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Towards Scaling Multi-Benefit Type Projects in LDCs: Empirical Analyses on CDM Project Hosting

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Submitted to the Department of Economics of
the Graduate School of Economics
in partial fulfillment of the requirements for
the degree of Ph.D. in Economics

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Empirical Analyses on CDM Project Hosting

By

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Abstract

The CDM has boosted various GHG reduction activities in developing countries and its contributions to the promotion of sustainable development in host countries have been recognized. There remains however a controversial issue which is a skewed distribution of CDM projects amongst eligible host countries. In reality, while some emerging economies, especially China and India, have benefitted from the CDM as a form of CER sales and various multi-benefit (e.g., an increase in electricity generating capacity and better air quality), most LDCs do not host any CDM activities or host only a few. Therefore, several studies were conducted in this dissertation to specify more precise and appropriate factors affecting CDM project hosting utilizing both cross- country data and panel data sets in order for LDCs to suggest more promising approaches to achieve multi-benefit from implementing GHG reduction project activities such as CDM projects.

Prior to conducting empirical analyses, the effects of the CDM on the host country's GHG emission tax rate and GHG reduction policies were investigated by examining the effects of increased environmental awareness in the Annex I country using the two-country model created by Hatzipanayotou *et al*. (2002). This macroeconomic analysis shows that, in a Nash equilibrium where the Annex I country chooses the amount of CDM investment and the host sets the proportion of CDM revenue used in GHG reduction activities and GHG emission tax rate, a rise in environmental awareness of the Annex I country increases the CDM investment, does not affect the GHG emission tax rate, and plausibly reduces GHG emissions of the host country. Moreover, the results indicate that the degree of effectiveness of CDM projects in reducing GHG emissions affects the behavior of the Annex I country. This

means that, in a plausible case, the more effective the CDM investment is, the greater the reduction of GHG emissions in the host country is. If the effectiveness reflects the recipient country's ability to adopt advanced technologies (e.g., education levels or human capital stock of the country), the Annex I country tends to undertake CDM investments in such countries with greatest human capital. This prediction arises from our theoretical consideration.

With respect to empirical analyses, several significant factors have been confirmed by both cross-country and panel data analyses. The result of cross-country analyses indicates that several factors regarding a business environment (i.e., "ease of registering property," "ease of getting credit," and "ease of trading across borders") are significant for both bilateral and unilateral CDM projects. Similarly, the scientific and technical levels were found to be significant, but only for unilateral CDM projects. On top of these findings, panel data analyses reveal four important factors that have a significant and positive impact on CDM project hosting. They are: "GHG reduction potentials," "government effectiveness," "science and technology levels," and "economic ties with advanced countries in the private sector." The important point to note is that some determinants can be controlled by host countries, but other determinants cannot. LDCs, therefore, should focus exclusively on improving factors that they can control (i.e., "business environment," "government effectiveness," "science and technology levels," and "economic ties between host and Annex I countries in the private sector"). If this is actually achieved, LDCs will have better conditions for attracting CDM investors. Alternatively, by taking a different perspective on a promising approach for LDCs, it seems feasible to implement the programmatic CDM that allows a collection of a vast number of small-scale interventions to be grouped, registered, and verified as a single CDM program. Because LDCs have a serious disadvantage in their lower GHG reduction potentials, they cannot be expected to simulate the major GHG emitters, such as China. It is hoped that more promising and useful new market-based mechanisms will be developed by international organizations such as UNFCCC. In addition, as a more realistic suggestion, LDCs should continue to request financial assistance from the international society by closely working together. As mentioned above, a rise in the level of citizens' environmental awareness in the Annex I country reduces GHG emissions in the host country and increases the amount of investment required in CDM activities. LDCs, hence, should raise the environmental awareness level not only by enhancing political dialogues, but also by implementing various activities at the grassroots level in cooperation with international organizations and NGOs. This is because, from a standpoint of equality, LDCs have a right to receive more financial assistance from developed countries and some emergent nations.

In conclusion, an effective strategy to promote CDM activities in LDCs is constructed with three dimensions: 1) efforts made by the host country. LDCs should improve the significant factors that this paper identified by themselves and attempt to implement the programmatic CDM; 2) efforts of international organizations (i.e., UNFCCC) as it would be helpful to improve and/or simplify the CDM policies/rules and create new mechanisms, such as the programmatic CDM; and 3) efforts by the international community, particularly developed countries, which are responsible for a vast amount of GHG emissions that are of concern in the climate change discussion. Their further efforts are absolutely necessary to provide funds, subsidiaries, technical assistance, capacity development programs and other forms of assistance.

Reference List

This dissertation is based mainly on the following papers written by the author himself:

- Kasai, Katsuya (2012a), "A cross-country empirical analysis of determinants of Clean Development Mechanism (CDM) projects", *Journal of Environmental Information Science*, 40 (5), pp.1-10.
- Kasai, Katsuya (2012b), "How can LDCs benefit from the CDM?: A panel data analysis of determinants of CDM project hosting", *MPRA Paper* 52137, University Library of Munich, Germany.
- Kasai, Katsuya (2013), "Factors Affecting the Distribution of CERs: A Cross-Sectional Empirical Analysis", *Journal of Environmental Information Science*, 41 (5), pp.37-46.
- ACP (2014), *Asian Co-benefits Partnership White Paper 2014: Bringing Development and Climate Together in Asia*, Tokyo, The Ministry of the Environment, Japan.

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List of Abbreviations and Acronyms

ACP	Asian Co-benefits Partnership
AR	Assessment Report
BPP	Beneficiary-Pays Principle
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CMP	The Conference of the parties serving the Meeting of the Parties to the Kyoto Protocol
COP	The conference of parties to the UN Framework Convention on Climate Change (UNFCCC)
EB	The CDM Executive Board
ERF	Effective Radiative Forcing
FCCC	Framework Convention on Climate Change
FDI	Foreign Direct Investment
DNA	Designated National Authority
DOE	Designated Operational Entity
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
HDI	Human Development Index
HFC	Hydrofluorocarbon
IET	International Emission Trading
IGES	Institute for Global Environmental Strategies
iid	Independent and Identical Distributed
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
JI	Joint Implementation
LDC	Least Developed Country
NGO	Non-Governmental Organization
N_2O	Nitrous Oxide
ODA	Official Development Assistance

OLS	Ordinary Least Squares
PFC	Perfluorocarbon
PoA	Programme of Activities
PP	Project Participant
PPP	Pollutant-Pays Principle
QML	Quasi-Maximum Likelihood method
REDD+	Reducing Emissions from Deforestation and Forest Degradation plus
RF	Radiative Forcing
SD	Sustainable Development
SF_6	Sulfur Hexafluoride
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
WB	The World Bank
WDI	World Development Indicators
WGI	Worldwide Governance Indicators
WTP	Willingness To Pay

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1. Introduction

This doctoral dissertation focuses on how least developed countries (LDCs) can benefit from the Clean Development Mechanism (CDM). Prior to the theoretical and empirical analyses, this section presents basic information about the climate change issue, including the history of climate change negotiations and background information on the CDM and the status of the unequal distribution of CDM projects followed by the objectives and structure of this paper.

1.1 Climate Change Issue

There is a wide agreement that, due to increasing concentrations of greenhouse gasses (GHGs) such as carbon dioxide concentration, it is expected that climate change will cause negative environmental and socio-economic impacts in the long run (e.g., Christensen *et al*., 2007; UNEP, 2010a). According to IPCC (2007), the average annual temperature, in fact, has risen by 0.74 degree centigrade in the past hundred years (Figure 1-1).

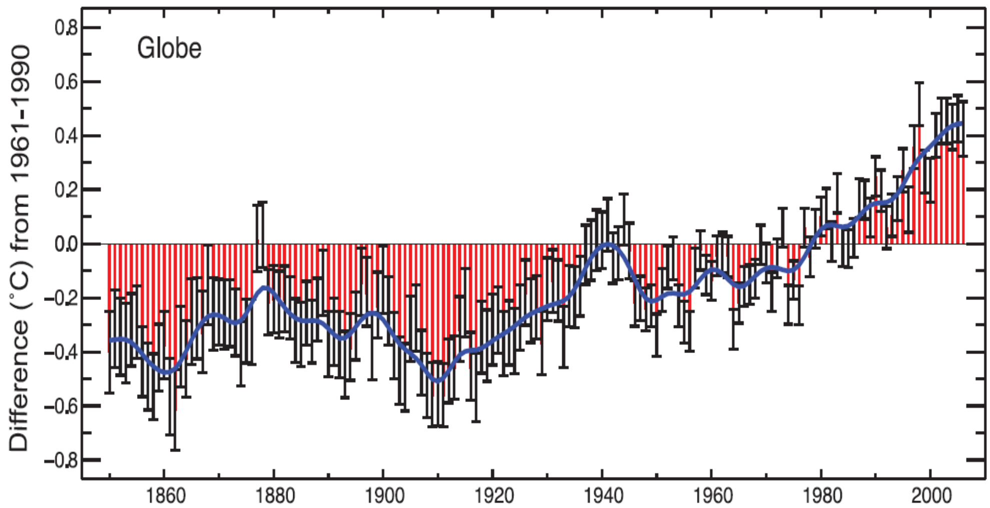

Figure 1-1 Global Annual Combined Land-Surface Air Temperature with 5-95% Error Bar Ranges

The blue curve indicates decadal variations.

Source: Brohan, *et al*. (2006)

The latest and the most accredited integrated assessment report on climate change (IPCC, 2013) alleges that: “It is extremely likely that human activities caused more than half of the observed increase in global average surface temperature from 1951 to 2010." The cause of climate change is GHGs that have radiative forcing (RF) effects. Six GHGs have been designated under the Kyoto Protocol, known as "Kyoto Six Gasses" (CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6). As can be seen from Figure 1-2, best estimators for totals and individual components of the response are shown in the right column. It can be confirmed that the six GHGs have strong RF. Values in the effective radiative forcing (ERF) column indicates an actual RF after considering the impact of aerosol-cloud interactions. The total RF due to aerosol-radiation interaction (-0.35 Wm-2) is slightly smaller than the sum of the RF of the individual components (-0.33 Wm-2) (IPCC, 2013).

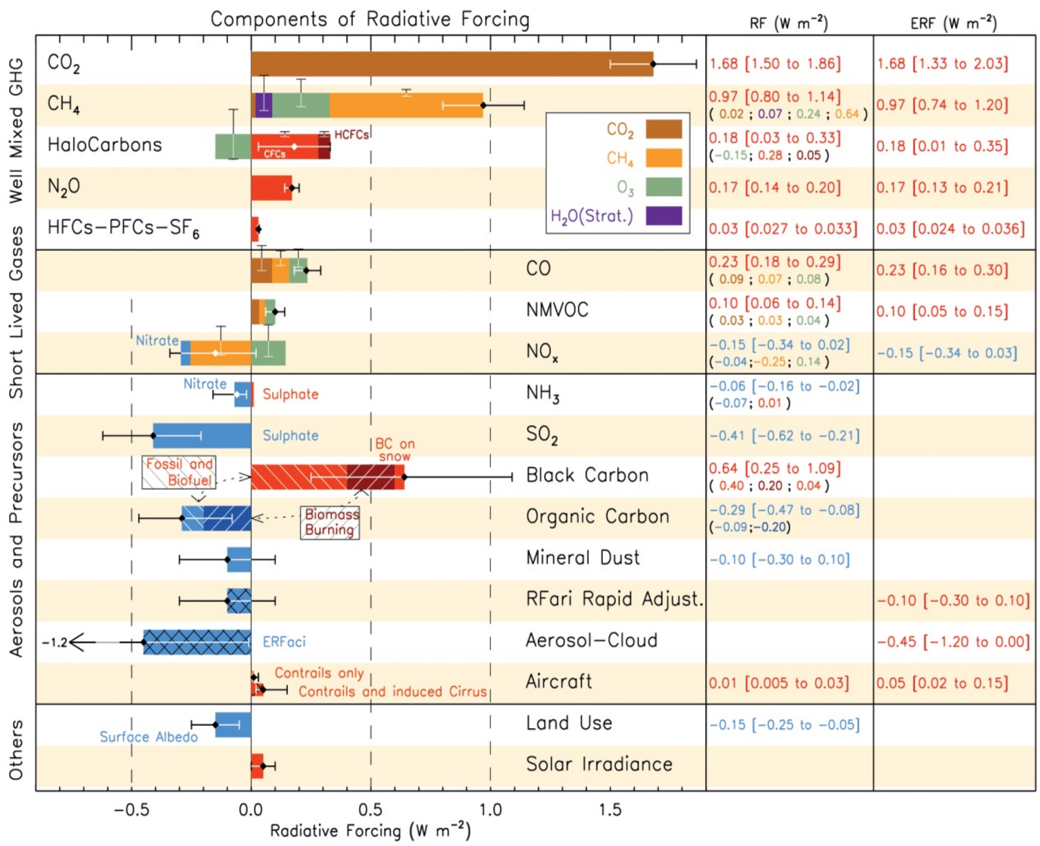

Figure 1-2 Radiative forcing (RF) of Climate Change during the Industrial Era shown by Emitted Components from 1750 to 2011

The horizontal bars indicate the overall uncertainty, while the vertical bars are for the individual components (vertical bar lengths proportional to the relative uncertainty, with a total length equal to the bar width of a ±50% uncertainty).

Source: IPCC (2013)

In fact, a number of studies on climate change have been globally carried out globally and most conclude that the influence of global warming seriously threatens every person on earth. For example, significant negative impacts on agricultural productivity have been estimated by many studies (e.g., Mendelsohn *et al*., 1994; Seo *et al*., 2005) and climate change is surely one of the most complicated and complex issues human beings must contend with in the twenty-first century. Failure to respond to this issue will stall and then reverse efforts to reduce poverty (UNDP, 2007). One particularly problematic feature of climate change is that it influences human lives in various ways, not only the obvious temperature rise, but also changes in sea levels, rainfall patterns, and in frequency of droughts, heat waves, cold waves, and typhoons (IPCC, 2013), all of which directly and negatively affect our lives. In addition, Goodman (2009) indicates that the poorest nations and the most vulnerable regions will suffer the earliest and most severe damages, despite the fact that, on average, they have contributed the least to climate change. Regardless, no country would be immune from the adverse effects of global warming in spite of their economic standing. Although there are many uncertainties about the mechanisms of the climate system, it can be predicted that existing disadvantages resulting from global warming will be serious (UNDP, 2007).

In order to avoid the severe repercussions of climate change, ensuring a temperature rise of no more than 2°C has emerged as the principal focus of international consensus (Anderson and Bows, 2008). The Copenhagen Accord, which was adopted at the fifteenth session of the conference of the parties (COP15) in 2009, agreed that "deep cuts in global emissions are required according to science, and as documented by the IPCC Fourth Assessment Report with a view to reduce global emissions so as to hold the increase in global temperature below 2 degrees Celsius" (UNFCCC, 2009). This is based on evidence that anticipates the world is reaching the point at which irreversible ecological catastrophes have becomes inevitable (UNDP, 2007). Osbahra (2008) states climate change will cause frequent and severe droughts, floods, and storms, which will destroy various opportunities (e.g., damage to food crops) and reinforce inequality. It therefore is imperative to curb the temperature rise to below 2°C.

1.2 International Climate Change Negotiations

This section briefly summarizes the history of international negotiations on climate change. A chronological breakdown containing major events is listed in Table 1-1 below.

In general, the negotiations about climate change have been conducted based on the scientific evidence that has been published in the IPCC Assessment Reports since 1990 and the Framework Convention on Climate Change (FCCC) was adopted in 1992 with the ultimate objective that aims to stabilize GHG concentrations below a level that would prevent dangerous anthropogenic interference in the global climate system (UNFCCC, 1992).

After the issuance of IPCC AR2, the Kyoto Protocol was adopted in the COP3 in Kyoto, Japan. The Kyoto Protocol has imposed legally binding targets only on industrialised countries (Annex I Parties)[1] and introduced three market mechanisms, called the Kyoto Mechanism, namely CDM (Clean Development Mechanism), JI (Joint Implementation), and IET (International Emission Trading), in order to enable economical reductions of GHG emissions (UNFCCC, 1998). The Marrakesh Accord, containing the ground rules of the Kyoto Protocol, was adopted in COP7, followed by the Bonn Agreement adopted in COP6 Part 2. Russia's ratification of it in 2005 finally made the Kyoto Protocol effective.

Following the issuance of IPCC AR4 in 2007, the necessity of reducing 50% of global GHG emissions by 2050 to meet the 2°C threshold was highlighted at COP13 held in Bali, Indonesia (Boston, 2008). Likewise, in 2009, the Copenhagen Accord, adopted in COP15, declared it was necessary to largely cut global emissions in order to limit the increase of average global temperature within 2°C. As of 12 November 2010, 140 countries have associated themselves with the Copenhagen Accord and, of these, 85 have committed to reduce their GHG emissions or constrain their economic growth up to 2020 (UNEP, 2010b).

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[1] Annex I Parties are mainly industrialised countries comprised of the members of the OECD, the EU, and fourteen countries with "economies in transition" which are committed to greenhouse gas reduction targets.

This consensus has remained consistent throughout all international conferences after COP13. While the detailed rules of the second commitment period of the Kyoto Protocol have not been determined yet, the international community, excluding Canada, Japan, and Russia, reached an agreement that secures the existence of the second commitment period in COP17 in 2011. The Kyoto Protocol worked efficiently for the first several years, however, as time went by, there had been the eruptions of disputable issues, including uneven distribution of CDM projects, vague additionality, and each country's future estimation on GHG emission in the first commitment period with elusive intentions. Meanwhile, the Certified Emission Reduction (CER)[2] price started decreasing in 2009; and the latest price was listed at 0.08 Euro/ton as of November 27, 2014 (ICE, 2014). There are three major reasons why the CER market has an imbalance of demand versus supply: first reason is the issue of equality on legally binding targets, as the targets were set with on the basis of inadequate evidence and inequitably. Due to this, Russia, Canada, and Japan did not join the second commitment period of the Kyoto Protocol; the second reason is the lower GHG emissions in Annex I countries as the Lehman Brother's fall in 2008 caused economic stagnation and many Annex I countries, especially within the EU, did not have much demand for CERs to fulfil their targets; and third, the increasing amount of CER issuance as this accelerated the sharp depreciation of CER price.

Currently, the governments involved have been working on negotiations for the details of the post-Kyoto Protocol. There is still a year until COP21 but time is running and the necessary decisions need to be made to realize the less than 2-dgree goal.

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[2] The Kyoto Protocol unit equal to one metric tonne of CO_2 equivalent. CERs are issued for emission reductions from CDM project activities. Two special types of CERs called temporary certified emission reduction (tCERs) and long-term certified emission reductions (lCERs) are issued for emission removals from afforestation and reforestation CDM projects.

