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The support of Multilateral Development Banks to renewable energy projects in developing countries

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Multilateral Development Banks (MDBs) are extensively involved in the Paris Climate Agreement and play a key role in climate finance. However, the amounts recently channeled to carbon-based projects may raise doubts about this involvement. This empirical approach seeks to explore whether MDB participation actually favors renewable energy projects in developing countries, aligning with their commitment to this Agreement. An empirical analysis is conducted to explore the determinants of MDBs' participation in energy infrastructure projects developed in 64 countries using data from 2011 to 2018 obtained from the World Bank's Private Participation in Infrastructure Database. The results reveal that MDBs' participation is higher in renewable energy projects, confirming their commitment to clean energy; however, this is not confirmed by the amount of financial support provided.

Keywords: climate finance; limited dependent variable models; Multilateral Development Banks; renewable energy projects
JEL classification codes: H54; Q54; F35

1. Introduction

Climate change is a fact. According to the World Economic Forum (WEF 2020), the last five years have witnessed natural disasters that are more intense and more frequent than ever before. The warming of global temperatures increases the likelihood of extreme weather events and related natural disasters. In December 2015, the Paris Agreement, the first global international treaty on climate, was established, marking a significant milestone. Its objective is to unite the efforts of all nations in taking ambitious actions to combat climate change and adapt to its effects. The main landmark was the definition of a threshold for global warming, which should be well below 2 °C, ideally targeting 1.5 °C (UNFCCC 2015).

The fight against climate change, although a topic that garners global consensus, has not progressed uniformly. For instance, at the most recent Climate Summit in 2022, held in Egypt, a "historic agreement" was reached, allowing for the creation of a fund to finance the losses and damages experienced by the poorest and most vulnerable countries affected by climate change. However, no substantial progress or decisions were made on pressing issues such as reducing greenhouse gas (GHG) emissions or phasing out fossil fuels.

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In the Global Risks Perception Survey conducted by the World Economic Forum, environmental concerns rank at the top of the list of long-term risks. Among the five primary global risks in the environmental category, the "Failure of climate change mitigation and adaptation" ranks as the number one risk by impact and the second most likely risk for the next 10 years (WEF 2020). Furthermore, if we continue on our current trajectory, global temperatures are projected to rise by at least 3 °C by the end of the century, exceeding twice what climate experts have identified as the limit to avoid extreme and irreversible consequences.

As mentioned by Ha, Hale, and Ogden (2016) estimating how much money will be required to mitigate and adapt to climate change is a very difficult task facing high levels of uncertainty. The available estimates are based on various assumptions, but the fundamental conclusion is clear: the needs are expected to surpass the target of USD 100 billion per year set at the Copenhagen Climate Conference in 2009, where developed countries committed to mobilizing this amount annually from both private and public sources.

Energy policy is pivotal in the fight against climate change. The energy sector bears the brunt of global GHG emissions. In 2020, the energy sector (covering electricity, heat, and transportation) accounted for nearly three-quarters of global emissions. Within the energy sector, the largest emitter is electricity and heat generation – data from 2020, available at https://www.climatewatchdata.org/.

According to the World Economic Forum, the past decade has witnessed transformative changes across the energy system, yet challenges persist. In 2018, fossil fuels still supplied 81% of the world's energy, and furthermore, the total electricity generated from coal has increased over the past 10 years. Nonetheless, over 770 million people worldwide still lack access to electricity, primarily in Africa and Asia (WEF 2021).

With a focus on clean energy and energy efficiency, annual investment in renewables – including various types of power generation, solar heat and biofuels – reached a record high of USD 1.3 trillion in 2022. However, annual investments need to at least quadruple to remain on track to achieve the 1.5 °C scenario (IRENA and CPI 2023).

Despite the recent infusion of capital into the sector, significant funding gaps persist, especially in emerging countries and nascent technologies (WEF 2021).

The transition to low-carbon, climate-resilient, and sustainable pathways to achieve the Sustainable Development Goals (SDGs) requires a substantial mobilization of capital. This capital can be mobilized through a wide range of financial instruments and institutions (Deschryver and Mariz 2021). Among these financial instruments, some examples are green bonds, climate funds, carbon markets, impact investing, and sustainable and socially responsible investment. Regarding institutions, Multilateral and National Development Banks, private sector financial institutions, public-private partnerships, non-governmental organizations, central banks, green banks, and other international financial institutions, such as the IMF or the United Nations, are fundamental in this mobilization.

Yet, Multilateral Development Banks (MDBs)[1] are at the forefront of this challenge, given their development mandates, technical expertise, and commitment to the goals of the Paris Agreement. According to the Joint Declaration "The MDBs' alignment approach to the objectives of the Paris Agreement" (MDB 2018) it is well established and accepted internationally that policy engagements and financial flows should be consistent with lowering GHG emissions and fostering climate-resilient development. All MDBs have incorporated climate actions into their strategies and developed action plans to guide their activities in climate finance (Bábosik 2019).

The latest data on energy finance from MDBs shows that overall project finance spending on fossil fuels in 2018–2020 fell by 40%, compared to the period 2015–2017. Apparently, this is an encouraging result, but experts highlight that the 2020 drop is partially a consequence of the pandemic crisis that led to a decline in major oil and gas project approvals. Furthermore, in 2020, some of the major MDBs provided at least 3 billion US dollars in support for fossil fuels, a figure that goes against the general commitment that all the banks have made to support the transition to a green economy (I4CE 2021).[2]

It is against this background that this study attempts to examine the empirical evidence provided by energy projects implemented in developing countries concerning their support by MDBs. Are MDBs favoring renewable energy projects to the detriment of fossil fuel projects? Is their decision to provide support and financial flows being channeled to green energy projects? Is clean energy effectively a priority area in their strategy?

An empirical analysis is conducted to explore the determinants of MDBs' participation in 1,702 energy infrastructure projects developed in 64 developing countries, using data from 2011 to 2018, obtained from the World Bank's Private Participation in Infrastructure database (https://ppi.worldbank.org/en/ppi) and adopting appropriate regression techniques.

The results reveal that the probability of MDBs' participation is higher for renewable energy projects, as expected. In addition, this probability is higher for larger projects, with some form of government support, developed in less populous, poorer countries, and where the political system is less stable, but with better regulatory quality and with higher levels of financial openness. However, when we disentangle the decision to provide support from the amounts of financial support provided by MDBs, our results do not hold. Particularly, the type of energy project (based on renewable sources or not) is no longer a relevant determinant.

Our research contributes to the current debate on climate finance and the role of MDBs. Given the scarce literature on the field, empirical approaches could shed light on key factors affecting MDBs' participation in energy projects. Given the high financial amounts necessary for climate transition, MDBs play a key role in this process, acting as catalysts for further investments and leveraging other financial sources (public and private). The clarification of which factors matter the most to explain their participation in energy projects is of critical importance to practitioners and policymakers.

This paper is structured as follows: the next section shows some facts and figures about climate finance, showing MDBs' financial stake alongside other financial sources. Section 3 provides a brief literature review to frame this research, introducing the hypotheses. Section 4 describes the data, variables, and research method. Section 5 details and discusses the results. Finally, Section 6 draws the main conclusions and limitations, highlighting avenues for future research.

