Challenge or opportunity of climate financial fragmentation

Evidence from China-initiated cooperation with emerging multilateral institutions

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Abstract

Purpose – This study aims to investigate the environmental effects of climate financial fragmentation in the form of emerging multilateral institutions.

Design/methodology/approach – Among the countries that have economic relations with China, those involved in climate finance cooperation are taken as the experimental group, and those not involved in other areas are taken as a control group. Using system generalized method of moments regression, the difference-in-differences method is used to test the environmental effects of climate finance cooperation of emerging multilateral institutions. In this way, this study explores the financial and trade mechanisms of cooperation among emerging multilateral institutions.

Findings – The results of this empirical study show that the cooperation of emerging multilateral institutions has a positive impact on the environment. Research results further reveal the financial and trade mechanisms of climate finance cooperation projects. When the invested countries are more likely to obtain international capital, environmental effects will be greater. However, trade intimacy could inhibit the improved environmental effects.

Originality/value – This research is one of the few studies to test the environmental effects of climate financial fragmentation empirically. This study provides a better understanding of the multilateral cooperation of emerging economic entities and China's climate finance policy, thus providing evidence for the collaborative governance of global climate finance.

Keywords China, Fragmentation, Environmental effects, Climate finance, Emerging multilateral institutions

Paper type Research paper

1. Introduction

Global climate change has become an indisputable fact that poses huge risks to human life and health around the world (Korhonen *et al.*, 2019). Currently, a great deal of climate

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mitigation action can be observed worldwide. International multilateralism, with the United Nations Framework Convention on Climate Change (UNFCCC) and the Conferences of Parties at its core, remains a central forum for global climate governance. However, from the latest climate investment and financing situation, the global climate funding gap is continuing to expand. With the widening gap of climate finance, many multilateral, small, transnational, national, sub-national and non-state actors have emerged, making global climate finance fragmented and complicated.

For over nearly 30 years, global climate financing channels have been expanding, and the climate financing system has been evolving with more complexity. Uncoordinated fragmentation, with the contradictory effects of policies and actions, may pose a fundamental challenge to overall environmental and economic performance. Khan and Roberts (2013) argue that the fragmentation and uncertainty of climate finance may reduce its environmental effects. On the other hand, Dorsch and Flachsland (2017) claim that in the current, highly dynamic transition phase of climate architecture, the changing empirical realities and promising architectural possibilities of an increasingly polycentric system of climate governance must be acknowledged. Whether fragmentation brings more challenges or opportunities to climate finance has not been determined by existing research. Further, most existing studies are theoretical analysis, with few empirical tests of climate aid investment in emerging markets and neighboring countries.

In the climate finance system, which is highly dependent on official development assistance (ODA), the scale of public funds from developed countries is relatively fixed. After the financial crisis of 2008, international financial institutions have tended to focus on large-scale projects with quick results and relatively high return on investment to achieve established performance goals. This has resulted in the lack of financial support for small projects urgently needed in some of the world's most vulnerable regions. To provide financial support to climate-fragile countries and regions, emerging market countries are gradually providing official financial support to underdeveloped neighboring countries, thereby strengthening global and regional risk management capabilities. As most developing countries are experiencing rapid development, they are still the major emitters of carbon dioxide (CO_2). As the world's second largest economy and the biggest greenhouse gas emitter, China is under great pressure to reduce emissions (Zhang *et al.*, 2019). Therefore, China's attitude and efforts toward climate finance will undoubtedly affect global carbon emissions. It is necessary for us to understand China's policies and their effects on international climate finance and further explore the collaborative innovation of global climate finance in a new pattern.

Our research is driven by an apparent lack of consensus in the scholarly literature on the consequences of fragmentation. What are the exact consequences of fragmentation on climate finance? Specifically, do the different forms of fragmentation bring opportunities or challenges? How does the mechanism of fragmentation affect the environment? This study is designed to fill these research gaps by contributing to the literature in the following ways. First, this research tests the environmental effects of climate financial fragmentation empirically, aiming to clarify the as yet inconclusive theoretical findings on the impact of fragmentation. Further, this study contributes to the understanding of the role of cooperation of emerging multilateral institutions in climate finance, which has been rarely investigated in prior research. Understanding the impact of emerging multilateral institutions' cooperation and operational mechanisms may encourage regulators, green organizations, investors and other stakeholders to motivate, manage and invest in such partnerships.