Table 1-1 Chronological Breakdown of International Climate Negotiations

Year	Event
1990	IPCC First Assessment Report (AR1) issued.
May 1992	FCCC adopted.
March 1994	FCCC came into effect.
1995	IPCC AR2 issued.
December 1997	COP3 held in Kyoto, Japan.
	- The Kyoto Protocol adopted.
November 2000	COP6 held in Hague, the Netherlands.
March 2001	The United States seceded from Kyoto Protocol.
2001	IPCC AR3 issued.
July 2001	COP6 Part 2 held in Bonn, Germany.
November 2001	COP7 held in Marrakesh, Morocco.
	- The Marrakesh Accord adopted.
February 2005	Kyoto Protocol entered into force.
December 2005	COP11 and the first session of the Conference of the Parties serving the meeting of the Parties to the Kyoto Protocol (CMP1) held in Canada.
2007	IPCC AR4 issued.
December 2007	COP13 and CMP3 held in Bali, Indonesia.
	- The Bali Action Plan adopted.
December 2009	COP15 and CMP5 held in Copenhagen, Denmark.
	- The Copenhagen Accord taken note.
December 2010	COP16 and CMP6 held in Cancun, Mexico.
	- The Cancun Agreement adopted.
December 2011	COP17 and CMP7 held in Durban, South Africa.
	- The Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP) established.
	- The Kyoto Protocol without Russia, Canada, and Japan continued.
December 2012	COP18 and CMP 8 held in Doha, Qatar
	- Doha Climate Gateway adopted.
2013	IPCC AR5 issued
December 2013	COP19 and CMP9 held in Warsaw, Poland
	- Warsaw international mechanism for loss and damage associated with climate change impacts.
December 2014	COP20 and CMP10 to be held in Lima, Peru
2015	COP21 and CMP11 to be held in Paris, France

1.3 Contribution to Sustainable Development (SD) by CDM Projects

The CDM has dual objectives: to reduce GHG emissions; and to contribute to sustainable development (SD) in host countries (UNFCCC, 1998). Prior to the ratification of the Kyoto Protocol, many policy makers believed that CDM would address environmental and social problems while facilitating investment and technology transfer (Begg *et al*., 2003).

Some projects have indeed lived up to these expectations. For example, the Indian Bagepalli CDM Biogas Programme (registered in 2005) has not only provided clean and smoke-free cooking environments, it has also reduced the burden of fuel-wood collection, improved health, given women taking part in the project more time to engage in income-generating activities and shared its revenues with the 5,500 women who have received biogas units so far (ACP, 2014). Looking more broadly across CDM project design documents (PDDs), the majority of projects have a variety of positive effects on SD in host countries (Figure 1-3).

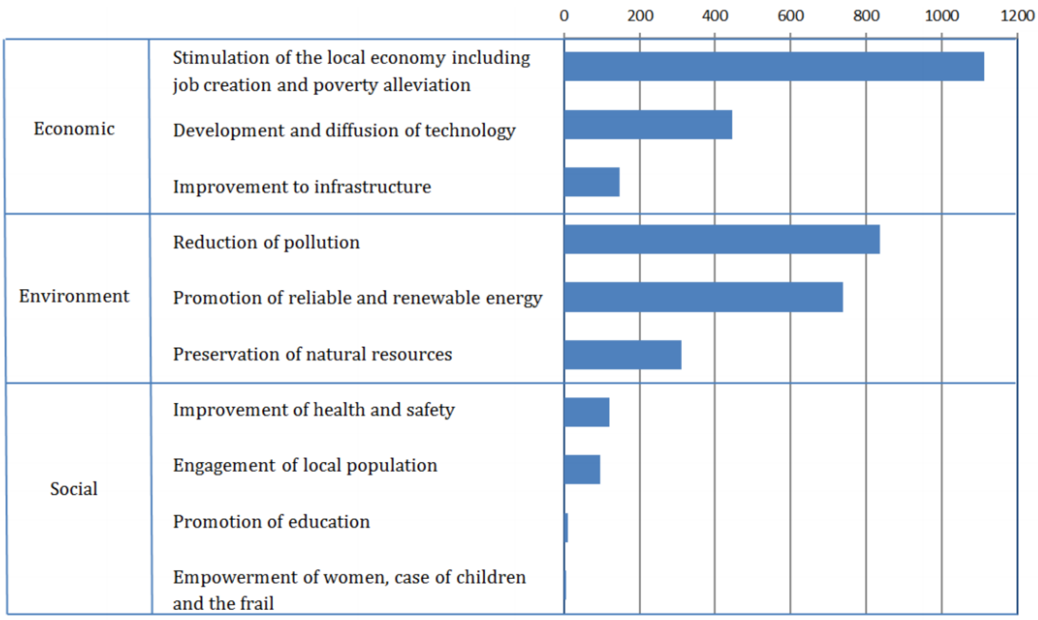

Figure 1-3 Number of Sustainable Development Claims by Indicator

Source: UNFCCC (2012f)

Certainly, positive effects leading SD in host countries can be expected from CDM projects but much of the literatures expresses scepticism about CDM's contribution to SD.

Illustrating this view, Sutter and Parreño (2007) states that CDM projects can generate employment, improve local air quality, or distribute CER sales equally but those positive effects are limited. Other researchers who have investigated a larger number of cases also conclude that the CDM does not greatly contribute to SD (e.g., Sirohi, 2007). This kind of negative feedback must be attributed to two major reasons: 1) various definitions of and different expectations for SD; and 2) a systematic problem of validation and verification of the impact of SD from CDM projects.

There have been some movements to secure and improve the contribution to SD, such as the facilitation of the gold standard. The important thing is how to design CDM projects to make them more sustainably attractive. Although there are some challenges, it can be said that CDM projects have huge potential to generate multi-benefit in addition to reducing GHG emissions.

1.4 The Distribution Status of CDM Projects

At the international level, the most promising climate mechanism with the potential to generate multi-benefit is the CDM. The CDM is a project-based offset mechanism that enables developed countries to fulfil their national GHG reduction targets under the Kyoto Protocol by implementing GHG mitigation activities in host countries (Non-Annex I Parties)[3] Host countries can earn tradable CERs issued by the CDM executive board and the amounts of CERs earned are determined based on the amounts of GHG emissions reduced by CDM projects. While it is likely that the CDM has been achieving the first objective, namely reducing GHG emissions in a cost-effective manner (e.g., Huang and Barker, 2008; Paulsson, 2009; Sutter and Parreño, 2007), several controversial issues have since appeared, such as an unequal distribution of CDM projects and ignorance of the issues facing the LDCs (e.g., IGES, 2010; UNEP Riso Center, 2008).

Though CDM activities have been very slow now, the numbers of registered CDM

[3] Eligible host countries are countries that ratify the Kyoto Protocol and establish a designated national authority.

projects and projects submitted for registrations have been steadily increasing in 2012 (Figure 1-4). As of 2012, there were 4,322 CDM projects across developing countries (UNFCCC, 2012b) yet the top two emerging economies, namely China and India, possess 2,121 and 855 CDM projects, respectively (UNFCCC, 2012b). In other words, only two countries account for approximately 70% of total CDM projects (Figure 1-5) and it is undeniable that they benefit from the tremendous amount of funds that flow from the sales of CERs (Figure 1-6). Due to the aforementioned imbalance, there is a clear and wide-ranging 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). This can be seen in data as, despite 128 non-Annex I countries being able to host CDM projects (UNFCCC, 2012b), 53 of these countries did not have any CDM projects and 50 of them hosted less than ten projects (UNFCCC, 2012c) (Table 1-2). Most LDCs listed in Table 1-3 belong to the latter group. As LDCs have emitted little GHGs in the past, Annex I countries and other emerging countries emitting a vast amount of GHGs must actively help LDCs reduce their GHG emissions and adapt to the adverse impact of climate change.

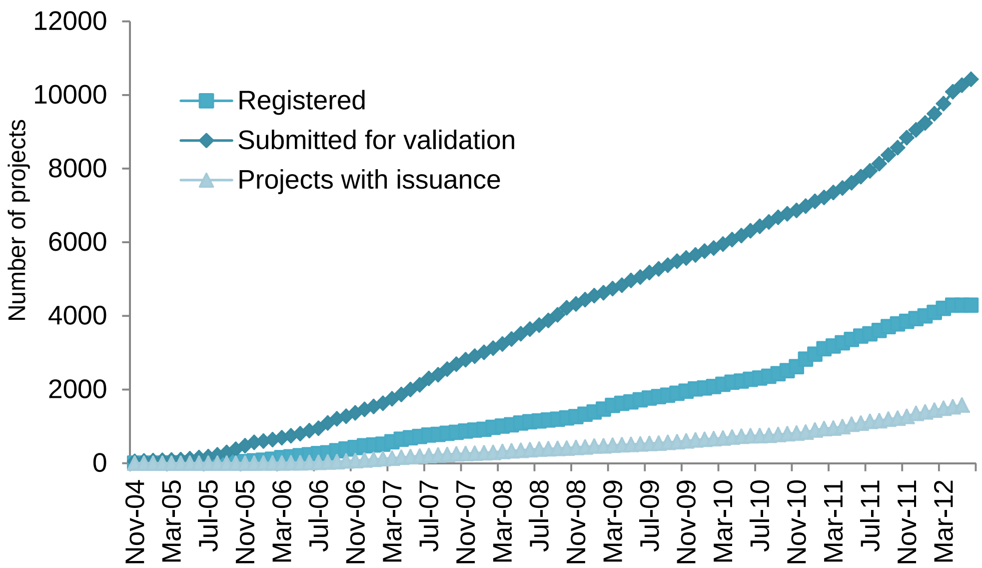

Figure 1-4 Accumulated Numbers of Projects Submitted for Validation, Registered CDM Projects, and CDM Projects with Issuance

Source: UNEP Risø Centre (2012)

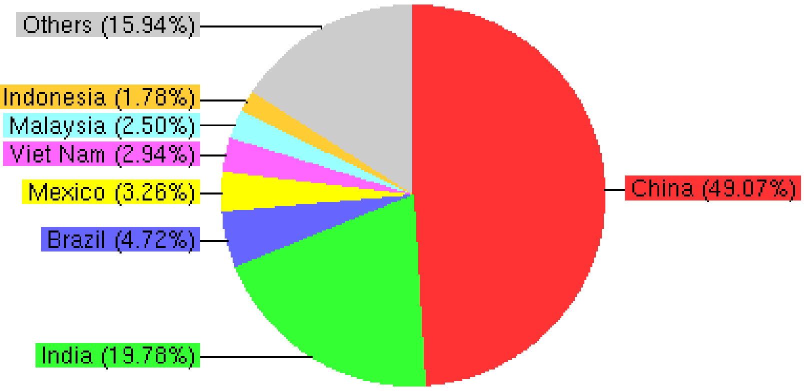

Figure 1-5 Registered CDM Projects by Host Party

Source: UNFCCC (2012c)

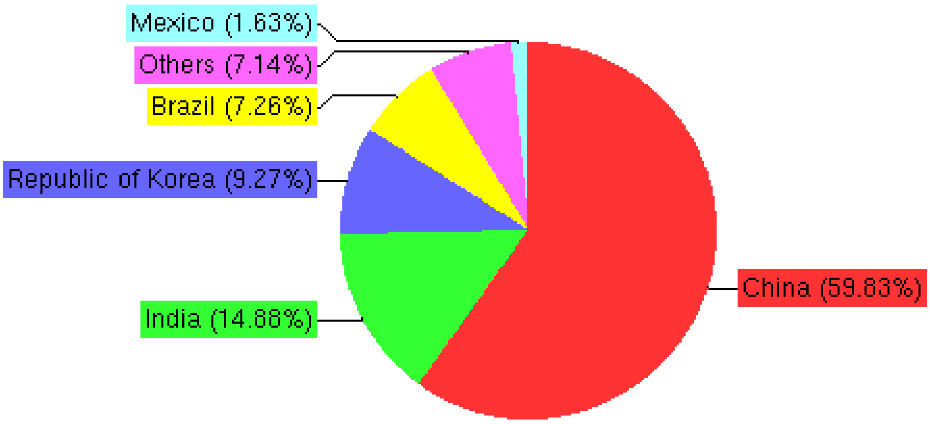

Figure 1-6 CERs Issued by Host Party

Source: UNFCCC (2012d)

Table 1-2 Number of Countries Having Less Than Ten CDM Projects

	Africa	Asia and the Pacific	Latin America and the Caribbean	EIT*	TOTAL
Countries with a DNA and 1-9 CDM projects	18	16	11	5	50
Countries with a DNA with NO CDM projects	28	13	9	3	53

* EIT refers to a list of fourteen countries undergoing the process of transition to a Market Economy under the UNFCCC. Ten of those countries are members of the EU (27).

Source: UNFCCC (2011)

Table 1-3 List of Least Developed Countries (LDCs)

Africa (33)			
1	Angola	18	Madagascar
2	Benin	19	Malawi
3	Burkina Faso	20	Mali
4	Burundi	21	Mauritania
5	Central African Republic	22	Mozambique
6	Chad	23	Niger
7	Comoros	24	Rwanda
8	Democratic Republic of the Congo	25	São Tomé and Príncipe
9	Djibouti	26	Senegal
10	Equatorial Guinea	27	Sierra Leone
11	Eritrea	28	Somalia * Not parties to the UNFCCC
12	Ethiopia	29	Sudan
13	Gambia	30	Togo
14	Guinea	31	Uganda
15	Guinea-Bissau	32	United Republic of Tanzania
16	Lesotho	33	Zambia
17	Liberia		
Asia (15)			
1	Afghanistan	9	Nepal
2	Bangladesh	10	Samoa
3	Bhutan	11	Solomon Islands
4	Cambodia	12	Timor-Leste
5	Kiribati	13	Tuvalu
6	Lao People's Democratic Republic	14	Vanuatu
7	Maldives	15	Yemen
8	Myanmar		
Latin America and the Caribbean (1)			
1	Haiti		

Source: UNFCCC (2012a)

In response to this imbalance in CDM project distribution, many developing nations have lodged complaints against the imbalance of CDM benefits distribution on the basis of Decision 17/CP.7 of the Marrakesh Accords that stipulates the necessity of the promotion of equitable distribution of CDM activities at regional and sub-regional levels (UNFCCC, 2001). This situation seems to be becoming critical as there are two conditions for the Kyoto Protocol to fully take effect: one is to secure the ratifications of no less than 55 countries; and the other is to secure 55% of the total GHG emissions of all developed nations at the 1990 level, regardless of the number of ratified nations (UNFCCC, 1998). If the issue were mishandled it could potentially result in the secession of many developing countries and remaining countries would be likely to criticize the protocol's effectiveness. Because of this negative potential, the imbalance needs to be resolved to ensure equality among developing countries and to maintain stable operations of the Kyoto Protocol itself.

1.5 Objectives

As the most probable cause of the unequal distribution of CDM projects, lower GHG reduction capabilities are frequently mentioned in the corresponding literature (e.g., Haites, 2004) and some empirical studies on the distribution of CDM projects have exposed several conflicting decisive factors for a CDM project hosting using cross-country data (e.g., Wang and Firestone, 2010; Flues, 2010; Winkelman and Moore, 2011: Kasai, 2012a and Kasai, 2012b) and their findings are not identical.

The twofold objectives of this paper, therefore, are: 1) to specify more precise and appropriate factors affecting CDM project hosting using a panel data set and 2) to suggest more promising approaches for less endowed countries to achieve multi-benefit from implementing GHG reduction project activities. For those purposes, cross-country analyses and panel data analyses are carried out utilizing the data set between 2005 and 2010.

1.6 Structure

This doctoral dissertation is structured as follows: the effects of CDM impacts on the host country's GHG emission tax rate and GHG reduction policies are examined through the Nash equilibrium in the two-country model which is developed based on the model created by Hatzipanayotou *et al*. (2002) in Chapter 2. Chapter 3 provides the results of an empirical analysis of determinants of CDM project hosing using a cross-county data and the study focuses on factors concerning business environment using the eight sub-indices of the Doing Business Index published by the World Bank. In addition, a superior analysis (i.e., a panel data analysis) is carried out in Chapter 4 to obtain more precise and reliable estimation results in the identification of significant factors of hosting CDM projects. Finally, Chapter 5 summarizes the highlights of each study and provides policy implications and recommendations advantageous for LDCs to disseminate multi-benefit type projects in an effective manner.

2. The Effect of the CDM on GHG Reduction Policies: Macro- economic Analysis

2.1 Background

Since the Kyoto Mechanism including the CDM took effect in 2005, various groups and individuals (e.g., policy makers, scholars, scientists, and environmental activists) have been contesting the effectiveness of the CDM due to diverse causes such as unequal distribution, leakage, and suspicious additionalities. The CDM nevertheless can be theoretically regarded as a cost-effective GHG mitigation mechanism on a global scale. For instance, Alexeew *et al.* (2010) states that renewable energy projects were thought to be particularly conducive to generating both climate and other developmental benefits. Therefore, prior to carrying out empirical analyses, this section attempts to verify how CDM investment influences the environmental policies of developing countries utilizing the model created by Hatzipanayotou *et al.* (2002) by examining the effects of increased environmental awareness in Annex I country.

The model is explained by being broken down into the following sections: Section 2.3 carries out welfare analysis; the Nash equilibrium is characterized in Section 2.4; and concluding remarks are given in Section 2.5.

2.2 The model

In accordance with the model used by Hatzipanayotou *et al.* (2002), there are several assumptions in the model; first, this study sets a two-country model, namely the Annex I country (a CDM investor) and the host country (a recipient country); second, both countries have small open economies; third, commodity prices are exogenous; forth, for the sake of simplicity, only the host country emits GHG emissions but no GHG emissions are emitted by the Annex I country. However, the Annex I country suffers disutility from cross-border pollution (i.e., global warming) resulting from GHG emissions in the host country; fifth, the Annex I country can endogenously determine the amount of CDM investment; sixth, there are private and public GHG reduction activities in the host country and the latter will be financed from both GHG emissions tax revenue and a part of CDM revenue[4]; seventh, the host country can freely choose their GHG emission tax rate and how much of the CDM revenue they allocate for public GHG abatement activities.

Based on the aforementioned assumptions, this study characterizes a Nash equilibrium in that the Annex I country chooses the amount of CDM investment and the host country chooses the proportion of CDM revenue allocated to GHG reductions and the GHG emission tax rate. At this equilibrium, it is expected that an increase in the Annex I country's perceived rate of cross-border pollution (global warming) reduces GHG emission levels in the host country.

As mentioned above, the private producers and the public sector implement GHG reduction activities in the host country. The private sector changes its behavior in response to a GHG emission tax rate, *t*, and the public sector abates GHG emissions using the tax and CDM revenues. The private sector produces private goods with GHG emissions and behaves competitively, while the public sector determines its level of abatement by minimizing the cost of the public GHG reduction. The vector of total factor endowment, *V*, in the host country can be decomposed into two parts: one is a private sector V^p and the other is public abatement activities, V^g; thus, $V = V^p + V^g$. The revenue function, $\bar{R}(P, t, V^p)$, which is a host country's maximum value of domestic production of private goods, can be defined as follows:

$$\bar{R}(P, t, V^p) = \max_{x,z}\{P'_x - tz: (x, z) \epsilon\, T(V^p)\},$$

where P is the vector of world commodity prices, x and z are the vectors of net outputs and GHG emission, respectively, and $T(V^p)$ is a country's aggregate technology set.

