Renewable Energy Policies and Private Capital Participation
– A Study on Energy Investment Projects in BRI Countries

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Abstract: *This paper examines the effectiveness of renewable energy policies in catalyzing private green investment based on data of 1,293 energy investment projects from 45 BRI countries between 2010 and 2019. According to our empirical results, a country's renewable energy policies have a key influence in private capital decisions to make and scale up green investments. Regression results show that renewables policies encourage private green investments only when the renewables market is still in its infancy. When the market enters growth and maturity stages, however, financial markets will take the place of policy incentives as the primary force behind private green investments. While renewables policies help scale up private green investments by broadening the renewable energy market, it is yet unclear how such the policies promote renewable energy innovation. In order to advance green development under the Belt and Road Initiative (BRI), we should expand access to financing for the renewable energy industry in addition to improving the national renewable energy policy system.*

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1. Introduction

In 2013, President Xi Jinping introduced the Belt and Road Initiative (BRI) as an open platform that brings about opportunities and dynamism for international cooperation and development. Green development goals with carbon neutrality at the heart have become common aspirations for many countries, reflecting recent improvements in global environmental governance. According to the Energy and Climate Intelligence Unit (ECIU), 132 countries and regions around the world have adopted carbon neutrality goals, and China has promised to peak its carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. In the global context of low-carbon and sustainable development, green has become a conspicuous theme of the BRI for the new era. In May 2017, the then Ministry of Environmental Protection, Ministry of Foreign Affairs, National Development and Reform Commission

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(NDRC) and Ministry of Commerce jointly released the *Guidelines on Promoting Green BRI Development*, vowing to build a "Green Silk Road".

The promotion of sustainable development in BRI countries through green investment has become essential to the BRI's agenda in the new era, which focuses on infrastructure interconnectivity. Advanced infrastructures will facilitate regional exchanges and attract capital to spur economic growth. Yet infrastructure projects are capital-intensive and take time to build and recoup investment. Electric power and other energy projects, for instance, may damage local vegetation and create noise pollution during construction and emit large volumes of carbon dioxide during operation. At the Second Belt and Road Forum for International Cooperation, President Xi Jinping stressed that "The Belt and Road is not an exclusive club; it aims to promote green development. We may launch green infrastructure projects, make green investment, and provide green financing". In promoting the BRI's green development, it is vital to steer sustainable infrastructure development and increase the consumption of renewable energies.

Sluggish economic situation and shortage of funds have stymied renewable energy development in some BRI countries. According to the *Quantified Report on Green Investment and Carbon Emission Paths in BRI Countries*, it would take additional green investments worth at least 12 trillion US dollars between 2016 and 2030 for these countries to achieve the climate goals under the Paris Accord (Climate Works Foundation, 2019). Developing economies have faced fiscal deficits and pressures from deleveraging operations since the 2008 global financial crisis. To make things worse, the global economic recession due to COVID-19 fallout is challenging the fiscal systems of BRI countries, leaving them short on funds for promoting renewable energy sources. Infrastructure spending remains insufficient even with support from existing financial markets and international financial institutions (Xu et al., 2017). Hence, priority should be given to creating diversified investment and financial mechanisms to encourage private capital investments in renewable energy projects worldwide.

The problem, however, is that developing countries are less attractive to private capital (Fay et al., 2021). Energy projects provide public goods with great externalities. Their high entry barriers and modest investment returns discourage private investors — unless policy incentives come into play. According to the PPI database of the World Bank, private financing for renewable energy investments has grown over the past 20 years in BRI countries, but the rate is slowing down. The question then becomes how to encourage private green investment through the BRI.

Under the "Green Silk Road" initiative, Chinese companies and investors have ramped up investments in renewables. Green BRI, though advocated by China, requires broad cooperation from BRI countries. Green development is a key principle of the BRI and a shared aspiration of all BRI countries. Compared to other types of infrastructure investment, renewable energy projects are more reliant on policy incentives from host country governments because they are riskier, more capital-intensive, and offer modest returns in the early stages. Although BRI countries have implemented several policy incentives for renewable energies, it is still unknown whether these incentives help decision-making on private capital investments in green energies. Countries across the world are implementing a variety of renewables policies as their knowledge of renewable energies grows. Renewable energy markets in BRI countries are in various stages of growth with uneven levels of technological sophistication and resource endowment. This study will determine whether different renewables policies and market development stages have varied effects on the volume of private renewable energy investments.

Specifically, we will focus on four questions:

First, is there any difference in the impact of host countries' policy incentives for the renewables market on the volume of private green investments? Second, is there any difference in the efficacy of green investment policy incentives between countries at various stages of renewable energy development? Third, how will various policies for renewable energy boost green investment? Fourth, what are the potential pathways through which renewables policies may influence green investment? The answers to the above-mentioned questions will aid in the investigation of the efficacy of current renewables policies and the formulation of strategies to encourage private capital to provide crucial funding for green energy investments in BRI countries.

We conducted a regression analysis of mixed cross-sectional data using the probit and the cross-section models with 1,293 energy investment projects from 45 countries between 2010 and 2019 and arrived to the following conclusions: Policy incentives may persuade private capital to engage in green projects and scale up green investment. After investigating different stages of renewables market development, regression analysis indicated that renewables policies are conducive to private green investment only during the early stage of the renewables market development. When a country's renewables market is full-fledged, financing freedom becomes the driving force for private green investments, and the market begins to play a decisive role in allocating resources. Our heterogeneity analysis showed that while market incentives like renewables auctions dampen private investment in the early stage, macro-policies such as a long-term strategy help increase private investment. It was found that renewables policies encourage private green investment by expanding the renewables market. However, it is still unclear to what extent those policies inspire renewable energy innovations.

The focus on private capital participation in the "Green Silk Road" is an innovation and marginal contribution of this study. First, previous research has been mainly concerned with the way in which the BRI helped improve the environment in participating countries (Cao et al., 2020), the way it boosted China's green total factor productivity (TFP) (Liu and Xin, 2018), and how foreign direct investment (FDI) could be used to advance the green BRI. However, most studies have paid little attention to the crucial role that private capital plays in financing renewable energies. Our study fills this vacuum in the academic literature by focusing on private financing for green investments.

