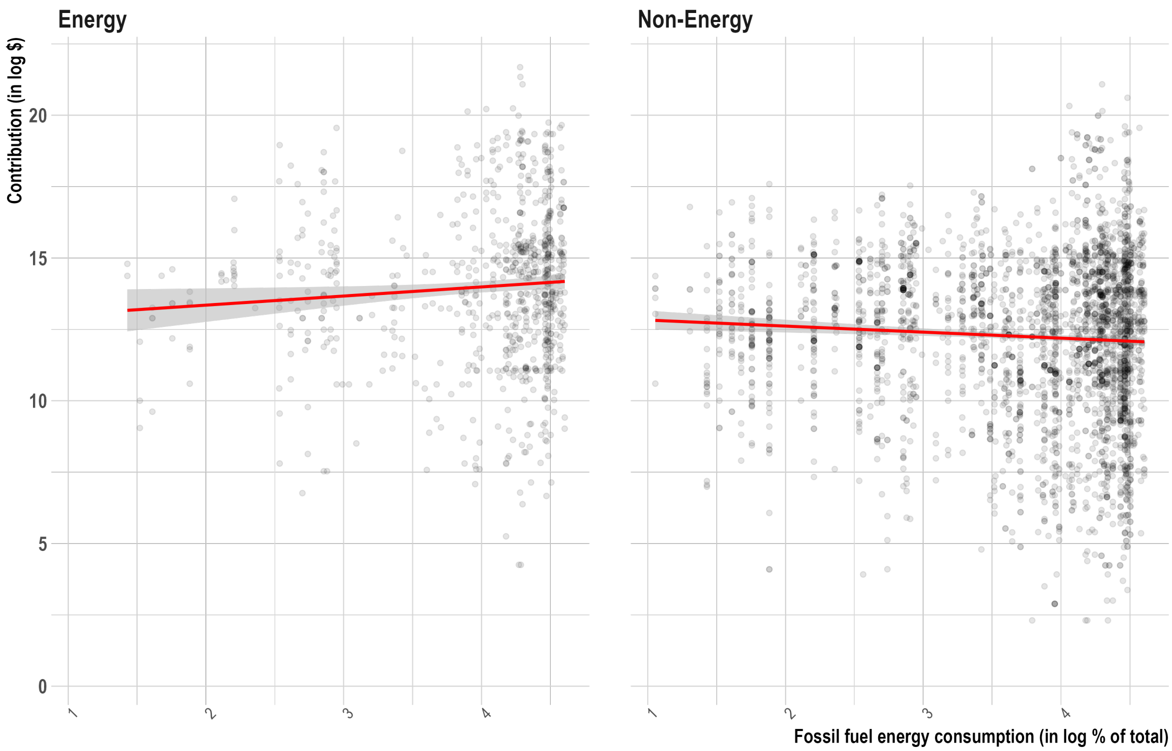

Figure 11: Budget balance risk and fossil fuel consumption

7 Conclusion

We study the determinants of funding contribution for climate change projects, particularly for energy-related ones. We find that various factors in governance, economy, energy, and the environment in developing countries determine the size of funding contribution for the energy projects in their countries.

The results of our study imply that governance quality can shape the feasibility of energy projects in the developing world. Although it is capable for the government to implement energy policies, the low quality of governance can slow down financing energy projects in developing countries. The results of our study also confirm that it is important for recipient countries to understand the microeconomic mechanism of financing energy projects through various factors in energy markets, macroeconomic conditions, and the environment in their local setting.

The results have policy implications for both contributors' and recipients' climate change projects and funding decisions. First, recipient countries with improved governance quality are able to raise higher climate funds with regards to energy projects. In particular strong legal systems, rule of law, and accountability arise as the most influential governance factors. For example, recipient countries can shape step-by-step in those details to implement energy projects that tend to require an enormous amount of funding from contributors. This would help convince contributors to invest in their energy projects.

We leave several important questions that are worth to be investigated in future research. First, we do not consider the effectiveness of climate finance on mitigating GHG emissions in the energy sector through benefit-cost analysis. Although there would be the positive association between the size of funding contribution and the amount of GHG emissions reduction, it is empirically challenging to evaluate the welfare implication of climate finance. This task may require more details in data with regards to how much an emission reduction a specific energy project realizes. Post-evaluation of the energy project should help these tasks. Second, we do not model the strategic interaction between the contributor and the recipient. For example, contributors can use contribution as a strategic instrument to influence other activities that involve both parties. This type of strategic behaviors with regards to climate finance may play an important role in transitioning into low-carbon economy in the developing world.

