



Munich Personal RePEc Archive

A Cross-Country Empirical Analysis of Determinants of Clean Development Mechanism (CDM) Projects

Katsuya Kasai

MSc in Carbon Finance, University of Edinburgh Business School,
The University of Edinburgh, (International Development Studies
Program, National Graduate Institute for Policy Studies)

September 2011

Online at <https://mpra.ub.uni-muenchen.de/59697/>

MPRA Paper No. 59697, posted 6 November 2014 17:07 UTC

A Cross-Country Empirical Analysis of Determinants of Clean Development Mechanism (CDM) Projects

Katsuya KASAI*

Abstract : The CDM seems to play a significant role in international GHG reduction activities. Yet, a few emerging countries have hosted majority of CDM projects whereas most LDCs have not hosted CDM projects at all. Given the current distributional imbalance, this study aims to identify determinants of CDM project hosting based on an empirical analysis using the tobit model. On the basis of the literature review, this study focuses on two factors, namely the host countries' qualities of business environment and scientific level. As a result, this study finds the significance of business environment for both bilateral and unilateral CDM projects. Likewise, the significance of scientific and technical level is confirmed especially for unilateral CDM projects. Finally, this article suggests that eligible host countries should focus exclusively on the improvement of controllable determinants such as business environment to attract CDM investors. In addition, it is likely to be better for eligible host countries with low GHG emissions to develop CDM projects unilaterally using programmatic CDM due to their lower economic attractiveness.

Key Words : CDM, Kyoto Protocol, unequal distribution, business environment, tobit model

INTRODUCTION

The Kyoto Protocol was adopted at the third session of the conference of the parties (COP3) to the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan, in 1997. The protocol was designed to curb global warming and its detailed rules for the implementation were adopted at COP7 in Marrakesh, Morocco, in 2001, so called the Marrakesh Accords, and entered into force in 2005 after the Russia's ratification.

There are two accomplishments in the Kyoto Protocol. First, it sets legally binding targets, which is to reduce five per cent of greenhouse gas (GHG)¹⁾ emissions against 1990 levels over the five-year period between 2008 and 2012, stipulated only on developed countries and the European Union reflecting their accumulated GHG emissions. Second, the protocol introduced the Kyoto Mechanisms which comprise Clean Development Mechanism (CDM), Joint Implementation (JI), and International Emission Trading, to help Annex I Parties²⁾ meet the legally binding emission targets in a cost-effective way³⁾.

The CDM has dual objectives that are to reduce GHG emissions and to contribute to sustainable

development in host countries⁴⁾. It enables Annex I Parties to fulfill their national targets set out under the Kyoto Protocol by carrying out by reducing GHG emissions in their own countries or in developing countries ratifying the Kyoto Protocol (Non-Annex I Parties⁵⁾). Host countries can earn and sell tradable credits that are called Certified Emission Reductions (CERs) issued by the CDM executive board. The amounts of CERs are determined based on the amounts of GHG emissions reduced by CDM projects. Annex I Parties can use CERs to achieve the legally binding targets. Whilst it is likely that the CDM has been achieving the first objective, reducing GHG emissions in a cost effective manner (e.g., Huang and Barker, 2008; Sutter and Parreño, 2007; Paulsson, 2009), several controversial issues have appeared such as the unequal distribution of CDM projects and ignorance of Least Developed Countries (LDCs)⁶⁾ (e.g., IGES, 2010; Muller, 2007; UNEP Riso Center, 2008).

In fact, CDM projects have disproportionately spread into various parts of the world. There is a wide agreement that the distribution of the CDM projects has been quite uneven among the developing nations (e.g. Muller, 2007; Boyd *et al.*, 2009; Flamos, 2010). To date, 125 countries are able to host CDM projects

* MSc in Carbon Finance, The University of Edinburgh (IDS Program, National Graduate Institute for Policy Studies)

under the Kyoto Protocol⁷ ⁸). Of the 125 countries, 53 countries have no CDM projects and 50 countries possess less than 10 projects, whereas the numbers of registered CDM projects and projects submitted for registrations have been steadily increasing (Fig. 1). Currently, there are 3,339 CDM projects across developing countries⁹). Yet the top three countries, namely China, India, and Brazil, possess 1,509, 706, and 194 CDM projects, respectively as of 29 July 2011⁹). In other words, only these three countries account for over 70% of total CDM projects. They surely enjoy receiving the tremendous amount of fund flows from Annex I Parties.