Second, the "Green Silk Road" calls for joint participation and mutual consultation between China and other BRI countries for shared benefits. By examining how national renewable energy policies stimulate private green investment, this study is expected to help guide host countries in improving business climate for green investment through top-down policy design, which helps overcome the funding shortfall for the "Green Silk Road". While other studies focused on a small number of countries, this paper's sample universe consisted of 45 BRI countries with diverse economic development levels and renewable energy development stages. This wide focus allows a more accurate examination of how policymaking may influence private capital investment on renewable energies.

Third, this study examines how the efficacy of renewable energy policies varies when the renewables market is in different stages of development. Even though the majority of BRI countries are developing countries, some of them enjoy the most advanced renewables markets for reasons such as resource endowment. In other words, the sophistication of a country's renewable energy industry may not be correlated with its level of economic development. Therefore, it is hard to ascertain the effectiveness of a country's renewables policies in disregard to the development level of its renewable energy market. This paper presents important policy suggestions for targeted renewables policies by situating policy efficacy within the context of the renewables market's development stage.

The rest of this paper is structured as follows: Part 2 is a review of the literature and research hypotheses; Part 3 contains a description of the model and an explanation of the data; Part 4 describes the empirical study; and Part 5 includes the study conclusions and policy suggestions.

2. Literature Review and Research Hypotheses

This section evaluates the state of existing research conducted in China and other countries on renewable energy policies, the BRI and green investment, and private capital involvement in BRI development. In this section, we will conduct a theoretical investigation of the implications of renewables policies, changes in policymaking and financial market conditions, and potential mechanisms underlying such policy effects. Based on this, we will present three research hypotheses for this study.

2.1 Literature Review

Countries across the world have issued policy incentives including subsidized feed-in tariffs (FiT) and long-term strategies to stimulate investments and collaboration in the renewable energy industry. The impact of renewables policies on the clean energy market has also caught the attention of academics. Most other studies that explored renewables policy incentives focused on theoretical analyses and case studies (Berry & Jaccard, 2001; Gan et al., 2007; Zarnikau, 2011). Recent studies on renewable policies used econometric models. Overall, those studies discovered that policy incentives for renewable energies may augment the total installed capacity and the share of renewables (Wu et al., 2015; Zhao et al., 2013) and accelerate innovations in green technologies (Zhang et al., 2019).

Some academics have categorized renewable energy policies and discovered that the Renewable Portfolio Standard (RPS) and subsidized feed-in tariff (FiT) policies are the most effective at luring private capital investments among all renewable energy policy instruments (Friedemann et al., 2015), and that the RPS policy, despite being more effective than the FiT policy in the European market (Dong, 2012), is subject to some restrictions in the US energy market due to flaws in the policy's design (Carley, 2009). Based on their analysis of renewables market segments, some scholars have concluded that policy uncertainty will discourage developers from investing in the US photovoltaic (PV) industry (Tsvetanov, 2019), and that policy discontinuity will also result in investment fluctuations in the US wind power market (Barradale, 2010).

Some researchers have focused on less developed countries and regions, which began to place more weight on the renewable energy market. Based on their study on the effectiveness of renewable energy policies in the Caribbean islands, Kersey et al. (2021) found the net metering tariff to be the most effective at increasing the total installed capacity of renewables. Based on their study on countries with different levels of economic development, Zhao et al. (2013) concluded that renewables policies would help increase the installed capacity of clean energy only for advanced and emerging economies.

The studies mentioned above, regrettably, focus on just one or a small number of nations, therefore their empirical findings may not apply to emerging economies, least of all BRI countries. Most studies only examined a single renewable energy policy, rarely considering how the policy environment influences renewable energy investments. Prior research examined the heterogeneity of policy efficacy across countries with various levels of economic development, overlooking how such policy efficacy is subject to the sophistication of the renewable energy market. Based on a broader scope of samples, this report uncovers how national policy incentives for renewable energy spurred private capital investment for countries with varied levels of renewables market development.

The Belt and Road Initiative (BRI) in the new era has made going green a prominent theme, particularly in the context of global low-carbon and sustainable development. Green BRI has become the subject of increasing academic research. The BRI has been shown to help both the home and host countries, as evidenced by environmental improvement (Cao, 2020) and industrial upgrade (Zhang et al., 2021) in host countries, as well as green TFP and corporate green transition for China (Liu and Xin, 2018; Yang and Li, 2021). To further the BRI's green development, some scholars have studied how to implement the "Green Silk Road" from the perspectives of environmental law and clean energy diplomacy (Li, 2020; Sun, 2017). Researchers have examined the potentials and influencing factors of China's green outward direct investment (ODI) and found that the BRI has a favorable effect on green investments (Cheng and Qi, 2021; Liu et al., 2020). Other studies evaluated the risks of investing in renewable energy in BRI countries using the TODIM approach (Hashemizadeh et al., 2021).

Academics have shown great interest in the role of private capital in BRI development. Some have attributed the success of public-private partnership (PPP) infrastructure projects to host countries' project operational experience (Luo et al., 2017) and industrial concentration (He et al., 2021), the private sector's share of risk assumption (Luo et al., 2017), and the project finance model (Patricia G.

and Francesca M., 2010). Others discussed how to beef up private capital spending on infrastructure projects in BRI countries (Qiu et al., 2021; Deng and Chen, 2018; Xu and Du, 2018). Notably, the research literature has paid little attention to private capital investments in renewable energy sources in BRI countries. The profit-seeking nature of private capital means that it is highly sensitive to changes in policies such as subsidies for renewable energy sources in host countries. However, few studies have considered the policy effects on the amount of private capital investments in renewables in BRI countries. This study will conduct an empirical investigation to fill this gap by unraveling how host countries' renewable energy policies affect the volume of private green investments. Our empirical findings are intended to supplement existing research literature.

2.2 Research Hypotheses

Renewable energies are recognized by the international community as a common choice for the global energy transition. Countries should incentivize market entities and adopt market-based solutions to expedite renewable energy development. There is a broad range of public policies for the renewable energy market, as can be seen in the compilation of renewable energy policies by the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), and the existing research literature (Kersey et al., 2021; Polzin et al., 2019). This study categorizes the common renewables policies of BRI nations into four groups: Macro-policies, market-based policies, economic subsidies, and supportive power grid policies.