The rest of the paper is organized as follows: Section 2 discusses the theoretical and practical backgrounds of China's foreign investment policy and climate finance fragmentation; Section 3 develops the three hypotheses that this study tests; research methodology is described in Section 4; results are reported and discussed in Section 5; and finally, Section 6 summarizes the research conclusions and policy implications.

2. Theoretical and practical backgrounds

2.1 China's foreign investment policy

To build a new all-round opening-up pattern and deeply integrate into the world economic system, China established a regional economic cooperation framework with its neighboring countries in 2013 (Central Committee of the Communist Party of China [Central Committee], 2013). The regional economic cooperation is devised to reconfigure China's external sector to continue its strong growth. While infrastructure development among participating countries plays a central role, economic cooperation also includes unimpeded trade, financial support, and people-to-people exchange (Huang, 2016).

In April 2017, the Ministry of Environmental Protection of China issued guiding opinions for promoting the construction of the green 'one belt and one road'. The guidance puts forward that, in 5-10 years, a relatively complete system of ecological environmental protection shall be established, and many important ecological environmental protection projects shall be implemented (Liu and Xin, 2019). Promoted by policy and industry initiatives, the funds of 14 Chinese-foreign joint ventures currently total nearly US$140 billion. These funds are mainly invested in developing countries in Africa and Latin America, as well as in economic cooperation countries in Asia. These funds include two green theme funds, the Climate Change South–South Cooperation Fund and the China–US Green Fund. In addition, China has also carried out a number of climate investment projects in economic cooperation countries.

2.2 Fragmentation of climate finance

Traditional "top-down" climate financial governance has played an important role in raising public funds and reducing CO_2 emissions. Fragmentation is often conceptualized as the opposite of globalization. In international environmental governance, fragmentation is often used to describe phenomena of the "decentralization" or "multiplicity," "division of labor" among international norms and institutions or, with a more negative connotation, "treaty congestion" (Haas, 2004).

The climate financing system includes a wide range of institutions and actors, ranging from new bodies such as the Green Climate Fund and national climate funds in developing countries to existing institutions that have increased their funding for mitigation and adaptation. At the same time, the climate finance system – understood as a mix of institutions, customs and actors – shows a large degree of "fragmentation" and a dynamic that is also found in broader climate management (Betzold and Weiler, 2017).

In bi- and multilateral agreements, such as the US–China Climate Agreement and the EU, group of seven or group of twenty commitments, many nation states coordinate and mutually foster their climate policies (Rayner and Jordan, 2013; Falkner, 2016). On the other hand, emerging market countries also provide official financial and technological support to underdeveloped neighboring countries. Emerging multilateral organizations and regional development banks have exceeded the traditional multilateral development bank-led aid framework in terms of the scale of aid funds.

A more decentralized approach to climate governance has provided financial support and motivation for climate finance to a certain extent. However, the decentralization of

climate financing architecture also brings uncertainty and coordination costs. Thus, two following research questions are proposed:

RQ1. What are the environmental effects of climate financial fragmentation in the form of emerging multilateral institutions?

RQ2. What is the mechanism for the role of climate finance cooperation in emerging multilateral institutions?

3. Hypotheses

3.1 Effectiveness of climate cooperation in emerging multilateral institutions

Billions of dollars are needed to address climate change by reducing greenhouse gas emissions and their impact on some of the poorest countries. According to the theory of economic rational choice, international cooperation does not exist or has a weak motivational force. For almost three decades, classical top-down approaches have emphasized the global character of the climate change problem and identified international multilateralism seen as a cooperative effort between nation states as the central and most appropriate forum for climate governance (Hare *et al.*, 2010).

Although the multilateral climate mechanism based on the Organization for Economic Co-operation and Development aid system can benefit the whole world, its contribution to climate finance is the smallest of all channels. Various forms of climate finance are welcomed by the sponsoring countries with its unique advantages of high efficiency and direct help; the contribution of funds is on the rise. Therefore, more scholars have begun to pay attention to the implications of fragmentation and complexity for the outputs and outcome of the emerging climate financing system. In addition, scholars are focused on how to assess the effects of fragmentation on values such as accountability, democratic legitimacy, effectiveness and equity.