Assuming constant returns to scale in public GHG reduction activities, the

4 CDM project owners and/or CDM investors are normally required to pay fees (e.g., a registration fee) to the government when they start to develop CDM projects. The government of the host country can then spend the *subsequent income as CDM revenue.*

cost-minimization problem in the public sector generates a unit cost of GHG reduction function, $C^g(w)$, where the vector of factor prices (w), is given by

$$w = R_{V^p}\ (P, t, V^p).$$

As is well known, the demand for factors of production in the public sector (V^g) equals $C_w^g(w)g$. Therefore,

$$V^p = V - C_w^g\ (w)g = V - C_w^g\ \left(R_{V^p}(P, t, V^p)\right)g.$$

We obtain V^p=$V^p(P, t, g, \mathrm{V})$ by solving the above equation for V^p and because P and V do not vary in this analysis, the restricted revenue function can be defined as below.

$$R(g, t) = \overline{R}\left(P, t, V^p(p, t, g, V)\right).$$

$R(g, t)$ function is strictly convex in the GHG emission tax rate (i.e., $R_{tt} > 0$). This implies that an increase in the GHG emissions tax rate decreases GHG emissions in the private sector, while we assume $R_{gg} = 0$ in this analysis. This assumption indicates that changes in g, which changes factor supplies for the production of private goods, have no effect on its unit cost of production. For instance, in the Heckscher–Ohlin model (H-O model), factor prices are determined by commodity prices. Hence, when g changes, we assume $C_g^g(w) = -R_{gg} = 0$. It is also well known that $-R_g[= (\partial R/\partial g)]$ is the unit cost of public pollution abatement and that $-R_t(g, t) = z$ is the amount of pollution caused by the private sector. Additionally, in order to reflect on the effects of the CDM, the amount of GHG emissions reduced by CDM projects, εb, where ε is an effectiveness of reducing GHG emissions by CDM projects and b is CDM investment from the Annex I country, needs to be considered. We assume that ε is greater than 1 as it is expected that the CDM induces technology transfer from CDM investors to the host country, resulting from the fact that pollution-abatement technologies to be provided by investors are usually more efficient than those available in the host country. Another factor affecting ε is the capability of human resources in the host country. This is because individual CDM project owners in the host country operate CDM projects for a long stretch of time (e.g., a few decades) which requires the separate projects to secure proper human resources in implementing CDM projects that adopt advanced technologies. As a result, considering the impacts of the technology transfer, εb is regarded as GHG reductions by CDM projects. Taking GHG reductions from the public and private sectors as well as the CDM into consideration, the net GHG emission in the host country r is defined as follows:

$$r = z - g - \varepsilon b. \quad (1)$$

$$z = -R_t(g, t). \quad (1)'$$

where

r: net GHG emission in the host country;

z: gross GHG emission in the host country;

g: GHG reduction generated using the government expenditure (i.e., GHG tax revenue and CDM revenue) of the host country;

εb: GHG reduction generated by the CDM projects in the host country; and

t: GHG emission tax rate in a host country.

Also, we assume that $R_{tg}(= \partial z/\partial g) > 0$. This is because of $z = -R_t(t, g)$ which states that an increase in the government-provided GHG abatement reduces emissions by the private sector. In other words, it implies that GHG emissions and public abatement activities are substitutes in the host country.

Turning to the Annex I country perspective, their expenditure function $E(r, u)$ denotes the minimum expenditure required to achieve a level of utility u when a net GHG emission is r. The partial derivative of the expenditure function regarding u (E_u) indicates the reciprocal of marginal utility of income. As GHG emission adversely influences the utility level in the Annex I country, the partial derivative of the expenditure function with regard to r (E_r) is positive and shows the households' marginal willingness to pay (WTP) for GHG reduction. Thus, a larger amount of net GHG emission requires a higher level of spending on private goods in order to mitigate its detrimental effects to maintain the constant utility level. Furthermore, the expenditure function is likely to be strictly convex in r, $E_{rr} > 0$. That is to say, a larger level of net GHG emission raises households' marginal WTP for its reduction.

Concerning a host country government's budget constraint, it is assumed that the government finances the cost of publicly provided abatement (i.e., $gC^g = -gR_g(g,t)$) by using a proportion or the entire amount of CDM revenue provided by the Annex I country (e.g., income taxation and domestic registration fees). In principle, the proportion of β is strictly greater than zero, meaning that the host country's government should provide measures, such as matching funds for public GHG emission reduction activities. The government revenue consists of the GHG emission tax revenue and a part of income generated by CDM investment in the host country. Therefore, the government's budget constraint in the host country can be written as follows:

$$\beta b + tz + gR_g(g,t) = \beta b - tR_t(g,t) + gR_g(g,t) = 0. \tag{2}$$

where

β: the proportion of CDM revenue allocated to GHG reduction activities ($0 \leq \beta \leq 1$);

b: CDM revenue of a host country;

t: GHG emission tax rate in a host country;

z: gross GHG emission in a host country; and

g: host country's government expenditure for GHG reduction activities.

There is one observation on the above Equation (2); in defining the government budget constraint, it can be assumed that GHG emission tax revenue is basically earmarked for public abatement. This is the nature of special accounts in country budgetary systems as special accounts have their special purposes based on the idea of polluter-pays principle (PPP) or beneficiary-pays principle (BPP). An example of this would be that Japan's gasoline tax is earmarked for road construction and maintenance.

The description of the host country is completed by writing its budget constraint function formula. The budget constraint requires that private expenditure, $E(r,u)$, has to be equal to the revenue of the production of private goods, $R(g,t)$, and the cost of GHG emission tax, $-tR_t(g,t)$, plus CDM revenue, b. Therefore, utilizing Equation (2), a host country's expenditure function can be written as

$$E(r,u) = R(g,t) - tR_t(g,t) + b. \quad (3)$$

where

r: net GHG emissions in a host country;

u: utility level of a host country;

g: host country's government expenditure for GHG reduction activities;

t: GHG emission tax rate in a host country; and

b: CDM revenue (profits on CER sales from the Annex I country).

With regard to the Annex I country perspective, as conditioned, the Annex I country does not emit any GHG emissions. However, the utilities of the Annex I country are negatively affected by trans-boundary pollution generated in the host country, r. Thus, using θ which is the perceived degree of trans-boundary pollution, the welfare of the Annex I country is adversely affected by the perceived amount of trans-boundary pollution, θr. An increase in θ seems to indicate that residents in the Annex I country are more aware of trans-boundary pollution. However, in reality, the actual level of trans-boundary pollution is not dependent on θ, but merely on net GHG emissions, r.

Hence, the Annex I country's income-expenditure identity requires that private expenditure. The expenditure function, $E^*(\theta r, u^*)$, has to be equal to revenue from the production of private goods, R^*, minus the amount of CDM investment transferred to the host country. Therefore,

$$E^*(\theta r, u^*) = R^* - b. \quad (4)$$

where

θ: the perceived degree of trans-boundary pollution in the Annex I country;

r: net GHG emissions in the host country;

θr: the perceived amount of trans-boundary pollution in the Annex I country:

u^*: the utility level of the Annex I country;

R^*: revenue from the production of private goods in the Annex I country; and

b: CDM investment (investment in CDM projects and/or expenditure on CER purchase).

E_u^* denotes the reciprocal nature of the marginal utility of income in the Annex I country. It is assumed that $E_{rr}^* > 0$. The factors of production are inelastically supplied because the commodity prices are exogenous. No pollution and its reduction activities occur in both the public and private sectors in the Annex I country. Thereby, R^* is exogenous in this analysis.

Equations (1)' to (4) constitute a system that may reveal four primary unknowns (i.e., $u, u^*, g,\ and\ z$). The model contains one policy parameter for the Annex I country, the amount of CDM investment, b, and two policy parameters for the host country: the proportion of CDM revenue allocated to GHG reduction activities, β, and GHG emissions tax rate, t.

2.3 Welfare effects in the host and Annex I countries

In this section, the Nash optimal levels of the policy parameters are characterized. Based on Equations (1)' to (4) explained in the previous section, the system of basic equations can be written in a matrix form as shown below:

$$\begin{bmatrix} E_u & 0 & (E_r - t) & -(E_r + R_g) \\ 0 & E_u^* & \theta E_r^* & -\theta E_r^* \\ 0 & 0 & t & R_g \\ 0 & 0 & 1 & R_{tg} \end{bmatrix} \begin{bmatrix} du \\ du^* \\ dz \\ dg \end{bmatrix}$$

$$= \begin{bmatrix} (\varepsilon E_r + 1) \\ (\varepsilon \theta E_r^* + 1) \\ -\beta \\ 0 \end{bmatrix} db + \begin{bmatrix} 0 \\ -r E_r^* \\ 0 \\ 0 \end{bmatrix} d\theta + \begin{bmatrix} 0 \\ 0 \\ -b \\ 0 \end{bmatrix} d\beta + \begin{bmatrix} 0 \\ 0 \\ -(z + gR_{gt}) \\ -R_{tt} \end{bmatrix} dt.$$

Before deriving welfare effect in the host and Annex I countries utilizing the above determinant, Equation (5) which explains how the policy parameters influence the level of net GHG emissions was obtained based on Equation (1):

$$\Delta dr = -\left[\beta\left(R_{tg}+1\right)+\varepsilon\left(tR_{tg}-R_g\right)\right]db - b\left(1+R_{tg}\right)d\beta$$
$$-\left[\left(z+gR_{gt}\right)\left(1+R_{tg}\right)-R_{tt}\left(R_g+t\right)\right]dt. \qquad (5)$$

As Equation (5) shows, an increase in b or β unquestionably reduces net GHG emissions. When it is assumed that $\beta = 0$, CDM revenue does not have a direct effect on net GHG emissions (i.e., $(dr/db) = 0$) because Equations (1) and (2) determine the levels of g and r uniquely, and CDM revenue has no impact in determining those two variables. An increase in t has an ambiguous effect on net GHG emissions: a rise in t increases public reduction activities and reduces private production activities simultaneously, increasing demand for factors of GHG reduction in the public sector and decreasing demand for factors of production in the private sector. Hence, the overall effect on the demand for the factors is ambiguous.

With regards to welfare effects, changes in the level of welfare in both the Annex I and host countries can be obtained by differentiating the equations as follows:

$$E_u du = \Delta^{-1}A_b db + \Delta^{-1}A_\beta d\beta + \Delta^{-1}A_t dt \qquad (6)$$

$$E_u^* du^* = \Delta^{-1}C_b db + \Delta^{-1}C_\beta d\beta + \Delta^{-1}C_t dt + \Delta^{-1}C_\theta d\theta, \qquad (7)$$

where

$$A_b = \beta E_r\left(R_{tg}+1\right) + \left(tR_{tg}-R_g\right)(\varepsilon E_r + 1 - \beta),$$

$$A_\beta = b\left[E_r\left(1+R_{tg}\right) - \left(tR_{tg}-R_g\right)\right],$$

$$A_t = \left(z+gR_{gt}\right)\left[E_r\left(1+R_{tg}\right) - \left(tR_{tg}-R_g\right)\right] - R_{tt}E_r\left(R_g+t\right),$$

$$\Delta = tR_{tg} - R_g > 0,$$

$$C_b = \beta\theta E_r^*\left(1+R_{tg}\right) + (\varepsilon\theta E_r^* + 1)\left(tR_{tg}-R_g\right),$$

$$C_\beta = b\theta E_r^*(1 + R_{tg}) > 0,$$

$$C_t = \theta E_r^*[(z + gR_{gt})(1 + R_{tg}) - (t + R_g)R_{tt}],$$

$$C_\theta = -rE_r^*(tR_{tg} - R_g) < 0.$$

As $R_{tg} > 0$ and $R_g < 0$, the term A_t is positive and CDM revenue, therefore, improves welfare in the host country. There are direct and indirect positive effects: a direct positive impact is owing to transferring funds and an indirect positive impact is owing to $\beta E_r(1 + R_{tg})$. The term C_b in Equation (7) denotes that CDM investment has an ambiguous effect for the Annex I country since CDM investment induces the direct negative effect due to possible income transfers. However, as long as a part of b is spent on GHG reduction activities (i.e., $\beta > 0$), there is a positive indirect effect on the Annex I country's welfare. The signs of A_β and A_t are unclear as an increase in either t or β reduces GHG emissions. However, it results in taking resources away from the private sector and giving them to the public sector, which in turn result in the reduction of the budget of private sector. While the effect of the change in t is unclear, as can be seen from the term C_β, an increase in β unambiguously improves the welfare of the Annex I country. The term C_t denotes that a rise in t has an ambiguous effect on the welfare of the Annex I country because, as explained above, a change in t would have both positive and negative impacts on the level of net GHG emission.

Ultimately, as indicated by the term C_θ, an increase in the perceived level of trans-boundary pollution (θ) in the Annex I country has a detrimental impact on their welfare level, whereas it has no direct impact on the welfare level of the host country.

Next, this study analyses the optimal choice of the instruments by the two countries. To do this, it is assumed that the Annex I country decides the amount of CDM investment (b), while the host country decides the proportion of CDM revenue allocated to GHG reduction activities (β) and the rate of GHG emission tax (t). In addition, this study assumes that the two countries behave non-cooperatively which is an essential condition of the Nash equilibrium. Then, the first-order conditions (F.O.C.) are set as follows:

$$E_u^* \Delta(du^*/db) = C_b = 0 \tag{8}$$

$$E_u \Delta(du/d\beta) = A_\beta = 0 \tag{9}$$

$$E_u \Delta(du/dt) = A_t = 0. \tag{10}$$

Under an optimality condition that Equations (8) to (10) simultaneously determine the optimal values of b, β, and t, this study analyses the impact of changes in θ on the level of net GHG emission, r. For this, this study differentiates Equations (8) to (10) utilizing Equations (5) to (7). The results are as follows:

$$C_{bb} db + C_{b\beta} d\beta + C_{bt} dt = -C_{b\theta} d\theta, \tag{11}$$

$$A_{\beta b} db + A_{\beta\beta} d\beta + A_{\beta t} dt = 0, \tag{12}$$

$$A_{tb} db + A_{t\beta} d\beta + A_{tt} dt = 0. \tag{13}$$

where

$$C_{bb} = -\beta\theta(1 + R_{tg})E_{rr}^* \Delta^{-1}\left[\beta\left(R_{tg} + 1\right) + \varepsilon(tR_{tg} - R_g)\right],$$

$$C_{b\beta} = \left(1 + R_{tg}\right)\theta E_r^*[1 - \left(1 + R_{gt}\right)\beta b(r\Delta)^{-1}(\eta_{rr}^* - \theta\eta_{ru}^*)],$$

$$C_{bt} = C_t \beta\theta\left(1 + R_{tg}\right)(r\Delta)^{-1}(\theta\eta_{ru}^* - \eta_{rr}^*)E_r^*,$$

$$C_{b\theta} = (1 + R_{tg})\beta E_r^*(1 - \theta\eta_{ru}^*),$$

$$A_{\beta b} = b\left(1 + R_{tg}\right)\Delta^{-1}\left\{E_{ru}E_u^{-1}A_b - E_{rr}[\beta\left(R_{tg} + 1\right) + \varepsilon(tR_{tg} - R_g]\right\},$$

$$A_{\beta\beta} = -b^2(1 + R_{tg})^2 E_{rr}\Delta^{-1},$$

$$A_{\beta t} = -b(1 + R_{gt})\Delta^{-1}E_{rr}[(z + gR_{gt})\left(1 + R_{tg}\right) - R_{tt}(R_g + t)]$$

$$A_{tb} = \left[\left(z + gR_{gt}\right)\left(1 + R_{tg}\right) - R_{tt}\left(R_g + t\right)\right]$$

$$\left[(1 - \beta)E_{ru}E_u^{-1} + \beta\left(1 + R_{tg}\right)(r\Delta)^{-1}E_r(\eta_{ru} - \eta_{rr}) + \right.$$

$$\left.(tR_{tg\_}R_g)\varepsilon E_r(r\Delta)^{-1}(\eta_{ru} - \eta_{rr})\right],$$

$$A_{tt} = -E_{rr}\Delta^{-1}[\left(z + gR_{gt}\right)\left(1 + R_{tg}\right) - R_{tt}\left(R_g + t\right)]^2 - R_{tt}E_r\left(1 + R_{gt}\right),$$

$$\eta_{ru} = r(E_{ru}/E_u),\ \eta_{rr} = r(E_{rr}/E_r), \eta_{ru}^* = r(E_{ru}^*/E_u^*), \eta_{rr}^* = r(E_{rr}^*/E_r^*).$$

Having obtained the general expression for changes in the policy parameters (b, β, and t), the case of the Nash equilibrium is examined in the next section.

2.4 The case of the Nash equilibrium

As defined before, this study assumes that the Annex I country endogenously decides the amount of CDM investment (b), and that the host country optimally sets both the proportion of CDM revenue allocated to GHG reduction activities (β) and the GHG emission tax rate (t) by themselves. Under this condition, the Nash equilibrium is obtained when $A_\beta = A_t = C_b = 0$. Moreover, the condition $A_\beta = A_t = 0$ denotes $t = E_r = -R_g$.

From a common sense perspective, GHG emission is a global public bad and its abatement, conversely, is a global public good. In this case, it can be interpreted that the optimality conditions would be the combination of the Samuelson rule and the Pigouvian rule. The first equality in the optimality conditions is attributable to the Pigouvian rule, that is, that the marginal WTP for GHG emission reduction equals a GHG emission tax rate. Then, the second equality is ascribable to the Samuelson rule which the marginal WTP for a public good equals the marginal cost of its production.