For policy definitions and descriptions, please refer to Table 1.

The BRI countries have in recent years implemented macro-policies, most notably long-term strategies for renewable energies, in an effort to reach carbon neutrality and build a clean, low-carbon, secure, and effective energy system. Such policies are intended to promote the long-term development of national energy markets. They usually include a country's goals for installed renewable energy capacity and carbon emissions abatement for the next decade.

Table 1: Summary of New Energy Policies

Category	Policy title	Definition
Macro-policies	Long-term strategic plan for renewable energy development	Issuance of a national strategy to specify the goals of national renewable energy development for a certain future period, including for instance, the share of renewables in the national energy mix and the installed capacity of renewables
Economic subsidies	Direct fiscal subsidies	Grants from the government to businesses involved in the development, financing, and management of renewable energy projects
	Tax preferences	Tax preferences to renewable energy projects through tax credits or VAT deductions
	Subsidized feed-in tariffs (FiT)	State subsidies to bring down the cost of renewables-based power generation to grid parity to offset the high operational costs of renewable energy projects and ensure their stable revenues in the long run
Market-based policies	Renewable energy auctions	The state power authority chooses renewable energy producers through open bidding to set electricity tariffs and production rates through market-based competition
Supportive power grid policies	Mandatory grid connection policy	The power grid company provides non-discriminatory or priority grid connection for renewables-based electricity while ensuring the security of power grid operation.
	Power grid infrastructure support policy	Extending financial support to the construction of power grid infrastructure or easing restrictions on eligible entities to invest in power transmission and distribution networks

On the other hand, economic incentives including tax breaks and subsidized feed-in tariffs are commonly used for the renewables markets in BRI countries. Private capital is primarily concerned with the financial return of renewable energy projects. In less developed BRI countries with greater price elasticities of demand for electric power, renewable energy projects are more dependent on public subsidies to sustain revenues (Maianne et al., 2021). Local government allowances may be an efficient way to lower the risk of private capital investment in renewables and encourage green technology innovations (Zhang et al., 2019).

Clean energy power generation is now more affordable than traditional coal and natural gas power generation thanks to economies of scale and technological advancement. The renewables market is shifting from dependence on subsidies to market-based competition. This transition is particularly evident in some advanced economies with mature technologies and in the PV and wind power sectors. In some BRI countries, market-based incentives like renewable energy auctions and performance allowances have started to gain popularity.

By the end of 2018, 106 countries had purchased renewable energy through auctions (International Renewable Energy Agency, 2019). For instance, the Philippine Electric Power Authority sets maximum tariff rates before each round of tendering and, following an assessment of the power generation volumes and tariff rates specified in the bid documents, awards contracts to bidders with the lowest marginal costs, who will then enter into a long-term power purchase agreement (PPA) with the local power distribution company. Competitive power purchase policy for renewables contributes to lowering the cost of clean energy power generation through open market competition. Long-term power purchase agreements help reduce investment risk. Put together, these initiatives have supercharged renewable energy development across the country. Based on the above, this paper proposes Hypothesis 1:

Hypothesis 1: By implementing a renewable energy strategy, BRI host countries may boost private green investments.

The BRI countries are at diverse levels of development of renewable energy, with varying degrees of economic strength and renewable energy resources. Bird et al. (2005) used the amount of renewables-based power generation as the criterion for identifying a country's stage of renewable energy development. Marques et al. (2010) used the percentage of renewables in a country's energy mix as the criterion. The percentage of power generation from renewable sources has been used by Ma and Huang (2022) and Romano et al. (2017) to gauge a nation's level of renewable energy development. In this study, the proportion of electricity generated by renewable sources is used to assess a country's level of renewable energy development. Our research samples of BRI countries are categorized into the fledgling stage if renewables-based power generation accounts for 0% to 30% and the mature stage if this ratio exceeds 30%.

Countries focus on technological innovation and market exploration in the early stage of developing its renewable energy sector (Surana and Anadon, 2015). Incentives from host country governments could be a major force behind the energy transition towards renewables in the early stage when market mechanisms for renewable energy are incomplete; renewables-based power generation is more expensive than conventional energy sources, and less attractive and affordable for consumers (Fan and Yi, 2021).

The cost differences between renewable energy and conventional energy power generation continue to get closer as a result of technology advancement and economies of scale. Additionally, as government policy incentives recede, the renewables sector transitions from policy-driven to market-driven development (International Energy Agency, 2016). At this point, the government must unleash market dynamism to further the development of renewables - an endeavor in which financial markets will be crucial for the reasons listed below.

First of all, as renewable energy projects are capital-intensive with a long payback period, investors need long-term financing arrangements to ease their financial strains (Kim & Park, 2016; Mainanne et al., 2021).

Second, the demand for funds from renewable energy developers will increase as the market for renewable energy expands. Financial markets will help ease the shortage of funds for private investors by providing equity financing and lowering borrowing cost (Egli et al., 2019; Ji and Zhang, 2019; Shahbaz et al., 2013).

Third, there will be more competition and less variation in construction costs among different renewable energy companies as soon as the renewables market reaches a more advanced level; at that point, the cost of capital becomes a key determinant of competitiveness and investment return. Therefore, when the industry reaches a mature stage, financial markets will become the primary force behind the development of renewable energy sources. Thus, we propose Hypothesis 2:

Hypothesis 2: In the early stage of the development of renewable energies, host countries introduce policy incentives as the biggest attraction for private investments in renewables; in a more advanced stage, however, financial markets and other market-based mechanisms will play a significant role in driving those investments.

Following are some ways that policy incentives for renewables could boost private green investments:

First, policy incentives may support early-stage market development. In the early stage, renewable energies are less competitive since they are both costlier and riskier than conventional energy sources. Public acceptance of renewable energies is also hampered by a lack of environmental awareness and the high cost of producing clean energy (Almulhim, 2022). At this stage, the government should implement a range of policy initiatives to support the renewable energy industry. The *Energy Policy Act* and the *National Renewable Energy Strategy*, among other broad policy frameworks, have elevated renewable energy to a status on par with conventional energy at the legislative level, showing the commitment of relevant countries to renewables (Terrados et al., 2007). Legislation has opened up a new stage for the development of the renewable energy market. The cost of developing renewable energy has significantly decreased thanks to direct economic support at the policy level, such as subsidies, tax breaks, and low-interest loans (Ozdemir et al., 2020). Policy dividends encourage additional private capital to invest in renewable energies, leading to the renewables market's continued growth.