There are two main views on the impact of fragmentation on global climate finance. Some scholars supporting a more integrated overall architecture hold a view that more integrated governance architectures promise higher effectiveness in terms of solving the core problems in an issue area (Khan and Roberts, 2013). Others, however, assert the value of fragmentation, often referred to as "diversity," or at least implicitly accept it (Dorsch and Flachsland, 2017). Although climate capital flows are generally increasing, the amount of global climate funding that is needed is far greater than the amount already invested. To provide financial support to climate-fragile countries and regions that the ODA cannot reach, emerging market countries are gradually providing official financial support to underdeveloped neighboring countries, thereby strengthening global and regional risk management capabilities. Climate investment cooperation between emerging multilateral institutions can make up for the gap in climate funds to a certain extent but more importantly can achieve the mutual benefit between economic transformation and environmental protection through mutual learning among participating countries. Thus, the first hypothesis is suggested:

H1. Climate cooperation in emerging multilateral institutions can reduce local carbon emissions.

3.2 Financial mechanism for the effectiveness of climate cooperation in emerging multilateral institutions

In general, climate projects have a large investment scale and a long construction period. Therefore, construction funds must be guaranteed to be stable and sufficient during

construction. Regrettably, the current global climate funding gap is huge, and the funding needs for climate projects in many vulnerable regions and populations cannot be met. Moreover, this problem is particularly prominent in developing countries. The backwardness of the allocation of financial resources and the lack of financial discourse power have severely restricted the improvement of climate investment performance in various countries.

When a large amount of foreign direct investment enters countries along the investment line, it greatly eases the financial constraints faced by relevant countries in climate construction projects, thus playing a beneficial role in improving the effect of climate investment in countries along the investment line. On the other hand, multilateral financial institutions such as the Asian Infrastructure Investment Bank, the Silk Road Fund and the New Development Bank, established in 2014, can make up for the shortcomings of the current international financial institutions. Multilateral financial institutions can alleviate the current inability of international financial institutions to meet the financial needs of infrastructure construction in developing countries. Therefore, this study assumes that mitigating the financial constraints of countries along the investment line is an important mechanism to improve the effectiveness of climate investment projects in emerging multilateral institutions. Thus, the second hypothesis is suggested:

H2. Access to international funds can improve the effectiveness of climate cooperation in emerging multilateral institutions.

3.3 Trade mechanism for the effectiveness of climate cooperation in emerging multilateral institutions

Trade plays an important role in a country's economic and environmental development. Because CO_2 is produced in the process of producing products and services, it can be transferred between countries through foreign trade (Peters and Hertwich, 2008; Davis *et al.*, 2011). Emerging economies that engage in climate cooperation often have close trade relations because of their close geographical relationship. Taking China's foreign investment as an example. Countries in Association of Southeast Asian Nations (ASEAN) are closely related to China's landscape. Especially in recent years, with the rapid development of China's economy, China and ASEAN countries have closer ties in many aspects, such as economic and trade cooperation, mutual investment and personnel exchanges. On the other hand, China has submitted its intended nationally determined contributions (INDCs) and pledged to cut its carbon emissions per unit of Gross Domestic Product (GDP) by 60-65 per cent of the 2005 level by 2030 (National Development and Reform Commission of China (NDRC), 2015). To achieve these INDC commitments, China may need domestic reduction actions as well as trade carbon transfer. Therefore, the effect of climate investment projects may be reduced in both climate partners with close trade links. Thus, the third hypothesis is suggested:

H3. International trade between climate partners can reduce the effectiveness of climate cooperation projects.

4. Research methodology

4.1 The sample

To explore the effects of climate investment in emerging multilateral institutions, this study selects the foreign investment conducted by China, the world's largest emerging economy,

as a research sample. As mentioned above, in September 2013, China put forward a new strategic layout for opening up and achieving common economic development by strengthening economic cooperation with countries in Southeast Asia, South Asia, Central Asia, West Asia, North Africa, Central and Eastern Europe and Mongolia (Central Committee of the Communist Party of China [Central Committee], 2013).

China has increased the climate investment projects along with the outbound investment. As of the end of October 2018, there were 51 clean transportation and clean energy projects along the route, including 20 clean transportation projects and 31 clean energy projects. These projects were in countries in Southeast Asia, South Asia, West Asia, Central Asia, Europe and Africa. These projects can meet the needs of local residents, improve the overall living standards and improve the local climate conditions.

This paper takes China's foreign investment countries as a research sample to test the mitigation effect of climate investment projects on local carbon emissions. The annual data of carbon emissions come from the "global carbon" website; other data are from the World Bank.