Differentiating these equations, we obtain followings:

$$D(db/d\theta) = -C_{b\theta}\left(A_{\beta\beta}A_{tt} - A_{t\beta}A_{\beta t}\right), \tag{14}$$

$$D(dt/d\theta) = -C_{b\theta}\left(A_{\beta b}A_{t\beta} - A_{\beta\beta}A_{tb}\right), \tag{15}$$

$$D(d\beta/d\theta) = C_{b\theta}\left(A_{tt}A_{\beta b} - A_{\beta t}A_{tb}\right). \tag{16}$$

where D is the determinant of the matrix of coefficients for db, dt, and $d\beta$ in Equations (11) to (13). Stability requires that D is negative. As mentioned before, $t = E_r = -R_g$ is one of the conditions in this analysis. Therefore, the expressions of the coefficients on the right hand side are simplified as follows:

$$A_{\beta b} = b\left(1 + R_{gt}\right)\left[E_{ru}E_u^{-1} - \beta\Delta^{-1}\left(1 + R_{gt}\right)E_{rr} + \varepsilon t r^{-1}\left(\eta_{ru} - \eta_{rr}\right)\right],$$

$$A_{\beta t} = A_{t\beta} = -b(1 + R_{gt})^2 \Delta^{-1} E_{rr}(z + gR_{gt}),$$

$$A_{tb} = \left(z + gR_{gt}\right)\left(1 + R_{tg}\right)[E_{ru}E_u^{-1} - \beta\left(1 + R_{tg}\right)\Delta^{-1}E_{rr} + \varepsilon tr^{-1}(\eta_{ru} - \eta_{rr})],$$

$$A_{tt} = -E_{rr}\Delta^{-1}(z + gR_{gt})^2(1 + R_{tg})^2 - R_{tt}E_r\left(1 + R_{gt}\right).$$

Plugging the above expressions into Equations (14) to (16), we obtain

$$D(db/d\theta) = -C_{b\theta}b^2(1 + R_{gt})^3 E_{rr}E_r R_{tt}\Delta^{-1} > 0, \tag{17}$$

$$D(dt/d\theta) = 0, \tag{18}$$

$$D(d\beta/d\theta) = C_{T\theta}\big\{-(1 + R_{tg})^2 b\big[E_{ru}E_u^{-1}\beta\Delta^{-1}\left(1 + R_{tg}\right)E_{rr} + \varepsilon tr^{-1}(\eta_{ru} - \eta_{rr})\big]R_{tt}E_r\big\}\ either > 0\ or < 0. \tag{19}$$

Based on Equation (17), due to the result $(db/d\theta > 0)$, it is evident that θ positively affects the amount of CDM investment. Similarly, Equation (18) clearly indicates that θ has no effect on a GHG emission tax rate. Lastly, it is less clear whether or not θ has a certain effect on the proportion of CDM revenue allocated to GHG reduction activities, β (Equation (19)). The reason for this ambiguity is attributed to an assumption that a change in g has no impact on R_g (i.e., $R_{gg} = 0$).

Finally, the effect on net GHG emissions in the case of the Nash equilibrium can be expressed

$$(dr/d\theta) = -\Delta^{-1}\left(1 + R_{tg}\right)[\beta(db/d\theta) + b(d\beta/d\theta)]$$
$$= (\Delta D)^{-1}C_{b\theta}b^2(1 + R_{tg})^3 E_r R_{tt}[E_{ru}E_u^{-1} + \varepsilon tr^{-1}(\eta_{ru} - \eta_{rr})]. \tag{20}$$

If $\eta_{ru} - \eta_{rr} \geq 0$, we have $dr/d\theta < 0$, that is, that increases in the environmental awareness in the Annex I country will reduce pollution emissions. Since η_{ru} demotes the host country's marginal propensity to pay for pollution abatement and η_{rr} is a host country's marginal WTP for the reduction in pollution, $\eta_{ru} - \eta_{rr} \geq 0$ means that the host country is willing to pay for pollution abatement more than pollution reduction. This is because if the host country's marginal propensity to pay for pollution abatement is large enough, the government would allocate a larger amount of CDM revenue to public GHG reduction activities and would raise the GHG emission tax rate resulting in the reduction of production activities in the private sector. In this case, the host country, receiving CDM investment, will reduce GHG emissions. On the other hand, we cannot rule out the possibility that $\eta_{ru} - \eta_{rr} < 0$. If $\eta_{ru} - \eta_{rr} < 0$ and the absolute value is sufficiently great, we have $dr/d\theta > 0$. In this case, the host country's high marginal WTP for the reduction of GHG emissions means a high price of GHG reductions. If this "price" is sufficiently great, the government would need a larger amount of budget to reduce GHG emissions and thus the host country results in accepting higher GHG emission, receiving CDM revenue from the Annex I country. However, it is plausible that $\eta_{rr} < 1$, that is, consumers will not be willing to pay for more than their additional income for pollution abatement (Hatzipanayotou *et al.* 2002). With small η_{rr}, it can be considered the case of $dr/d\theta < 0$ as realistic.

In addition, this study considers the impact of the effectiveness of CDM projects, ε. It can be said that, if ε is sufficiently great (i.e., $\varepsilon > 1$), meaning that CDM projects, *ceteris paribus*, reduce GHG emissions more efficiently than other GHG reduction activities, we may have ($dr/d\theta < 0$), that is, higher awareness of the environment in the Annex I country that reduces the amount of net GHG emissions. Although this is not necessarily the case, when a CDM project can adopt more efficient GHG abatement technologies and know-how transferred by the Annex I country, this is the case.

2.5 Conclusions

This chapter examined the effects of the CDM on the host country's GHG emission tax rate and GHG reduction policies by examining the effects of increased environmental awareness in the Annex I country utilizing the two-country model created by Hatzipanayotou *et al.* (2002). In the Nash equilibrium where the Annex I country chooses the amount of CDM investment and the host sets the proportion of CDM revenue used in GHG reduction activities and GHG emission tax rate, this study finds that a rise in the environmental awareness of the

Annex I country increases the CDM investment and does not affect the GHG emission tax rate and, plausibly, reduces GHG emissions of the host country. These results are similar to those obtained by Hatzipanayotou *et al.* (2002). In addition, this study can formally show that the degree of the effectiveness of CDM projects in reducing GHG emissions affect the behavior of the Annex I country. It is also shown that, in a plausible case, the more effective the CDM investment is, the greater the reduction of GHG emissions in the host country is. If the effectiveness reflects the recipient country's ability to adopt the advanced technologies (e.g., education levels or human capital stock of the country) the Annex I country tends to undertake CDM investments in such countries with greatest human capital. This prediction arises from our theoretical consideration. In the following chapters, we will take into account the human capital as one of possible factors determining the directions of CDM investments from Annex I countries. Furthermore, one obvious advantage of tackling the reduction of GHG emissions by implementing CDM projects is that CDM projects can directly reduce GHG emissions while providing financial aids has an inevitable risk which is the diversion of the funds by the host country's government.

3. Empirical Analysis Focusing on Business Environment: A Cross-Country Analysis

3.1 Background

As explained in Introduction, CDM projects have become disproportionately allocated 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).

Responding to this status, many developing countries lodged complaints against the unequal distribution of CDM benefits on the basis of Decision 17/CP.7 of the Marrakesh Accords which stipulates the necessity of the promotion of equitable distribution of CDM activities at regional and sub-regional levels (UNFCCC, 2001). This situation seems to be nearing critical status since the Kyoto Protocol stipulates two conditions for an inurement of the protocol: one is to secure the ratifications of no less than 55 countries; and the other is to secure 55% of the total GHG emissions of all developed nations in 1990 level regardless of the number of ratified nations (UNFCCC, 1998). If a number of developing countries secede from the protocol, Annex I Parties would be in a position to criticize the effectiveness and equitability of the protocol and, as a result, the effects of the protocol might be diminished. Therefore, this issue should be solved for a stable operation of the Kyoto Mechanism including 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) and empirical studies on the distribution of CDM projects have had interesting results. For instance, Flues (2010) found that the number of CDM projects is explicitly influenced by factors categorized into three groups: CDM potential, feasibility, and profitability. However, findings identified by previous empirical studies contain many contradictions. Responding to these previous studies, the objective of this chapter is to identify additional significant decisive factors of CDM project hosting not found in previous studies, especially those focusing on identifying specific elements of business environments using the sub-indices of the Doing Business Index[5].

The remainder of this chapter is structured as follows: Section 3.2 reviews previous studies and creates a conceptual framework with assumptions; the data and methodology used in this study are explained in Section 3.3; and finally, Section 3.4 presents estimation results and discussions.

3.2 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 that identify several determinants based on quantitative analyses. The major findings of existing theoretical and empirical studies are summarized in Sections 3.2.1 and 3.2.2, respectively. Finally a conceptual framework is expounded in Section 3.2.3.

3.2.1 Theoretical Studies

The already sizeable and continually 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 that are well-endowed with CDM projects emitted a large amount of GHGs before the CDM came into effect in 2005 and they appear eager to boost their shares further without any investment from advanced nations. In contrast, there have been few industries emitting vast amounts of GHGs in LDCs and the potential for launching CDM projects in LDCs is, thus, likely to be fundamentally very low (Haites, 2004) because projects that produce small amounts of CERs must be judged as commercially unattractive by CDM investors following the principle of the market mechanism.

Jahn *et al*. (2004) and Michaelowa (2007) argue theoretically that certain levels of

5 The Doing Business Index is an index created by the World Bank where higher rankings indicate more effective, usually simpler, regulations for business and stronger protection for property rights.

human capital, institutional and infrastructural capacities, and financial capital availability are required in order for a country to successfully host CDM projects. Accordingly, in case a 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 advanced GHG reduction technologies to be transferred by CDM investors with comparative ease, LDCs must confront considerable technical barriers owing to their insufficient technological advancements.

3.2.2 Empirical Studies

Compared to theoretical studies, the number of empirical studies on the distributional issue is limited and many of their conclusions have been mired in controversy.

First of all, Dinar *et al*. (2008) analysed the levels of cooperation between host and investor countries using regression analysis, and revealed five significant factors: 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, also 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 projects[6]. 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 in addition to the host countries' educational level and a certain level of infrastructures. In addition, Winkelman and Moore (2011) studied the determinants of CDM activities using a Probit model across the eligible host countries that have ratified the

[6] Bilateral CDM projects are the standard form of CDM projects involving an 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 on by a host country independently without the participation of Annex I Parties at the time of registration.

Kyoto Protocol and established a Designated National Authority (DNA)[7]. As a result, the study verifies the significance of three explanatory variables: GHG emissions, electricity capacity growth rates, and educational levels.

3.2.3 Conceptual Framework

Based on the literature review, we developed the conceptual framework which includes four groups of explanatory variables. Those are explained in the following paragraphs.

As mentioned in the previous section, the significance of GHG reduction potential is proven by both existing theoretical and empirical studies and this study also adopts it into a model. The next group is human capital which is theoretically thought of as an important factor in implementing CDM projects. However, there are contradictions among the results of empirical studies. For instance, while the study carried out by Wang and Firestone (2010) was unable to observe any significance of tertiary education obtained from the Global Competitive Report, Winkelman and Moore (2011) illustrated the significance of the education index, one of the components of the Human Development Index (HDI). These two findings seem to offer opposite results. When considering the CDM project hosting, the quality of human capital must be considered very important, especially with regard to scientific and technological levels, as to be able to effectively embark on CDM projects a certain level of scientific knowledge is inevitably required. This study, thereby, adopts two independent variables to verify the significance of human capital: the log of tertiary school enrolment rates and the log of the number of scientific and technical journal articles as proxies for general education levels and scientific levels, respectively.

The most important factor this study attempts to reveal is the quality of business environment in host countries. Combined with the results of existing empirical studies, there

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[7] 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.

is an obvious contradiction between the theoretical and the empirical literature. On the one hand, Jung (2006) theoretically maintains that foreign direct investment (FDI) inflows are good predictors of host countries' attractiveness for CDM investments particularly for countries receiving abundant FDI. Furthermore, Dinar *et al*. (2008) imply that the CDM can be regarded as a type of FDI. On the other hand, although the study carried out by Winkleman and Moore (2011) adopted FDI inflows as proxies for the qualities of business environment in their analytical models, the result did not show its significance. Moreover, Niederberger and Saner (2005) refute the connection between FDI and CDM investment by stating that some countries, after having failed to induce FDI, have actually succeeded in hosting CDM projects. As can be seen from the above discussion, the results with respect to the business environment are not homogenous. There appears to be two problems with the previous studies in terms of the 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; and second, previous studies did not analyse sufficient aspects of business environment. Thus, in this study, sub-indices of the Doing Business Index are applied because of its comprehensive coverage.

The last group is links to advanced nation. This also seems to be a substantial factor as host countries need to find CDM investors or at least certified emission reduction (CER) buyers. In the previous studies, Dinar *et al*. (2008) and Flues (2010) demonstrated the importance of links to advanced nations in order to promote CDM projects, though the results of the study carried out by Flues (2010) have limited credibility (10% significance level) using a dummy valuable which indicates 1 if a country is one of former British, Spanish, Dutch, German, and French colony. As colonial relationships between advanced nations and eligible host countries are likely to affect investment decisions, this study adopts a former British colony dummy in order to know how the largest CDM investor utilizes colonial relationships in their CDM business.

Based on the above discussions, this study differs from the past studies by attempting to verify the significance of 1) sub-indices of the Doing Business Index as proxies for specific elements of a business environment; 2) scientific and technology levels using the number of scientific and technical journal articles; and 3) former British colony dummy.

3.3 Data and Methodology

3.3.1 Data

This survey covered 125 eligible host countries which have ratified the Kyoto Protocol and established a Designated National Authority (DNA). Dependent variables used in this study are the log of the numbers of bilateral and unilateral CDM projects, sourced from the CDM project database as of 29 April 2011, created by the Institute for Global Environmental Strategies (IGES).

Definitions of all variables are explained in Table 3-1. Because the CDM registration was started in 2005, this study utilises data from 2005 for all independent variables except the data of colonial status which come from literature written by Hensel (2006).

Table 3-1 Definitions of independent and dependent variables

Variable	Description	Source
Log of no. of bilateral CDM projects $_i$	The natural logarithm of the number of registered bilateral CDM projects of the country *i* (as of April 29 2011).	CDM project database (2011), IGES
Log of no. of unilateral CDM projects $_i$	The natural logarithm of the number of registered unilateral CDM projects of the country *i* (as of April 29 2011).	CDM project database (2011), IGES
Log of GHG emissions $_i$	The natural logarithm of GHG emissions of the country *i* (ktCO2e) including CO2, CH4, N2O, HFCs, PFCs, and SF6. (2005)	World Resources Institute (2005), World Bank
Net energy imports $_i$	Net energy imports of the country *i* (% of energy use). A negative value indicates that the country *i* is a net exporter. (2005)	World Development Indicators (2005), World Bank
Log of no. of scientific articles $_i$	The natural logarithm of the number of scientific and technical journal articles of the country *i*. (2005)	World Development Indicators (2005), World Bank
Log of tertiary school enrolment rate $_i$	The natural logarithm of gross tertiary school enrollment rate of the country *i*. (2005)	World Development Indicators (2005), World Bank
Ease of starting a business $_i$	The percentile rank of starting a business of the country *i*. (2005)	Doing Business (2007), World Bank

No. of procedures for starting a business $_i$	The number of procedures required for starting a business of the country *i*. (2005)	Doing Business (2007), World Bank
Log of time for starting a business $_i$	The natural logarithm of the time required for starting a business of the country *i* (days). (2005)	Doing Business (2007), World Bank
Log of cost for starting a business $_i$	The natural logarithm of the cost required for starting a business of the country *i* (% of income per capita). (2005)	Doing Business (2007), World Bank
Min. capital for starting a business $_i$	The paid-in minimum capital required for starting a business of the country *i* (% of income per capita). (2005)	Doing Business (2007), World Bank
Ease of dealing with construction permit $_i$	The percentile rank of dealing with construction permits percentile rank of the country *i*. (2005)	Doing Business (2007), World Bank
Ease of registering property $_i$	The percentile rank of registering property of the country *i*. (2005)	Doing Business (2007), World Bank
Ease of getting credit $_i$	The index of getting credit of the country *i*. (2005)	Doing Business (2007), World Bank
Ease of protecting investors $_i$	The index of protecting investors rank of the country *i*. (2005)	Doing Business (2007), World Bank
Ease of paying taxes $_i$	The percentile rank of paying taxes rank of the country *i*. (2005)	Doing Business (2007), World Bank
No. of tax payments $_i$	The number of tax payments of the country *i* (number per year). (2005)	Doing Business (2007), World Bank
Time for paying taxes $_i$	The time required for paying taxes of the country *i* (hours per year). (2005)	Doing Business (2007), World Bank
Log of total tax rate $_i$	The natural logarithm of the total tax rate of the country *i* (% of commercial profit), which measures the amount of taxes and mandatory contributions borne by the business in the second year of operation. (2005)	Doing Business (2007), World Bank
Ease of trading across borders $_i$	The percentile rank of trading across borders of the country *i*. (2005)	Doing Business (2007), World Bank
Ease of enforcing contracts $_i$	The percentile rank of enforcing contracts of the country *i*. (2005)	Doing Business (2007), World Bank
Colonial dummy $_i$	Dummy variable (Former British colonies =1, 0 otherwise)	Hensel (2006)
Log of net ODA $_i$	The natural logarithm of net ODA of the country *i* (million US$). (2005)	World Development Indicators (2005), WB

Note: Doing Business Index 2007 contains data in 2005.

Descriptions of variables and the correlation coefficients among independent variables are shown in Tables 3-2 and 3-3. There are some missing values in explanatory variables due to data availability but the number is much smaller than the total number and thus, these deficits must have very limited impacts on the analytical results.

Table 3-2 Descriptive Table of Dependent and Independent Variables

Category	Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent variables	Log bilateral CDM projects	125	0.759	1.31	0	7.18
	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
	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
	Log tertiary school enrolment rate	75	2.370	1.18	-0.755	4.52
Business environment	Ease of starting a business	113	53.7	20.9	3.33	99.6
	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
	Ease of trading across borders	113	52.3	22.8	2.08	99.6
	Ease of enforcing contracts	113	51.2	18.6	13.8	95.9
Links to advanced nations	Colonial dummy	125	0.328	0.471	0	1
	Log net ODA	111	-1.491	1.38	-4.85	1.86

Note: This study regarded log 0 as zero (0) for simplicity.