2. A brief picture: climate finance sources and green transition

The international climate finance architecture is complex and includes several funding channels, such as public resources primarily allocated through development finance institutions (DFIs), encompassing both bi- and multilateral finance. Additionally,

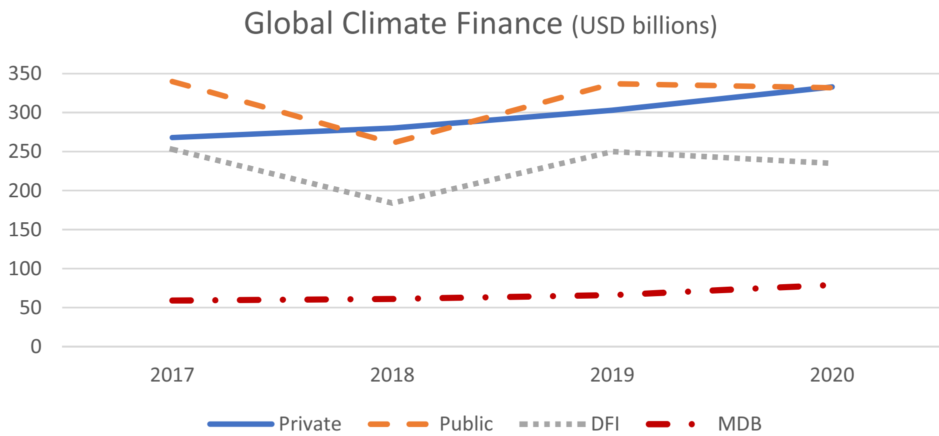

Figure 1. Global climate finance by public and private actors.
Data source: Based on CPI (2022) – Global Landscape of Climate Finance: A Decade of Data 2011–2020 (more details on Table A.1. in the Appendix [online supplementary material]).

private finance is facilitated through international market mechanisms, and there are also hybrid forms of financing (Michaelowa *et al.* 2020).

The analysis of Figure 1 reveals that private funding has been on the rise over the years. However, public funding for climate finance typically surpasses private funding, except for the year 2018. In 2020, global climate finance was equally divided between private and public sources.

The majority of public funding is directed towards climate action through DFIs, accounting for 72.5% of total public funds, on average over the four years. And particularly, Multilateral Development Banks and Multilateral Funds, on average, represented 21% of total public funding and 10.8% of global climate finance. It is important to note that these global averages can vary significantly from country to country and across different sectors.

Especially in low and middle-income economies, MDBs mobilized a total of 50.67 USD billion in 2021, with 65% allocated to climate change mitigation actions and 35% for climate change adaptation finance. Furthermore, MDBs leveraged an additional 43.6 USD billion in co-finance from public and private partners (EIB 2022). More details can be found in Table A.2. in the Appendix (online supplementary material).

Although a small share of total funding is coming from MDBs, it should be emphasized that

> even more important than the direct financial assistance provided by MDBs is how this assistance is used to catalyze, mobilize and crowd-in both public and private sources of funds for development. Through policy advice, technical assistance and capacity building, MDBs support government efforts to increase available resources and spend them effectively. (Inter-Agency Task Force on Financing For Development 2016, 2)

Global investment in renewable energy has been increasing over recent years. However, investments are not flowing at the pace or scale needed, and several challenges arise. First, investments in fossil fuel energy continue to rise, as all countries should have access to ‘reliable, affordable, and economically viable renewable energy’

(UN Commission on Sustainable Development 2007) and we are far from reaching this goal. Second, the financial funds required for the transition are enormous, with annual investments of more than USD 5 trillion, on average, needed between 2023 and 2030. Third, significant disparities exist between regions, sectors, and technologies. Some recent trends are highlighted below (IRENA and CPI 2023; CPI 2022):

- Despite all efforts towards decarbonization, investments in fossil fuel are on the rise. This is particularly true for fuel companies based in emerging markets and developing economies. Estimates from IRENA suggest that redirecting 1 USD trillion per year from fossil fuels to green energies is necessary to align with the ambitious scenario established in the Paris Agreement of limiting global warming to 1.5 °C.
- Some large multinational commercial banks maintained and even increased their investments in fossil fuels, averaging about USD 750 billion per year. Surprisingly, this industry continues to receive considerable support through subsidies.
- Global investments in renewable energy are mostly driven by the private sector, accounting for approximately 75% of the total between 2013 and 2020. However, the balance between public and private investments varies by country and technology. Private investors typically prefer renewable energy technologies that are commercially viable and highly competitive, such as solar photovoltaic. Conversely, for geothermal and hydropower projects, public finance is primarily used (only 32% and 3%, respectively, came from private investors in 2020).
- Commercial financial institutions and corporations are the primary private finance providers, together accounting for almost 85% of private finance for renewables in 2020.
- Globally, the public sector contributed less than one-third of renewable energy investments in 2020. State-owned financial institutions, national DFIs and state-owned enterprises were the main sources of public finance. Multilateral DFIs provided 9% of public finance in 2020.
- Mitigation actions dominated renewable energy investments over the last decade, accounting for almost 70% of the total.
- There are significant asymmetries between regions, with 75% of all climate finance concentrated in North America, Western Europe, and East Asia and Pacific, primarily led by China. Regions where the majority of low- and middle-income countries are located received less than 25% of climate finance flows.

Finally, it should be noted that the pace of investments in renewable energy in a specific country, whether higher or lower, is influenced by several factors. On one hand, it is affected by the availability of capital, which depends on easy access to financing, market liquidity, and the existence of risk mitigation instruments, among others. On the other hand, factors such as energy demand, energy prices, and supply-demand imbalances in the energy market can stimulate the demand for renewable energy investments, especially when renewable sources can provide cost-effective solutions. Additionally, technological advancements, the policy and regulatory framework, local conditions, and environmental and social considerations can also drive the demand for investments in renewable energy projects (Donovan 2015).

3. Literature review and research hypotheses

3.1. Multilateral Development Banks and climate finance

This paper is supported by several existing strands of the literature. First, it is related to the literature on the role of international financial institutions (IFIs) in addressing financial market failures in the provision of public goods, such as infrastructure assets (Lindbaek, Pfeffermann, and Gregory 1998; Stiglitz 1998). IFIs and private international capital markets may be seen as complements or substitutes (Bird and Rowlands 2007). MDBs' participation is claimed to have a 'catalytic effect' on private participation, fostering private sector investment – a complementary effect. Alternatively, MDBs lending will be directed to countries that have limited access to private international capital markets and underdeveloped internal financial markets – a substitution effect (Basílio 2014).

Several authors tested the 'catalytic effect', but the results were inconclusive (Bird and Rowlands 2007; Clemens 2002; Cottarelli and Giannini 2002; Ghosh *et al.* 2002). In contrast, Ratha (2001) found evidence that multilateral lending encouraged private flows, by signaling and fostering a better investment environment. In the same vein, Marcelo and House (2016) showed that infrastructure projects with multilateral support have lower cancellation rates, providing evidence that MDBs' participation is important in mitigating project risks and increasing private investors' confidence. Additionally, Wu, Wang, and Mao (2018), with a focus on water projects developed in three Chinese cities, highlighted how multilateral financial institutions promoted sustainable infrastructure planning through economic appraisal and innovative approaches.

Second, the paper is grounded in the general aid allocation literature. Since the pioneering work of McKinlay and Little (1977), aid allocation patterns are divided into donor interest and recipient need models. The former is based on the assumption that donors are primarily motivated by commercial, political, and strategic self-interest, while the latter assumes that donors are primarily motivated by humanitarian motives. Empirical evidence has shown that aid allocation oriented towards recipient needs is more effective in terms of development impact (Dreher, Eichenauer, and Gehring 2016; Kilby and Dreher 2010). Authors exploring aid allocation oriented towards donor interests include Gates and Hoeffler (2004), Gelb (2010), Harrigan, Wang, and El-Said (2006), and Kilby (2006), among others. It is also important to stress that, while bilateral DFI are majority-owned by national governments and have historically served to implement government foreign development and cooperation policies, Multilateral DFI (or MDBs) are less susceptible to pressures from donor countries due to their multilateral shareholding structure.

When focusing on recipient need models, it is important to note that traditionally the concept of 'need' was almost always measured by income level. Interestingly, two systematic biases have been reported in the aid-allocation literature. First, less populous countries receive more aid per capita than more populous ones and, second, very poor countries often tend to receive less aid than less poor countries (Alesina and Dollar 2000; Dowling and Hiemenz 1985; Neumayer 2003). As explained by Neumayer (2003) and McGillivray and Feeny (2008), aid is potentially more effective in small countries and very poor countries are considered unimportant and uninteresting to donor countries. Moreover, these countries may lack the capacity to absorb and manage larger aid flows. Authors focusing on MDBs and their lending patterns include, for instance, Frey and Schneider (1986), Maizels and Nissanke (1984), and Tsoutsoplides (1991).