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Appendix

A Variable description

Variable descriptions in this Section are from the documents from the original sources.

Table 9: The World Bank's Governance Indicators

Variable	Description
Control of Corruption	The extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.
Voice and Accountability	Perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media
Regulatory Quality	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
Government Effectiveness	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies
Rule of Law	The extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence
Political Stability and Absence of Terrorism/Violence	Perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism.

Table 10: The PRS Group's Governance Indicators

Variable	Description
Government Cohesion	The extent to which the executive/cabinet is coalesced around the government's general policy goals.
Legislative Strength	Whether the government can realize its policy program through the legislative arm of government.
Repatriation	To what extent can profits be transferred out of the host country (impediments include exchange controls, excessive bureaucracy, a poor banking system, etc.)
Popular Support	The level of support for the government and/or its leader, based on credible opinion polls.
Civil War	The actual or potential risk of civil war (where a rebel force, which holds territory, is in armed conflict with the security forces of the government, and where both forces are citizens of the state in which the conflict occurs).
Terrorism	The actual or potential risk of terrorism (where forces opposed to the government carry out violent acts against civilian or state targets to achieve a political goal). The fundamental difference between a terrorist campaign and a civil war is that the former do not hold and administer territory within a nation state.
Civil Disorder	The potential risk to governance or investment from mass protest, such as anti-government demonstrations, strikes, etc.
War	Actual or potential armed conflict with another nation borne out of the desire of either combatant state to subjugate the governance of people and/or acquire territory of the other, primarily through the use of its own armed forces.
Cross-border Conflict	Actual or potential conflict with another nation state that does not affect the whole nation and which can range in severity from cross-border armed conflict and incursion to territorial claims subject to civil mediation or litigation.
Foreign Pressures	Actual or potential risk posed by pressures brought to bear on the government by one or more foreign states to force a change of policy. Such pressures can range from diplomatic pressures, through suspension of aid and/or credits, to outright sanctions.
Military in Politics	A measure of the military's involvement in politics. Since the military is not elected, involvement, even at a peripheral level, diminishes democratic accountability. Military involvement might stem from an external or internal threat, be symptomatic of underlying difficulties, or be a full-scale military takeover. Over the long term, a system of military government will almost certainly diminish effective governmental functioning, become corrupt, and create an uneasy environment for foreign businesses.
Religious Tensions	A measure of religious tensions arising from the domination of society and/or governance by a single religious group – or a desire to dominate – in a way that replaces civil law by religious law, excludes other religions from the political/social processes, suppresses religious freedom or expressions of religious identity. The risks involved range from inexperienced people imposing inappropriate policies to civil dissent or civil war.
Law & Order	Two measures comprising one risk component. Each sub-component equals half of the total. The "law" sub-component assesses the strength and impartiality of the legal system, and the "order" sub-component assesses popular observance of the law.
Ethnic Tensions	A measure of the degree of tension attributable to racial, national, or language divisions. Lower ratings (higher risk) are given to countries where tensions are high because opposing groups are intolerant and unwilling to compromise.
Democratic Accountability	A measure of, not just whether there are free and fair elections, but how responsive government is to its people. The less responsive it is, the more likely it will fall. Even democratically elected governments can delude themselves into thinking they know what is best for the people, regardless of clear indications to the contrary from the people.
Contract Viability	The risk of unilateral contract modification or cancellation and, at worst, outright expropriation of foreign owned assets.
Bureaucracy Quality	Institutional strength and quality of the bureaucracy is a shock absorber that tends to minimize revisions of policy when governments change. In low-risk countries, the bureaucracy is somewhat autonomous from political pressure.