Table 3-3 Correlations Among Independent Variables

	lnghg	energyim	lnjour~l	lntert~y	start	start~ce	lnstar~e	lnsta~st	start_~i	permit	property
lnghg	1.0000										
energyim	-0.3209	1.0000									
lnjournal	0.7640	0.1179	1.0000								
lntertiary	0.0383	0.1352	0.2776	1.0000							
start	-0.0960	0.4299	0.2877	0.4089	1.0000						
start_proce	0.1809	-0.3338	-0.0416	-0.1000	-0.6433	1.0000					
lnstart_time	0.0186	-0.2728	-0.3151	-0.3915	-0.6653	0.5438	1.0000				
lnstart_cost	-0.0341	-0.3397	-0.4167	-0.5660	-0.8056	0.3068	0.4919	1.0000			
start_capi	0.0192	-0.2161	-0.1156	-0.0693	-0.4186	0.0360	-0.0135	0.3944	1.0000		
permit	-0.1377	-0.0781	-0.0880	0.0812	0.1536	-0.1915	0.0016	-0.0493	0.1924	1.0000	
property	-0.1849	0.2360	0.0313	0.5658	0.2122	0.0231	-0.1742	-0.3935	0.1053	0.2023	1.0000
credit	0.0590	0.1240	0.1693	0.2941	0.4748	-0.0380	-0.0123	-0.3957	-0.3674	0.2288	0.2810
protect	0.3369	-0.1979	0.1453	0.0649	0.1809	0.0262	0.0243	-0.0106	-0.1847	0.1227	0.0334
tax	-0.1245	0.0544	-0.1395	-0.0991	0.0193	-0.1132	0.0346	0.0339	0.1714	0.1311	0.1789
tax_num	-0.2128	0.0821	-0.2457	-0.0139	-0.0721	0.0507	-0.0322	0.0809	-0.0710	-0.1990	-0.1254
tax_time	0.3158	0.0435	0.4088	0.0803	0.0926	-0.0145	-0.0170	-0.1354	-0.1888	0.0789	-0.0902
lntax_rate	0.2779	-0.1270	0.2475	0.1423	-0.0407	0.1207	-0.1460	-0.0287	-0.0927	-0.3527	-0.1884
trade	0.2999	0.1501	0.4799	0.3726	0.2681	-0.0527	-0.3022	-0.2052	0.0025	0.2249	0.2175
contract	-0.1515	0.3081	0.0122	0.3382	0.3430	-0.0473	-0.3071	-0.5187	0.0578	-0.0590	0.4529
colony	0.0994	0.0692	0.1458	-0.2697	-0.0741	0.1480	-0.0438	0.2153	0.2965	-0.0919	-0.0734
lnoda	0.2917	0.0634	0.1676	-0.4898	-0.2452	0.0364	-0.0558	0.3176	0.0659	-0.1832	-0.3949

	credit	protect	tax	tax_num	tax_time	lntax_~e	trade	contract	colony	lnoda
credit	1.0000									
protect	0.5537	1.0000								
tax	0.0512	0.1803	1.0000							
tax_num	-0.0979	-0.1236	-0.7212	1.0000						
tax_time	0.1062	0.0038	-0.6506	0.1658	1.0000					
lntax_rate	-0.2169	-0.2231	-0.7707	0.4465	0.3110	1.0000				
trade	0.2952	0.2418	0.1378	-0.3011	0.2274	-0.2063	1.0000			
contract	0.1229	-0.1462	0.1194	-0.0646	-0.1393	-0.0089	0.0403	1.0000		
colony	0.1432	0.2390	0.1198	0.0115	-0.1541	-0.1023	0.1558	-0.0399	1.0000	
lnoda	-0.3817	0.0224	-0.1618	0.1180	0.2216	0.1765	-0.0734	-0.2621	0.1951	1.0000

3.3.2 Methodology

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

$$y_i^* = \mathrm{x}_i\,\beta + \varepsilon_i, \varepsilon_i|\mathrm{x}_i, \mathrm{c}_i \sim \mathrm{Normal}(0, \sigma^2)$$

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

where y_i^* is a latent response variable, x_i is an independent variable, 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 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 are added, all of which are categorized into four groups as listed in the models shown below:

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

where dependent variables, $lnbi_i$ and $lnui_i$, are the log of numbers of bilateral and unilateral CDM projects of host country *i*, respectively. G_i , H_i , B_i , and L_i represent sets of characteristics of host country *i* relevant to GHG reduction potential (G_i), human capital (H_i), business environment (B_i), and links to advanced nations (L_i), respectively. The details of all independent variables are explained in detail in the following paragraphs.

1) GHG reduction potential

This study uses the 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 bigger motivations to tackle GHG reduction activities than other countries who may be responding to current soaring fossil fuel prices and the concerns of resource depletion (Kasai, 2012a).

2) Human capital

This study adopts the log of tertiary school enrolment rate to investigate the impacts of general education levels of people in eligible host countries. In addition, the log of the number of scientific and technical journal articles is used in the models of the other countries as the number of journal articles can be thought of as a good proxy of the science levels of eligible host countries (Kasai, 2012a).

3) Business environment

This study utilizes the data of the sub-indices of the Doing Business Index as proxies for the qualities of a business environment. The 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. Therefore, data of eight sub-indices of the Doing Business Index are included in the model (Kasai, 2012a).

4) Links to advanced nations

This study utilizes the log of net official development assistance (ODA) and a former British colonial dummy. As discussed 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 the colonial dummy used in this study is revised, which indicates 1 if a country is only former British colony. This is because the U.K. is the largest investor and many major CDM investors (CERs buyers) are headquartered in the U.K. (UNEP Risø Centre, 2012), leaving other colonial powers far behind (Kasai, 2012a).

3.4 Results and Discussions

The regression results for determinants of bilateral and unilateral CDM project hosting are shown in Tables 3-4 and 3-5, respectively.

In the models for bilateral and unilateral CDM projects, six specifications are set and examined. Specification 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: the colonial dummy, the log of net ODA, net energy imports, and the log of tertiary school enrolment rate. In Specification 6, the components of "ease of starting a business" and "ease of paying taxes" are included to examine the reasons for their negative results, which are explained and discussed as follows.

1) GHG reduction potentials

As can be seen from Tables 3-4 and 3-5, the log of GHG emissions is statistically significant and positive for all specifications of bilateral CDM projects at a 1% significance level and is statistically significant only for Specification 4 of unilateral projects with the 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, for things such as investment and technology borrowing. CDM investors usually decide the projects' locations following the market mechanism (i.e., profitability) and thus it is important to have reasonable abatement costs to host bilateral projects (Flues, 2010).

On the other hand, unilateral projects essentially 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 are consistent with the arguments and findings of previous studies (Kasai, 2012a).

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 of CDM projects for their host countries (Kasai, 2012a).

2) Human capital

As Tables 3-4 and 3-5 show, the log of the tertiary school enrolment rates is statistically significant and positive for bilateral projects but insignificant for unilateral projects. The former is in accordance with previous studies, though their significance levels are at the maximum limit. The latter might indicate that the important factor of promoting CDM projects is not the general educational level, but other specific fields of education. This study also confirms that the 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 must 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 (Kasai, 2012a).

3) Business environment

As Tables 3-4 and 3-5 indicate, two independent variables, namely "ease of dealing with construction permits" and "ease of enforcing contracts," are statistically insignificant. The results of the remaining six variables related to the business environment are discussed in the following paragraphs.

This study was able to 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 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 as 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 (Kasai, 2012a).

In contrast, the regression results indicate that three other variables have significant negative effects. Nevertheless, one of them, “ease of enforcing contracts,” is judged as insignificant since the negative result seems to be strongly influenced by an outlier. In fact, by running the regression model excluding it, 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 the significant negative effects in all specifications for bilateral projects and in Specification 1 for unilateral projects. These two variables contradict the expectations (Kasai, 2012a).

The significant and negative effects are not expected amongst variables regarding a business environment. In order to identify factors causing the negative results, all components of those two variables are incorporated into Specification 6. Consequently, the analysis suggests that the cause of the 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 a 5% significance level. Regarding “ease of paying taxes,” “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 a comprehensive business environment. One explanation for this set of results is that countries with a more matured business environment tend to impose more severe rules and regulations on private firms (Kasai, 2012a).

Overall, the 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 environments (Kasai, 2012a).

4) Links to advanced nations

There are two independent variables in the links to advanced nations, both of which are insignificant for both bilateral and unilateral project hosting. The results of the colonial dummy might allude to the fact that CDM investors in the U.K. do not give credence to colonial ties and this may be due to the impacts caused by growing globalization. In addition, the statistical insignificance of the log of net ODA may imply that CDM investors act differently from their governments for other factors or simply by following the market mechanism (Kasai, 2012a).

Table 3-4 Regression Result for Determinants of Bilateral CDM Projects

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 number 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	-0.003	-0.002	-0.006	-0.013	-0.002	
	Number of procedures for starting a business						0.059
	Log of time for starting a business						0.311
	Log of cost for starting a business						-0.015
	Min. capital for starting a business						0.000
	Ease of dealing with construction permits	-0.004	-0.005	-0.001	0.004	-0.001	-0.003
	Ease of registering property	0.020**	0.0182**	0.020**	0.023***	0.019*	0.022**
	Ease of getting credit	0.315**	0.317**	0.316***	0.155	0.104	0.306**
	Ease of protecting investors	-0.087	-0.071	-0.053	0.064	0.146	-0.036
	Ease of paying taxes	-0.040***	-0.039***	-0.031***	-0.043***	-0.046***	
	No. of tax payments						0.034***
	Time for paying taxes						0.002**
	Log of total tax rate						0.547
	Ease of trading across borders	0.019**	0.019**	0.026***	0.021***	0.025**	0.017**
	Ease of enforcing contracts	0.004	0.003	0.006	0.003	0.005	0.006
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 3-5 Regression Result for Determinants of Unilateral CDM Projects

Category	Specification	(1)	(2)	(3)	(4)	(5)	(6)
GHG reduction potential	Log of GHG emissions	0.241	0.249	0.076	0.475*	0.108	0.283
	Net energy imports				0.685**		
Human capital	Log of the number 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	-0.037**	-0.032*	-0.045**	-0.046***	-0.020	
	Number of procedures for starting a business						0.092
	Log of time for starting a business						0.126
	Log of cost for starting a business						0.452*
	Minimum capital for starting a business						-0.004**
	Ease of dealing with construction permits	0.008	0.004	0.007	0.019	0.007	0.003
	Ease of registering property	0.039***	0.035**	0.048***	0.041***	0.0422**	0.043***
	Ease of getting credit	0.452**	0.507**	0.486**	0.374**	-0.0361	0.358*
	Ease of protecting investors	-0.149	-0.126	-0.070	-0.112	0.286	-0.326
	Ease of paying taxes	-0.023*	-0.016	-0.018	-0.018	-0.017	
	No. of tax payments						0.008
	Time for paying taxes						0.002
	Log of total tax rate						-0.312
	Ease of trading across borders	0.009	0.008	0.014	0.004	-0.000	0.019
	Ease of enforcing contracts	-0.028*	-0.034**	-0.027	-0.032**	-0.031	-0.039**
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

4. The Revisit of Empirical Analysis: A Panel Data Analysis

4.1 Background

Chapter 3 successfully identified hidden determinants for CDM project hosting. Having said that, as well as in previous studies, the data set used in the analysis is cross-sectional data, which caused the limited reliability of its analytical results. Moreover, due to the existence of many independent variables with respect to the business environment, several vital variables do not seem to be included in the model. Therefore, we try to carry out a panel data analysis with the twofold objectives in this chapter: firstly, to specify more precise and appropriate factors affecting CDM project hosting; and secondly, to figure out more promising approaches for less endowed countries.

This chapter is structured as follows: Section 4.2 provides a conceptual framework to be utilized for establishing empirical models and selected hypotheses generated based on findings from literature review; Section 4.3 explains analytical methodologies and data used in this study; and estimated results and relevant discussions are presented in Section 4.4.

4.2 Literature Review

This section reviews the earlier literature on the decisive factors of CDM project hosting. All in all, whilst many theoretical studies have presumed and argued the determinants of CDM project hosting, the number of empirical studies based on quantitative analysis has been very limited. The major findings of existing theoretical and empirical studies are summarized in Sections 4.2.1 and 4.2.2, respectively. Based on the findings of the literature, the conceptual framework for a panel data analysis is illustrated in Section 4.2.3.

4.2.1 Theoretical Studies

The growing theoretical literature has shown that the low potentials for GHG emission reductions hinder the implementation of CDM project activities in LDCs (e.g., Haites, 2004; Jung, 2006). For instance, Jung (2006) states that countries well-endowed with CDM projects emitted a large amount of GHGs before the CDM came into effect in 2005 and, seem eager to boost their number of independent CDM activities further without investments from advanced nations. In contrast, there have been few industries emitting the vast amount of GHGs in the LDCs. The potential for launching CDM projects in LDCs is, therefore, likely to be fundamentally very low (Haites, 2004). This is because projects that produce small amounts of CERs may be considered commercially unattractive by investors following the principle of the market mechanism (Kasai, 2012a).

With respect to disputes about socioeconomic factors, Jahn *et al*. (2004) and Michaelowa (2007) theoretically argue that certain levels of human capital, institutional and infrastructural capacities, and financial capital availability are required to host CDM project activities. Accordingly, if host countries have higher risk premiums for CDM investors, it ought to be more appropriate and feasible for those countries to implement CDM activities unilaterally (Jahn *et al*., 2004). Flues (2010) alleges that, while some eligible industrialized host countries are able to adopt relatively advanced GHG reduction technologies with comparative ease, LDCs must confront considerable technical barriers for the use of those technologies due to their insufficient technological levels. Moreover, governance levels can be regarded as one of determinants in theoretical literature as effective governance is needed to facilitate CDM activities due to its complex procedures. For instance, Olawuyi (2009) implies that the gaps in economic, social and administrative conditions among developing countries directly and powerfully affect the attractiveness of CDM host countries.

In summary, based on the theoretical literature, GHG emission levels, economic conditions, and social conditions are thought to play important roles in promoting CDM project activities and are likely to be found as decisive factors of CDM project hosting in this study.

4.2.2 Empirical Studies

Prevailing empirical research papers have applied various analytical methods and their results have been occasionally mired in controversy. Compared to theoretical studies, the number of empirical studies on the distributional issue is limited including the study in Chapter 3, and are chronologically explained in the following paragraphs and summarized in Table 4-1. The data in the table helps to describe the appropriateness and effectiveness of the conceptual framework and the selection of methodologies that appear later.

Dinar *et al*. (2008) conducted an empirical study focused on identifying significant factors influencing the levels of cooperation between host and investor countries. They hypothesized that theories of international relations (FDI inflows and trade) play roles in the promotion of CDM activities and thus applied theories of international economic activities as mentioned above. As a result, their analyses utilizing four models (Poisson, Logit, Probit, and Tobit models) identifies several significant factors for the levels of cooperation in CDM activities: economic development, institutional development, the energy structure levels of vulnerability to climate change impacts, and relationships between the host and investor countries. Finally, they emphasized the importance of simplifying regulations and registration processes regarding the CDM towards a CDM reform, improving the governance levels of host countries, and strengthening economic activities between host and investor countries.

Similarly, Wang and Firestone (2010) analysed the determinants of the amount of CERs using a gravity model based on an international trade theory. Consequently, the study demonstrates that the domestic GHG emission levels of both host and investor countries are the primary determinant of CDM project hosting, which is consistent with their hypotheses. The regression result also indicates that the degrees of openness to international trade, infrastructure, and project sizes are significant determinants. Based on their findings, Wang and Firestone (2010) speculated the importance of technical support and official development assistance (ODA) from advanced nations in the context of improving infrastructure in host countries.

A study conducted by Flues (2010) also considered the uneven CDM distribution issue. They created a framework consisting of three dimensions: potential, feasibility, and profitability on the basis of a hypothesis that the probability of CDM projects is thought to be determined by the three dimensions. The estimation results affirm, based on the estimation results of the Poisson QML model and negative binomial hurdle model, that the number of CDM projects is positively affected by economic development and growth, fossil fuel, renewable energy potential, and institutional qualities as significant determinants of CDM project distribution. Of special note is that the study reveals the fact there are clear differences in the size of coefficients between the determinants of bilateral and unilateral CDM projects. Ultimately, Flues (2010) concluded that the CDM is not a promising mechanism for LDCs, noting the need for financial assistance from the GEF (Global Environmental Facility)[8] to LDCs.

Subsequently, Winkelman and Moore (2011) investigated the determinants of CDM projects and CERs distributions using Probit and truncated regression models, respectively. The study differs from the past studies in terms of the selection of independent variables and the scope of a dependent variable. The Probit model covered 115 eligible host countries, excluding developing countries that have not established DNAs yet as it is technically impossible to host CDM projects without establishing a DNA. As a result, the study confirms that GHG emissions, electricity capacity growth rates, CDM capacity building, and educational levels have positive and significant effects on both the number of CDM project hosting and the amount of CERs. Meanwhile, the institutional index and FDI inflows are statistically and insignificantly different from their expectations. Lastly, Winkelman and Moore (2011) pointed out that their findings proved the inevitability of poor opportunities of developing CDM projects in LDCs.

In the most recent empirical research paper on the CDM imbalance issue, Kasai (2012a) also attempted to identify the determinants of CDM project hosting using the Tobit model. Following the study conducted by Flues (2010), the study adopted dependent variables of registered unilateral and bilateral, including multilateral, CDM projects. Independent variables used were categorised into four categories: GHG reduction potentials,

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8 The GEF is the world's largest international fund which grants funds and technical support to help developing countries tackle global environmental issues. It also performs as a financing mechanism for the FCCC.

human capital, business environment, and links to advanced nations. The study particularly focused on two factors, namely the qualities of business environment and scientific levels in host countries. Consequently, the study found that three factors relevant to the business environment and the scientific levels in eligible host countries using proxies of the sub-indices of the Ease of Doing Business Index and the number of scientific and technical journal articles. As a result, Kasai (2012a) stated that LDCs would be better off considering using programmatic CDM with emphasis on the need of capacity building programs by international organisations.

Table 4-1 Previous Empirical Studies on Determinants of CDM Projects

Author(s) and year	Model	Dependent variable	Significant factors
Dinar *et al*. (2008)	Poisson, Logit, Probit, and Tobit models	The number of CDM projects, the amount of CO_2 abatement, and the volume of investments.	GDP, energy use, governance, Ease of Doing Business, renewable energy, level of vulnerability, and trade.
Wang and Firestone (2010)	Gravity model	The expected amounts of CERs during the 1st period.	GHG emissions of host and investor countries, project size, openness to world trade, and infrastructure.
Flues (2010)	Poisson QML and negative binomial hurdle models	The number of registered CDM projects (as of the end of 2008).	GDP per capita, GDP growth rate, trade per GDP, renewable energy potential, and political freedom.
Winkelman and Moore (2011)	Probit model, Truncated regression model	The number of CDM projects, the amount of expected CERs.	GHG emissions, electricity capacity growth, CDM capacity building, and education index.
Kasai (2012a)	Tobit model	The numbers of bilateral and unilateral CDM projects.	GHG emissions, energy imports, science levels, tertiary school enrolment rates, ease of registering property, ease of getting credit, and ease of paying tax.

4.2.3 Conceptual Framework

This section describes a conceptual framework which is structured based on the findings of existing papers and further hypothetical theories in accordance with the study carried out by Kasai (2012b). This framework guides the selection of dependent and independent variables used in the analytical models of this study.

To begin with, this study utilizes a dependent variable of the number of registered CDM project activities. When considering the amount of cash flows stemming from CER sales to host countries, the amount of (expected) CERs generated by CDM project activities should be used as a dependent variable. This study, however, chose the number of CDM projects because its objective is to make realistic suggestions that enable LDCs to embark upon CDM project activities even with small-scale projects. Furthermore, it is not really feasible to adopt CERs in this case since the amount of CERs is heavily distorted by the stage of industrial development of a host country, meaning that there are few chances for LDCs owing to lower industrial levels (Kasai, 2012b). In fact, as can be seen from Table 4-2, only advanced developing countries have possessed CDM projects, thereby generating a larger amount of CERs by reducing GHGs with higher global warming potentials (GWPs) (see Appendix I), such as HFCs, PFCs, and SF_6. The CERs generated from such productive projects have been widening the gap between advanced host countries and other potential host countries including LDCs (e.g., Kasai, 2013), and this was a controversial issue at early stage of the CDM (Hourcade and Toman, 1999).

With regard to independent variables, as Figure 4-1 shows, variables used in this study are categorized into four groups, each of which contains one to three variables selected based mainly on the aforementioned findings of existing theoretical and empirical studies. For the sake of carrying out more valuable analysis, those variables are chosen by thoroughly taking into account the importance and data availabilities of those variables to build better panel data sets in long format. The independent variables' expected effects are shown in Table 4-3.