Responding to this status, many developing nations lodged complaints against the unequal distribution of CDM benefits on the basis of Decision 17/CP.7 of the Marrakesh Accords stipulating the necessity of the promotion of equitable distribution of CDM activities at regional and sub-regional levels¹⁰). This situation seems to be nearing critical status since the Kyoto Protocol stipulates two conditions for an inurement of the protocol, one of which is to secure the ratifications of not less than 55 countries and the other is to secure 55% of the total GHG emissions of all developed nations in 1990 regardless of the number of ratified nations⁴). If many developing countries seceded from the protocol, Annex I Parties would be likely to criticize the effectiveness and equitability of the protocol. Therefore, this issue should be solved from a standpoint of equality among developing countries and stable operations of the CDM.

As the most possible cause of this issue, low potentials for GHG emission reductions in LDCs are frequently mentioned in the literature (e.g., Haites, 2004). Meanwhile, some empirical studies on the distribution of CDM projects uncover several findings. For instance, Flues (2010) finds that the number of CDM projects is explicitly influenced by factors categorized into three groups which are CDM potential, feasibility, and profitability. However, findings identified by previous empirical studies contain some contradictions. The objective of this study, responding to previous studies, is to identify further significant determinants of CDM project hosting, which have not been found in previous studies, especially focusing on identifying specific

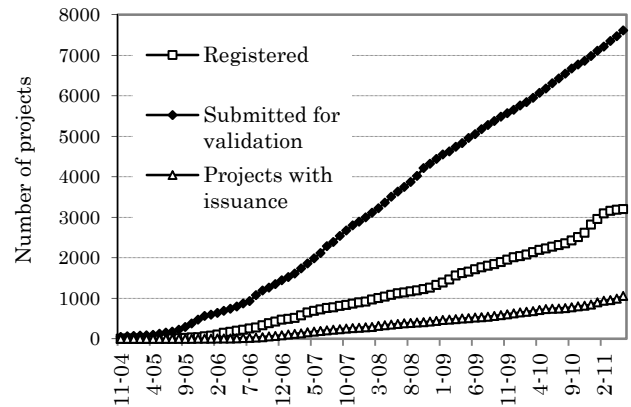


Fig.1 Accumulated number of projects submitted for validation & registered projects¹¹

elements of business environments using sub-indices of Doing Business Index¹²). Ultimately, this study aims to suggest promising approaches to remedy the distributional imbalance of CDM activities based on analytical results.

The remainder of this article is structured as follows. Section 1 reviews previous studies and creates a conceptual framework with assumptions. In Section 2, the data and methodology used in this study are explained. Section 3 presents estimation results and discussions. Finally, some policy implications are suggested in Conclusions.

1. Literature Review

This section reviews previous studies on the unequal distribution of CDM projects. In previous studies, the determinants of CDM project hosting have been theoretically presumed with the exception of some empirical studies identifying several determinants based on quantitative analyses. The major findings of existing theoretical and empirical studies are summarized in the following paragraphs.

1.1 Theoretical studies

The large and growing theoretical literature argues that the low potentials for GHG emission reductions hinder the establishment of CDM projects in LDCs (e.g., Haites, 2004; Jung, 2006). For instance, Jung (2006) states that the countries well-endowed with CDM projects had emitted a large amount of GHGs before the CDM came into effect in 2005 and what is

more, those countries seem eager to boost the shares further without investments from advanced nations. In contrast, there have been few industries emitting vast amounts of GHGs in the LDCs. The potential for launching CDM projects in LDCs is, thus, likely to be fundamentally very low (Haite, 2004) because projects that produce small amounts of CERs must be judged as commercially unattractive by investors following the principle of the market mechanism.

Jahn *et al.* (2004) and Michaelowa (2007) argue theoretically that certain levels of human capital, institutional and infrastructural capacities, and financial capital availability are required to host CDM projects. Accordingly, in case that host countries' risk premiums for CDM investors are high, unilateral CDM projects must be feasible and economically viable (Jahn *et al.*, 2004). In addition, Flues (2010) alleges that while some emerging nations can adopt GHG reduction technologies, which are typically advanced technologies, with comparative ease, LDCs must confront considerable technical barriers to hosting CDM projects owing to their insufficient technical advancements.

1.2 Empirical studies

Compared to theoretical studies, the number of empirical studies on the distributional issue is limited and the conclusions seem to be mired in controversy.

First of all, Dinar *et al.* (2008) analyzed the levels of cooperation between host and investor countries using the regression analysis, and reveals some significant predictive factors which are economic development, institutional development, the energy structure, the level of vulnerability to impacts of climate change, and ties to Annex I Parties.

