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What matters in the distributions of Clean Development Mechanism projects? A panel data approach

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ABSTRACT

The Clean Development Mechanism (CDM) is an important approach that developed and developing countries can take actual actions to mitigate global climate change. Both carbon reduction and sustainable development are the goals of CDM. However, the uneven distribution of CDM projects in developing countries may jeopardize the fulfilment of the goals. This paper used a panel data of 107 host countries and explored the influencing factors with the panel negative binomial regression. And the club convergence model is used to divide the host countries into different groups according to their numbers of operating CDM projects each year. The results show that affluence, the sophisticated international trading experience, and the growing demands for energy of the host countries have a positive impact on the successful registrations of the CDM projects, while the cost of carbon emission abatement hinders the registration. But for countries with fewer CDM projects, the industrial level and national carbon emission have no significant impacts on the distribution of CDM projects. In the end, target policy implications were offered according to the results.

Keywords: Clean Development Mechanism, uneven distribution, panel negative binomial regression, club convergence, market-oriented

NONMENCLATURE

Abbreviations	
APEN	Applied Energy
Symbols	
n	Year

1. INTRODUCTION

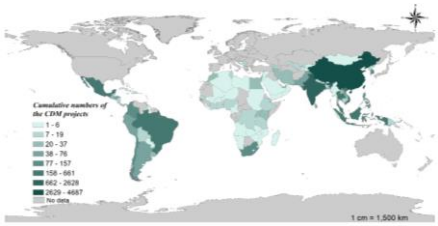

Fig 1 The distribution of CDM projects up to 2019

Global climate governance requires both developed and developing countries to participate in the action to slow down the process of global climate change. The Clean Development Mechanism (CDM) is an important approach that developed and developing countries can take actual actions to cooperate, which includes the regular CDM projects (PA) and the CDM Programmes of Activities (PoA). The implements of PoA aim at overcoming the defects of the regular CDM projects (PA) and helping less developed developing countries to have a chance to participate in CDM with less cost. As of December 31, 2019, the CDM Executive Board database recorded 13,026 CDM projects (including PAs and PoAs) and 11076 of them has been successfully registered. The project type includes methane avoidance, CO2 usage, N2O, coal bed/mine methane, PFCs and SF6, HFCs, landfill gas, wind, hydro, biomass energy, tidal, geothermal, energy distribution, energy efficiency (EE), EE household, EE industry, EE supply side, EE own generation energy efficiency, transport, fugitive, fossil fuel switch. In 2018, there were 7414 operating CDM projects and 85 of them were newly-operating. Among the host countries, China, India, and Brazil were the top 3, held 3303, 1795, and 283 CDM projects respectively.

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The possible contributions are (1)we collate an integrated panel dataset of CDM projects and factors of 107 host countries that may affect the distribution of CDM projects in between 2000 and 2018, (2) the panel negative binomial regression is applied to find quantitative evidence for the possible relationships between the economical, trade, industrial, environmental factors and CDM projects, (3) the club convergence model is used to divide the host countries into different groups according to the numbers of operating CDM projects they are holding each year, (4)we provide target policy implications according to the analysis.

2. PAPER STRUCTURE

2.1 Introduction

The CDM helped to achieve the low carbon development of both sides of the country (Huang & Barker, 2012), besides, the implements of CDM projects are expected to happen with promising technology transfer and capital investments(Costa et al., 2013; Hultman et al., 2012; Millock, 2013). Evidence showed that the implementation of CDM promoted the firms' innovation and spillover effects contributing to the non-CDM firms also existed in China (Cui et al., 2020). Companies that hold CDM projects tend to take their environmental and social responsibilities more positively in Brazil, Mexico, and Peru (Benites-Lazaro et al., 2018), therefore, the welfare of the residents could be amended. The revenue brought by CDM projects can be part of the incentive that makes Brazil continue its deforestation reduction (Fearnside, 1999). And there is the so-called "double clean development mechanism" as a CDM project can reduce the emission of both CO2 and SO2 at the same time in some specific cases which indicates that there is more than carbon emission but also better air quality (Shimazaki et al., 2000). Thus, CDM also a mechanism that helps the local economy and sustainable development of the community if it has been implemented properly through the improved cooperation between developed countries and host countries.