The second channel is technological innovation, which is essential for making clean energies cheaper and more efficient to speed up the energy transition. Governments should establish a policy environment that supports innovation. Carbon trading will, from a policy standpoint, give renewable energies a competitive advantage over traditional fossil fuels by increasing the tariff rates for the latter, encouraging market actors to invest in the industrial chains from upstream to downstream links (Qi and Zhang, 2019). By internalizing the environmental cost and lowering the risk of technology development, carbon trading may also encourage the development of low-carbon breakthroughs (Cong and Wei, 2010; Friedmann et al., 2015; Rogge and Hoffmann, 2010). In addition, countries have initiated budgetary spending on clean energy R&D to promote its development, and some use revenues from carbon auctions to support clean energy R&D (Qi et al., 2018). Considering this we propose hypotheses 3a and 3b:

Hypothesis 3a: Renewable energy policies will help a country expand its renewable energy market.

Hypothesis 3b: Renewable energy policies will spur a country's renewable energy innovations.

3. Model Specification and Data Explanation

The volume of private capital investments in the renewable energy sector as well as investment decisions are influenced by host countries' renewable energy policies. This paper explains the data sources used in the empirical research and develops two models to analyze how host countries' renewable energy policies relate to private green investments in BRI nations.

3.1 Model Specification

Model 1: In what way will a host country's renewable energy policies influence private green investment decisions?

Referencing Luo et al. (Luo et al., 2017), the following equation is used to construct a typical probit model to analyze how host countries renewables policies influence decisions for private green investment:

$$Pr(Green{=}1)=\Phi(\alpha_0+\alpha_1\times Policy_{it}+\alpha_2\times Control_1+\varphi_t+\gamma_c+\varepsilon) \qquad (1)$$

In equation (1), the binary choice variable *Green* has a value of 1 when private capital invests in a renewable energy project and a value of 0 when it does not. The investment projects discussed in this paper that use renewable energy as a primary energy source include solar power, hydropower, wind power, biomass, geothermal power, and biogas. Key explanatory variable *Policy* quantifies country *i*'s level of policy activity in year *t* for the renewable energy sector. The project characteristic variable and the host country characteristic variable are both included in this benchmark model as a control variable ($Control_1$). Among them, the project characteristic variable includes the installed capacity of renewable energy projects (*Capacity*), access to credit from multilateral financial institutions (*Multi*), and project risk profile (*Risk*); host country characteristic variables include host country GDP (ln*GDP*) and GDP growth rate (*GDPgrowth*) to control for the impact of the host country's economic development level on the green investment decisions of private capital. In addition, the fixed effect of year (φ_t) and the fixed effect of region (γ_c) are introduced to include the impacts of unobservable factors on the regression result. ε is the stochastic disturbance term.

Model 2: In what way will a host country's renewable energy policies affect the amount of private capital invested in renewable energies?

$$\ln Investment=\beta_0+\beta_1\times Policy_{it}+\beta_2\times FinFreedom_{it}+\beta_3\times Control_2+\theta_t+\sigma_c+\mu \qquad (2)$$

The key explained variable in Model 2 is the volume of private capital investments in renewable energy projects (lnInvestment). The definition of policy is the same as in Model 1, and the explanatory variable *FinFreedom* is a measure of country *i*'s financial freedom in year *t*. Two types of control variables are included in $Control_2$ at the project and host country levels, respectively. In particular, project-level variables include the installed capacity of renewable energy projects (*Capacity*) and availability of support from multilateral financial organizations (*Multi*); variables at the host country level include those in Model 1 and the variable of host country governance, which is expressed by the three indicators - corruption control (*AntiCorrupt*), public voice (*Voice*), and political stability (*Stability*). Model 2 controls for the impact of unobservable factors on the regression results by introducing the fixed effect of time θ_t and the fixed effect of country σ_c, and μ is stochastic disturbance term.

3.2 Data Explanation

The World Bank's private participation in infrastructure (PPI) database, which contains data on 10,421 projects in 127 middle- and low-income countries between 1990 and 2020, serves as the source for the study samples used in this paper. According to Luo et al. (2017), it is currently the most trustworthy data source for information on private capital infrastructure investments in developing countries and has the largest sample size. It covers the main infrastructure sectors, including energy, transportation, water conservation, and information and communication technologies.

This study examines the energy investment projects of the 45 BRI countries in the PPI database between 2010 and 2019 (see Table 2), focusing on the four key data points listed below:

(i) Energy attributes: Non-renewable and renewable energy projects are both included in the PPI database of energy projects with private capital participation in BRI countries. Renewable energy projects include solar energy, hydropower, wind power, biomass, geothermal, and biogas projects, while non-renewable energy projects include petroleum, natural gas, and coal-fired power plants.

Table 2: Regional Distribution of Projects under Research and Grouping by Income Level

Country	Region	Income level	Country	Region	Income level
Algeria	Middle East and North Africa	Medium-high	Indonesia	East Asia	Medium-low
Iran	Middle East and North Africa	Medium-high	Peru	Latin America and the Caribbean	Medium-high
Morocco	Middle East and North Africa	Medium-low	Jamaica	Latin America and the Caribbean	Medium-high
Egypt	Middle East and North Africa	Medium-low	Costa Rica	Latin America and the Caribbean	Medium-high
Serbia	Europe and Central Asia	Medium-high	Dominican Republic	Latin America and the Caribbean	Medium-high
Türkiye	Europe and Central Asia	Medium-high	Ecuador	Latin America and the Caribbean	Medium-high
Russia	Europe and Central Asia	Medium-high	Angola	Sub-Saharan Africa	Medium-low
Romania	Europe and Central Asia	Medium-high	South Africa	Sub-Saharan Africa	Medium-high
Bulgaria	Europe and Central Asia	Medium-high	Kenya	Sub-Saharan Africa	Medium-low
Kazakhstan	Europe and Central Asia	Medium-high	Cameroon	Sub-Saharan Africa	Medium-low
Ukraine	Europe and Central Asia	Medium-high	Zambia	Sub-Saharan Africa	Medium-low
Sri Lanka	South Asia	Medium-high	Côte d'Ivoire	Sub-Saharan Africa	Medium-low
Thailand	South Asia	Medium-high	Nigeria	Sub-Saharan Africa	Medium-low
Vietnam	South Asia	Medium-low	Senegal	Sub-Saharan Africa	Medium-low
Pakistan	South Asia	Medium-low	Zimbabwe	Sub-Saharan Africa	Medium-low
Bangladesh	South Asia	Low	Mali	Sub-Saharan Africa	Low
Nepal	South Asia	Low	Mozambique	Sub-Saharan Africa	Low
Malaysia	East Asia	Medium-high	Sierra Leon	Sub-Saharan Africa	Low
China	East Asia	Medium-high	Ethiopia	Sub-Saharan Africa	Low
Cambodia	East Asia	Medium-low	Chad	Sub-Saharan Africa	Low
Laos	East Asia	Medium-low	Rwanda	Sub-Saharan Africa	Low
Mongolia	East Asia	Medium-low	Uganda	Sub-Saharan Africa	Low
The Philippines	East Asia	Medium-low			