Table 11: The World Bank, the IMF, and the FAO's Data on Energy and the Environment

Variable	Description
Energy Intensity Level of Primary Energy (MJ/$2017 PPP GDP)	Energy intensity level of primary energy is the ratio between energy supply and gross domestic product measured at purchasing power parity. Energy intensity is an indication of how much energy is used to produce one unit of economic output. Lower ratio indicates that less energy is used to produce one unit of output.
Exports and imports of low carbon technology products	Low carbon technologies include mechanics like wind turbines, solar panels, biomass systems and carbon capture equipment.
Greenhouse Gas Emissions from Various Sectors	Greenhouse gas emissions from each of various sectors, including (a) energy, (b) electricity and heat, (c) transportation, (d) manufacturing and construction, (e) agriculture, (f) fugitive emissions, (g) industrial process, (h) building, waste, (i) land use change and forestry, (j) bunker fuels, and (k) other fuel combustion
Access to Electricity in Urban and Rural Areas	Access to electricity is the percentage of population with access to electricity. Electrification data are collected from industry, national surveys and international sources.
Fuel Imports and Exports	Fuels comprise the commodities in mineral fuels, lubricants and related materials.
Energy Depletion	Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas.
Natural Resources Depletion	Natural resource depletion is the sum of net forest depletion, energy depletion, and mineral depletion. Net forest depletion is unit resource rents times the excess of roundwood harvest over natural growth. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas. Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime (capped at 25 years). It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.
Natural Resources Rents	Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.
Access to Basic Drinking Water	Percentage of population using at least basic drinking water services

Table 12: The World Bank, the IMF, and the PRS Group's Finance and Economic Indicators

Variable	Description
GDP PPP	GDP, PPP (constant 2017 international $)
Population	Population, total
Unemployment	The official rate as defined by credible sources (e.g. IMF, World Bank, CIA Factbook); significant levels of underemployment or employment in the informal economy in emerging markets can affect the rating.
Consumer Confidence	The level of consumer confidence vis-à-vis credible surveys, where available, or approximations based on employment trends, economic growth and investment, etc.
Poverty	The level of poverty vis-à-vis credible sources (e.g., IMF, World Bank, CIA Factbook)

Table 13: The PRS Group's Data on Financial and Economic Risks

Variable	Description
Risk for Budget Balance	Ranging from high % of 4.0+ with risk points at 10.0, to a low of -30.0 with 0.0 points. The higher the points, the lower the risk.
Risk for Debt Service	Ranging from high % of >85.0 with risk points at 0.0, to a low of 0.0 with 10.0 points. The higher the points, the lower the risk.
Risk for Exchange Rate Stability	Ranging from high % change of either 0.0 - 9.9 appreciation or depreciation of 0.1-4.9 with risk points at 10.0, to a midpoint of either appreciation at 50.0+ or depreciation of 30.0 - 34.9 with risk points at 5.0 to a low depreciation of 100.0+ with 0.0 points. The higher the points, the lower the risk.
Risk for Foreign Debt	Ranging from high % of >200.0 with risk points at 0.0, to a low of 0.0 with 10.0 points. The higher the points, the lower the risk.
Risk for GDP Growth	Risk points determined by expressing this number as a percentage of the average of the estimated total GDP of all the countries covered by ICRG, then assigning risk points, ranging from high % of 6+ with risk at 10.0, to a low of <0.4 with 5.0 points. The higher the points, the lower the risk.
Risk for Inflation	Ranging from high % of 130+ with risk points at 0.0, to a low of 0.0 with 10.0 points. The higher the points, the lower the risk.
Risk for International Liquidity	Ranging from high % of 15.0+ with risk points at 5.0, to a low of 0.0 with 0.0 points. The higher the points, the lower the risk.
Risk for Per Capita GDP	Risk points determined by expressing this number as a percentage of the average of the estimated total GDP of all the countries covered by ICRG, then assigning risk points ranging from high % of 250+ with risk at 5.0 points, to low of <10 with O.0 points. The higher the points, the lower the risk.