Likewise, Flues (2010) affirms through regression analyses that the number of CDM projects is positively affected by economic development and growth, fossil fuel, the potential of renewable energy, links to developed countries and institutional quality as significant determinants. Furthermore, the study reveals that there are clear differences in the size of coefficients between the determinants of bilateral and unilateral CDM projects¹³. A similar study carried out by Wang and Firestone (2010) additionally confirms that GHG emissions of Annex I Parties are also one of

the major determinants as well as host countries' educational level and a certain level of infrastructures. Moreover, Winkelmann and Moore (2011) studied the determinants of CDM activities using a probit model across the eligible host countries that have ratified the Kyoto Protocol and established the Designated National Authority (DNA)¹⁴. As a result, the study verifies the significance of GHG emissions, electricity capacity growth rates, and educational levels.

1.3 Conceptual framework

As mentioned in the theoretical literature review, many theoretical studies argue that GHG reduction potential is a major significant determinant of CDM project hosting, and GHG emissions are statistically significant in some empirical studies. As well as GHG reduction potential, one study conducted by Dinar *et al.* (2008) demonstrate the importance of links to advanced nations to promote CDM projects. Flues (2010) also confirms the significance of links to advanced nations by showing that a positive effect of former British, Spanish, Dutch, German, and French colony cannot be rejected at 10% significance level, though the result has limited credibility. Hence, this study adopts a revised colonial dummy because colonial relationships between advanced nations and eligible host countries are likely to increase or decrease the number of CDM projects. With the exception of minor revisions, this study basically followed the previous studies in terms of GHG reduction potentials and links to advanced nations.

Combined with the results of existing empirical studies, there is a contradiction with respect to business environment. On the one hand, Jung (2006) maintains that FDI inflows are good predictors of host countries' attractiveness for CDM investments particularly for countries receiving abundant FDI. Moreover, Dinar *et al.* (2008) imply that the CDM can be regarded as a sort of FDI. On the other hand, although the study carried out by Winkelmann and Moore (2011) adopted FDI inflows as proxies for the qualities of business environment, they could not observe the significance of it. Moreover, Niederberger and Saner (2005) refute the connection between FDI and CDM investment by mentioning that some countries having failed to induce FDI have actually

succeeded in hosting CDM projects. As discussed above, the results with respect to business environment are not homogenous (e.g. Dinar *et al.*, 2008). There appears to be two problems with the previous studies in terms of precise estimation of business environment. First, the notion of business environment is vague and has a broader concept, resulting in various approaches and results from one another. Second, previous studies did not analyze sufficient aspects of business environment. Thus, in this study, sub-indices of Doing Business Index are applied because of its comprehensive coverage.

As for human capital, while the study carried out by Wang and Firestone (2010) could not observe significance of tertiary education obtained from the Global Competitive Report, Winkelman and Moore (2011) confirm the significance of education index which is one of components of the Human Development Index (HDI). The findings from previous studies show opposite results. However, when considering the CDM project hosting, quality of human capital must be a very important especially scientific levels since in order to embark CDM projects, a certain level of scientific knowledge are inevitably required. This study, thereby, adopts two independent variables to verify the significance of human capital, which are Log of tertiary school enrolment rate and Log of the number of scientific and technical journal articles as proxies for general education levels and scientific levels, respectively.

Based on the above discussions, this study differs from the past studies by attempting to verify the significance of sub-indices of Doing Business Index as proxies for specific elements of business environment and significance of scientific levels using Log of the number of scientific and technical journal articles.

2. Data and methodology

2.1 Data

This survey covered 125 eligible host countries which have ratified the Kyoto Protocol and established the Designated National Authority (DNA). Dependent variables used in this study are Log of the numbers of bilateral and unilateral CDM projects which are sourced from the CDM project database, as

of 29 April 2011, created by the Institute for Global Environmental Strategies (IGES)¹⁵.

Data on independent variables are obtained from several sources as shown in Table 1. Because CDM registration has been started in the year 2005, this study uses data in 2005 on independent variables. Note that data of business environment in 2005 are contained in Doing Business 2007 and data of colonial status come from the study carried out by Hensel (2006).

Descriptions about variables used in the analysis are shown in Table 1, including categories, numbers of observations, mean values, standard deviations, minimum values, maximum values, and data sources of all variables. There are some missing values in independent variables due to the data availabilities. However, as the missing counties tend to host few CDM projects, these deficits must have limited impacts on the analytical results.

2.2 Methodology

In order to examine the characteristics of eligible host countries, this study utilizes the tobit model, which was developed by Tobin (1958), because data of independent variables are available for all eligible host countries including countries not hosting CDM projects. The data can be regarded as censored data in which any negative values of dependent variables are set to a lower bound of zero. Hence, Type I tobit model (censored regression model) shown below (Amemiya, 1984) is used in the analysis:

$$y_i^* = x_i \beta + \varepsilon_i, \varepsilon_i | x_i, c_i \sim \text{Normal}(0, \sigma^2)$$

$$y_i = \begin{cases} y_i^* & y_i^* \geq 0 \\ 0 & y_i^* < 0 \end{cases}$$

where y_i^* is a latent response variable, x_i is an independent variables, and ε_i is a residual. The latent variable y_i^* satisfies the classical linear model assumptions that have a normal, homoscedastic distribution with a linear conditional mean. An observed variable y_i is equal to y_i^* when $y_i^* \geq 0$, but y_i equals 0 when $y_i^* < 0$. Since y_i^* is normally distributed, y_i has a continuous distribution over strictly positive values.