Source: The World Bank's PPI database.

(ii) The amount of private capital invested in renewable energy projects.

(iii) The year the project was implemented. This means the year in which the project's financing was finalized through the execution of a legally binding contract between the government and private capital, which covers critical issues like risk assumption, the division of rights and responsibilities, and the financing strategy.

(iv) Project installed capacity: This metric illustrates the size of a project. A greater demand for investment results from more installed capacity.

The key explanatory variable *Policy* in this study is taken from Regulatory Indicators for Sustainable Energy (RISE) of the World Bank. The RISE database assesses 138 countries' access to electricity, availability of clean cooking fuels and technologies, energy efficiency, and renewable energy sources. Seven sub-indicators have been developed for the renewable energy sector, including the legal framework (*Legal*), long-term strategic plan (*Plan*), incentive policies (*Incentives*), auction policies (*Auction*), support for internet access (*Connection*), financing support policies (*Finance*), and carbon pricing (*Carbon*). For a country's renewable energy policy sub-indicators, closed-end questions (answers are either yes or no) were created, and values were assigned based on the responses from industry insiders or experts. To acquire data of variables, the weighted average scores of the individual sub-indicators were then taken. Higher values indicate stronger policy actions for the renewable energy market.

FinFreedom, the explanatory variable for Model 2, is from the US Heritage Foundation. This variable assesses the degree to which a country's banks and other financial institutions operate efficiently without interference from the government. Financial institutions may offer individuals and businesses credit, deposits, foreign exchange, and other services in a market-based way with little to no government interference when government actions in financial institutions are restricted to corporate supervision and fraud prevention. Higher values of financing freedom indicate that resources are more productively allocated through the nation's financial markets in a market-based manner.

The host country's governance variable comes from the World Governance Indicators (WGI) of the World Bank, and the economic volume (*lnGDP*) and growth (*GDPgrowth*) variables are from the World Bank's database. In accordance with above specifications, Model 1 in this study comprises 1,293 energy investment projects as research samples, while Model 2 includes 1,010 renewable energy investment projects.

Tables 3 and Table 4 display the variable descriptive statistics.

Table 3: Descriptive Statistics of Variables in Model 1

Variable	Observations	Mean Value	Standard deviation	Min.	Max.
Green	1,293	0.830	0.376	0.000	1.000
Policy	1,293	40.420	19.700	1.000	86.000
Multi	1,293	0.193	0.395	0.000	1.000
Risk	1,254	7.736	1.183	2.000	12.000
Capacity	1,293	230.300	879.800	0.500	12900.000
GDPgrowth	1,293	5.454	2.681	-4.387	12.320
ln*GDP*	1,293	6.182	1.940	1.079	9.571

Table 4: Descriptive Statistics of Variables in Model 2

Variable	Observations	Mean Value	Standard deviation	Min.	Max.
ln*Investment*	1,010	4.178	1.203	0.148	7.601
Policy	1,010	41.910	20.230	2.000	86.000
FinFreedom	1,010	42.510	14.110	10.000	70.000
Multi	1,010	0.198	0.399	0.000	1.000
Capacity	1,010	65.020	102.500	0.500	1360.000
AntiCorrupt	1,010	-0.396	0.327	-1.421	0.762
Voice	1,010	-0.688	0.806	-1.802	1.152
Stability	1,010	-0.625	0.660	-2.810	0.841
GDPgrowth	1,010	5.481	2.767	-1.590	12.320
ln*GDP*	1,010	6.365	2.022	1.079	9.571

4. Empirical Research

This section runs a benchmark model regression based on the prior theoretical analysis to show how renewable energy policies affect private capital investment decisions. It then conducts a robustness test and a heterogeneity analysis to discuss the robustness of benchmark results and the variations of results across samples and creates a couple of two-way fixed-effect models to further explore the potential channels through which the host country's renewable policies may affect the size of private green investments.

4.1 Benchmark Model Regression

To validate the relationship between a host country's renewable energy policies and private capital investment, this section makes use of the two-benchmark model developed in the preceding section.

Model 1: In what way will a host country's renewable energy policies influence private capital decisions to invest in renewable energies?

The standard probit model is used as Model 1 in this study, with the intensity of the host country's renewables market policymaking serving as the explanatory variable and the binary choice variable of private green investment decisions serving as the explained variable. In order to investigate the effects of the host country's renewables policies on the green investment decisions of private capital, such control factors as the project and host country characteristic variables are included.

The benchmark regression results of how the renewables policies of a host country may affect the green investment decisions of private capital are shown in Table 5. After including the explanatory variable that affects private green investment decisions, column (1) displays the regression coefficient results. The dummy variables of time and region are included in columns (2) and (3), respectively. The results of the regression coefficient with the dummy variables of time and region simultaneously controlled for are shown in column (4). The regression results indicate that a country's renewables policies strongly influence private capital's decisions to invest in renewable energy. This has confirmed the positive impact of renewables policies on private capital's green investment decisions.