B OLS estimates

Table 14: OLS estimates for **Governance**$_{r,y-1}$

Interaction w/ Energy OLS	(1)	(2)	(3)	(4)	(5)	(6)
Contract_Viability	-35102.44	-82051.92	-59691	-49872.22	-161234.72	62689.8
	(96479.68)	(99925.25)	(101690.12)	(134531.58)	(132196.94)	(141615.06)
Contract_Viability:Energy	-48778.7	-8054.12	-22534.88	91834.12	-88589.81	1374662.29
	(327536.69)	(327488.65)	(327855.28)	(332017.15)	(326304.81)	(340527.45)
Control_of_Corruption	-45523.44	17670.31	3618.45	-984320.62	-606891.14	-779235.99
	(125259.6)	(128661.89)	(134006.32)	(292054.64)	(287424.23)	(303315.91)
Control_of_Corruption:Energy	479154.07	513425.09	498711.38	391876.36	773348.42	243580.98
	(411389.93)	(411305.51)	(411484.62)	(417810.74)	(410948.04)	(437654.71)
Ethnic_Tensions	206021.61	202169.84	-15705.88	-808831.39	-1104970.56	-115578.37
	(115799.65)	(116466.67)	(145014.28)	(714856.11)	(702469.79)	(745572.71)
Ethnic_Tensions:Energy	-1234956.42	-1275947.58	-1275491.32	-1286763.04	-1400135.99	-2747802.17
	(388363.79)	(388254.02)	(388722.38)	(398317.75)	(391839.47)	(454271.02)
Government_Cohesion	46656.12	20303.71	32763.52	42575.17	210427.19	-1083.13
	(99310.47)	(102480.49)	(103463.02)	(128384.98)	(126233.27)	(133310.94)
Government_Cohesion:Energy	-499014.13	-524610.17	-547698.44	-554050.43	-683915.17	-1425522.27
	(333226.46)	(333306.85)	(333515.83)	(336604.53)	(330847.52)	(341485.07)
Law_and_Order	-87986.97	-12293.26	-118789.2	-27259.69	-146405.4	184655.72
	(151385.29)	(153395.57)	(169045.97)	(472105.08)	(463576.71)	(489899.19)
Law_and_Order:Energy	1514255.76	1529389.41	1509746.21	1459576.22	1304585.39	247026.39
	(574460.63)	(574774.93)	(574929.48)	(587267.61)	(576529.8)	(604316.99)
Legislative_Strength	113612.17	-23609.04	6007.27	85920.25	160511.8	26191.23
	(92599.9)	(95998.25)	(97148.42)	(128633.86)	(126359.79)	(131415.72)
Legislative_Strength:Energy	1629518.81	1662857.44	1693758.97	1724196.63	2042727.48	2669907.02
	(314903.18)	(315068.97)	(315219.24)	(317902.4)	(312519.83)	(324019.97)
Popular_support	251528.29	213664.75	190019.12	191864.61	177786.07	165328.4
	(81789.17)	(83125.66)	(85488.5)	(100819.11)	(99103.04)	(103092.75)
Popular_support:Energy	802538.63	767748.12	749707.27	604093.82	598228.54	901968.48
	(283734.88)	(283633.23)	(283733.01)	(285995.79)	(281108.21)	(287371.65)
Voice_and_Accountability	155129.96	15153.98	-89597.76	81414	96962.84	1269316.8
	(203510.27)	(205908.51)	(219211.83)	(548979.75)	(540497.55)	(570652.94)
Voice_and_Accountability:Energy	4773541.1	4781733.85	4753682.19	4953584.12	4412652.84	4408768.24
	(635624.08)	(635540.4)	(637008.97)	(645183.87)	(635190.4)	(706227.64)
Year FE	No	Yes	Yes	Yes	Yes	Yes
Continent FE	No	No	Yes	Yes	Yes	Yes
Recipient FE	No	No	No	Yes	Yes	Yes
Contributor FE	No	No	No	No	Yes	Yes
Contributor-Recipient FE	No	No	No	No	No	Yes
N	52,833	52,833	52,833	52,833	52,833	52,833
R^2	0.3304	0.3317	0.3318	0.3347	0.3623	0.4524

Standard errors are in the parentheses.