4.2 Model setting

The difference-In-differences (DID) method is mainly used for external policy effect evaluation in sociology. In recent years, the DID method has been used more in management research (Sunak and Madlener, 2016; Mao and Zhang, 2018). More recently, Pan *et al.* (2019) adopted the DID method to analyze the effect of environmental policy in China's national program to address climate change on carbon emission efficiency. To examine the specific impact of climate investment projects on local carbon emissions and to verify possible impact mechanisms, this paper uses the DID method to design and test the following measurement models:

Model 1:

$$Carbon_{i,t} = C + \alpha_1 time_i * treat_t + \alpha_2 Control_{i,t} + \varepsilon_{i,t}$$

Model 2:

$$Carbon_{i,t} = C + \beta_1 time_i * treat_t + \beta_2 Ic_{i,t} * time_i * treat_t + \beta_3 Ic_{i,t} + \beta_4 Control_{i,t} + \varepsilon_{i,t}$$

Model 3:

$$Carbon_{i,t} = C + \gamma_1 time_i * treat_t + \gamma_2 FDI_{i,t} * time_i * treat_t + \gamma_3 FDI_{i,t} + \gamma_4 Control_{i,t} + \varepsilon_{i,t}$$

Model 4:

$$Carbon_{i,t} = C + \delta_1 time_i * treat_t + \delta_2 Ip_{i,t} * time_i * treat_t + \delta_3 Ip_{i,t} + \delta_4 Control_{i,t} + \varepsilon_{i,t}$$

Among them, Model 1 is used to test whether the climate investment projects can reduce local carbon emissions. The dependent variable $Carbon_{i,t}$ is the CO_2 emission level of country i in t years. In the explanatory variables, $time_i$ represents the dummy variable of policy occurrence, and $treat_t$ is the dummy variable to judge whether country i is carrying out climate investment. The interaction between the two variables is the core explanatory variable of this paper. C represents constant terms in regression. Models 2 and 3 are used to verify the financial mechanism in which climate investment projects work. $Ic_{i,t}$ and $FDI_{i,t}$

represent the level of international credit and foreign direct investment in the host country, respectively. β_2 and γ_2 are the key coefficients in the model. Model 4 adds $Ip_{i,t}$ to Model 1 to test the trade mechanism of climate investment. $Ip_{i,t}$ indicates whether the invested countries belong to the Central and South Peninsula region with close trade relations with China. $Control_{i,t}$ are other control variables that may affect a country's total CO_2 emissions, and $\varepsilon_{i,t}$ is a random error term.

This study controls the lag term of the dependent variable ($Carbon_{i,t}$) in the control variables to reflect the path dependence of CO_2 emissions, which can be explained by the slow improvement of production structure and technology. Referring to previous studies, the authors have controlled for the economic development level, population, industrial structure and opening-up level of the sample countries which may affect the total carbon emissions (Apergis and Payne, 2009; Ibrahim and Law, 2014). The specific measurement of variables is shown in Table I.

4.3 Estimation method

To estimate the econometric relationship between climate investment projects and CO_2 emissions, this study uses the system generalized method of moments (GMM) estimation method proposed by Arellano and Bond (1991) and used by Blundell and Bond (1998) for estimating dynamic panel models. The system GMM method solves the fixed effects of individual differences in countries, the potential endogenous nature of all explanatory variables and the lack of good exogenous instrumental variables in the model when using mixed ordinary least square regression, fixed effect panel regression and random effect panel regression. To reduce the potential errors and inaccuracies in the differential estimation, the system GMM method combines differential GMM regression and the horizontal GMM regression and puts the difference equation and the horizontal equation into the same equation system for estimation. Blundell and Bond (1998) proved that system

Variables	Operational definition
Dependent variable	
Carbon	Carbon emissions of invested countries, measured by logarithm of local CO_2 emissions
Explanatory variables	
time	Dummy variable of policy occurrence, if the climate investment project has been completed during the year, it takes 1, otherwise 0
treat	Dummy variable to judge whether the country carries out a climate investment
Ic	International credit level, sort the proportion of international credit in the sample, higher than the median, it takes 1, otherwise 0
FDI	Foreign direct investment level, sort the proportion of foreign direct investment in the sample, higher than the median, it takes 1, otherwise 0
Ip	The degree of trade between the invested country and China, if the country belongs to the Central and Southern Peninsula, it takes 1, otherwise 0
Control variables	
GDP	The economic development level of a country, measured by per capita GDP
Pop	Natural logarithm of a country's total population
Ind	Industrial structure, measured by the percentage of the added value of the secondary industry to GDP
Exp	Openness to the outside world, measured by the percentage of exports of goods and services to GDP

Table I. The operational definitions of dependent, independent and control variables

GMM estimation can significantly improve the consistency and validity of the model estimation results.