On the other hand, the size of a project and the risks taken by private capital show a significant negative correlation with the decisions made by private capital regarding green investments. In other words, when companies make green investment decisions, larger and riskier projects are less attractive. This means private capital is still testing waters when it comes to investing in renewable energy projects in BRI countries. One explanation could be that renewable energy markets in BRI countries are discouragingly less sophisticated and more costly and risky for private capital to invest in large renewable energy projects.

Model 2: In what way will a host country's renewable energy policies influence the amount of private investment in renewables?

Model 2 is concerned with the renewable energy projects in BRI countries that involve private investment and uses the investment level in such projects as the explained variable. To explore the effects of the host country's renewables policies on the quantity of private renewable investments, the host country's financing freedom is included as another key explanatory variable in addition to Model 1's.

Column (1) of Table 6 presents the regression coefficient results after including the explanatory variable for the impact on the amount of private green investments. Columns (2) and (3) include the dummy variables of time and country, respectively, and Column (4) provides the regression coefficient result with the dummy variable of time and the dummy variable of country controlled for simultaneously.

Then we move on to look at the relationship between the amount of private green investments and the host country's renewable energy policies. As can be seen from the regression results of Table 2, the core variable of the host country's renewables policies will significantly increase the amount of private

Table 5: Benchmark Regression Results of Model 1

Variable	(1)	(2)	(3)	(4)
	Green	*Green*	*Green*	*Green*
Policy	0.0028***	0.0025***	0.0022***	0.0013**
	(0.0005)	(0.0006)	(0.0005)	(0.0007)
Multi	-0.0049	-0.0093	0.0029	-0.0059
	(0.0179)	(0.0181)	(0.0182)	(0.0182)
Risk	-0.0471***	-0.0435***	-0.0470***	-0.0406***
	(0.0066)	(0.0067)	(0.0066)	(0.0067)
Capacity	-0.0005***	-0.0005***	-0.0005***	-0.0005***
	0.0000	0.0000	0.0000	0.0000
GDPgrowth	0.0018	0.0022	-0.0005	0.0011
	(0.0032)	(0.0032)	(0.0033)	(0.0034)
ln*GDP*	0.0235***	0.0244***	0.0141***	0.0125**
	(0.0047)	(0.0047)	(0.0050)	(0.0051)
Dummy variable of time		Yes		Yes
Dummy variable of region			Yes	Yes
Observations	1,293	1,293	1,293	1,293

Note: The table reports the marginal effects of the estimated results; numbers in parentheses are standard errors; *** p<0.01, ** p<0.05, * p<0.1.

green investments, and the higher the level of financial market freedom, the more private capital will invest in renewable energy projects. The reason is that the renewable energy sector is an asset-heavy one that entails a sizable upfront investment in fixed assets as well as hefty financing costs during the operating stage. As a result, financial markets are vital for financing renewable energy projects.

The following is suggested by the regression results of other control variables: International financial institutions' participation may encourage private green investments in renewable energy projects, which are public goods and typically managed by host country governments. When the public interest conflicts with the profit-seeking nature of private capital, the government tends to maintain those projects as public goods, placing private capital in an unfavorable position. Governments hold significant sway over pricing, operational mode, and profit sources for renewable energy projects (Gong et al., 2019).

Intergovernmental financial organizations pool sovereign wealth funds from various countries and engage in negotiations with host country governments on behalf of capital-contributing countries or private capital (Luo et al., 2017). International financial institutions may strengthen the negotiating position of private capital and develop reasonable financing plans according to project characteristics to lower the political, financial, and operational risks of private capital participation in those projects, allowing private capital to increase investment in renewable energy projects. These institutions have extensive experience financing infrastructure projects and have significant global influence.

On the other side, the level of private capital may benefit from the political stability of the host countries. There are military conflicts, geopolitical dangers, and political unrest in some countries along the BRI routes (World Economic Forum, 2022). Flip-flops in national renewable energy policies and guarantees result from frequent changes in the ruling parties. Newly elected governments sometimes disregard commitments made by previous administrations. Private capital is therefore more likely to invest in politically stable BRI countries. The above findings suggest that a host country's policies on renewable energy have a significant effect in welcoming private green investments. As a result, Hypothesis 1 is validated.

Table 6: Benchmark Regression Results of Model 2

Variable	(1)	(2)	(3)	(4)
	ln*Investment*	ln*Investment*	ln*Investment*	ln*Investment*
Policy	-0.0007	-0.0013	0.0057*	0.0088**
	(0.0017)	(0.0023)	(0.0030)	(0.0041)
FinFreedom	0.0049	0.0047	0.0198**	0.0210**
	(0.0033)	(0.0033)	(0.0086)	(0.0094)
Multi	0.5680***	0.5660***	0.4600***	0.4630***
	(0.0810)	(0.0798)	(0.0852)	(0.0860)
Capacity	0.0072***	0.0071***	0.0064***	0.0064***
	(0.0011)	(0.0011)	(0.0010)	(0.0010)
AntiCorrupt	-0.1520	-0.1770	0.2430	0.1520
	(0.1300)	(0.1340)	(0.4330)	(0.4640)
Voice	0.2360***	0.2460***	-0.2040	-0.1630
	(0.0644)	(0.0652)	(0.2970)	(0.3070)
Stability	0.1400***	0.1430***	0.5310***	0.554***
	(0.0519)	(0.0526)	(0.1920)	(0.2080)
GDPgrowth	-0.0317*	-0.0201	0.0287	0.0308
	(0.0183)	(0.0197)	(0.0229)	(0.0244)
ln*GDP*	0.1470***	0.1360***	-0.3880	-0.2240
	(0.0267)	(0.0276)	(0.3420)	(0.4350)
Dummy variable of time		Yes		Yes
Dummy variable of country			Yes	Yes
Observations	1,010	1,010	1,010	1,010

Notes: Numbers in parentheses are standard errors.

4.2 Further Analysis

4.2.1 Robustness test

(1) Exclusion of special countries

Our samples include 281 conventional energy projects (21.7%) and 275 renewable energy projects (27.5%) with private capital participation in China, which could bias the regression results. Additionally, this study intends to examine how the policy environment in BRI countries may influence private green investments in order to help reduce the gaps in the BRI countries' green finance. In order to uncover those policy effects, this section excludes Chinese samples from the overall research samples and runs another regression using Models 1 and 2. The robustness of the benchmark test is validated by the regression results in columns (1) and (2) of Table 7, which are consistent with the outcomes of the benchmark test.