With the influential work of Burnside and Dollar (2000), the recipient's 'merit' began to be considered to capture political and institutional quality. Aid is expected to be more effective in countries that adopt appropriate and stable policies. In addition to the macroeconomic policy environment, other aspects of governance were considered, such as democracy (Kosack 2003), the level of corruption, the rule of law, and the burden of bureaucracy (Dollar and Levin 2006; Kenny 2008).

The role of MDBs has evolved to reflect this view. Since their inception, their primary function has been to support the development of the poorest countries by providing financial assistance, usually in the form of loans or grants. Initially, the focus was on a country's 'needs.' More recently, alongside 'needs,' MDBs have begun to consider 'merit,' and support for developing countries may be conditional on policies and institutional reforms. Some common channels of support to foster these reforms include policy-based MDB funding, technical assistance, and capacity building.

However, for climate change mitigation actions, this conceptual framework is not applicable, as recently argued by Castro, Michaelowa, and Namhata (2020). When considering global public goods, the benefits are independent of the geography, of the specific location of project implementation. As pointed out by Castro, Michaelowa, and Namhata (2020, 3), with global public goods,

> the characteristics of the recipient, i.e. the country in which the funds are invested, can no more be considered to be a relevant proxy for the needs orientation of the donor. Even if there are some local side-benefits, the primary effect is of global nature, and as a consequence, other countries may benefit much more than the recipient itself.

The Paris Agreement calls for a balance between mitigation and adaptation finance, but the reality shows that the majority of funds go to mitigation interventions rather than adaptation. As stated by Michaelowa *et al.* (2021), adaptation funding should be allocated in response to recipient vulnerability, while mitigation funding should be directed to those places where the greatest benefits in terms of GHG reductions can be achieved (Michaelowa and Michaelowa 2012; Smit and Wandel 2006).

MDBs face some critical challenges. On one hand, MDBs' funding for mitigation interventions should apparently not be directed to the poorest countries, as it turns out to be an inefficient allocation. However, it should be recalled that MDBs' involvement with their expertise and operational assistance can counteract some of the identified vulnerabilities in host countries. On the other hand, MDBs should help crowd-in private sector development finance by improving the investment climate, identifying bankable projects, and advising on well-designed public–private partnerships (Michaelowa *et al.* 2021). MDBs should be seen as complementary agents, catalyzing private sector interventions.

To finish, this research is also related to the empirical literature about energy projects. The literature explored particular projects and countries, for instance: wind power in Spain (Dinica 2008); wind power in Portugal (Martins, Marques, and Cruz 2011); renewable energies in Algeria (Stambouli 2011). With a focus on energy projects, Fleta-Asín and Muñoz (2021) explored the determinants of private investment in developing countries. These authors showed that MDBs' support has a positive impact on the participation of private investors, particularly when the economic and institutional frameworks are weaker. Ragosa and Warren (2019) studied the determinants of cross-border private investment and conclude that the effect of business environment factors may vary according to the source of finance. But the provision of international public finance, political stability, regulatory support measures and feed-in tariffs, are strong drivers of cross-border investment in renewable energy projects.

In this paper, our main focus is the explanation of MDBs' involvement in infrastructure energy projects based on a recipient need/merit model. The main contribution of this research is to explore whether green energy projects benefit from higher MDBs' involvement compared to carbon-based projects. As far as we know, this issue has not been examined in the literature.

In addition, several characteristics of the project (size, the existence of government support, and the degree of private sector involvement) and the macroeconomic, institutional, and financial environment of the host country, are examined in their role in the MDBs' decision to invest and in the amount of this investment.

The next section presents the hypotheses to be tested and several control variables used to account for potential relevant effects on MDBs' participation.

3.2. Research hypotheses

MDBs have defined six core areas for alignment with the objectives of the Paris Agreement. The first one is alignment with mitigation goals, mentioning that their activities should be "consistent with the different countries' low-emissions development pathways and compatible with the overall climate change mitigation objectives of the Paris Agreement" and further that MDBs will "scale up the provision of climate finance" (MDB 2018, 2–3). As Bábosik (2019) mentioned, MDBs are committed to prioritizing climate interventions and their role is extremely important due to the funds they provide and moreover, due to the norms, standards, and expectations they create and implement.

The main goal is to assess whether MDBs are favoring renewable energy projects, i.e. if the probability of MDBs' participation is higher in green energy projects rather than in carbon-based projects and to highlight whether the financial support provided is consistent with that claim. For the purpose of this study, we divided the energy projects into renewable sources (biogas, biomass, geothermal, hydrothermal,[3] waste, wind, solar photovoltaic, and concentrated solar power) or carbon-based (coal, diesel, natural gas).

The database used is related to infrastructure energy projects. These projects encompass electricity generation, transmission, and distribution, which include power plants, transmission lines, and distribution networks. Furthermore, the majority of the projects in the database (95%) are *Greenfield* projects, which mean that are *new* projects. Therefore, they may be classified as mitigation interventions rather than adaptation.

Based on the arguments presented our main hypotheses are as follows:

Hypothesis 1: The probability of MDBs' participation in energy projects is higher for green projects, based on renewable sources.

Hypothesis 2: The financial amounts provided by MDBs are higher for green projects, based on renewable sources.

In addition, several control variables were considered. The first group is related to project-specific characteristics that may affect MDBs' participation.

- *Size*, measured by the amount of investment. Projects requiring more funds are typically more complex (Fleta-Asín and Muñoz 2021; Jiménez *et al.* 2017; Wang *et al.* 2018) and will benefit more, if an MDB is involved. Taguchi and Yasumura (2021), using the PPI database, show that projects, with multilateral support, have significantly larger investment commitments than the total average projects.
- *Government Support*,[4] either Direct or Indirect to the energy project. Governments can facilitate and foster private investments in infrastructure in several ways. Using financial leveraging tools such as guarantees, insurance policies, and credit enhancements or through grants, tax exemptions and other fiscal incentives, among other possibilities (World Bank 2015). MDBs' participation will reinforce the attractiveness of the project, given their enabling and capacity building role. It is expected that MDBs' participation will be affected by the Government support to the project, although the sign of the effect is not clear. It is possible to expect a positive effect, if the government acts as complementary agent, providing additional guarantees or, a negative effect is expected, if they act as substitutes.
- The degree of *Private Participation* in the infrastructure project. The goal is to ascertain whether the degree of commitment by the private sector has an effect on the MDBs' probability of entering the energy project and in the financial support provided.[5] If a catalytic effect is on place, then higher levels of private participation will be associated with higher probabilities of MDBs' participation. On the other hand, a substitution effect will be noticeable, if the probability of MDBs' participation is higher for projects with lower levels of private participation (Basílio 2014; Fleta-Asín and Muñoz 2021).

The second group of control variables aims to account for the macroeconomic, financial, and institutional/political environment of the host country. To account for the 'needs' of a country, as a proxy for poverty, variables such as GDP per capita and GDP growth will be used. To account for the 'merit', political stability and institutional quality will be tested.

In general terms, macroeconomic conditions affect MDBs' participation in energy projects (Neumayer 2003; Banerjee, Oetzel, and Ranganathan 2006; Fleta-Asín and Muñoz 2021). In addition, countries that enjoy political stability and a democratic regime should be preferred for the development of infrastructure projects (Dollar and Levin 2006; Kosack 2003; Wang *et al.* 2019), namely energy projects (Ragosa and Warren 2019). It should be mentioned that the development of these projects with high asset specificity, high complexity, uncertainty, and low competitiveness is based on contracts (naturally incomplete and prone to opportunistic behavior). Therefore, investors must ensure they have legal rights and that the local law enforcement is efficient. It is expected that countries with stronger property rights recognizable to investors, to be able to raise more long-term private capital to develop infrastructure projects, and higher MDBs' participation is expected in countries with 'good' legal practices, sound institutions, and political stability. For this purpose, Jandhyala (2016) adds that MDBs provide a more balanced allocation of risks between investors and Governments, increase oversight in projects' implementation, and provide political assistance by leveraging their influence to resolve disputes that may arise.