The world is chasing sustainable development, it concerns that the uneven distribution of CDM projects in the developing countries may jeopardize the goals' fulfilling of CDM(Kaswan & Rathi, 2020; Subbarao & Lloyd, 2011). China, India, and Brazil hold over 70% of the projects and the Certified Emission Reduction (CERs), but the least developed countries have little chance to be part of the mechanism because of the high cost of time and finance to finish the entire CDM project registration cycle (Castro & Michaelowa, 2011; Millock, 2013). Although there have been preferential access measures to whittle down the barriers that less developed developing countries may run into, for example, the distribution of CDM projects is still uneven. China, India, and Brazil, together with countries in the region where the three countries locate, are still occupying the largest share of the cake(Winkelman & Moore, 2011).

2.2 Material and methods

Up to 31st day of 2019, there have been 11,076 projects that passed the registration, whose status is one of End of crediting period, Registered, Registered with a monitoring report, Registered with an issuance request, and Registered with issuances. Those projects distributed in 108 countries or regions, 43 of them are collaboration projects hosted by two or more countries. We take the number of newly-operating CDM projects including CDM projects in the first year of its renewed credits period. The original data is from the United Nations Climate Change Conference (UNFCCC) CDM Database of PAs and PoAs. The carbon emission data is from the Emissions Database for Global Atmospheric Research (EDGAR) v5.0 Global Air Pollutant Emissions. And GDP (constant 2010 US$), trade (% of GDP, Trd), the proportion of industrial output (Ind), the fuel imports (% of merchandise imports, Fip) are from Worldbank Open Data. In this study, we collate an unbalanced panel dataset of 107 CDM projects host countries from the year 2000 to 2018

2.3 Theory/calculation

The Poisson regression model and the negative binomial regression model are frequently used in the analysis of events. The Poisson distribution assumes that the mean and variance of the time series are the same. If there is no excessive dispersion, the Poisson regression model and the binomial regression model are equivalent to use. But it is the negative binomial regression model that should be applied when there exists the excessive dispersion phenomenon as the variance tends to exceed the mean of the dataset due to unobserved heterogeneity(Fávero & Belfiore, 2019; Månsson, 2012).

The club convergence is based on the log t-test regression test which is introduced by Phillips and Sul (2007). It has been used in studies about economic growth, sustainable development. energy intensity, energy efficiency, carbon emission, and so on(Li et al., 2019; Sueyoshi & Wang, 2020; Yu et al., 2018; P. Zhang et al., 2019; Zhu & Lin, 2020)

2.4 Results and discussion

We made both the panel fix-effects negative binomial regression (m1, m3, and m4) and the panel random-effects negative binomial regression (m2, m4, and m6), taking CDM, CDMs (CDM projects of small scale), and CDMl (CDM projects of large scale) as the dependent variable respectively. All the results of negative binomial regression indicate that our assumptions are proved. The affluence, the experience of international trade, and the need for energy have positive impacts on the establishments of CDM projects, while the carbon emission level and the industrial level have negative impacts on the registration of CDM projects because of the possible higher cost of carbon emission abatements. And these rules apply whether the CDM project is of large or small scale. The same rules between CDMl and CDMs may indicate that the countries that held CDM projects of large scales might use the experience to continue their advantage in the registration and operation of CDM projects of small scales. The Hausman test was conducted and the results show that the fix-effects regression model has better explanations.

The club clustering algorithm results show that the host countries can be divided into 5 groups. There are 4 convergence clubs, and they include 29, 2, 5, and 69 host countries respectively, China and India are in the Not convergent group because of the wide disparity between them and the other host countries. China and India held around 44.55% and 24.21% of the total operating CDM projects, which were much bigger than all the rest of the host countries in 2018. From Club1 to Club 4, the host countries of the club held fewer CDM projects. The host countries included in the convergence club (Club1 and Club2) with a relatively large number of CDM projects are mainly in Asia and Latin America, while the host countries included in the convergence club (Club3 and Club4) with a smaller number of CDM projects are mainly in West Asia and Africa.