Table 4-2 Nnumber of CDM Projects Reducing HFCs, PFCs, and SF_6

The table clearly shows that CDM projects reducing high GWP gases are located only in industrially well developed countries.

Host country	The number of CDM projects			
	HFCs	PFCs	SF_6	Total
China	11	0	1	12
India	7	1	0	8
South Korea	1	0	6	7
Brazil	0	1	1	2
Argentina	1	1	0	2
Israel	0	0	2	2
Indonesia	0	1	0	1
Mexico	1	0	0	1

Source: IGES (2012)

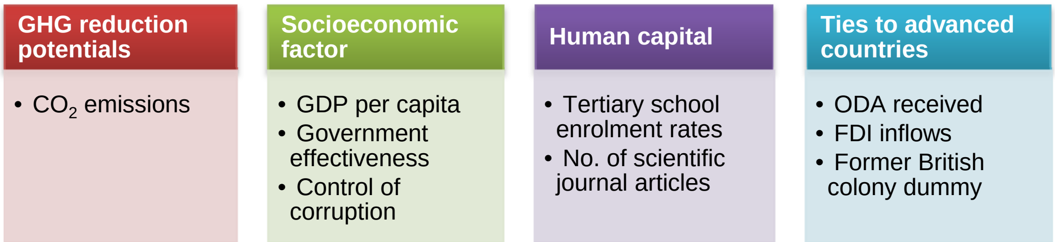

Figure 4-1 Four Categories of Independent Variables

Table 4-3 Expected Regression Results

Factors	Control possibility [a]	Expected result	Expected effect [b]
CO_2 emissions	Low	Significant	Positive (+++)
GDP per capita	Medium	Significant	Positive (+++)
Government effectiveness	High	Significant	Positive (++)
Control of corruption	Medium	Significant	Positive (+)
Tertiary school enrolment rate	High	Significant	Positive (++)
No.of scientific journal articles	High	Significant	Positive (+++)
ODA received	Medium	Significant	Positive (++)
FDI inflows	Medium	Significant	Positive (+++)
Former British colony dummy	n/a	Significant	Positive (+)

[a] Control possibility shows the ease of control of a factor by host countries.

[b] The number of "+" reflects the degree of expected influences on CDM project hosting.

The reasons of the selection of independent variables and hypotheses derived from controversial and/or inadequate points in the earlier researches are illustrated in the following paragraphs.

1) GHG reduction potentials

As frequently argued in many theoretical literatures (e.g., Haites, 2004; Jung, 2006), GHG reduction potentials is likely to be one of the crucial factors for CDM project hosting and has actually been proven by three empirical studies carried out by Kasai (2012a), Wang and Firestone (2010), and Winkelman and Moore (2011). The importance of GHG reduction potentials can be regarded as reasonable because any CDM activities cannot be developed in host countries without certain levels of GHG emissions in the past. Hence, this study adopts an independent variable of CO_2 emissions, which is a GHG making the most significant contribution to global warming, as a proxy for GHG reduction potentials in accordance with the findings of previous studies.

2) Socioeconomic factors

A mainstream perspective in the theoretical literature has argued that socioeconomic factors are important for hosting CDM projects. It has been maintained that economic, political, governance, and infrastructure conditions all have the influence to attract CDM investors. This study adopts three independent variables regarding socioeconomic factors: GDP per capita, governance effectiveness, and the control of corruption.

Independent variables explaining economic conditions in host countries are confirmed as significant determinants of CDM project hosting in two empirical studies conducted by Dinar *et al*. (2008) and Flues (2010) which utilized the variables of GDP and GDP per capita, respectively. These findings are consistent with the theoretical literature and are reasonable considering the fact that GHG emission levels and GDP levels are highly correlated (e.g., a correlation coefficient between GHG emissions and GDP in 2009 = .961). This study judges that GDP per capita is a better variable than GDP because GDP per capita can decrease the population gap among eligible host countries and capture their real economic conditions more appropriately (Kasai, 2012b). GDP per capita, thus, is selected as a proxy of an economic status in this study.

As one of factors explaining socioeconomic conditions, a growing theoretical literature has explained that governance levels in host countries matters in order to attract CDM investors (e.g., Jahn *et al*., 2004; Michaelowa, 2007). This argument is supported by one empirical study (Dinar *et al*., 2008) which analyzed the factors affecting the cooperation levels between developing and developed countries in terms of the CDM. Alternatively, the other empirical study carried out by Winkelman and Moore (2010) reports the insignificance of the institutional index from the World Governance Indicators (WGI)[9]. The significance of governance levels, thereafter, needs to be further assessed to figure out its real influence on CDM activities. This study, therefore, employs an independent variable of governance effectiveness sourced from WGI. In line with Kasai (2012b), the first hypothesis is formulated here as shown below:

H1: The better governance capacity eligible host countries have, the more CDM projects the countries will be able to host.

Another factor that may or may not hold influence in the promotion of CDM activities is corruption. As it is often assumed in the literature regarding developing economics (e.g., Gupta *et al*., 2002; Mauro, 1995), corruption is likely to be a major factor responsible for income inequality and poverty in developing nations, lowering the probability of the implementation of CDM projects. The mechanism that causes inequality of CDM project distribution seems to be similar to that of income inequality (Kasai, 2012b). Therefore, this study attempts to test the impacts of corruption on CDM project hosting using one of indicators of WGI, namely the control of corruption.

3) Human capital

Theoretically speaking, human capital must be one of the significant factors promoting CDM project activities (Michaelowa, 2007) and the diversity of views can be found in the empirical literature. For example, Winkelman and Moore (2011) show that the educational index, which

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[9] WGI reports aggregate and individual governance indicators for 213 countries over the period between 1996 and 2010.

is one of the components of the Human Development Index (HDI) created by UNDP, is positively and statistically significant. On the other hand, Wang and Firestone (2010) were not able to observe the significance of the general educational level using an independent variable of tertiary education percentages obtained from the Global Competitive Report. These contradicting findings are to be assessed in this study. As is often argued in the literature, when considering hosting CDM project activities, it must be important for host countries to secure qualified personnel in general because developing and managing CDM projects are complex tasks which require persons in charge of CDM activities to correctly grasp complicated regulations, procedures, methodologies, and tools (Kasai, 2012b).

Taking into account the realistic implementation of CDM project activities, host countries require personnel particularly familiar with scientific knowledge as CDM projects reduce GHGs normally using scientific and technical methodologies (Kasai, 2012b). Such abilities may not be necessarily important if project participants (PPs) from Annex I countries were fully in charge of writing project design documents (PDDs), validations and verifications carried out by designated operational entities (DOEs)[10], and actual implementation of CDM projects. Having said that, PPs in host countries must manage CDM projects including monitoring the amounts of GHGs reduced by CDM projects. Thus, science and technology levels of host countries still seem to matter (Kasai, 2012b). Based on the above discussions, the second hypothesis (*H2*) has been formulated in accordance with Kasai (2012b):

H2: The better scientific and technical levels eligible host countries have, the more CDM projects the countries will be able to host.

In summary, this study uses two variables related to human capital: tertiary school enrolment rate; and the number of scientific and technical journal articles. This follows the

[10] DOEs are independent auditors accredited by the CDM Executive Board to validate proposed CDM projects and verify whether or not implemented CDM projects have achieved expected GHG reductions.

study conducted by Kasai (2012a) which revealed the significance of those two factors.

4) Ties with advanced countries

In addition to host countries' endogenous factors, exogenous factors are also important. Given that the CDM is a mechanism to be implemented by PPs in both host and investor countries, holding strong links to advanced countries should increase the probability of receiving investment in CDM projects (Flues, 2010).

An example of empirical literature (Dinar *et al*., 2008) demonstrates the importance of tighter links to advanced nations using an independent variable of total trade (the sum of the volume of bilateral imports and exports) between the host and investor countries. On the contrary, whilst Flues (2010) attempted to confirm the significance of links to advanced nations using a dummy variable of colonial status, which indicates 1 if countries were the former British, Spanish, Dutch, German, and French colonial counties and 0 otherwise, the result fails to demonstrate it. Also, another empirical literature (Wang and Firestone, 2010) shows insignificant results on common colony dummies. Considering this result, this study adopts a revised colonial dummy, stating 1 as countries that were in the British colony in the past and 0 otherwise. This revision is based on the fact that the U.K. is the largest CDM investor in the world. As can be seen from Figure 4-2, Spain, the Netherlands, Germany, and France have had limited influence in CDM markets. This study therefore hypothesizes that:

H3: Former British colonies will be able to host a larger number of CDM projects thanks to a strong connection to the U.K. (a leading CDM investor).

In addition to the revised colonial dummy, this study utilizes two more independent variables as proxies of links to advanced countries, namely foreign direct investment (FDI) inflows and ODA received. This is because both factors can be thought to be good indicators for the relationship between the host and the developed countries as explained in the following paragraphs.

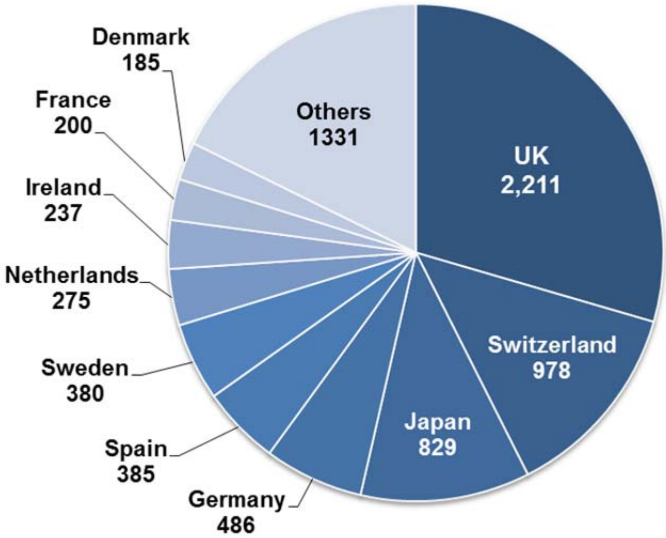

Figure 4-2 Number of CDM Projects by Investor Countries

CDM investors in the U.K. have participated in 2,211 projects out of the total 5,916 projects in the pipeline (as of 1 July 2012). It is obvious that CDM investors in the U.K. have an outstanding presence in the CDM market.

Source: UNEP Risø Centre (2012)

With regard to FDI inflows, there is a contradiction amongst the existing literature. On the one hand, a theoretical literature (Jung, 2006) states that host countries having abundant FDI inflows tend to host a larger number of CDM activities and Dinar *et al*. (2008) insist that the CDM can be regarded as a type of FDI. On the other hand, when looking at the result of an empirical study (Winkleman and Moore, 2011), the insignificance of FDI inflows is shown, though it was adopted as a proxy of a business environment. Furthermore, Niederberger and Saner (2005) keenly refute the effects of FDI inflows on CDM investment based on the fact that some countries, after having failed to induce FDI, have actually succeeded in hosting CDM projects. This study attempts to verify whether or not FDI inflows has significant impacts in promoting CDM activities since, as discussed above, the results regarding FDI are not identical in the previous literature. The fourth hypothesis, therefore, is formulated in accordance with Kasai (2012b) as follows:

H4: The larger the FDI inflows eligible host countries receive, the more CDM projects the countries will be able to host.

Another factor to consider is ODA as no study so far has analyzed its significance except for Kasai (2012a) whose results indicate the statistically insignificance of ODA received. This result seems inconclusive as the variable of ODA is employed only in one specification out of six. This study expects that the amount of receiving ODA reflects the political and/or economic closeness between developing and developed countries. This study attempts to testify the significance of ODA. Hence, in line with Kasai (2012b), this study proposes the fifth hypothesis as shown below:

H5: The larger amount of ODA eligible host countries receive, the more CDM projects the countries will be able to host.

4.3 Methodology and Data

4.3.1 Methodology

This study attempts to identify decisive factors of CDM project hosting by using, not only a cross-section analysis, but also a panel data analysis which never before been undertaken. There are two major obstacles to creating a panel data set: firstly, its complexity of data analysis; and secondly, the limited data availabilities as a panel data requires a lot of data collected from both time series and cross-section dimensions. However, it is worth performing a panel data analysis since, according to Kitamura (2006), the panel data analysis can bring several advantages, such as the improved precisions of regression results and the negative influence of outliers or errors that can subsequently be weakened due to the increased number of observations. Hence, although some restrictions occur when selecting variables, this study carries out panel data analyses in addition to a multiyear cross-section data analysis as a reference.

More specifically, this study adopts the Tobit model as a primary estimator, developed by Tobin (1958). Data of independent variables are available for all eligible host countries, including countries not currently hosting CDM projects. The data set, thereafter, can be regarded as censored data in which any negative values of dependent variables are set to a lower bound of zero. Therefore, the Type I Tobit model (censored regression model) described below, defined by Amemiya (1984), is utilized for cross-section analyses:

$$y_i^* = x_i \beta + u_i, \; u_i \sim iid\text{Normal}(0, \sigma^2)$$

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

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

With respect to panel data analyses, panel Tobit model with random effect estimators are employed. The panel Tobit model is described as follows:

$$y_{it}^* = x_{it}'\beta + u_{it}, \; u_{it} = \mu_i + v_{it}, \; v_{it} \sim iid\text{Normal}(0, \sigma_v^2)$$

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

where y_{it}^* represents a latent variable of individual *i* at time *t*. x_{it}' is a vector of independent variable of individual *i* at time *t*. u_{it} is an error term of individual *i* at time *t*, which captures the unobserved factors influencing dependent variables. μ_i represents the unobserved time invariant individual effects which measures unobserved individual heterogeneity. Lastly, v_{it} is an unobserved time variant errors which is assumed to be normal distribution as described in the equation above. However, if v_{it} is influenced by unobserved independent heterogeneity, the assumption which v_{it} is *iid* normal distribution cannot be maintained, meaning that the unobserved characteristics of individual countries have significant impacts on the number of CDM projects they are hosting. For instance, the level of motivation towards CDM activities might be unobserved characteristics significantly affecting the number of CDM projects. In theory, it is reasonable to simulate that such factors and unobserved heterogeneity exist and this problem can be resolved by making use of the proxy of an unobserved factor. However, the variable of such a factor is not available in reality. This is the reason why the panel Tobit model contains additional equation, $u_{it} = \mu_i + v_{it}$. In other words, μ_i is the proxy of an unobserved characteristic of host countries and the unobserved effects μ_i is assumed to be either fixed or random effects. Fixed effects imply that μ_i is correlated with the observed variables. On the contrary, a random effect means that μ_i is not correlated with any of the observed variables in the model. When considering applying this model to this study, since the Tobit model is a non-linear model, it is technically impossible to utilize the fixed effect estimator (Wooldridge, 2002). Thus, this study adopts random effects estimator.

In order to observe the variation of the regression results and to capture the effect of each factor separately, this study forms six specifications. The main model (Specification 6) contains nine independent variables, which can be categorized into four groups (i.e., GHG reduction potential, G, socioeconomic factors, S, human capital, H, and ties to advanced countries, T) following the conceptual framework created on the basis of thorough literature reviews on both theoretical and empirical studies as shown below:

$$lncdm_{it} = f(G_{it}, S_{it}, H_{it}, T_{it})$$

where

$lncdm_{it}$: the log of the number of registered CDM projects of country *i* at time *t*;

G_{it}: $lnco2_{it-2}$, the log of CO_2 emissions of country *i* at time *t* with a two-year lag;

S_{it}: $lngdppc_{it-2}$, the log of GDP per capita of country *i* at time *t* with a two-year lag;

:$govef_{it-2}$, governance effectiveness of country *i* at time *t* with a two-year lag;

:$corrup_{it-2}$, control of corruption of country *i* at time *t* with a two-year lag;

H_{it}: $lntertiary_{it-2}$, the log of tertiary school enrolment rate of country *i* at time *t* with a two-year lag;

:$lnarticle_{it-2}$, the log of the numbers of scientific and technical journal articles of country *i* at time *t* with a two-year lag;

T_{it}: $lnfdi_{it-2}$, the log of FDI inflows of country *i* at time *t* with a two-year lag;

: $lnoda_{it-2}$, the log of ODA received of country *i* at time *t* with a two-year lag;

: $colony_i$, the former British colony dummy of country *i*.

As shown above, all independent variables have a two-year lag as it generally took around two years for proposed CDM projects to be registered as CDM projects by the CDM EB (Figure 4-3). Thus, to capture the characteristics of host countries at the time when they launch CDM activities, two-year lags are applied to this study.

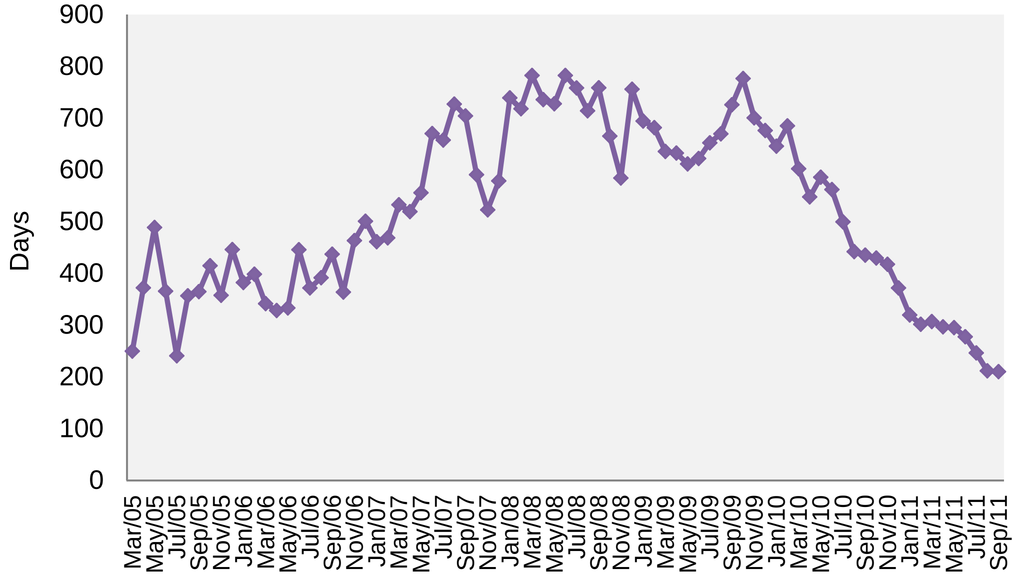

Figure 4-3 Periods Needed to Obtain CDM Status

This graph shows the actual number of days needed for proposed projects to be registered as CDM projects (i.e., the periods from the request for registration to registrations by the CDM executive board).

Source: UNEP Risø Centre (2012)

4.3.2 Empirical Strategy

This study utilizes cross-sectional Tobit models, pooled and random effects panel Tobit models applying robust standard errors owing to heterogeneity of error terms in accordance with Kasai (2012b).