In line with the conceptual framework, independent variables are thoroughly selected from variables used in the previous studies and newly adopted variables,

Table 1 Descriptive table of dependent and independent variables

Category	Variable	Obs	Mean	Std. Dev.	Min	Max	Data Source
Dependent variables	Log bilateral CDM projects	125	0.759	1.31	0	7.18	IGES CDM project database ¹⁵⁾
	Log unilateral CDM projects	125	0.481	1.10	0	6.27	
GHG reduction potential	Log GHG emissions	123	10.1	1.94	5.70	15.8	World Resources Institute ¹⁶⁾
	Net energy imports	88	-0.453	1.66	-7.55	1.00	
Human capital	Log scientific articles	122	3.75	2.44	-1.61	10.6	WDI ¹⁷⁾
	Log tertiary school enrolment rate	75	2.370	1.18	-0.755	4.52	
Business environment	Ease starting a business	113	53.7	20.9	3.33	99.6	Doing Business ¹⁸⁾
	No. of procedures for starting a business	115	10.3	2.91	5	20	
	Log time for starting a business	115	3.68	0.713	1.79	6.54	
	Log cost for starting a business	115	3.72	1.49	-0.223	8.76	
	Min. capital for starting a business	115	191.5	509.5	0	4,234	
	Ease of dealing with construction permits	112	51.4	20.3	13.6	97.1	
	Ease of registering property	113	52.5	20.6	0	97.7	
	Ease of getting credit	113	3.52	1.62	0	8	
	Ease of protecting investors	113	4.70	1.47	1.68	9.33	
	Ease of paying taxes	113	50.5	21.8	10	100	
	Tax payments	115	37.2	17.0	3	89	
	Time for paying taxes	110	302.7	168.3	0	872	
	Log total tax rate	115	3.79	0.578	2.23	5.68	
Links to advanced nations	Colonial dummy	125	0.328	0.471	0	1	Hensel ¹⁹⁾
	Log net ODA	111	-1.491	1.38	-4.85	1.86	WDI ¹⁷⁾

all of which are categorized into four groups as listed in the models as shown below.

$$lnbi_i \text{ or } lnui_i = f(G_i, H_i, B_i, L_i)$$

where dependent variables, $lnbi_i$ and $lnui_i$, are Log of numbers of bilateral and unilateral CDM projects of host country i . G_i , H_i , B_i , and L_i , represent sets of characteristics of host country i relevant to GHG reduction potential, human capital, business environment, and links to advanced nations, respectively. The independent variables utilized are listed in Table 1 and explained in detail below.

1) GHG reduction potential

This study uses Log of GHG emissions as a proxy for GHG reduction potential following the previous study carried out by Winkelman and Moore (2010). In general, it can be said that countries with larger GHG emissions have larger GHG reduction potential.

Net energy imports are also adopted as a proxy for energy independency. This is because countries depending heavily on imports for energy must have higher motivations to tackle GHG reduction activities than others responding to current soaring fossil fuel prices and the concerns of resource depletion.

2) Human capital

This study adopts Log of tertiary school enrolment rate to investigate the impacts of general education levels of people in eligible host countries.

In addition, Log of the number of scientific and technical journal articles is used in the models on the other. The number of journal articles can be thought of as a good proxy of the science levels of eligible host countries.

3) Business environment

This study utilizes eight sub-indices of Doing Business Index as proxies for the qualities of business environment. Doing Business Index is published by the World Bank and consists of nine sub-indices. However, one of them, "ease of closing a business", is excluded from the models due to its tenuous connection to CDM project hosting. In addition, further analysis is performed using components of sub-indices that show significant negative effects to investigate specific factors causing opposite results.

4) Links to advanced nations

This study utilizes Log of net ODA and Colonial

dummy. As indicated in the previous section, the study carried out by Flues (2010) indicates that a colonial status dummy has vague positive effects. Thereafter, the definition of colonial dummy used in this study is revised, which takes 1 if a country is only former British colony. This is because the U.K. is the largest investor, and major CDM investors (CERs buyers) are headquartered in the U.K.¹⁰, leaving other colonial powers far behind.

3. Results and Discussions

The regression results for determinants of bilateral and unilateral CDM project hosting are shown in Tables 2 and 3, respectively.