Table 15: OLS estimates for $\textbf{EnergyEnvironment}_{r,c,y-1}$

Interaction w/ Energy OLS	(1)	(2)	(3)	(4)	(5)	(6)
Access_to_Electricity_Urban	-644341.24	-725645.11	-697680.45	-370698.61	-379166.53	-207322.81
	(290567.81)	(291859.88)	(294638.67)	(703966.36)	(692093)	(719031.83)
Access_to_Electricity_Urban:Energy	-1981297.48	-1912224.91	-1894638.86	-1937119.02	-1844271.54	-1433774.38
	(1062146.44)	(1061883.36)	(1062674.6)	(1074903.57)	(1056791.85)	(1079551.91)
Electricity_Capacity_Renewables_excluding_Hydro	-248444.54	-126773.13	-220569.16	-658564.21	-1628067.91	67043.84
	(138560.02)	(143306.97)	(152898.5)	(505564.57)	(497991.09)	(531343.97)
Electricity_Capacity_Renewables_excluding_Hydro:Energy	1817982.64	1902815.71	1858905.29	1825503.07	1818478.87	2305746.31
	(518175.64)	(518245.8)	(518701.36)	(525486.75)	(515951.89)	(528887.87)
Exports_of_Low_Carbon_Tech_Products	-1595.64	-1372.11	-1333.5	-1596.18	-1724.54	-1481.51
	(209.09)	(228.02)	(229.09)	(263.71)	(259.58)	(259.57)
Exports_of_Low_Carbon_Tech_Products:Energy	1060.3	1065.42	1069.1	1297.33	1939.45	2376.22
	(587.54)	(587.16)	(587.22)	(589.11)	(578.87)	(559.3)
Fuel_Exports	-172068.97	33409.11	54149.24	383566.32	303367.7	168872.2
	(140659.23)	(150475.47)	(155088.47)	(261259.38)	(256874.61)	(272247.76)
Fuel_Exports:Energy	-1601683.69	-1637212	-1564494.81	-1347742.9	-1131320.58	-2302302.1
	(492975.26)	(492968.2)	(493541.94)	(499609.32)	(492089.51)	(517144.81)
GHG_Land_Use_Change_and_Forestry	-2229840561.24	-1968551994.6	-1762430362.97	-835064119.84	-99823965.73	988735214.31
	(1442644079.03)	(1467883931.34)	(1472251233.15)	(1626588971.17)	(1595737015.7)	(1602042806.25)
GHG_Land_Use_Change_and_Forestry:Energy	23461225510.89	24323245897.18	24107110179.74	25115876331.41	24256446263.72	26917206673.57
	(4688185746.81)	(4686344217.25)	(4688456122.92)	(4711781513.52)	(4624789889.01)	(4558116958.94)
GHG_Manufacturing_Construction	-1114540688.14	-1111285226.51	-1938991711.08	-3289002880.77	-4707185168.24	-1122090012.38
	(1321641964.2)	(1327845336.29)	(1364717140.38)	(1538044041.34)	(1511561291.59)	(1512558120.91)
GHG_Manufacturing_Construction:Energy	19625567733.44	19602547989.49	19762885244.29	20161585314.12	21134734972.19	24874229513.71
	(4408036720.72)	(4405196878.53)	(4407385034.7)	(4433424375.14)	(4347849691.35)	(4342228475.54)
GHG_Other_Fuel_Combustion	-110282228.54	-110506085.86	-192135986.01	-324500656.37	-462191475.38	-110763239.25
	(130078823.29)	(130683625.82)	(134326209.01)	(151492609.9)	(148882329.34)	(148999740.23)
GHG_Other_Fuel_Combustion:Energy	1941995248.31	1939698308.08	1955230889.85	1994689426.61	2089418831.39	2465225217.2
	(433890301.35)	(433609754.31)	(433823586.35)	(436397651.35)	(427974050.21)	(427487743.68)
Natural_Resources_Rents	508720.3	329321.47	200504.16	461866.92	1020486.53	-92789.82
	(232540.36)	(240509.12)	(255732.9)	(540062.14)	(530565.61)	(570812.05)
Natural_Resources_Rents:Energy	20212.24	138234.81	183247.73	302587.22	-276222	2418235.61
	(745212.53)	(745502.52)	(745739.78)	(758601.42)	(747073.6)	(813733.51)
Year FE	No	Yes	Yes	Yes	Yes	Yes
Continent FE	No	No	Yes	Yes	Yes	Yes
Recipient FE	No	No	No	Yes	Yes	Yes
Contributor FE	No	No	No	No	Yes	Yes
Contributor-Recipient FE	No	No	No	No	No	Yes
N	52,833	52,833	52,833	52,833	52,833	52,833
R^2	0.3304	0.3317	0.3318	0.3347	0.3623	0.4524

Standard errors are in the parentheses.