5. Results and discussion

5.1 Descriptive statistics

Table II shows descriptive statistics of the total samples, the control group and the test group. There are 501 samples in the total sample, involving 68 countries. Among them, the test group, which is composed of the countries that have completed climate projects, are 36 samples. The number of samples in the control group is 465. Carbon ranged from −1.45 to 39.754, indicating a substantial variation within the total sample. The average mean of Carbon was 3.956, which suggests that the level of carbon emission is high. In addition, the carbon emissions of the control group and the experimental group are quite different. To sum up, experimental countries generally have lower levels of economic development. They tend to have a lower GDP, lower levels of industrialization and lower degrees of openness. However, compared with the control group, the test group has a higher level of CO_2 emissions. This may be the main reason why China cooperates with these countries in climate projects.

Figure 1 shows the total carbon emissions and annual growth rate of China's investment in foreign countries in recent years. China's foreign investment countries are located in ecologically fragile and sensitive areas, especially in Asia, which has become the fastest-growing consumer of fossil energy in the world. From 2015 to 2017, the carbon emissions of the countries along the line were on the rise, and the growth rate is still rising year by year. The investment area covers the major global carbon emitters, such as India, Russia and so on; the total carbon emissions are huge. The economic development model of these countries is extensive. The production and operation activities bring an enormous burden to the local ecological environment. The environmental problems are prominent, and the pollution is serious. Adjusting the economic development model and making a low-carbon investment is urgent. If effective measures are taken, the countries along the route will have greater emission reduction potential in the future.

Variable	Mean	Sd	P50	Min	Max	N
Total sample						
Carbon	3.956	3.093	3.782	−1.450	39.754	501
GDP	9.512	0.954	9.552	7.254	11.728	501
Pop	16.223	1.655	16.007	12.810	21.015	501
Ind	0.325	0.144	0.286	0	0.844	501
Exp	0.48	0.301	0.423	0	2.033	501
Control group						
Carbon	3.678	1.829	3.752	−1.450	7.454	465
GDP	9.606	0.904	9.618	7.394	11.73	465
Pop	16.101	1.585	15.856	12.81	19.394	465
Ind	0.331	0.147	0.29	0	0.844	465
Exp	0.492	0.303	0.429	0	2.033	465
Test group						
Carbon	7.553	8.831	4.623	1.593	39.75	36
GDP	8.293	0.719	8.125	7.254	9.794	36
Pop	17.798	1.753	16.879	16.064	21.015	36
Ind	0.249	0.062	0.264	0.131	0.354	36
Exp	0.316	0.217	0.222	0.0763	0.668	36

Table II.
Descriptive statistics results

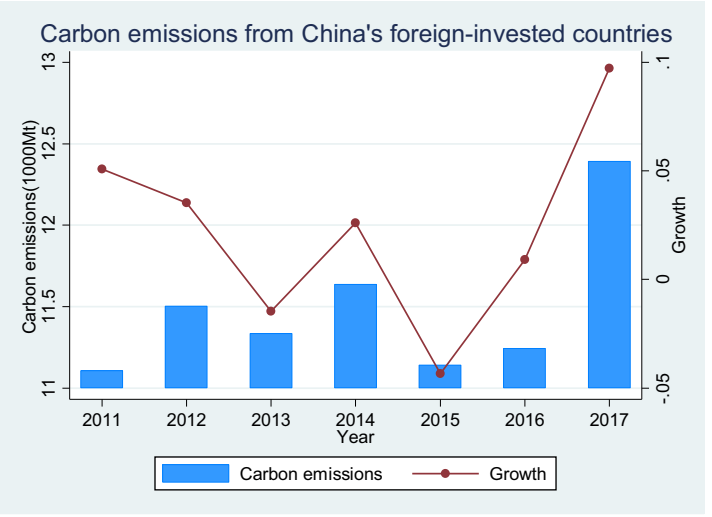

Figure 1.
Carbon emissions and growth rates of China's foreign investment countries

5.2 Details of the climate cooperation project

Because of the high climate risk, the low level of social and economic development and the backward infrastructure construction of China's investment countries, China's investment in foreign countries is mainly concentrated in clean energy, clean transportation and other infrastructure.