Furthermore, it is expected that MDBs will participate more in energy projects implemented in countries with a low level of financial development. One of their primary roles is to act as lending institutions; therefore, MDBs are a fundamental source of funds for countries where the local capital markets are incipient and poorly developed. Sun *et al.* (2020) stressed that the difficulty in accessing financial resources is the main barrier hampering the development of green projects, as these projects are capital-intensive and are associated with several risks and a low rate of return compared to fossil fuel projects. In the same vein, Kim and Park (2016) corroborated that countries with well-developed financial markets experience growth in renewable energy due to easier access to external financing.

Still in the financial dimension, the degree of financial openness of a country to external capital flows may be an important driver of energy investments. Recent research has highlighted the effect of financial openness (measured by a country's degree of capital account openness) on renewable energy investments, pointing to a positive impact in the long term (Koengkan, Fuinhas, and Vieira 2020).

In general terms, it is expected that MDBs will participate more in energy projects developed in poor countries and with poorly developed financial systems, emphasizing their role as *development* agents. However, based on the 'merit' of the recipient, countries with a better institutional environment, enjoying greater political stability and with few restrictions on external capital flows should be preferred.

Time dummies are also included to capture potential time-specific effects that may influence MDBs' participation in energy infrastructure projects.

4. Research method

4.1. Data and variables

A sample of 1,702 energy projects was obtained from the PPI database using projects developed in low- and middle-income countries that reached financial closure from 2011 to 2018 and developed in 64 different countries. First, all projects classified in the "Energy" primary sector were selected, with financial closure between 2011 and 2018, for all the countries available. In addition, all types of private participation in infrastructure were considered, with project status "Active" or "Concluded." With these filters, we obtained 1,894 observations. Second, we matched this data with the data extracted from other sources, by country and year, achieving 1,702 observations. Our unit of analysis is the infrastructure project.

For the first set of regressions, the dependent variable is a categorical variable (*MDB*) capturing whether the energy project was supported by at least one MDB or not – a dummy variable, taking the value of 1 if the project has MDBs' support and 0 otherwise. For the second set of regressions, we use the total amount of the financial support provided by MDBs, in millions of USD, expressed in logarithmic form.

The main variable to be tested is *renewable*, a dummy variable taking the value 1 if the energy project is based on renewable sources and 0 otherwise. In addition, MDBs' involvement in infrastructure energy projects is expected to be affected by several factors. Given their pivotal role in supporting developing countries, their participation is conditioned by factors related to the intrinsic characteristics of the project, as well as factors related to the environment in which the project is developed. The latter accounts for the 'needs' and 'merit' of the country. Therefore, we consider the following factors at the project level and also in relation to the host country's macro-economic, financial, and institutional/political environment.

4.1.1. Project-specific

- *Size*, measured by the total amount of investment in the energy project, in millions of USD, expressed in logarithmic form.
- Government Support, either Direct or Indirect to the energy project, is measured by a *Gov* dummy variable (1 if the project has Government support, 0 otherwise).
- The degree of Private Participation (*PrivatePart*) in the energy infrastructure project is expressed as a percentage.

4.1.2. Macroeconomic conditions

The following macroeconomic fundamentals are important as explanatory variables of the capital flows to emerging markets (e.g. Basílio 2017; or Jandhyala 2016). Real GDP per capita and population are set in logarithms to avoid scaling issues.

- *Real GDP* per capita and GDP *growth*, used to measure the evolution of the country's wealth and as proxies to measure the 'needs' of a country.
- *Inflation* – controlled inflation is a sign of macroeconomic stability and a factor of attractiveness to investors.
- *Population* – to proxy for the dimension of the market, particularly if the project is also to be financed with user charges. For energy projects, where consumers (both the retail and wholesale markets) pay a fee or tariff, larger markets should be preferred by investors.

4.1.3. Financial conditions

To account for the level of financial development, two proxies were used, that are standard measures of the financial sector's depth, used in the empirical literature (e.g. Beck and Levine 2002; Hsu, Tian, and Xu 2014).

- *Private credit to GDP*—measured by the financial claims on the private sector by deposit money banks and other financial institutions, divided by GDP.
- *Bank Deposits to GDP* – deposit money banks as a share of GDP.

In addition, we included a proxy to measure the degree of financial openness. The free flow of capital between countries is affected by capital account restrictions that may exist, and as such, may affect MDBs flows to energy projects in developing countries (Koengkan, Fuinhas, and Vieira 2020).

- *Financial Openness Index* (kaopen) – Chinn-Ito capital market openness index. This is based on restrictions on cross-border financial transactions and ranges from −1.93 and 2.31 with higher numbers indicating a more open capital account. The index is based on the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's

Annual Report on Exchange Arrangements and Exchange Restrictions (Chinn and Ito 2006).

4.1.4. Political/institutional framework

The next two indexes were chosen from the World Governance Indicators and were used to account for the 'merit' of the country:[6]

- *Political stability* – Political Stability and Absence of Violence measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism.
- *Rule of Law* – To measure the degree of confidence of the agents in 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.

All the projects' information was obtained in the Private Participation in Infrastructure (PPI) Database (https://ppi.worldbank.org/en/ppidata). This database records information about private investment in infrastructure, covering several sectors – telecommunications, transportation, water/sanitation, and energy – developed in low- and middle-income countries.

Macroeconomic data are from the World Bank's World Development Indicators. Proxies for a country's level of financial development are taken from the World Bank's Financial Development and Structure Dataset, available at https://www.worldbank.org/en/publication/gfdr/data/financial-structure-database, the financial openness index is from Chinn and Ito (2006) database, and finally, institutional/political indicators are drawn from the World Governance Indicators (WGI) available at https://info.worldbank.org/governance/wgi/.

Matching the different data sources, we obtain a database of energy infrastructure projects with 1,702 observations. Table 1 summarizes the information on the variables and data sources.

Summary statistics for all the variables, except time-dummies, are presented in Table 2.

The variable *MDB* participation takes a value of 1 in about 20.92% of the sample, meaning that 356 energy projects were supported by one or more MDBs.[7] Additionally, the majority of the projects considered in the sample were energy projects from renewable sources (81.4%) and near 46% benefitted from Government support.

To check for collinearity problems, a correlation matrix was computed (results in Appendix A.3 [online supplementary material]) with no particular high values of pairwise correlation (the highest is below 0.55). In addition, a statistical test was performed using the variance inflation factor (VIF) confirming the absence of any problems. Mean VIF is 1.67, being the highest value related to the *PrivCredit* variable (2.44).[8]

4.2. Empirical approach

The probability of MDBs' participation in the energy project is a dichotomous variable and as such, a binary choice model should be used. Our choice rests on the *Probit* model. In order to estimate the parameters, a likelihood function is maximized. The

Table 1. Summary of variables.