Table 16: OLS estimates for $Population_{r,y-1}$ and $\textbf{EconomicRisks}_{r,y-1}$

Interaction w/ Energy OLS	(1)	(2)	(3)	(4)	(5)	(6)
Population	-1002.29	-815.26	-883.36	1229.2	1090	520.79
	(342.97)	(344.64)	(357.61)	(759.32)	(747.18)	(798.85)
Population:Energy	2820.72	2884.38	2836.36	2551.15	2609.44	3521
	(1039.36)	(1039.05)	(1039.6)	(1056.33)	(1045.44)	(1122.29)
Risk_for_Budget_Balance	219002.74	194386.93	178751.95	40203.1	119188.55	-4204.44
	(86866.65)	(87860.23)	(93442.58)	(128097.99)	(125987.85)	(133029.85)
Risk_for_Budget_Balance:Energy	-747393.07	-758167.28	-742916.72	-654427.8	-535852.94	-934907.6
	(274830.64)	(275367.2)	(275765.62)	(278716.43)	(273842.22)	(287063.34)
Risk_for_Current_Account_as_percentage_of_XGS	86217.12	87458.56	124967.24	790591.94	526580.97	280986.72
	(244200.13)	(253496.33)	(256531.45)	(353780.9)	(347081.23)	(365380.04)
Risk_for_Current_Account_as_percentage_of_XGS:Energy	3824568.95	3836304.45	3819485.18	3736987.49	3569242.2	2174571.95
	(773588.07)	(773088.46)	(773172.77)	(780447.29)	(766556.81)	(812554.55)
Risk_for_Debt_Service	259323.41	279199.61	208850.35	379298.37	483069.7	257667.52
	(78052.09)	(83301.98)	(87300.18)	(113541.61)	(111862.39)	(119186.41)
Risk_for_Debt_Service:Energy	-784309.37	-761134.93	-732988.87	-796031.92	-863956.42	-698166.01
	(249117.9)	(249328.5)	(249620.49)	(252100.44)	(247677.41)	(257364.43)
Risk_for_International_Liquidity	-81010.54	-80480.87	-97057.72	-313732.17	-566542.33	-422963.21
	(115999.14)	(118599.61)	(130869.49)	(245692.72)	(241447.9)	(251500.12)
Risk_for_International_Liquidity:Energy	2661305.31	2657752.04	2622738.98	2742981.93	2511399.39	2897227.66
	(348905.31)	(348852.54)	(349288.39)	(354497.57)	(348684.54)	(376753.91)
Risk_for_Per_Capita_GDP	186870.32	322347.38	32921.1	-1280333.04	-1433143.01	-689698.18
	(191126.29)	(193956.45)	(233506.24)	(475773.7)	(467257.67)	(488117.88)
Risk_for_Per_Capita_GDP:Energy	-2295888.04	-2386470.64	-2348249.6	-2371198.25	-2253457.53	-1453580.67
	(593728.47)	(593632.12)	(595582.59)	(609863.61)	(598652.4)	(665440.95)
Year FE	No	Yes	Yes	Yes	Yes	Yes
Continent FE	No	No	Yes	Yes	Yes	Yes
Recipient FE	No	No	No	Yes	Yes	Yes
Contributor FE	No	No	No	No	Yes	Yes
Contributor-Recipient FE	No	No	No	No	No	Yes
N	52,833	52,833	52,833	52,833	52,833	52,833
R^2	0.3304	0.3317	0.3318	0.3347	0.3623	0.4524

Standard errors are in the parentheses.

C Difference in Results between the Random Forests, the LASSO, and the OLS

Notice that some variables that appear as top 20 most important variables in the Random Forests estimation (see in Figure 9) does not appear in Tables of the LASSO estimates 6, 7, and 8. First, some interactions the Random Forest model might take into account are not necessarily the interaction with $Energy_s$. Therefore, the Random Forest estimation might miss the relationships by $Energy_s$ presented in Tables of the LASSO estimates. Second, the Random Forest captures non-linear relationship between funding contribution and an independent variable, while the LASSO assume the linear relationship between them. Therefore, the linearity assumption in the LASSO model we estimate may not capture the non-linear relationship with contribution.

Also, notice that the OLS estimates, provided in the previous section in Appendix, tend to be much larger than the LASSO estimates. This could be due to severe multicolinearity that OLS cannot handle well without carefully selecting a small set of relevant variables to explain the variation of the contribution. Secondly, the OLS estimation is susceptible to the overfitting to data, resulting in a significant bias in the estimates.