In the models for bilateral and unilateral CDM projects, six specifications are set and examined. Spec 1 is the base specification containing major independent variables. One additional independent variable is added to the base specification to test the validities of four additional independent variables that are colonial dummy, Log of net ODA, net energy imports, and Log of tertiary school enrolment rate. In Spec 6, the components of “ease of starting a business” and “ease of paying taxes” are included to examine reasons for their negative results. The results are explained and discussed as follows.

1) GHG reduction potentials

As can be seen from Tables 2 and 3, Log of GHG emissions is statistically significant and positive for all specifications of bilateral CDM projects at 1% significance level and is statistically significant only for Spec 4 of unilateral projects with maximum limit of significance level (10%). Therefore, the results for unilateral projects are not very robust. Bilateral CDM projects tend to rely on assistance from advanced nations, such as investment and technology borrowing. CDM investors usually decide the projects’ locations following the market mechanism (i.e. profitability). Thus, it is important to have reasonable abatement costs to host bilateral projects (e.g., Flues, 2010).

On the other hand, unilateral projects basically need to be developed by host countries themselves, so it is not necessarily required to have large GHG reduction potentials. These results can be regarded as

reasonable and is consistent with the arguments and findings of existing studies.

From the standpoint of energy independence, Net energy imports are statistically significant and positive for both bilateral and unilateral projects. This result is likely to express that countries relying heavily on energy imports tend to be motivated to participate in GHG reduction projects since those activities quite often reduce fossil fuel consumptions which is one positive side effect from CDM projects for host countries.

2) Human capital

As can be seen from Tables 2 and 3, Log of the tertiary school enrolment rates is statistically significant and positive for bilateral projects whereas it is insignificant for unilateral projects. The former is in accordance with previous studies though the significance level is the maximum limit. The latter might indicate that the important factor for promoting CDM projects is not general educational level, but other specific fields of education.

This study also confirms that Log of the number of scientific and technical journal articles is significant and positive specifically for unilateral CDM projects. Taking into account the feature of unilateral projects, scientific levels seem to be more important for unilateral projects because those projects basically have to be implemented independently. Therefore, this analysis is likely to demonstrate that scientific levels are a significant determinant of CDM project hosting especially for unilateral projects, which is fully consistent with the assumption of this study.

3) Business environment

As Tables 2 and 3 indicate, two independent variables, Ease of dealing with construction permits and Ease of enforcing contracts are statistically insignificant. Therefore, the results of remaining six variables related to business environment are discussed in the following paragraphs.

This study could obtain three significant and positive variables. Firstly, Ease of registering property is statistically significant and positive in all specifications for both bilateral and unilateral projects. Secondly, Ease of getting credit is also statistically

Table.2 Regression result for determinants of bilateral CDM project hosting

Category	Specification	(1)	(2)	(3)	(4)	(5)	(6)
GHG reduction potential	Log of GHG emissions	0.666***	0.654***	0.595***	0.933***	0.663***	0.505***
	Net energy imports				0.632***		
Human capital	Log of the No. of scientific articles	0.165	0.173	0.171	-0.0489	0.0934	0.278**
	Log of tertiary school enrolment rate					0.433*	
Business environment	Ease of starting a business	-0.00265	-0.00210	-0.00585	-0.0131	-0.00188	
	No. of procedures for starting a business						0.0592
	Log of time for starting a business						0.311
	Log of cost for starting a business						-0.0146
	Min. capital for starting a business						0.000122
	Ease of dealing with construction permits	-0.00360	-0.00458	-0.000631	0.00353	-0.000849	-0.00265
	Ease of registering property	0.0195**	0.0182**	0.0197**	0.0231***	0.0194*	0.0215**
	Ease of getting credit	0.315**	0.317**	0.316***	0.155	0.104	0.306**
	Ease of protecting investors	-0.0866	-0.0712	-0.0534	0.0640	0.146	-0.0360
	Ease of paying taxes	-0.0401***	-0.0388***	-0.0305***	-0.0428***	-0.0463***	
	No. of tax payments						0.0340***
	Time for paying taxes						0.00232**
	Log of total tax rate						0.547
	Ease of trading across borders	0.0190**	0.0191**	0.0256***	0.0210***	0.0253**	0.0167**
Ease of enforcing contracts	0.00426	0.00327	0.00551	0.00333	0.00473	0.00575	
Links to advanced nations	Colonial dummy		-0.233				
	Log of net ODA			0.160			
N		110	110	102	78	72	105
pseudo R-sq		0.381	0.382	0.403	0.382	0.447	0.395