Dimension	Variable definition	Source
Project	**MDB** (DEPENDENT VARIABLE 1): A dummy variable adopting the value of 1 when one or several Multilateral Development Banks support the energy project and 0 otherwise.	PPI database
	invMDB (DEPENDENT VARIABLE 2): The financial support to energy projects provided by MDBs, in millions US$, expressed in logarithm form.	
	Renewable: A dummy variable adopting the value of 1 when the energy project is based on renewable sources (biogas, biomass, geothermal, hydrothermal, waste, wind, solar photovoltaic and concentrated solar power), and 0 otherwise (coal, diesel, natural gas).	
	Size: The size of the energy project is measured by the logarithm of the total investment in millions US$.	
	Gov: A dummy variable adopting the value of 1 when the energy project has direct or indirect Government support and 0 otherwise.	
	PrivatePart: The degree of private participation in the energy project, which varies between $0 < \text{PrivatePart} \leq 1$.	
Macroeconomic	**LnRealGDPpc:** The log of GDP per capita (constant 2010 US$).	World Bank's World Development Indicators (WDI)
	Growth: GDP growth (annual %).	
	Inflation: Consumer prices (annual %).	
	lnPOP: The log of total Population.	
Financial	**PrivCredit: Private credit to GDP**—measured by the financial claims on the private sector by deposit money banks and other financial institutions, divided by GDP	World Bank's Financial Development and Structure Dataset
	Deposits: Bank Deposits to GDP – deposit money banks as a share of GDP.	Chinn and Ito (2006)
	Kaopen: Financial Openness Index – Chinn-Ito capital market openness index. It is based on restrictions on cross-border financial transactions and ranges from −1.93 and 2.31 with higher numbers indicating a more open capital account.	
Political/institutional	**PolStab: Political Stability** and Absence of Violence – An index to measure the likelihood of political instability and/or politically-motivated violence. It ranges from approximately −2.5 (weak) to 2.5 (strong) governance performance.	World Governance Indicators (WGI)
	RLaw: Rule of Law – An index to measure the quality of contract enforcement, property rights, and confidence on the police and courts operation. It varies from −2.5 (weak) to 2.5 (strong) governance performance.	

Table 2. Descriptive statistics for the variables.

Variable	Obs	Mean	Std. Dev.	Max	Min
MDB	1702	0.2092	0.4068	1	0
invMDB (levels)	305	144.2889	216.5493	1800	0.338
invMDB (ln)	305	4.2831	1.2132	7.496	−1.085
Renewable	1702	0.8143	0.3889	1	0
size (ln *inv*)	1702	4.3700	1.3357	9.602	−0.511
Gov	1702	0.4553	0.4981	1	0
PrivatePart	1702	0.9682	0.1177	1	0.2
ln*RealGDPpc* (ln)	1702	8.4349	0.8421	9.614	5.996
Growth (%)	1702	5.0447	3.1503	17.291	−3.546
Inflation (%)	1702	5.7580	3.4818	18.678	−4.298
ln*POP* (ln)	1702	18.8997	1.7144	21.050	11.552
PrivCredit (% GDP)	1702	70.6656	40.5497	164.184	0.793
Deposits (% GDP)	1702	51.1551	20.5238	233.07	11.1847
PolStab (index)	1702	−0.6630	0.5862	1.02	−2.81
Rlaw (index)	1702	−0.2665	0.3304	0.95	−1.37
kaopen (index)	1702	−0.5006	1.1232	2.311	−1.927

coefficients β_j for $j = 1, 2, \ldots, k$; give the signs of the partial effects of each x_j on the response probability, but not their magnitude. Average marginal effects (AME) are also presented, that are more informative than coefficients.

In addition, clustered robust standard errors are used, to allow for intragroup correlation, relaxing the usual requirement that the observations are independent. Observations are independent across countries (clusters) but not necessarily within groups, which is a more reasonable assumption (Cameron and Trivedi 2010).

Furthermore, because our data may suffer from endogeneity problems, we assume that the probability of MDBs' participation (*MDB*) is affected by the macroeconomic, financial and institutional situation of a country the previous year, following a similar approach to Fleta-Asín and Muñoz (2021), Moszoro *et al.* (2014) or Basílio (2017).[9] The cross-sectional regression model is formulated as follows:

$$\begin{aligned} MDB_{i,t} = {} & \beta_0 + \beta_1 Renewable_{i,t} + \beta_2 size_{i,t} + \beta_3 Gov_{i,t} + \beta_4 PrivatePart_{i,t} \\ & + \beta_5 \ln RealGDPpc_{t-1} + \beta_6 Growth_{t-1} + \beta_7 Inflation_{t-1} + \beta_8 \ln POP_{t-1} \\ & + \beta_9 PrivCredit_{t-1} + \beta_{10} Deposits_{t-1} + \beta_{11} PolStab_{t-1} + \beta_{12} RLaw_{t-1} \\ & + \beta_{13} kaopen_{t-1} + \beta_{14} yeardummies + \mu_{i,t} \end{aligned}$$

where, i is the project and t stands for the year.

To further investigate the MDBs' participation in energy projects, we disentangle this process into two sequential decisions. The first is the MDBs' decision as to whether or not to invest in a specific energy project, based on the characteristics of each project and relevant macroeconomic/institutional and financial country indicators. The second decision has to do with 'how much' to invest in the selected energy projects.

There are many different situations where the problem under study may be seen as a two-part decision of first to engage in an activity and then deciding the level of the activity. If we expect independence between these two parts, a Two-Part model is the better choice. Alternatively, if the same factors that influence one part are expected to influence the other, with decisions intertwined, then the suitable model is the bivariate sample selection model or Heckman sample selection model.[10] A two-part model is appealing because it is possible to explain y with two different mechanisms: a *Probit* or a *Logit* model to explain the probability of $y=0$ versus $y>0$, and a second process to explain 'how much' y using only the positive outcomes. As such, MDBs' participation is described as a two-stage process, that is, 'yes/no' (stage one deciding on eligibility) and 'if yes, how much' (stage two).

Concerning the Heckman sample selection model, a joint distribution for the censoring mechanism and outcome is considered. In this specification, a censoring latent variable differs from the latent variable generating the outcome of interest. Following Cameron and Trivedi (2010), the model includes a *participation equation*,

$$y_1 = \begin{cases} 1 & \text{if } y_1^* > 0 \\ 0 & \text{if } y_1^* \leq 0 \end{cases} \tag{2}$$

and a resultant *outcome equation,*

$$y_2 = \begin{cases} y_2^* & \text{if } y_1^* > 0 \\ - & \text{if } y_1^* \leq 0 \end{cases} \tag{3}$$

In this formulation, y_2 is observed when $y_1^* > 0,$ and no particular value of y_2 is necessarily observed when $y_1^* \leq 0.$ For the latent variables, we have linear models with additive errors, according to,

$$\begin{aligned} y_1^* &= \beta_{01} + \boldsymbol{X}_1{}'\boldsymbol{\beta}_1 + \varepsilon_1 \\ y_2^* &= \beta_{02} + \boldsymbol{X}_2{}'\boldsymbol{\beta}_2 + \varepsilon_2 \end{aligned} \tag{4}$$

where $\boldsymbol{X}_1, \boldsymbol{X}_2$ are vectors of explanatory variables. And the conditional mean in the sample selectivity model is,

$$\begin{aligned} \mathrm{E}\left[y_2|\mathbf{X}_1, \boldsymbol{X}_2, y_1^* > 0\right] &= \mathrm{E}\left[\beta_{02} + \boldsymbol{X}_2{}'\boldsymbol{\beta}_2 + \varepsilon_2|\beta_{01} + \boldsymbol{X}_1'\boldsymbol{\beta}_1 + \varepsilon_1 > 0\right] \\ &= \beta_{02} + \boldsymbol{X}_2{}'\boldsymbol{\beta}_2 + \mathrm{E}\left[\varepsilon_2|\varepsilon_1 > \ -(\beta_{01} + \boldsymbol{X}_1{}'\boldsymbol{\beta}_1)\right] \end{aligned} \tag{5}$$

If the errors $\boldsymbol{\varepsilon}_1$ and $\boldsymbol{\varepsilon}_2$ are independent, then the last term simplifies to $\mathrm{E}[\boldsymbol{\varepsilon}_2] = 0,$ and OLS regression of $\boldsymbol{y}_2$ on $\boldsymbol{X}_2$ will give a consistent estimate of $\boldsymbol{\beta}_2$ (assumption made in a Two-Part model). However, any correlation between the two errors means that the conditional mean is no longer $\boldsymbol{\beta}_{02} + \boldsymbol{X}_2{}'\boldsymbol{\beta}_2$ and is necessary to account for selection. With the additional assumption that the correlated errors are joint normally distributed and homoscedastic, the unknown parameters can be estimated through Maximum Likelihood Estimation (MLE). However, if it is a strong assumption, then an alternative estimation procedure that relies on weaker distributional assumptions may be used – the Heckman's two-step procedure or Heckit estimator.