4.3.3 Data Descriptions

This section explains definitions, units, data sources and their validities to be used in the econometric models of all data used in this study. Both dependent and independent variables are thoroughly selected based on the conceptual framework developed by reviewing the existing literature and are derived from various data sources. Some data are processed and transformed into the logarithmic form for the purpose of empirical analysis. Definitions, units and data sources of both dependent and independent variables are listed in Table 4-4.

Table 4-4 Descriptions of Dependent and Independent Variables

Variables	Descriptions	Sources
$lncdm_{i,t}$	The natural logarithm of the number of registered CDM projects of a host country *i* at year *t* (2005-2010).	CDM project database (2012), IGES
$lnco2_{i,t}$	The natural logarithm of CO_2 emissions stemming from the burning of fossil fuels and the manufacture of cement of a host country *i* at year *t* (Mt) (2003-2008).	World Development Indicators (2012), The World Bank (WB)
$lngdppc_{i,t}$	The natural logarithm of GDP per capita of a host country *i* at year *t.* (US$1,000). (2003-2008)	World Development Indicators (2012), World Bank
$govef_{i,t}$	Government effectiveness is an indicator reflecting the degree of the quality of public services, its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to those policies of a host country *i* at year *t*.	Worldwide Governance Indicators (2012), WB
$corrupt_{i,t}$	Control of corruption which reflects perceptions to the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as the "capture" of the state by elites and private interests.	Worldwide Governance Indicators (2012), WB
$lntertiary_{i.t}$	The natural logarithm of gross tertiary school enrolment rate of a host country *i* at year *t* (%) (2003-2008).	World Development Indicators (2012), WB
$lnarticle_{i,t}$	The natural logarithm of the number of scientific and technical journal articles of a host country *i* at year *t* (2003-2008).	World Development Indicators (2012), WB
$lnfdi_{i,t}$	The natural logarithm of net FDI inflows of a host country *i* at year *t* (US$ million) (2003-2008).	World Development Indicators (2012), WB
$lnoda_{i,t}$	The natural logarithm of net ODA of the country *i* at year *t* (US$ million) (2003-2008).	World Development Indicators (2012), WB
$colony_i$	Dummy variable (Former British colonies = 1, 0 otherwise)	Hensel (2006)

Dependent variables used in this study are the log of the numbers of CDM projects registered between 2005 and 2010 which are sourced from the CDM project database created by the Institute for Global Environmental Strategies (IGES, 2012). The data of registered CDM projects is listed in Appendix II. The selection of a dependent variable is in accordance with that of Flues (2010) and Kasai (2012a). The econometric models cover 128 eligible host countries which have ratified the Kyoto Protocol and established the Designated National Authority (DNA)[11].

Independent variables are obtained from various data sources as shown in Table 4-4. Two-year lags are set for all independent variables except for the colony dummy and the two-year lagged independent variables consist of data between 2003 and 2008. There are some missing values in the independent variables because of the data unavailability. In the case that a missing value can be reasonably estimated by taking the average between adjacent years' data, the average value is inputted in the data set as an instant solution. Essentially, it can be predicted that those deficits are unlikely to have crucial impacts on the regression results since the numbers of missing values are limited.

Descriptive statistics of both dependent and independent variables and correlation coefficients among independent variables with cross-section data sets are shown in Tables 4-5 to 4-10 (2005 to 2010). Those of the panel data set are shown in Table 4-11 (2005-2010). Furthermore, scatter diagrams indicating the relationships between dependent variables and independent variables of the panel data set are shown in Figure 4-4. The following paragraphs provide the overviews of the data of independent variables by category.

1) GHG reduction potentials

Although it is desirable to use GHG emission data consisting of six GHGs, this study adopts the log of CO_2 emissions as a proxy of GHG reduction potentials due to the necessity of

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[11] DNA is a body granted responsibility by a developing country 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 PPs.

creating a panel data set. Unfortunately, it is unlikely that historical emission data of CH_4, N_2O, HFCs and PFCs have been regularly collected even by major international organizations and institutes. Using CO_2 emission does not seem to have a crucial negative impact as CO_2 emission accounts for around 80% of total GHG effects. The CO_2 emission data between 2003 and 2008 are sourced from World Development Indicators (WDI) created by the World Bank which shows there is a clear upward trend across the all eligible host countries. The average increase rate is approximately 27% during the six-year period. Furthermore, there is an obvious trend that major CDM host countries have larger amounts of CO_2 emissions during the period.

2) Socioeconomic factors

This study adopts three independent variables in this category. Firstly, the log of GDP per capita as a proxy of economic level of host countries and, needless to say, richer countries can develop CDM project activities much easier than poorer countries can. This clear conjecture, however, can be viewed differently if per capita base GDP is used because the larger economies in terms of GDP levels very often have larger populations (Figure 4-4). This trend can be observed in the data of GDP per capita (2003-2008) and are sourced from the WDI.

Aside from that, the eligible host countries' entire increase rate of GDP per capita during the six-year period is approximately 45%. Secondly, government effectiveness and control of corruption as proxies of important social factors in eligible host countries and the data about "government effectiveness" and "control of corruption" cover the period from 2003 to 2008 and originate from Worldwide Governance Indicators. In general, good governance is likely to help in promoting CDM activities. However, there is a wide gap in the average percentile ranks between LDCs and other eligible host countries; for instance, the average percentile rank within LDCs in 2010 is about 24 and within non-LDCs it is around 48. Likewise, "control of corruption" measured in a percentile rank has an obvious gap. While the average percentile rank among LDCs is approximately 29, non-LDC countries' average percentile rank is around 49.

3) Human capital

In this category, there are two independent variables: "the log of tertiary school enrolment rate" and "the log of the number of scientific and technical journal articles". The data of both variables from 2003 to 2008 are derived from the WDI. As can be seen from Figure 4-4, the data of "tertiary school enrolment rate" do not show clear trends. In contrast, the data of "scientific and technical journal articles" indicate a strong proportionality relation implying its positive effects on hosting CDM projects.

4) Ties with advanced countries

Three independent variables are employed in this category. Firstly, the log of FDI inflows as a proxy of the economic cooperation levels in private sectors between developed and developing countries: Based on the trends shown in the scatter diagrams in Figure 4-4, it is evident that FDI inflows are highly correlated with the number of CDM projects (e.g., ρ=.953 in 2008). Secondly, the log of ODA received as a proxy of cooperation levels in the governmental sector: In contrast to FDI inflows, there is no strong relationship between the CDM activities and ODA. Thirdly, former British dummy variables where, according to Hensel (2006), 43 out of 128 eligible host countries are the former British colonies.

Table 4-5 Descriptive Statistics and Correlation Coefficients (2005)

Panel A: Descriptive statistics

Variable	Obs	Mean	S.D.	Min	Max
Log of the number of CDM projects	128	0.123	0.414	0	2.833
Log of CO_2 emissions (lnco2)	126	2.024	2.166	-2.302	8.417
Log of GDP per capita (lngdppc)	126	0.286	1.344	-2.407	3.471
Government effectiveness (govef)	128	41.04	23.85	0	96.59
Control of corruption (corrupt)	128	40.64	24.87	0	98.05
Log of tertiary school enrolment rate (lntertiary)	105	2.293	1.275	-1.56	4.486
Log of the number of scientific journal articles (lnarticle)	122	3.722	2.343	-0.693	10.26
Log of FDI inflows (lnfdi)	118	5.373	2.046	-0.673	10.75
Log of ODA received (lnoda)	103	5.03	1.263	1.818	6.905
Former British colony dummy (colony)	128	0.334	0.474	0	1

Note: This study regarded log 0 as zero (0) for the sake of simplicity.

Panel B: Correlation coefficients among independent variables

	lnco2	lngdppc	govef	corrup	lntertiary	lnarticle	lnfdi	lnoda	colony
lnco2	1.000								
lngdppc	0.446	1.000							
govef	0.294	0.687	1.000						
corrup	0.087	0.536	0.844	1.000					
lntertiary	0.599	0.618	0.370	0.195	1.000				
lnarticle	0.816	0.291	0.362	0.193	0.451	1.000			
lnfdi	0.752	0.528	0.361	0.162	0.517	0.641	1.000		
lnoda	0.193	-0.504	-0.347	-0.322	-0.140	0.206	0.107	1.000	
colony	0.013	-0.028	0.194	0.080	-0.206	0.111	-0.009	-0.171	1.000

Table 4-6 Descriptive Statistics and Correlation Coefficients (2006)

Panel A: Descriptive statistics

Variable	Obs	Mean	S.D.	Min	Max
Log of the number of CDM projects	128	0.327	0.886	0	4.82
Log of CO_2 emissions (lnco2)	126	2.074	2.178	-2.302	8.573
Log of GDP per capita (lngdppc)	126	0.416	1.351	-2.407	3.682
Government effectiveness (govef)	128	40.38	24.16	0.490	96.10
Control of corruption (corrupt)	128	39.74	24.44	0.490	98.54
Log of tertiary school enrolment rate (lntertiary)	105	2.344	1.26	-1.609	4.505
Log of the number of scientific journal articles (lnarticle)	123	3.725	2.377	-1.204	10.45
Log of FDI inflows (lnfdi)	123	5.493	2.21	-3.218	10.91
Log of ODA received (lnoda)	99	4.979	1.22	0.488	6.899
Former British colony dummy (colony)	128	0.335	0.474	0	1

Note: This study regarded log 0 as zero (0) for the sake of simplicity.

Panel B: Correlation coefficients among independent variables

	lnco2	lngdppc	govef	corrup	lntertiary	lnarticle	lnfdi	lnoda	colony
lnco2	1.000								
lngdppc	0.421	1.000							
govef	0.343	0.733	1.000						
corrup	0.121	0.680	0.855	1.000					
lntertiary	0.602	0.590	0.405	0.278	1.000				
lnarticle	0.852	0.312	0.390	0.193	0.502	1.000			
lnfdi	0.754	0.537	0.449	0.228	0.510	0.644	1.000		
lnoda	0.232	-0.452	-0.238	-0.333	-0.060	0.247	0.083	1.000	
colony	-0.083	0.058	0.140	0.126	-0.233	-0.044	-0.031	-0.199	1.000

Table 4-7 Descriptive Statistics and Correlation Coefficients (2007)

Panel A: Descriptive statistics

Variable	Obs	Mean	S.D.	Min	Max
Log of the number of CDM projects	128	0.311	0.882	0	5.081
Log of CO_2 emissions (lnco2)	127	2.105	2.172	-2.207	8.664
Log of GDP per capita (lngdppc)	126	0.534	1.365	-2.207	3.884
Government effectiveness (govef)	128	39.38	23.68	0.490	98.54
Control of corruption (corrupt)	128	39.83	24.24	0.490	98.05
Log of tertiary school enrolment rate (lntertiary)	102	2.452	1.152	-0.755	4.520
Log of the number of scientific journal articles (lnarticle)	126	3.661	2.48	-2.302	10.64
Log of FDI inflows (lnfdi)	120	5.923	2.083	-0.579	11.67
Log of ODA received (lnoda)	98	5.054	1.159	2.052	6.901
Former British colony dummy (colony)	128	0.335	0.474	0	1

Note: This study regarded log 0 as zero (0) for the sake of simplicity.

Panel B: Correlation coefficients among independent variables

	lnco2	lngdppc	govef	corrup	lntertiary	lnarticle	lnfdi	lnoda	colony
lnco2	1.000								
lngdppc	0.484	1.000							
govef	0.216	0.702	1.000						
corrup	0.076	0.625	0.865	1.000					
lntertiary	0.604	0.708	0.416	0.300	1.000				
lnarticle	0.857	0.309	0.232	0.106	0.436	1.000			
lnfdi	0.736	0.496	0.374	0.252	0.494	0.674	1.000		
lnoda	0.172	-0.512	-0.327	-0.321	-0.193	0.259	0.093	1.000	
colony	-0.169	0.147	0.327	0.243	-0.104	-0.110	-0.085	-0.294	1.000

Table 4-8 Descriptive Statistics and Correlation Coefficients (2008)

Panel A: Descriptive statistics

Variable	Obs	Mean	S.D.	Min	Max
Log of the number of CDM projects	128	0.296	0.851	0.000	5.403
Log of CO_2 emissions (lnco2)	127	2.136	2.175	-2.120	8.766
Log of GDP per capita (lngdppc)	126	0.662	1.369	-2.120	4.102
Government effectiveness (govef)	128	39.82	23.86	0.98	99.02
Control of corruption (corrupt)	128	39.87	24.57	0.49	98.05
Log of tertiary school enrolment rate (lntertiary)	102	2.478	1.147	-0.713	4.540
Log of the number of scientific journal articles (lnarticle)	127	3.810	2.402	-1.204	10.81
Log of FDI inflows (lnfdi)	120	6.177	2.134	-0.799	11.73
Log of ODA received (lnoda)	98	4.998	1.241	1.188	6.849
Former British colony dummy (colony)	128	0.336	0.474	0	1

Note: This study regarded log 0 as zero (0) for the sake of simplicity.

Panel B: Correlation coefficients among independent variables

	lnco2	lngdppc	govef	corrup	lntertiary	lnarticle	lnfdi	lnoda	colony
lnco2	1.000								
lngdppc	0.506	1.000							
govef	0.219	0.721	1.000						
corrup	0.014	0.576	0.820	1.000					
lntertiary	0.609	0.688	0.451	0.244	1.000				
lnarticle	0.830	0.306	0.260	0.096	0.453	1.000			
lnfdi	0.682	0.528	0.374	0.116	0.552	0.581	1.000		
lnoda	0.105	-0.575	-0.373	-0.426	-0.174	0.245	-0.014	1.000	
colony	-0.143	0.167	0.268	0.231	-0.166	-0.143	-0.028	-0.334	1.000

Table 4-9 Descriptive Statistics and Correlation Coefficients (2009)

Panel A: Descriptive statistics

Variable	Obs	Mean	S.D.	Min	Max
Log of the number of CDM projects	128	0.403	1.013	0.000	5.866
Log of CO_2 emissions (lnco2)	127	2.178	2.175	-2.120	8.823
Log of GDP per capita (lngdppc)	126	0.811	1.367	-2.040	4.263
Government effectiveness (govef)	128	40.24	24.03	0.49	99.51
Control of corruption (corrupt)	128	40.10	24.72	0.49	98.06
Log of tertiary school enrolment rate (lntertiary)	102	2.546	1.134	-0.713	4.689
Log of the number of scientific journal articles (lnarticle)	126	3.923	2.385	-1.204	10.95
Log of FDI inflows (lnfdi)	123	6.554	1.897	1.747	11.98
Log of ODA received (lnoda)	96	5.189	1.146	1.999	6.863
Former British colony dummy (colony)	128	0.336	0.474	0	1

Note: This study regarded log 0 as zero (0) for the sake of simplicity.

Panel B: Correlation coefficients among independent variables

	lnco2	lngdppc	govef	corrup	lntertiary	lnarticle	lnfdi	lnoda	colony
lnco2	1.000								
lngdppc	0.491	1.000							
govef	0.268	0.678	1.000						
corrup	0.066	0.601	0.814	1.000					
lntertiary	0.602	0.704	0.395	0.231	1.000				
lnarticle	0.837	0.358	0.337	0.142	0.483	1.000			
lnfdi	0.722	0.456	0.372	0.176	0.515	0.671	1.000		
lnoda	0.222	-0.491	-0.257	-0.357	-0.150	0.308	0.204	1.000	
colony	-0.229	0.197	0.329	0.282	-0.165	-0.221	-0.192	-0.466	1.000

Table 4-10 Descriptive Statistics and Correlation Coefficients (2010)

Panel A: Descriptive statistics

Variable	Obs	Mean	S.D.	Min	Max
Log of the number of CDM projects	128	0.346	0.960	0.000	6.223
Log of CO_2 emissions (lnco2)	127	2.201	2.192	-2.120	8.858
Log of GDP per capita (lngdppc)	126	0.962	1.371	-1.966	4.459
Government effectiveness (govef)	128	40.49	24.15	0.490	100
Control of corruption (corrupt)	128	40.39	24.94	0.490	98.54
Log of tertiary school enrolment rate (lntertiary)	102	2.600	1.130	-0.693	4.800
Log of the number of scientific journal articles (lnarticle)	127	3.830	2.542	-1.204	11.09
Log of FDI inflows (lnfdi)	122	6.622	2.024	0.000	12.07
Log of ODA received (lnoda)	94	5.232	1.199	1.963	6.880
Former British colony dummy (colony)	128	0.336	0.474	0	1

Note: This study regarded log 0 as zero (0) for the sake of simplicity.

Panel B: Correlation coefficients among independent variables

	lnco2	lngdppc	govef	corrup	lntertiary	lnarticle	lnfdi	lnoda	colony
lnco2	1.000								
lngdppc	0.540	1.000							
govef	0.270	0.670	1.000						
corrup	0.025	0.583	0.847	1.000					
lntertiary	0.581	0.693	0.473	0.300	1.000				
lnarticle	0.833	0.399	0.354	0.148	0.529	1.000			
lnfdi	0.659	0.439	0.356	0.171	0.442	0.612	1.000		
lnoda	0.079	-0.506	-0.321	-0.360	-0.215	0.173	0.111	1.000	
colony	-0.197	0.138	0.263	0.276	-0.146	-0.158	-0.116	-0.352	1.000

Table 4-11 Descriptive Statistics and Correlation Coefficients of the Panel Data (2005-2010)

Panel A: Descriptive statistics

Variable	Obs	Mean	S.D.	Min	Max
Log of the number of CDM projects	1024	0.226	0.755	0.000	6.223
Log of CO_2 emissions (lnco2)	760	2.120	2.170	-2.303	8.858
Log of GDP per capita (lngdppc)	756	0.612	1.376	-2.408	4.459
Government effectiveness (govef)	768	40.23	23.89	0	100
Control of corruption (corrupt)	768	40.10	24.55	0.000	98.54
Log of tertiary school enrolment rate (lntertiary)	618	2.451	1.186	-1.609	4.800
Log of the number of scientific journal articles (lnarticle)	751	3.779	2.417	-2.303	11.09
Log of FDI inflows (lnfdi)	726	6.027	2.116	-3.219	12.07
Log of ODA received (lnoda)	588	5.079	1.205	0.489	6.905
Former British colony dummy (colony)	1024	0.336	0.473	0.000	1.000

Note: This study regarded log 0 as zero (0) for the sake of simplicity.