According to China's Climate Finance Report 2018, by the end of October 2018, China had invested in 51 clean national transportation and clean energy projects, including 20 clean transportation projects and 31 clean energy projects. These projects take place in Southeast Asia, South Asia, West Asia, Central Asia, Europe and Africa. These projects not only meet the needs of local residents and improve the overall living standards but also improve the local climate conditions. The infrastructure construction cycle is usually long, and only half of the 51 projects are currently completed. Because CO_2 reduction is a long-term process, this study selected the projects that were put into use before 2017 as an experimental sample to examine the role of climate investment projects to the local climate. Involving nine countries, 14 climate cooperation projects were completed before 2017. Among the completed climate cooperation projects, hydropower projects were the largest with seven projects in number. There were two wind power generation, railway traffic and solar photovoltaic power projects each. There was one urban rail transit project. Further details are shown in Table III.

5.3 Correlation matrix and bivariate analysis

The bivariate relationships among the variables are shown in Table IV. The results indicate that there was a significant bivariate association between Carbon and GDP, Pop, Ind and Exp. Among them, the first three variables were positively correlated with Carbon; that is, with the improvement of economic level, population and industrialization, the carbon emissions of the invested countries increased. Yet, the level of openness was negatively correlated with the level of carbon emissions.

Item category	Project host country	Project name	Date of completion
Hydropower project	Cambodia	Cambodia Elsie Hydropower Station	2014.01
Urban rail transit	India	Mumbai Metro Line 1	2014.06
Solar photovoltaic power generation	Pakistan	Pakistan 100 MW large solar photovoltaic power station	2015.05
Hydropower project	Guinea	Guinea Kaleta Hydropower Station	2015.09
Wind power generation	Ethiopia	Adama Wind Power Project in Ethiopia	2016.05
Solar photovoltaic power generation	Pakistan	900 MW Photovoltaic Power Station Project in Punjab Province	2016.06
Railway traffic	Belarus	Belarus Railway Electrification Reconstruction Project	2016.07
Hydropower project	Ethiopia	Djibouti 3 Hydropower Station	2016.08
Hydropower project	Ecuador	Coca codo–Sinclair Hydropower Station in Ecuador	2016.11
Hydropower project	Nepal	Shangma Xiangdi A Hydropower Station	2017.01
Railway traffic	Kenya	Mombasa-Nairobi Railway	2017.05
Hydropower project	Belarus	Vitebsk Hydropower Station	2017.07
Wind power generation	Pakistan	Jim Poor Wind Power Project	2017.09
Hydropower project	Ethiopia	Tekeze Hydropower Station	2017.09

Table III.
Details of the climate cooperation project

Variable	Carbon	GDP	Pop	Ind	Exp
Carbon	1				
GDP	0.197***	1			
Pop	0.689***	−0.310***	1		
Ind	0.111**	0.403***	−0.072	1	
Exp	−0.129***	0.570***	−0.422***	0.226***	1

Notes: **$p < 0.05$; ***$p < 0.01$

Table IV.
Correlation analysis results

5.4 Multivariate analysis and discussion

5.4.1 Effectiveness of climate cooperation in emerging multilateral institutions. The data were based on the years between 2011 and 2017. For test group sample countries, the length was determined according to the length of the project completion year to the statistical deadline year (2017); the same length is chosen as the research sample before the project completion. Table V shows the results of the GMM estimation for a dynamic panel and the Sargan test statistics for model setting. The test results indicate that all models accept the original hypothesis of "all tool variables are valid" at 5 per cent level. In addition, the results of the sequence correlation test reject the original hypothesis without first-order sequence correlation, but not without second-order sequence correlation. Therefore, the system GMM estimation can be carried out.