From the previous expression, when $\boldsymbol{\varepsilon}_1$ and $\boldsymbol{\varepsilon}_2$ are correlated and jointly normally distributed, it implies that,

$$\varepsilon_2 = \sigma_{12}\varepsilon_1 + \xi \tag{6}$$

Where ξ is independent from ε_1. After some simplifications, the conditional mean becomes,

$$\mathrm{E}\left[y_2|\mathbf{X}_1, \boldsymbol{X}_2, y_1^* > 0\right] = \beta_{02} + \boldsymbol{X}_2'\boldsymbol{\beta}_2 + \sigma_{12}\lambda\left(\beta_{01} + \boldsymbol{X}_1'\boldsymbol{\beta}_1\right) \tag{7}$$

where $\lambda(z) = \frac{\phi(z)}{\Phi(z)}$ is the inverse Mills ratio. Heckman assumes (7) without explicitly imposing the normal distribution for the error term and noting that it is a linear function of the parameters $(\beta_{02},\ \boldsymbol{\beta}_2, \sigma_{12})$ that can be estimated by OLS, if the response $\lambda(.)$ is observed. However, because $\lambda(.)$ depends on the unknown parameters $(\beta_{01},\ \boldsymbol{\beta}_1)$, a two-step procedure is used, which allows $\hat{\boldsymbol{\beta}}_1$ to be obtained by a first step Probit regression of y_1 on $\boldsymbol{X}_{1.}$ The second step is to estimate the following model by OLS, using the positive values of y_2,

$$y_2 = \beta_{02} + \boldsymbol{X}_2'\boldsymbol{\beta}_2 + \sigma_{12}\lambda\left(\beta_{01} + \boldsymbol{X}_1'\hat{\boldsymbol{\beta}}_1\right) + \ \nu \tag{8}$$

where ν is an error term, and $\lambda\left(\beta_{01} + \boldsymbol{X}_1'\hat{\boldsymbol{\beta}}_1\right) = \ \phi\left(\beta_{01} + \boldsymbol{X}_1'\hat{\boldsymbol{\beta}}_1\right) / \ \Phi\left(\beta_{01} + \boldsymbol{X}_1'\hat{\boldsymbol{\beta}}_1\right)$ is the estimated inverse Mills ratio. Testing for correlation between the errors is to test if $\sigma_{12} = 0$ and in the presence of correlation, sample selection correction is needed.

This is a more general framework because the error terms do not need to follow a normal distribution. The main advantages of this model include its simplicity, the wider applicability, and the fact that it requires weaker distributional assumptions than using MLE.

5. Results and discussion

Table 3 reports the estimation results. For our main model (model 1), coefficients and AME are presented. Because projects developed in China, Brazil, and India represent 17.2%, 16.9%, and 14.1% respectively, dominating our sample (see Table A.5 [online supplementary material]), we include models 2–4, to exclude the projects in each of these three host countries by turn, to check for possible divergences in the results.

One measure of goodness of fit is the percentage of correctly classified observations, comparing fitted and actual values (PCP). In our model 84.61% of observations are correctly specified. Another measure presented is the Pseudo R^2, but it should be interpreted with caution, given its limitations for non-linear models. Concerning model specification, the model seems to be appropriate to deal with our data. The linktest performed show no evidence of misspecification problems (hatsquared *p*value = 0.716) and the Hosmer–Lemeshow test do not reject the null hypothesis that estimated and observed probabilities agree.

With a focus on model 1, let us begin by discussing the findings for the main variable, *Renewable,* that is positive and statistically significant.[11] This suggests that if the energy project is based on renewable sources, it is associated with a higher likelihood of MDBs' participation, supporting Hypothesis 1. The AME shows that if the energy project is a green project, based on renewable sources, then the probability of MDBs' participation increases 12.3% compared to carbon-based projects, all else held constant. This result allows answering our main research question, giving support to the claim that indeed, MDBs are favoring low-carbon projects, participating more in green and climate-resilient projects, in line with their commitment to the Paris Agreement.[12]

Second, we find, as expected, that larger projects or those with greater financial commitments, tend to have a higher likelihood of MDBs' participation (the variable *size* is positive and statistically significant). Increasing the amount of investment by 1%, increases, on average, the probability of MDBs' participation by 6%. As already mentioned, MDBs' participation could be more relevant in larger and complex energy projects. First, as a crucial source of funds, and second, given their technical assistance

Table 3. Probit models for MDBs' participation in energy projects (2011–2018).

	Model 1		Model 2	Model 3	Model 4
Dependent variable: *MDB*	Coef. (β)	*AME*	No China Coef. (β)	No Brazil Coef. (β)	No India Coef. (β)
Renewable	0.6214***	0.1233	0.6092***	0.6153***	0.4573***
	(0.1823)		(0.1812)	(0.1959)	(0.1575)
size	0.3031***	0.0601	0.2968***	0.3135***	0.3172***
	(0.0402)		(0.0408)	(0.0411)	(0.0438)
Gov	0.2996***	0.0594	0.3104***	0.3765***	0.3138**
	(0.1095)		(0.1091)	(0.1207)	(0.1369)
PrivatePart	−0.5382	−0.1068	−0.2829	−1.1517*	−0.5802
	(0.6635)		(0.7093)	(0.6369)	(0.6923)
ln*RealGDPpc*	−0.6316***	−0.1253	−0.6192***	−0.5808***	−0.5759***
	(0.073)		(0.0755)	(0.0799)	(0.1042)
Growth	0.0069	0.0014	0.0112	−0.0291	0.0056
	(0.0241)		(0.0245)	(0.0235)	(0.025)
Inflation	0.0232	0.0046	0.0211	0.0266	0.0152
	(0.0219)		(0.0221)	(0.0211)	(0.0244)
ln*POP*	−0.3364***	−0.0667332	−0.3262***	−0.3015***	−0.3757***
	(0.0418)		(0.0453)	(0.0414)	(0.053)
PrivCredit	−0.0018	−0.0004	−0.0012	−0.0034*	−0.0009
	(0.0021)		(0.0025)	(0.0019)	(0.0024)
Deposits	0.0003	0.0001	−0.0001	0.0007	−0.0012
	(0.0036)		(0.0038)	(0.0034)	(0.0042)
PolStab	−0.4537***	−0.0899843	−0.4451***	−0.3804***	−0.4791***
	(0.0965)		(0.0979)	(0.1081)	(0.1063)
Rlaw	0.4066*	0.0806	0.3662	0.4233**	0.3157
	(0.2224)		(0.2304)	(0.2131)	(0.2499)
kaopen	0.1555**	0.0309	0.1562**	0.1234**	0.1472**
	(0.0613)		(0.0633)	(0.0612)	(0.0621)
year-dummies	Jointly Significant***		Jointly Significant***	Jointly Significant***	Jointly Significant***
Constant	8.7097***		8.1923***	8.5413***	8.9087***
	(1.4517)		(1.511)	(1.526)	(1.4331)
# observations	1702		1410	1415	1462
Wald chi2	394.63***		384.53***	342.4***	443.24***
Pseudo R2	0.3058		0.2543	0.2896	0.3436
Log likelihood	−605.96		−591.67	−560.73	−495.79
PCP†	84.61%		81.70%	82.47%	85.29%

Note: Cluster-robust standard errors in parentheses.
*, ** and *** indicate significance at a 10%, 5% and 1% level, respectively.
† Percent correctly predicted.

and capacity building. MDBs provide countries with experience in using complex financial structures and dealing with international financial institutions, enhancing project viability. Jiménez *et al.* (2017) already noted that larger projects are more complex to manage and involve higher transaction costs. In this context, MDBs' involvement is considered more valuable.