The impacts of the influencing factors on the distributions of CDM projects in different convergence clubs are similar to that of the whole samples (see Table 2). m7 and m8 are the fix-effects and random-effects panel negative binomial regression results of Club1. m9 and m10 are the fix-effects and random-effects panel negative binomial regression results of Club4 respectively. The Hausman test was conducted and the results show that m7 and m10 have better explanations. For Club1, the host countries with many CDM projects, the affluence, the experience of international trade, and the need for energy have significant positive impacts on the number of newly-operating CDM projects, while the carbon emission level and the industrial level have significant negative impacts on the registration of CDM projects. As for the host countries of Club4, the coefficient of Ind is not significant, which means that the industrial level of host countries with fewer CDM projects have little impact on the distribution of those projects. In other words, carbon abatement cost wasn't a restriction on CDM project distribution in the study period. The possible reason is that these host countries are still at a low level of industrialization and carbon emission. For one thing, there are fewer projects that involve energy efficiency improvements, and for another thing, there is still considerable carbon emission reduction potential of easy availability in these countries.

2.5 Conclusions

In this study, we collate an unbalanced panel dataset from the UNFCCC CDM Database of PAs and PoAs, EDGAR v5.0 Global Air Pollutant Emissions, and Worldbank Open Data of 107 countries from 2000 to 2018. The panel negative binomial regression model was applied in the exploration of the factors that have an impact on the distribution of CDM projects. The club convergence analysis was used to divide the host countries into different groups according to how many CDM projects newly-operating each year within the study period in the country.

The main results show that the affluence, the trading experience, and the growing energy demand have significant positive impacts while the industrial level and the total carbon emission which indicate the carbon emission reduction cost has significant negative impacts on the distribution of CDM projects as well as both scales of CDM projects. The host countries are divided into 4 convergence clubs. We applied the panel negative binomial regression again with data of convergence clubs and found consistent results as the former regression except for the impacts on CDM projects' distribution of industrial level and the total carbon emission. For the host countries with fewer CDM projects, the impact of the industrial level is of less significance and the impact of the total carbon emission is not significant. According to the results, we have the following policy implications.

The distribution of CDM seems quite market-oriented, it goes to countries with less cost and better techno-economic foundations. All the regression results show positive correlations between the number of CDM projects and the level of economic development or the

international trade experience. The level of economic development is a strong constraint on a host country's ability to burden the cost and cope with financial risks. And the international trade experience helps to reduce transaction costs. Thus, making the costs of CDM projects more affordable are important, especially for less developed developing countries. Policymakers and participants in the CDM should be more pragmatic and flexible in solving practical problems to lower the cost(Haites & Yamin, 2000). Less developed host countries have been holding more projects of small scale whose accordingly less CERs (certified emission reductions) are less attractive to potential investors and more vulnerable to the shocks of all aspects of changes. However, transaction costs and registration processes are not proportionately reduced or simplified compared to larger projects, which needs to be aware of. The host countries included in the convergence club (Club3 and Club4) should participate in the CDM more proactively and UNFCCC may implement target policy aiming at promoting sustainable development(Teng & Zhang, 2010; Xu & Lin, 2020).

It should be noticed that not all CDM projects will achieve their intended objectives. So, it's one thing for the successful operation of CDM projects and fulfilling the goals of them is another. A host country should pay its efforts to maximize the benefits of CDM, creating a better market environment for example (Georgiou et al., 2008). For example, a country will not be able to fully explore the benefits from CDM projects as the marketization of electricity was limited and lack of policy incentives for renewable energy utilization as a case study of Mexico showed(Lokey, 2009). And according to Subbarao and Lloyd (2011), CDM projects of small-scale had little contribution to reaching the promised benefits of sustainable development in a rural area, based on empirical research on 500 small-scale CDM projects of India. But CDM projects of HFC-23 and renewable energy showed their contributions to the technological innovations in China (C. Zhang & Yan, 2015). It also has policy implications for other institutional frameworks like the CDM.

The number of CDM project registrations has gradually declined since 2012 and, in fact, plotting development mechanism projects, including renewable energy projects and energy efficiency improvement projects, still have significant potential in regions with fewer CDM project distribution(Kim & Park, 2018). The carbon abatement measures mainly including using renewable energy like bioenergy, wind energy and ocean energy, applying carbon capture and storage (CCS) technologies, electrifying transportation and building heating, are believed to dominate clean development (Yue et al., 2020). It has been proved that CDM is a great mechanism that helps both developed countries and developing countries reduce carbon emission with lower carbon abatement cost, and it also helps to transfer technology (Huang & Barker, 2012; Klepper, 2011).

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