(2) Replacement of explained variables

The total amount of private capital invested in renewable energy projects is chosen as the explanatory variable in Model 2's benchmark test. Such information not only covers the sum that private capital has invested in tangible assets, but also the license fees that private capital has paid to get the right to develop a project. Physical capital investments better reflect financing demand from renewable energy projects. By leveraging the private sector's expertise in everything from investment to construction and operation, host countries hope to increase their installed renewable energy capacity. For this reason, the original explained variable is replaced in this study with the amount of physical investments in renewable energy projects made by private capital (ln*Phyinvest*) to perform a regression analysis using the same methodology as the benchmark test. The robustness of the benchmark test findings has been validated by the results in column (3) of Table 7.

(3) Lag term of host country GDP

For the control variables of Model 2, there could be mutual causality between host country GDP and the explained variable of renewable energy investments. Moreover, a time lag may also exist for the host country's GDP to influence the volume of private green investments. With the results displayed in column (4) of Table 7, this study incorporates a one-phase lag of host country GDP to assess the robustness of the benchmark regression. The regression results demonstrate the robustness of the benchmark test and are consistent with the outcomes of the benchmark test.

4.2.2 Heterogeneity analysis

(1) Development stage of renewable energy

With regression results presented in Table 8, this paper further evaluates the role that renewable energy policies play at different stages of the renewable energy market's development on the basis of benchmark analysis in Model 2. The results of columns (1) and (2) in Table 8 indicate that when a country's renewables market is in its infancy, renewables policies will effectively attract private green investments, whereas the policy factor is no longer significant in the growth and maturity stage, when financial markets start to play a significantly positive role. Hypothesis 2 is thus proven.

(2) Types of renewable energy policies

The results of Model 2's benchmark analysis provide an explanation for why private green investments are drawn by a host country's renewable energy policies. The long-term strategic plan for renewable energy development (*Plan*), policy incentives for renewables (*Incentives*), renewable energy auction policy (*Auction*), policy support for power grid connection (*Connection*), and financing support

Table 7: Robustness Test

Variable	(1)	(2)	(3)	(4)
	Green	ln*Investment*	ln*Phyinvest*	ln*Investment*
Policy	0.0019**	0.0149**	0.0090**	0.0104**
	(0.0008)	(0.0070)	(0.0040)	(0.0044)
Control variable	Yes	Yes	Yes	Yes
Observations	978	735	988	1,010

Table 8: Regression Results after Differentiating Renewable Energy Development Stages

Variable	(1)	(2)
	Nascent stage	Growth and maturity stage
	ln*Investment*	ln*Investment*
Policy	0.0105*	0.0058
	(0.0054)	(0.0195)
FinFreedom	0.0089	0.1450***
	(0.0112)	(0.0399)
Control variable	Yes	Yes
Observations	774	193
Chow Policy	-0.0072***	
Chow Finfireedom	-0.0107***	

Note: *Chow Policy* and *Chow FinFreedom* are the Chi-square values of Chow test for the inter-group differences between the policy intensity for the renewables market and the regression coefficient of financing freedom.

policy (*Finance*) are the five national renewable energy policy sub-indicators used in this section's analysis of the role of specific policies in luring private capital. We run a further regression of Model 2 to examine the role of specific policies in attracting private capital. Column (1) of Table 9 displays the regression's results. The regression results show that a long-term strategy for renewable energy encourages private capital to invest more in renewable energy. By establishing a long-term strategy for renewable energy growth, the host country government demonstrates its commitment to expanding the renewable energy sector, possibly through increased economic support that appeals to private capital.

The green investment attraction effects of specific renewable energy policies at various stages of renewable energy development are further examined in columns (2) and (3) of Table 9. It has been discovered that a long-term strategy attracts private capital in all stages of renewables market development, whereas the renewables auction strategy considerably discourages investment in the early stage. The auction policy aims to lower the cost of producing clean energy power through competitive market forces. Such competition discourages private green investments by putting a strain on project cash flow in a nascent renewables market still dependent on subsidies.

4.3 Potential Policy Effect Pathways

After the benchmark study has demonstrated the effectiveness of renewable energy policies in attracting private green investments, this section will delve into the mechanism of such policy effects.

Table 9: Regression Results for Different Types of Renewable Energy Policies

Variable	(1)	(2)	(3)
	Total samples	Nascent stage	Growth and maturity stage
	ln*Investment*	ln*Investment*	ln*Investment*
Plan	0.0150***	0.0171**	0.0188*
	(0.0050)	(0.0080)	(0.0104)
Incentives	-0.0068	-0.0125	-0.0073
	(0.0052)	(0.0087)	(0.0153)
Auction	-0.0154	-0.0515***	-0.1120
	(0.0168)	(0.0230)	(0.1460)
Finance	0.0046	0.0107	-0.0014
	(0.0055)	(0.0081)	(0.0148)
Connection	-0.0101	0.0356	-0.0643
	(0.0166)	(0.0243)	(0.0708)
FinFreedom	0.0271***	0.0184	0.0733
	(0.0093)	(0.0124)	(0.0563)
Control variable	Yes	Yes	Yes
Observations	1,010	774	193
Chow Plan		-0.0084***	
Chow Incentives		-0.0096***	
Chow Auction		-0.0418***	
Chow Finance		-0.0084***	
Chow Connection		-0.0115***	
Chow FinFreedom		-0.0130***	

Note: Chow Plan, Chow Incentives, Chow Auction, Chow Finance, Chow Connection, Chow FinFreedom are the Chi-square values from Chow test for the inter-group differences of the renewables policy sub-indicators and the financing freedom regression coefficient.

(1) Policy effects on the renewable energy market

The model specification used in this study to develop a two-way fixed effect model of time and country is as follows: The total installed capacity of renewable energy (*GreenCapacity*), which is from the International Renewable Energy Agency (IRENA) database, is used to gauge the growth of a country's renewable energy sector. Only 38 of the benchmark samples are tested since not many BRI countries are in the database. Control factors ($Control_3$) consist of: (i) Environmental regulation, denoted by the stringency (*EnvStringency*) and enforcement (*EnvEnforcement*) of environmental regulation in country *i*, year *t*; (ii) governance, represented by corruption control (*AntiCorrupt*), political stability (*Stability*), and public voice (*Voice*) in country *i*, year *t*; (iii) the country's economic volume (ln*GDP* after logarithmic conversion) and economic growth rate (*GDPgrowth*).