Model 1 in Table V reports the results of the DID estimates of local carbon emissions from climate investment projects. The coefficient of *time*treat* in the results, which is a particular focus for this study, was significantly negative. If the coefficient is significantly negative, it shows that the construction of climate investment projects has a positive effect on the reduction of carbon emissions in the country. This empirical result is consistent with

Variable	(1)	(2)	(3)	(4)
*time*treat*	−0.624*** (−67.48)	−0.115 (−0.66)	−0.574*** (−28.94)	−0.612*** (−53.47)
*Ic*time*treat*		−0.567*** (−3.12)		
Ic		−0.047** (−2.56)		
*FDI*time*treat*			−0.066** (−2.57)	
FDI			0.068*** (9.88)	
*IP*time*treat*				0.718*** (13.02)
IP				−2.133*** (−8.30)
Carbon_1	0.944*** (169.30)	0.950*** (113.13)	0.945*** (130.36)	0.873*** (151.46)
GDP	−0.378*** (−20.07)	−0.398*** (−19.37)	−0.382*** (−19.64)	−0.421*** (−17.56)
Pop	−0.186*** (−9.44)	−0.206*** (−6.74)	−0.213*** (−8.02)	0.131*** (5.49)
Ind	−1.112*** (−14.70)	−1.078*** (−14.57)	−1.086*** (−13.64)	−1.596*** (−18.62)
Exp	0.329*** (8.84)	0.308*** (7.81)	0.299*** (8.59)	1.146*** (28.90)
Constant	7.131*** (15.84)	7.627*** (12.66)	7.582*** (14.92)	2.585*** (4.45)
Sargan: *p*	0.717	0.759	0.809	0.726
AR1: *p*	0.034	0.016	0.020	0.009
AR2: *p*	0.470	0.467	0.461	0.478
Observations	427	427	427	427

Notes: *t* statistics in parentheses; *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

Table V. Systematic GMM results of the impact of climate financing on carbon emissions

Wang and Wang's (2017) point of view, who hold that global cooperation will help China take more responsibility in climate change.

Consistent with Ibrahim and Law's (2014) research, carbon emissions have a strong path dependence. After controlling for other influencing factors, the impact factor of the previous carbon emissions on the current period is 0.944. In addition, increased GDP can reduce carbon emissions in the invested countries. The reason is that the areas with a high level of economic development are superior to those with backward economic development in industrial structure optimization, clean energy use, energy-saving equipment research and development of harmless waste disposal. Both the government and citizenry advocate the development of a low-carbon economy, resulting in lower carbon emissions in economically developed areas.

5.4.2 Financial mechanism for the effectiveness of climate cooperation in emerging multilateral institutions. In Models 2 and 3, this study verifies the moderating effect of international credit and foreign direct investment, respectively. The core variables are *Ic*time*treat* and *FDI*time*treat*. The empirical results show that both international credit and foreign investment can enhance the effect of climate projects on reducing carbon emissions. Reducing greenhouse gas emissions in poor countries requires billions of dollars (Schalatek, 2012) so international credit is an important channel for a country to obtain construction funds. International credit refers to public and public guaranteed debts provided by multilateral financial institutions. Similarly, if a country's investment projects are more favored by international capital, the country also gets more sufficient funds in the construction of climate projects. Therefore, climate cooperation plays a stronger role in reducing carbon emissions. The above results validate *H2* of this paper; that is, mitigating financial constraints is a possible mechanism for climate cooperation projects to reduce carbon emissions.

In addition, the moderating effect of international credit is much higher than that of foreign investment (coefficients are −0.567 and −0.066, respectively). Compared with foreign direct investment, international credit is mainly government or state behavior. There

is great autonomy in the scale of borrowing and capital investment. The use of funds often focuses on adjusting the industrial structure and alleviating bottleneck constraints. Therefore, compared with foreign direct investment, international credit is a more important financing channel to alleviate the shortage of funds in climate investment projects.

5.4.3 Trade mechanism for the effectiveness of climate cooperation in emerging multilateral institutions. Although some hold the view that regional economic cooperation initiated by China can reduce carbon emissions, some scholars (Zhang *et al.*, 2017; Ascencao *et al.*, 2018) believe that the cooperation may also promote permanent environmental degradation. The regression results of Model 4 in Table V show that trade has a reverse moderating effect on carbon emissions from climate investment projects, which supports *H3* of this study.

In addition, after adding item *IP*time*treat* to the regression model, the result of item time*treat is still significant, but the absolute value is less than the coefficient of item *IP*time*treat*. To some extent, the effect of increasing carbon emissions caused by foreign trade may be greater than that of reducing carbon emissions caused by climate cooperation projects. With the deepening of global economic integration, more emerging economies have increased their trade cooperation, which may be accompanied by a large amount of carbon transfer, thus further increasing the climate risk of some countries whose natural environment is already very fragile. These increased carbon emissions are hard to absorb through climate investment projects.