Third, Government support positively impacts the participation of MDBs, emphasizing a complementary role (the variable *Gov* is positive and statistically significant). If the project has Government support, then the probability of MDBs' participation increases 5.9% approximately, holding all other factors fixed. MDBs can transform the governance of the project and balance the bargaining power between the private sector and government actors (Buiter and Fries 2002). This feature is critical in regulated industries (namely, energy) where governments have the ability to dramatically change the profitability of projects by regulating entry conditions, imposing criteria on operations, or changing policies (Jandhyala 2016; García-Canal and Guillén 2008).

Four, concerning the degree of private sector participation, *PrivatePart* has no effect on the probability of MDBs' participation in energy projects. Neither a catalytic effect nor a substitution effect is verified. As already mentioned, private investors choose to invest in renewable energy technologies that are more competitive and with more profit prospects. This is the case for solar energy, which represents 35.5% of all the renewable energy projects in our data, followed by wind projects with 31%. The wind and solar industries are driving down costs and improving technology performance, making these renewable technologies more attractive to private investors who are willing to make the necessary investments without needing MDBs' support.

In addition, our results show that more populous countries and those that are richer (measured by *GDP* per capita) tend to have projects with lower participation of MDBs, in line with previous results (Neumayer 2003; or Basílio 2014). Countries with a lower GDP per capita, may suffer from greater budgetary constraints creating difficulties in funding infrastructure energy projects (Fleta-Asín and Muñoz 2021), making the involvement of MDBs more critical as a source of funds and emphasizing MDBs' primary role as development agents, responding to the 'needs' of a country. The systematic bias in favor of less populous countries that has been reported in the aid-allocation literature is also noticeable here. Other macroeconomic variables, such as *inflation* or *GDP growth*, do not exhibit statistical significance.

Financial development variables do not exhibit statistical significance. Where the domestic financial and capital markets are relatively underdeveloped, the capacity for local financing of large-scale investments will be constrained and, as such, all other things being equal, a relatively higher probability of MDBs' participation will be expected, but this effect was not noticeable here. Nevertheless, the degree of financial openness presents a statistically significant and positive effect on the probability of MDBs' participation in energy projects, meaning that countries with less restrictions on capital movements benefit with higher participation of MDBs.

The estimated coefficient on Political Stability is negative and statistically significant, revealing that the probability of MDBs' participation is lower for renewable energy projects developed in more stable countries, which is an unexpected result. According to the 'merit' of the recipient, aid is more effective in countries with more stable policies and sound institutions. However, Jandhyala (2016) already noted that the value of technical assistance and policy advice offered by MDBs is likely to be lower when projects are developed in host countries with more stable governments. MDBs' participation seems to be a way to overcome political instability, increasing energy projects' feasibility. MDBs' participation has the effect of an 'umbrella' for the entire project, acting as a mechanism for risk reduction, provision of guarantees and serving as a sign of creditworthiness to other investors. These features are less needed in more politically stable countries.

The instability of the regulatory framework is another critical factor that could hinder the development of energy projects. In this respect, the variable *Rule of Law* exhibited the expected positive sign (though only with statistical significance at the 10%

threshold). Countries with higher institutional quality benefit from a higher participation from MDBs in energy projects. The importance of the regulatory framework in energy is paramount. Experiences from numerous countries show that even if well-designed renewable energy support programs are in place, arduous bureaucratic procedures and administrative hurdles, along with difficulties in accessing the electricity grid, can prevent rapid market development (Tupy 2009).

Turning to models 2 to 4, in general, consistent and similar patterns are presented if we exclude energy projects developed in each of these countries: China, Brazil, and India, respectively. The exceptions are the variables – *PrivatePart* and *PrivCredit* – that gain statistical significance, keeping their signs, if all projects were considered except those developed in Brazil (model 3). Considering energy projects developed in the remaining 63 countries of the sample (see Appendix A.5. [online supplementary material]), the sign of the coefficient on *PrivatePart* seems to suggest that there is a 'substitution' effect between MDBs and private sector investors, and not the desirable 'catalytic' effect. Rather than crowding in private resources, MDBs seem to crowd out those private actors. In these countries, MDBs are acting to overcome the fragilities in local financial markets. This is reinforced by the analysis of the coefficient on *PrivCredit*, which gains statistical significance. However, if we exclude energy projects developed in China or India, then, local development financial variables and private sector participation are no longer relevant.

Time-dummies appear particularly relevant in explaining the MDBs' decision to give support, with several coefficients positive and statistically significant, showing a positive trend over time (individual coefficients not reported).

In Table 4, in order to complement the first analysis, factors that affect the 'amount' of MDBs' financial support to energy projects are explored. Three models are presented: a Two-part model (columns 1 and 2, where column 1 replicates the results of model 1 of Table 3, for convenience purposes), Heckman with Maximum Likelihood estimation (MLE), in columns 3 and 4; and Heckman two-step (columns 5 and 6).

Considering only the energy projects that received financial support from MDBs, we focus our attention on column 2. Surprisingly, the renewable dummy loses significance in this second part of the model. If the project is a green project, it is considered a key factor in the MDBs' decision to provide support, but concerning the financial amount, this variable is not significant. Factors explaining the 'amount' of financial support include the *size* of the project and variables accounting for the macroeconomic conditions of each country. Poorer countries, with smaller populations but with higher GDP growth and higher inflation (only significant at a 10% threshold), received more financial support for energy projects from MDBs.

When we drop the assumption of independence of the two parts of the model, an alternative model can be used – the sample selection model estimated through MLE (Heckman MLE). In this specification, the same variables were used in both equations (selection equation and outcome equation). Columns 3 and 4 of Table 4, exhibit the results. Comparing the results from the Two-Part Model and Heckman MLE, they are similar (coefficient estimates were very close to the previous results and with similar statistical significance achieved). The LR test of independence of the equations obtained with Heckman MLE, gives a p value of 0.8611. As such, the estimated correlation between the errors of the two-parts is not significantly different from zero and the hypothesis that the two parts are independent cannot be rejected.

Table 4. Determinants of the financial support provided by MDBs to energy projects (2011–2018).

Dependent variable *InvMDB* (ln)	Two – Part Model		Heckman (MLE)		Heckman Two-step	
	Probit (dy) (1)	OLS ($y>0$) (2)	dy (3)	$y>0$ (4)	dy (5)	$y>0$ (6)
Renewable	0.6214***	−0.0795	0.5468***	−0.0835	0.5464***	−0.1135
size	0.3031***	0.8131***	0.3294***	0.8104***	0.3295***	0.7903***
Gov	0.2996***	0.0524	0.2882**	0.0502	0.2883***	0.0341
PrivatePart	−0.5382	−0.2134	−0.7473	−0.2099	−0.7459*	−0.1844
ln*RealGDPpc*	−0.6316***	−0.1341**	−0.6076***	−0.1293**	−0.6075***	−0.0935
Growth	0.0069	0.0444**	0.0267	0.0441**	0.0267	0.0422*
Inflation	0.0232	0.0164*	0.013	0.0162*	0.0130	0.0152
ln*POP*	−0.3364***	−0.1030***	−0.3689***	−0.0999***	−0.3689***	−0.0769
PrivCredit	−0.0018	−0.0000	−0.0023	0.0000	−0.0024	0.0002
Deposits	0.0003	0.0005	0.0009	0.0005	0.0009	0.0004
PolStab	−0.4537***	0.0002	−0.4820***	0.0038	−0.4817***	0.0306
Rlaw	0.4066*	0.0897	0.2598	0.0879	0.2598*	0.0751
kaopen	0.1555**	0.0243	0.1575**	0.0231	0.1574***	0.0140
year-dummies	yes	yes	yes	yes	yes	yes
Constant	8.7097***	2.9957***	8.8507***	2.9364***	8.8478***	2.4981
# observations	1702	305	1651	305	1651	305

Note: Cluster-robust standard errors were used except for Heckman two-step.
*, ** and *** indicate significance at a 10%, 5% and 1% level, respectively.