* p<0.10 ** p<0.05 *** p<0.01

Table.3 Regression result for determinants of unilateral CDM project hosting

Category	Specification	(1)	(2)	(3)	(4)	(5)	(6)
GHG reduction potential	Log of GHG emissions	0.241	0.249	0.0761	0.475*	0.108	0.283
	Net energy imports				0.685**		
Human capital	Log of the No. of scientific articles	0.668***	0.682***	0.683**	0.500**	0.761***	0.769***
	Log of tertiary school enrolment rate					0.495	
Business environment	Ease of starting a business	-0.0372**	-0.0318*	-0.0453**	-0.0462***	-0.0202	
	No. of procedures for starting a business						0.0922
	Log of time for starting a business						0.126
	Log of cost for starting a business						0.452*
	Minimum capital for starting a business						-0.00354**
	Ease of dealing with construction permits	0.00841	0.00353	0.00742	0.0190	0.00721	0.00327
	Ease of registering property	0.0394***	0.0353**	0.0482***	0.0406***	0.0417**	0.0434***
	Ease of getting credit	0.452**	0.507**	0.486**	0.374**	-0.0361	0.358*
	Ease of protecting investors	-0.149	-0.126	-0.0698	-0.112	0.286	-0.326
	Ease of paying taxes	-0.0226*	-0.0164	-0.0183	-0.0177	-0.0171	
	No. of tax payments						0.00797
	Time for paying taxes						0.00173
	Log of total tax rate						-0.312
	Ease of trading across borders	0.00942	0.00803	0.0135	0.00424	-0.000374	0.0192
Ease of enforcing contracts	-0.0278*	-0.0355**	-0.0271	-0.0324**	-0.0305	-0.0390**	
Links to advanced nations	Colonial dummy		-1.012				
	Log of net ODA			0.297			
N		110	110	102	78	72	105
pseudo R-sq		0.348	0.359	0.357	0.322	0.373	0.363

* p<0.10 ** p<0.05 *** p<0.01

significant and positive in four specifications out of six for bilateral projects and in five specifications for unilateral projects. Thirdly, Ease of trading across borders is statistically significant and positive in all specifications for bilateral projects. This might imply that efficient trading systems are important assets for bilateral projects. These positive results are in line with the assumption of this study.

In contrast, the regression results indicate that three other variables have significant negative effects. However, one of them, Ease of enforcing contracts, is judged as insignificant since the negative result is strongly influenced by an outlier. In fact, by running the regression model excluding India, the results become insignificant. Next, Ease of starting a business is statistically insignificant for bilateral projects but significant and negative for unilateral projects. Similarly, Ease of paying taxes indicates significant negative effects in all specifications for bilateral projects and in Spec 1 for unilateral projects. These two variables contradict the expectation.

The significant and negative effects are not expected amongst variables regarding business environment. In order to identify factors causing the negative results, all components of those two variables are incorporated into Spec 6. Consequently, the analysis suggests that the cause of negative result of Ease of starting a business could be the cost for starting a business. At the same time, the analysis finds that minimum capital for starting a business has significant and positive effects on unilateral project hosting at 5% significance level. Regarding Ease of paying taxes, the number of procedures for tax payments and time for paying taxes are statistically significant and negative only for bilateral projects.

These negative results are likely to present the difficulty of measuring comprehensive business environment. One explanation for this set of results is envisaged that countries with more matured business environment tend to impose more severe rules and regulations on private firms.

Overall, business environment can be judged as a significant determinant because the regression result identifies four significant and positive factors, namely Ease of registering property, Ease of getting credit, Ease of trading across borders, and minimum capital

for starting a business. This is consistent with the assumption and regarded as reasonable since it is envisaged that CDM investors prefer not invest in countries with unfavourable business environment.

4) Links to advanced nations

There are two independent variables in Links to advanced nations, both of which are insignificant for both bilateral and unilateral project hosting. The result of Colonial dummy might allude to the fact that CDM investors in the U.K. do not lay weight on colonial ties and this must be thanks to the impacts of growing globalization.

In addition, the statistical insignificance of Log of net ODA may imply that CDM investors act differently from their governments simply following the market mechanism or other factors.

CONCLUSIONS

The CDM seems to play a significant role in the international GHG reduction activities in a cost-effective fashion (e.g., Sutter and Parreño, 2007). However, many LDCs have not hosted CDM projects yet. Given the current distributional imbalance, this study was carried out aiming to identify determinants of CDM project hosting in order to suggest promising approaches for solving the issue, especially for developing nations less endowed with CDM activities, based on the analytical results.

This study focused on two factors, the host countries' qualities of business environment and scientific levels. This is because while many previous studies have analyzed the significance of business environment using various variables, their results have not been homogenous, and what is more, their notions of business environment seem to be narrow and limited. As for the scientific levels, no previous studies have verified the significance of scientific level.