5.5 Robustness check

This paper uses the DID method to study the impact of climate cooperation projects between China and its foreign investment countries on local carbon emissions. One of the important premises of this method is the assumption of a parallel trend. Restricted by the number of samples, this study regards the countries without climate cooperation projects in China's foreign investment as the control group in the main test. In Fang *et al* 's (2017) research, they conduct a matched-sample analysis to address this concern by using a propensity score matching algorithm. Referring to their research, this paper uses the same approach to match the control group and the experimental group according to the level of economic development, industrial structure, total population and the degree of opening-up to the outside world and then retests *H1* according to the matched samples.

To further test the robustness of the results, the researchers conducted a placebo test by changing the time of policy implementation. Referring to Banerjee *et al*'s (2015) study, the current study assumes that the completion year of climate investment projects is three years ahead of schedule. If the *time*treat* variable becomes significantly negative at this time, it shows that the reduction of carbon emissions is likely to come from other policy changes or random factors rather than the development of climate financing projects. The regression results are consistent with the main test, which is not present in the paper.

6. Conclusion and policy implications

Existing climate financing systems are somewhat fragmented, which may have an impact on values such as accountability, democratic legitimacy, effectiveness and equity. Therefore, some scholars believe that fragmentation and complexity pose certain challenges to climate finance management (Betzold and Weiler, 2017; Abadie *et al.*, 2013). However, the impact of fragmentation and complexity on the output and outcomes of climate financing systems is not yet clear. The consequences of fragmentation and complexity should be understood descriptively. From the perspective of climate financing cooperation of emerging multilateral institutions, this study empirically examines the specific effects of climate

financial fragmentation, as well as its financial and trade mechanisms. The main conclusions are as follows:

- The empirical result indicates that local carbon emissions have been significantly reduced after the construction of climate investment projects. The climate financing cooperation of emerging multilateral institutions initiated by China can significantly improve environmental effects. Fragmentation may pose a challenge to traditional climate finance systems; however, cooperation of emerging multilateral institutions can increase environmental performance.
- Climate cooperation in emerging multilateral institutions works through the funding mechanism. Specifically, funds from international credit have more support for climate finance projects than foreign direct investment, which illustrates that the government or official capital still dominates climate financing projects initiated by emerging institutions.
- Trade intimacy can inhibit the beneficial environmental effects of climate financing projects to some extent. One possible reason for this result is that the effect of climate projects is weakened by the increased carbon generated by the transfer of carbon emissions from close trade exchanges.

On this basis, the collaborative innovation of global climate finance in the new pattern should be further explored. Specific policy recommendations are as follows:

- A more inclusive climate financing governance system should be established to foster emerging economies. Climate cooperation among emerging economies can not only alleviate the financing gap of global climate governance, but also help countries with similar development levels or vulnerabilities to climate change share solutions that are adaptable to local economic and social conditions. Therefore, the UNFCCC process needs to recognize and welcome the positive environmental effects of climate cooperation of emerging multilateral institutions.
- Policymakers should be engaged early to ensure timely and effective coordination on climate finance. Compared with traditional governance institutions, climate cooperation in emerging multilateral institutions is more capable of financing small projects in fragile areas. Through effective coordination, emerging economies can provide useful supplements for traditional institutions in climate governance.
- All countries engaged in climate finance should begin reporting their activities to the UNFCCC's standing committee on finance to effectively track climate finance activities of emerging economies. On the one hand, timely tracking may avoid possible carbon transfer and the moral hazard of emerging institutions. On the other hand, climate activity reports may put greater pressure on developed countries to fulfill their own finance commitments.
- Hybrid financing should be encouraged in climate policy. In developing countries, there is a large vacancy in public funds, and the inflow of private funds is often hindered. The financial mechanism of foreign investment is far lower than that of international credit in the climate cooperation initiated by China. Therefore, it is necessary to further increase the leverage of public funds to private capital through innovation in climate financing mechanisms of emerging multilateral institutions.

A number of limitations to this study should be noted. First, because the completion time of climate cooperation projects is concentrated in recent years, the sample's observation time is

limited, and the long-term impact of climate projects cannot be tested. In addition, this study is restricted by the limitation of detailed data acquisition of climate financing projects and, therefore, fails to examine other mechanisms of climate financing projects to enhance environmental effects. Further research should include more detailed data on climate finance to test the long-term impact of climate cooperation in emerging economies.

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Further reading

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