With Heckman two-step, for the decision to give support (column 5), the same qualitative results were obtained. To explain the amount of financial support (column 6) only *size* and *growth* maintain their statistical significance.

We also tested the hypothesis of independence of the errors, through the coefficient of lambda (the z-statistic is −0.24 with a p value of 0.814), do not reject the independence of the error terms. That means that the unobserved factors that explain the selection process are independent of the unobserved factors that explain the amount of investment. In general, simpler models are preferred over more complex formulations, stressing that in this research, a two-part model is the appropriate empirical strategy.

As a summary, the overall results show that the determinants of the amounts of financial support provided by MDBs to energy projects in developing countries are as follows:

- Size: larger projects require more funds and are considered riskier to investors. MDBs’ co-financing improves the feasibility of the project and mitigates risks for other investors.
- Need/Merit of the recipient: it is possible to ascertain that ‘merit’ is not considered in the amount of financial flows channeled to developing countries (the variables rule of law and political stability returned insignificant). Instead, only the 'needs’ are taken into account, with striking findings. MDBs provide more funds to poorer countries (proxied by real GDP per capita) but with better growth rates. As development institutions, financial flows are directed to those most in need, but as investors, countries with better growth rates will offer better guarantees in what concerns the repayment of loans.

- Furthermore, MDBs provide more financial flows to countries with smaller populations. As previously mentioned, this reflects a systematic bias documented in the aid allocation literature, where small countries typically receive more funds (Neumayer 2003; McGillivray and Feeny 2008).

6. Conclusions

To achieve the ambitious climate objectives established by the Paris Agreement, a profound and rapid transformation of the energy sector is necessary. The transition to clean energy will require vast amounts of capital, and although some record highs have been achieved in recent years, the current pace of investment is not sufficient. This article explores MDBs' participation in energy projects in developing countries using the PPI database from the period 2011 to 2018, an issue that has not been studied before.

As the world transitions toward more sustainable and cleaner energy sources to combat climate change, understanding how MDBs contribute to this transition is crucial. MDBs finance large-scale energy infrastructure projects, including power plants, transmission lines, and distribution networks, and play a fundamental role in expanding energy access, as they continue to fund projects in under-served and remote regions. Their influence on energy access, infrastructure development, and private sector engagement makes their involvement in this field a subject of ongoing interest and research.

Our results show that the probability of MDBs' participation is higher for renewable energy projects, apparently respecting their commitment to the Paris Agreement and low carbon and sustainability pathways. Additionally, MDBs are more likely to be involved in larger energy projects with some form of government support, especially in less populous and poorer countries with less political stability but better institutional quality and greater financial openness. However, when we separate the decision to provide support from the amount of financial support offered by MDBs, the type of energy project (based on renewable sources or not) no longer appears to be a relevant determinant. Instead, factors influencing the amount of support include the project's size and macroeconomic variables.

The current research has its limitations. First, for global public goods, measuring the effectiveness of development interventions requires a broader perspective that transcends geographical boundaries. The projects to be supported should yield the greatest benefits in terms of GHG reductions, irrespective of individual country borders. Unfortunately, the available data does not allow us to explore whether the renewable energy projects supported by MDBs are the ones with the greatest global benefits. Nevertheless, as demonstrated, MDBs tend to favor larger projects.

Second, the PPI database, while extensive and a good proxy for measuring trends, has its limitations. It encompasses only projects developed in low- and middle-income countries and lacks comprehensive coverage of small-scale providers due to the unavailability of publicly accessible information. This limitation might be particularly significant in the field of energy. Moreover, the PPI database categorizes projects in their primary sector, making it impossible to track information about other sectors with energy-related projects from the available data.

Third, disparities in legislation could impact the development and attractiveness of energy projects and their funding. Many countries have already liberalized their energy markets, while others are still striving to establish competitive market models. Further research could delve into how these differences influence the sources of finance and the involvement of various stakeholders.

Finally, this study may be expanded to examine the effects of MDBs' participation in terms of the success or failure of these projects as more data becomes available in the future.

These limitations, particularly those related to the available data, may seriously hamper our analysis. Nevertheless, we believe that significant insights have been gained. This research sheds light on the determinants of MDBs' support for energy projects, especially in the developing world, which continues to receive comparatively low investment in renewable energy projects. This issue is of critical importance.

This study suggests that MDBs participate more in renewable energy projects, but financial flows primarily respond to the size of the project rather than the type of energy technology (renewable or not). Policymakers and governments should take actions to promote MDBs' involvement in renewable energy projects, encompassing financial flows, encouraging their finance or co-finance. As our results have shown, government support is a key determinant affecting MDBs' involvement. Furthermore, the relevance of institutional quality highlights the importance of fostering investor confidence through better contract enforcement and the quality of institutions, such as the police and courts, which positively impacts MDBs' participation. These results can assist governments in designing more effective climate policies and regulations to attract investments in renewable energy.

While the private sector has dominated renewable energy investments, public investment, including funds provided by development institutions, is critically important in bridging the financial gap, especially in challenging sectors and regions. MDBs should serve as catalysts for private sector investment and, simultaneously, put forward strategies to help developing countries avoid fossil fuel pathways.

Notes

1. MDBs are international financial institutions that assist developing countries in reducing poverty, fostering economic growth, and tackling global challenges. MDBs operate as cooperative entities owned and funded by member countries. Their development finance activities include concessional and non-concessional loans, leveraging capital, risk mitigation, co-financing, technical assistance and policy advise.
2. The MDBs included in this analysis are the World Bank Group, the European Investment Bank, the Asian Development Bank, the European Bank for Reconstruction and Development, the Islamic Development Bank, the Inter-American Development Bank, the African Development Bank and the new MDBs established in 2015: the Asian Infrastructure Investment Bank (initiated by China) and the New Development Bank (BRICS bank).
3. We follow the International Renewable Energy Agency (IRENA) and classify hydropower as a renewable source. The largest sources of GHG emissions for hydropower are the construction of the facilities, and biomass decomposition from reservoir flooding (Steinhurst, Knight, and Schultz 2012) but large hydropower plants produce fewer greenhouse gas emissions when compared with fossil fuel-based plants.
4. In the PPI database, government support may be Direct support - capital subsidy, revenue subsidy or in-kind (lands, for instance); Or Indirect support, in the form of guarantees (e.g., payment guarantee, debt guarantee, revenue guarantee, exchange-rate guarantee).
5. Because only the percentage of private participation in each project is available on the database, it is not possible to use the financial amounts provided by the private sector.

6. Variables such as "control of corruption" and "government effectiveness" from the WGI dataset were also tested, but due to collinearity issues these variables were dropped from the analysis.
7. Differences in the number of projects, between Table 2 and Table A.4 or Table A.5 (online supplementary material), are due to projects that are being classified in the database with MDBs' support but without the information on the financial amount (not available).
8. VIF is an indicator of how much of the inflation of the standard error could be caused by collinearity. As a rule of thumb, values above 10 should be a cause for concern and must be corrected.
9. With annual data, the number of lags is typically small in order not to lose degrees of freedom (Wooldridge 2013).
10. Another possibility is to use a Tobit model, that estimates the financial support provided by MDBs in only one step, taking directly into account its censored nature. Nevertheless, because it relies on strong assumptions of normality and homoscedasticity of the error term, better results are often provided by more general models, used here.
11. To enrich the analysis, several interaction terms between the "renewable" dummy variable and other macroeconomic, financial, and institutional controls were tested but without statistical significance achieved (results not presented).
12. MDBs' participation in energy projects, besides funding, can encompass several distinct possibilities: operational assistance, technical and professional advice, political assistance, risk mitigation instruments (e.g., guarantees and insurance against political risks).

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