This study found the significance of business environment for both bilateral and unilateral CDM projects, whilst some variables are contrary to the expectations. Similarly, the significance of scientific and technical level was found but this was only for unilateral CDM projects. In addition, corresponding to one of findings by Flues (2010), obvious differences in

determinants between bilateral and unilateral CDM project hosting have been observed.

Some determinants can be controlled by host countries but others cannot be controlled. Hence, eligible host countries should focus exclusively on the improvement of controllable determinants. More specifically, if host countries desire to attract CDM investors to host bilateral CDM projects, it may be effective to ameliorate business environment focusing on ease of registering property, ease of getting credit, and ease of trading across borders. On the other hand, if eligible host countries attempt to develop CDM projects unilaterally, it can be better to upgrade their qualities of scientific levels as well. Furthermore, it should be imperative to politically and financially assist countries having few CDM projects not only giving free reins to market forces.

Apparently, the eligible host countries are likely to increase the chances to host bilateral CDM activities, if conditions of aforementioned factors are improved by certain levels. Nevertheless, it is predicted that those impacts are not tremendous due to the impacts of uncontrollable determinants that is GHG reduction potentials. Hence, it may be better for countries with less GHG reduction potential to undertake the development of CDM projects unilaterally. In such cases, the programmatic CDM is likely to be viable because it can develop CDM programmes by aggregating tiny GHG reduction activities unlimitedly, which is undoubtedly suitable for those countries. In order to promote such activities, it is necessary for eligible host countries to receive capacity building programs specializing in unilateral and programmatic CDM projects by international organizations.

The findings of this study are based on the cross-sectional analysis. Empirical studies using panel data need to be carried out to investigate more appropriate and timely implications for eligible host countries. Ultimately, the CDM is a mechanism not only for alleviating the impacts of global warming but also enhancing sustainable development in host countries, and what is more, CDM can be thought of as new type of fund flows, having similar feature to subsidies. Hence, through a perspective of benefits for host countries, developing countries should aggressively press ahead with the development of CDM projects

bilaterally and/or unilaterally whichever is feasible for the sake of promoting sustainable development.

ACKNOWLEDGEMENTS

The author would like to acknowledge Assistant Professor Chikako Yamauchi (National Graduate Institute for Policy Studies) and anonymous referees of this journal for their valuable comments.

NOTES

¹⁾ GHGs defined by the Kyoto Protocol are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

²⁾ Annex I Parties are mainly industrialized countries comprised of the members of the OECD, the European Union, and 14 countries with 'economies in transition' which are committed to greenhouse gas reduction targets.

³⁾ UNFCCC. (2006 updated) Report of the COP/MOP 1, Addendum Part Two. <<http://unfccc.int/resource/docs/2005/cmp1/eng/08a02.pdf>>, 05/01/2011 referred.

⁴⁾ UNFCCC. (1998 updated) Kyoto Protocol. <<http://unfccc.int/resource/docs/convkp/kpeng.pdf>>, 05/01/2011 referred.

⁵⁾ Non-Annex I Parties are mostly developing countries that have not written in Annex I to the Framework Convention on Climate Change (FCCC) without GHG emission reductions commitments.

⁶⁾ 49 countries are classified as Least Developed Countries (LDCs) by the United Nations are given special consideration under the Framework Convention on Climate Change (FCCC).

⁷⁾ In order to host CDM projects, it is necessary for developing nations to ratify the Kyoto Protocol and set up a Designated National Authority (DNA) in their country to supervise and review the CDM projects.

⁸⁾ UNFCCC. (2011 updated) Designated National Authorities (DNAs). <<http://cdm.unfccc.int/Statistics/Registration/RegisteredDNAPieChart.html>>, 05/01/2011 referred.

⁹⁾ UNFCCC. (2011 updated) CDM in Numbers: Registration. <<http://cdm.unfccc.int/Statistics/Registration/NumOfRegisteredProjByHostPartiesPieChart.html>>, 07/29/2011 referred.

¹⁰⁾ UNFCCC. (2001 updated) Decision 17/CP.7: Modalities and procedures for a CDM as defined in Article 12 of the Kyoto Protocol. <http://unfccc.int/files/meetings/workshops/other_meetings/application/pdf/17cp7.pdf>, 05/05/2011 referred.

¹¹⁾ UNEP Risø Centre. CDM/JI Pipeline Analysis and Database. <<http://cdmpipeline.org/>>, 07/26/2011 referred.

¹²⁾ Doing Business Index is an index created by the World Bank. Higher rankings indicate better, usually simpler, regulations for business and stronger protections of property right.

¹³ Bilateral CDM projects are the standard form of CDM projects involving Annex I Party and a host country. Projects involving more than one Annex I Parties are called multilateral CDM projects, though, in this article, bilateral projects include multilateral projects for convenience. Unilateral CDM projects are projects embarked by a host country independently without the participation of Annex I Parties at the time of registration.