The test results, which are displayed in column (1) of Table 10, indicate that renewables policies may significantly promote a country's renewable energy market, hence verifying 3a.

$$GreenCapacity_{it}=\beta_0+\beta_1\times Policy_{it}+\beta_2\times Control_3+\theta_t+\sigma_c+\mu \tag{3}$$

(2) Policy effects on technological innovation

The model used in this section specifies that a country's technological innovation in renewable energy is determined by the growth in the number of renewable energy patents (GreenPatent). Data source for this model is the IRENA database, which covers the complete data of 14 countries for almost ten years. Those 14 countries therefore serve as test samples in this section. The GreenPatent variable has the logarithmic form of +1 in order to increase the regression model's goodness of fit due to disparate numbers of new green patents in different countries, with some of them registering no green patents in some years. Control variables ($Control_4$) include: (i) Environmental regulation, represented by the stringency and enforcement of environmental regulation in country *i*, year *t*; (ii) governance, represented by the prevention of corruption (*AntiCorrupt*), political stability (*Stability*) and public voice (*Voice*) in country *i*, year *t*; (iii) the country's economic prowess, represented by economic volume (ln*GDP* after logarithmic conversion) and economic growth rate (*GDPgrowth*); θ_t is the fixed effect of country, σ_c is the fixed effect of time, and μ is the disturbance term.

$$GreenPatent=\beta_0+\beta_1\times Policy_{it}+\beta_2\times Control_4+\theta_t+\sigma_c+\mu \tag{4}$$

Due to the following factors, test results in column (2) of Table 10 cannot conclusively determine whether renewables policies would encourage or impede a country's technological innovation: Firstly, most BRI countries are emerging or developing economies, which are less affluent and sophisticated than developed countries. During the early stage, those BRI countries must import renewable energy technologies from industrialized nations (Kim, 2020). Therefore, national policies may not bolster innovation in any significant way in the short run. Only when the renewables market becomes more mature do national policies begin to encourage technological innovation. Second, incentives must be aimed at certain technologies to spur renewable energy innovations. Technology innovation might benefit

Table 10: Potential Pathways for the Effects of Renewable Energy Policies

Variable	(1)	(2)
	GreenCapacity	GreenPatent
Policy	1.019***	0.0106
	(0.210)	(0.008)
Control variable	Yes	Yes
Fixed effect of time	Yes	Yes
Fixed effect of country	Yes	Yes
Observations	380	140

more from targeted policy incentives as well as from improvements to the national R&D environment.

5. Conclusions and Policy Suggestions

Based on 1,293 energy investment projects in 45 BRI countries between 2010 and 2019, this study analyses the efficacy of renewable energy policies established by BRI host countries in attracting private capital for renewable energy investments. Our findings are intended to serve as theoretical basis and policy guide for strengthening the policy environment, addressing green finance gaps for the BRI, and co-opting private capital to build the "Green Silk Road". Our findings have the following policy implications:

First, the policy incentives offered by a country may considerably encourage private capital to invest in green energy and scale up such investments.

Second, regression results reveal that renewable energy policies are attractive to green investment only when the renewables market is at its fledgling stage. When the market grows bigger and more sophisticated, financing freedom replaces other factors as the main force behind private green investments, and the market starts to hold sway in mobilizing resources.

Third, further examination and categorization of renewables policies illustrate that, while policy incentives (i.e. renewable energy auctions) significantly discourage private capital investment in the early stage of the renewable energy market, macro-policies such as a long-term renewable energy strategy may attract private capital into the renewables market in all stages.

Fourth, although renewables policies encourage market growth by inviting private capital investment, these policies do little to spark innovation in host countries. Renewable energy markets in BRI countries are at varying levels of development. For those in initial stages, establishing a more effective policy framework is crucial to advancing their energy transition. The National Energy Administration (NEA) of China estimates that in 2021, renewable energy-based power generation in China accounted for 29.8% of its total power consumption. Coordination of China's renewables policies with market-oriented reform becomes crucial as the renewables market enters the growth and maturity stage. Therefore, 'we conclude this paper with the following policy suggestions:

(i) Enhance national renewables policies. To facilitate a swift transition to renewable energies, short-, mid-, and long-term strategic goals and plans should be developed in accordance with the market potential and energy resource endowments for various forms of renewable energy. Renewable energies can be made more competitive through the adoption of market-based pilot policies such as price difference contracts, price premium subsidies, and clean energy auctions.

(ii) Coordinate market-based mechanisms with policy incentives to develop the renewable energy industry. Market-based mechanisms are expected to strengthen and policy incentives to diminish amid the falling cost of generating electricity from renewable energy sources. The development of China's renewable energy industry from early stage to mature necessitates policy priorities. Priority one is to lower the marginal cost of renewables-based power generation through open competition in the electricity spot market, making it possible to complete the transition from massive subsidies to market-based price competition with the aid of policy instruments like power purchase agreements (PPA) and auction subsidies.

On the consumption side, initiatives should be made to enhance green power certification and speed up the grid integration of renewable energy sources. Market entities should fairly share responsibility for consuming power produced from renewable sources.

Finally, even though renewable energy is the main force behind the third global energy transition, considering the national circumstances of BRI countries, renewable energies should be supplemented with coal-fired power and other conventional energies to bring about an energy market transition through electric power market reforms and enhancing market-based tariff rates.

(iii) Harness financial market mechanisms and expand access to financing for renewable energy. Financial market development and green credit issuance should be given high priority to finance renewable energy projects. With the help of green financial solutions such as green bonds and green credit, eligible renewable energy projects could receive needed assistance. It is important to support the adoption of the BRI Green Investment Principles by the Silk Road Fund, the Asian Infrastructure Investment Bank (AIIB), and other international financial institutions. Implementation of policy financial instruments is necessary to allow claims, equities, equity-claim combinations, and private equity funds to participate in green investing. Proactive efforts should be made to explore the possibility of project financing using project assets as a payback guarantee, as well as hybrid financing with international institutions and commercial banks, in order to expand renewable energy finance and ease the shortage of funds. CE

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