¹⁴ DNA is the body granted responsibility by a Party to authorize and approve participation in CDM projects. The main task of the DNA is to assess potential CDM projects to determine whether they will assist the host country in achieving its sustainable development goals and to provide a letter of approval to project participants in CDM projects.

¹⁵ Institute for Global Environmental Strategies (IGES) (04/29/2011 updated) IGES CDM Database. <http://www.iges.or.jp/jp/cdm/report_cdm.html>, 05/20/2011 referred.

¹⁶ World Resources Institute. (2011 updated) The Climate Analysis Indicators Tool (CAIT) - UNFCCC4.0. <<http://cait.wri.org/>>, 05/25/2011 referred.

¹⁷ World Bank. (2011 updated) World Development Indicators. <<http://data.worldbank.org/data-catalog/world-development-indicators>>, 06/02/2011 referred.

¹⁸ World Bank. (2011 updated) Doing Business. <<http://doingbusiness.org/>>, 05/25/2011 referred.

¹⁹ Hensel, P. R. (2006) ICOW colonial history data 0.4, <<http://www.paulhensel.org/Data/colhist.zip>>, 03/10/2009 referred.

REFERENCES

- Amemiya, T. (1984) Tobit models: A survey, *Journal of Econometrics*, 24, 3-61.
- Boyd, E., Hultman, N., Roberts, T., Corbera, E., Cole, J., Bozmoski, A., Ebeling, E., Tippman, R., Mann, P., Brown, K. and Liverman, D. (2009) Reforming the CDM for Sustainable Development: Lessons Learned and Policy Futures. *Environmental Science & Policy*, Vol.12, No.7, 820-831.
- Dinar, A., Rahman, S., Larson, D. and Ambrosi, P. (2008) Factors affecting levels of international cooperation in carbon abatement projects. *World Bank Policy Research Working Paper 4786*.
- Flamos, A. (2010) The Clean Development Mechanism - Catalyst for Wide Spread Deployment of Renewable Energy Technologies? or Misnomer? *Environment, Development and Sustainability*, Vol.12, No.1, 89-102.
- Flues, F. (2010) Who Hosts the Clean Development Mechanism? Determinants of CDM Project Distribution. *CIS Working Paper 53*.
- Haites, E. (2004) Estimating the market potential for the CDM: review of models and lessons learned. The International Energy Agency and the International Emissions Trading Association, Washington DC, 71pp.
- Huang, Y. and Barker, T. (2008) The Clean Development Mechanism and Sustainable Development: A Panel Data Analysis. *Working Paper; University of Cambridge 39*.
- Institute for Global Environmental Strategies (IGES) (2010) Towards CDM reform. IGES, Kanagawa, 33pp.
- Jahn, M., Michaelowa, A., Raubenheimer, S. and Liptow, H. (2004) Measuring the potential of unilateral CDM - a pilot study. *HWWA Discussion Paper 263*.
- Jung, M. (2006) Host country attractiveness for CDM non-sink projects. *Energy Policy*, Vol.34, 2173-2184.
- Michaelowa, A. (2007) Unilateral CDM - can developing countries finance generation of greenhouse gas emission credits on their own? *International Environmental Agreements*, Vol.7, No.18, 17-34.
- Muller, A. (2007) How to Make the Clean Development Mechanism Sustainable - The Potential of Rent Extraction. *Energy Policy*, Vol.35, No.6, 3203-3212.
- Niederberger, A. and Saner, R. (2005) Exploring the relationships between FDI flows and CDM potential. *Transnational Corporations*, Vol.14, No.1, 1-40.
- Paulsson, E. (2009) A review of the CDM literature: from fine-tuning to critical scrutiny? *International Environ Agreements*, Vol.9, 63-80.
- Sutter, C. and Parreño, J. (2007) Does the Current Clean Development Mechanism (CDM) Deliver its Sustainable Development Claim? An Analysis of Officially Registered CDM Projects. *Climate Change*, Vol.84, No.1, 75-90.
- Tobin, J. (1958) Estimation of relationships for limited dependent variables. *Econometrica*, 26, 24-36.
- UNEP Risø Centre. (2008) A reformed CDM - including new Mechanisms for Sustainable Development. Roskilde, UNEP Risø Centre, 183pp.
- Wang, H. and Firestone, J. (2010) The analysis of country-to-country CDM permit trading using the gravity model in international trade. *Energy for Sustainable Development*, Vol.14, No.1, 6-13.
- Winkelman, A. and Moore, M. (2011) Explaining the differential distribution of Clean Development Mechanism projects across host countries. *Energy Policy*, Vol.39, No.3, 1132-1143.