Panel B: Correlation coefficients among independent variables

	lnco2	lngdppc	govef	corrup	lntertiary	lnarticle	lnfdi	lnoda	colony
lnco2	1.000								
lngdppc	0.465	1.000							
govef	0.269	0.671	1.000						
corrup	0.064	0.588	0.839	1.000					
lntertiary	0.593	0.667	0.409	0.258	1.000				
lnarticle	0.837	0.313	0.324	0.146	0.468	1.000			
lnfdi	0.166	-0.487	-0.310	-0.352	-0.150	0.235	1.000		
lnoda	0.697	0.523	0.366	0.187	0.518	0.612	0.094	1.000	
colony	-0.133	0.117	0.252	0.208	-0.168	-0.092	-0.303	-0.065	1.000

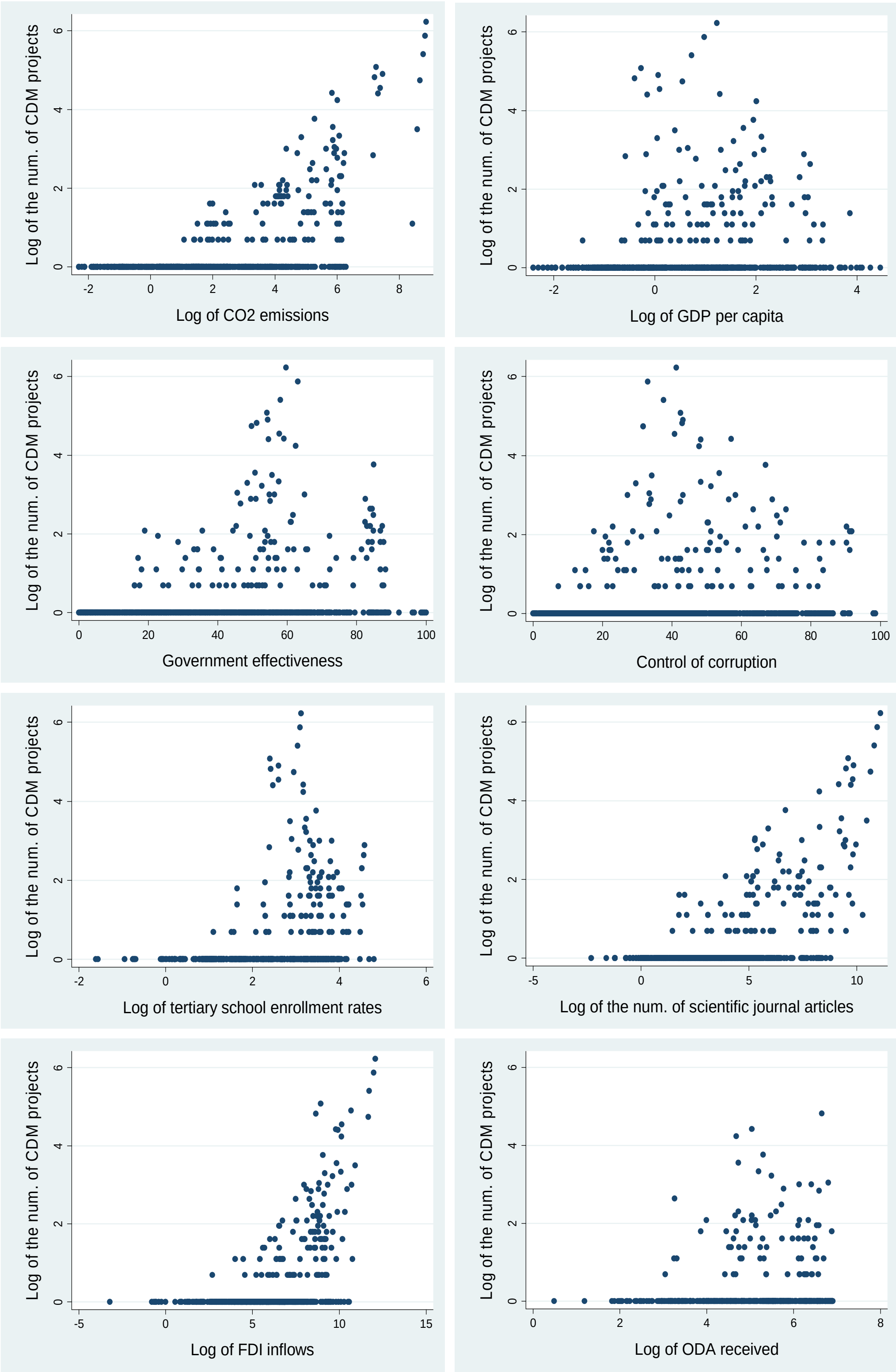

Figure 4-4 Scatter Diagrams: Dependent Variable vs. Independent Variables

4.4 Results and Discussions

In this section, estimation results are reported and discussed. Firstly, Section 4.4.1 presents the results of cross-section data analyses. Secondly, the main results derived from the random effects panel Tobit models are examined and five hypotheses formulated in the conceptual framework are verified in Section 4.4.2.

4.4.1 Cross-Country Data Analyses

This study analyzed cross-country data using Tobit models as a first step. The regression results for the years from 2005 to 2010 are shown in Tables 4-12 to 4-14.

Looking at log pseudo likelihood values, the main specification (Specification 6) fits the data sets of every year much better than other specifications, ranging from -44.8 in 2006 to -14.7 in 2010. Specification 6 has the highest pseudo R-squared value among six specifications throughout the period, representing the best fit for the Tobit models as well, ranging from .286 in 2006 to .741 in 2010.

The majority of the estimation results indicate the same signs and significance levels throughout the period. Specifically, "the log of CO_2 emissions" is positive and statistically significant at the 1% level in most specifications. The similar results can be found for "government effectiveness," "the log of FDI inflows," and "the log of ODA" for several reasons. Firstly, "government effectiveness" has statistically significant positive effects on hosting CDM projects except for the results for 2006. The models indicating insignificance for this variable also show the same positive signs. Secondly, "the log of FDI inflows" is significant, below the 1% level in most specifications, with positive signs. Lastly, "the log of ODA" is significant and positive in four specifications in 2006, 2008, and 2010. In contrast, the "former British colony dummies" clearly denote significant negative impacts on CDM project hosting. Of 36 models, 11 are statistically significant and negative, contrary to the expectation of this study. As for "control of corruption", it indicates significant positive effects at the maximum limit, the 10% significance level, in Specification 3 in 2007. This is the only model showing significance and all other models result in insignificance.

As can be seen from Tables 4-12 to 4-14, the remaining independent variables, namely "the log of GDP per capita," "the log of tertiary school enrolment rates," and "the log of scientific and technical journal articles," have both statistically significant positive and negative effects on hosting CDM activities. Their effects, therefore, are less clear and, as a result, their real effects cannot explicitly be judged by looking merely at the estimation results of single year cross-section data analyses. One possible reason for this is the smaller size of observations (e.g., the numbers of observations in Specification 6 range from 69 to 72) which make regression results less reliable. In addition, the multicollinearity is causally-related to the unstable estimation results. These problems are discussed in the next section which explains the results of panel Tobit models, the main analysis in this study.

Sensible time series variances cannot be observed from the estimation results with the exception of a trend that coefficients of "the log of CO_2 emissions" have been soaring year after year from .663 in 2006 to 1.964 in 2010. This is likely to imply that more and more CDM investors tend to focus on GHG reduction potentials rather than other factors in the light of projects' profitability.

4.4.2 Panel Data Analyses

This section discusses the regression results of the pooled and panel Tobit models with random effects. The estimation results are shown in Table 4-15. As stated in the methodology section, the panel data analysis enables the identification of more reliable decisive factors owing to its larger size of observations. In fact, the number of observations for the main panel Tobit model (Specification 6) is 433, which is six times larger than that of the cross-country data. Hence, it can be expected to obtain more accurate estimation results.

First of all, when looking at the results of the Wald tests, those in all specifications are significant, Prob > chi2 is 0.000, rejecting the null hypothesis; this means the models have explanation power at the 1% significance level. Hence, the results support the potencies of coefficients computed by the random effects Tobit estimators. Analogous to the cross-sectional Tobit models, the panel Tobit model with Specification 6 is the most appropriate model because the value of the log pseudo likelihood of Specification 6, -181.1, is the largest among the six specifications. The estimation results are examined by category in the following paragraphs.

1) GHG reduction potentials

Regarding GHG reduction potentials, this study achieves similar findings to the existing empirical literatures (Wang and Firestone, 2010; Winkelman and Moore, 2011; Kasai, 2012a).

As can be seen from Table 4-15, "the log of CO_2 emissions" is statistically significant and positive at the 1% significance level for all specifications as expected and the pooled Tobit models have the same results as well. As there are few huge GHG emission sources in those countries, the result indicates the fundamental difficulty of hosting CDM project activities for LDCs. Unsurprisingly, CDM investors would prefer to invest in eligible host countries with larger GHG reduction potentials following the principle of the market mechanism. Additionally, it is important for host countries to have modest GHG abatement costs to attract CDM investors (Flues, 2010). By further extension, the results seem to imply that levels of economic development influence the number of CDM projects as economically well developed countries should have succeeded at industrialization, which is the most common cause of being major GHG emitters. More importantly, the results reveal that industrially well developed countries receive a larger amount of CDM benefits (CER sales) because those countries have greater potential to implement CDM projects that generate a lot of CERs by reducing GHG and having higher GWPs such as HFCs, N_2O, and SF_6 (Kasai, 2012b).

To sum up, this study regards GHG reduction potentials as one of the important determinants of CDM project hosting. This finding is fully consistent with the study's expectations and those previously. GHG reduction potentials are solely determined by past GHG emission performances and cannot be controlled afterwards. As Kasai (2012b) states, it is hugely unfair that countries that have emitted a vast amount of GHGs in the past can easily benefit from the CDM despite the fact that they should assume stronger responsibilities for preventing global warming.

2) Socioeconomic factors

Three independent variables, namely “the log of GDP per capita,” “government effectiveness,” and “control of corruption,” are the socioeconomic factors that are expected to have positive effects on CDM project hosting. However, their individual results are not identical and some are inconsistent with findings of previous studies.

As for “the log of GDP per capita” used as a proxy of economic condition of host countries, this study finds significant negative effects on CDM project hosting at the 5% significance level in Specification 6 of panel Tobit models. Specifications 1, 4, and 5 are insignificant holding different signs. When looking at the results of the pooled Tobit model with Specification 5, it turns out statistically significant and positive at the 5% significance level, whereas it has significant negative effects in Specification 6 as well as that of the panel Tobit model. This study basically considers the result of the main panel Tobit model with Specification 6 as the most appropriate. However, from a theoretical point of view, this result cannot easily be acceptable since better economic conditions must be an advantage for the development of CDM activities. In fact, some empirical studies confirm its positive effects (Dinar *et al*., 2008; Flues, 2010). This may be attributable to the impacts of major CDM host countries which have relatively lower GDP per capita that have been derived from their huge population sizes. This study, therefore, concludes that GDP per capita levels cannot directly be thought of as a determinant of CDM project hosting but must have positive impacts indirectly.

Next, governance levels measured by an indicator of “government effectiveness” are significant and positive in all specifications at the 1% significance level. This result is in accordance with findings of a study carried out by Dinar *et al*. (2008). In contrast, this study cannot observe the significance of the “the control of corruption” which is a proxy of the degree of corruption in eligible host countries. Certainly, multicolleniarity must have occurred in the panel Tobit model with Specification 6 owing to a strong correlation between "government effectiveness" and "the control of corruption," .839. Yet, since the variable also is insignificant in Specification 3, this study judges that "the control of corruption" is not statistically significant, whilst this finding is inconsistent with the finding of literatures associated with development economics (Gupta *et al*., 2002; Mauro, 1995).

Based on the estimation results, acquiring effective governance levels is likely to help promote CDM project activities. This study, however, implies that clean governance is not an absolute necessity in so far as the governments are effective enough (Kasai, 2012b). Consequently, the first hypothesis below is proven here.

H1: The better governance capacity eligible host countries have, the more CDM projects the countries will be able to host.

⇨ Fail to reject

3) Human capital

In line with the study carried out by Kasai (2012a), this study employed two independent variables concerning human capital: "the log of tertiary school enrolment rates" adopted as a proxy of general educational levels, and "the log of the number of scientific and technical journal articles" as a proxy of science and technology levels of host countries.

As Table 4-15 indicates, contrary to this study's expectation, "the log of tertiary school enrolment rates" is found to be insignificant in all specifications under both pooled and panel Tobit models, though signs are positive in most specifications. This result differs from the findings of the existing literatures (Winkelman and Moore, 2011 and Kasai, 2012a). The results of the panel Tobit models are thought to be more reliable than the previous findings thus, this study judges that "tertiary school enrolment rates" are not a direct determinant for CDM project hosting (Kasai, 2012b). On the other hand, this study demonstrates the significance of "science and technology levels" at the 1% significance level in Specification 5 under the panel Tobit model though the variable is insignificant in Specification 6. This must be due to a strong correlation between the log of the number of scientific and technical journal articles and the log of CO_2 emissions, .837 and therefore, the results must have been distorted by the impact of muticolleneiarity (Kasai, 2012b). In this case, the effects between those two variables cannot be clearly captured individually.

Consequently, this study concludes that "science and technology levels" positively affect the number of CDM project hosting based on the result of the panel Tobit model with Specification 5. This conclusion is backed by the results of cross-country analyses, the majority of which indicates statistically significant and positive. Moreover, this finding is rational as it is imperative for PPs to grasp the technical aspects of GHG reduction technologies applied for CDM project activities (Kasai, 2012b).

Summing up, as Kasai (2012a) suggested, human capital is likely to be one of the crucial factors in developing CDM projects. Eligible host countries that are eager to promote CDM activities should improve scientific and technical levels to retain qualified personnel. Accordingly, the second hypothesis is demonstrated below.

H2: The better scientific and technical levels eligible host countries have, the more CDM projects the countries will be able to host.

⇨ Fail to reject

4) Ties with advanced countries

To host CDM projects, links to advanced countries must be one of material factors as CDM projects are usually developed by PP(s) in the host countries in cooperation with PP(s) in the Annex I countries. This category comprises of three independent variables: "the log of FDI inflows," "the log of ODA," and "the former British colony dummy."

Firstly, it is confirmed that the "former British colony dummy" has statistically significant negative impacts on the CDM project hosting contrary to expectations. The majority of estimation results of cross-country analyses and pooled Tobit show the same results, whereas this is consistent with the study carried out by Wang and Firestone (2010). The adverse effects of the former British colonies obviously allude to the fact that CDM investors in the U.K. do not give credibility to colonial ties but focus mainly on the profitability of projects (with larger GHG reduction potentials). This tendency must be due to the nature of CDM, which in turn can be attributed to as one of the mainstream issues that needs to be addressed (Kasai, 2012b). Given the above discussions, while this study cannot verify whether or not the former British colonies have strong ties with the U.K., it reveals that the former British colonies host less CDM projects. Therefore, the third hypothesis below is refuted by the analytical results.

H3: Former British colonies will be able to host a larger number of CDM projects thanks to a strong connection to the U.K. (a leading CDM investor).

⇨ Reject

Secondly, the regression results of the panel Tobit models show that the log of "FDI inflows" is statistically significant and positive at the 1% level in Specification 4 and the 5% level in Specification 6. Similarly, the cross-sectional and pooled Tobit models have the same results. This result is in accordance with the argument of the previous theoretical literature (Niederberger and Saner, 2005), but contradicts the empirical result of Winkleman and Moore (2011). Taking into account the characteristics of the CDM, CDM projects are normally invested in by private firms in Annex I countries and, it appears that economic ties between the host countries and developed nations in the private sector certainly help facilitate CDM activities. This study, hence, regards FDI inflows as a significant factor of CDM project hosting based on both theoretical and empirical points of views. Therefore, the forth hypothesis below is proven.

H4: The larger the FDI inflows eligible host countries receive, the more CDM projects the countries will be able to host.

⇨ Fail to reject

Lastly, "the log of ODA" is not significant in all specifications under the panel Tobit models and this result is consistent with that of the study carried out by Kasai (2012a). The primary reason must be the impacts of well-developed emerging countries, some of which have graduated from Japan's ODA loans. For example, the cash flow of ODA between Japan and China is positive from Japan's perspectives as China has been repaying a significant amount of money to Japan and this negative estimation result is likely to suggest that CDM investors act differently to their governments by following the market mechanism or other factors (Kasai, 2012b). Although this study generated the fifth hypothesis by supposing that the amount of receiving ODA reflects the political and/or economic closeness between developing and developed countries, the results explicitly refuted the hypothesis.

H5: The larger amount of ODA eligible host countries receive, the more CDM projects the countries will be able to host.

⇨ Reject

Table 4-12 Estimation Results of Cross-Country Data Analysis in 2005&2006

Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables	Log of the number of CDM projects registered in 2005						Log of the number of CDM projects registered in 2006					
Independent variables												
Log of CO_2 emissions	0.577***	0.501**	0.561***			0.174	0.963***	0.824***	0.862***			0.663*
	(3.74)	(2.62)	(2.90)			(0.65)	(5.48)	(4.06)	(4.22)			(1.84)
Log of GDP per capita	-0.058			0.047	0.251	-1.212**	0.017			0.279	0.899*	-0.188
	(-0.25)			(0.13)	(0.55)	(-2.47)	(0.07)			(0.53)	(1.69)	(-0.25)
Government effectiveness		0.035***				0.051		0.017				0.022
		(2.78)				(1.24)		(0.93)				(0.50)
Control of corruption			0.020			-0.005			0.008			-0.007
			(1.50)			(-0.15)			(0.57)			(-0.22)
Log of tertiary school enrolment rate		-0.184	-0.030			0.178		0.465	0.560			0.335
		(-0.60)	(-0.09)			(0.62)		(1.22)	(1.44)			(0.52)
Log of the number of scientific journal articles					0.559***	0.078					0.797***	-0.151
					(2.94)	(0.31)					(3.39)	(-0.43)
Log of FDI inflows				0.691***		0.579**				1.265***		0.697*
				(2.73)		(2.20)				(4.43)		(1.84)
Log of ODA received				0.339	0.359	-0.088				0.816*	0.979**	0.488
				(1.10)	(0.87)	(-0.24)				(1.97)	(2.08)	(1.07)
Former British colony dummy	-0.804	-1.839**	-1.642**	-0.309	-0.794	-1.637**	-0.883	-1.090	-0.922	-0.829	-1.458*	-0.921
	(-1.09)	(-2.59)	(-2.24)	(-0.41)	(-1.07)	(-2.05)	(-1.38)	(-1.46)	(-1.21)	(-1.02)	(-1.84)	(-1.03)
Observations	124	104	104	93	96	74	124	104	104	92	94	74
Log pseudo likelihood	-46.4	-38.2	-39.2	-37.3	-36.5	-28.5	-71.3	-64.2	-64.4	-50.6	-53.6	-44.8
Pseudo R-squared	0.173	0.245	0.226	0.197	0.222	0.305	0.231	0.230	0.227	0.271	0.232	0.286

Values in parentheses are t statistics.

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

Table 4-13 Estimation Results of Cross-Country Data Analysis in 2007&2008

Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables	Log of the number of CDM projects registered in 2007						Log of the number of CDM projects registered in 2008					
Independent variables												
Log of CO_2 emissions	1.125***	0.894***	1.015***			1.148***	1.108***	0.944***	1.021***			0.533
	(6.37)	(4.75)	(5.10)			(2.89)	(7.05)	(5.92)	(6.47)			(1.37)
Log of GDP per capita	0.127			0.635	1.170***	-0.739	0.010			0.625	0.870*	-0.040
	(0.50)			(1.29)	(2.64)	(-1.18)	(0.04)			(1.35)	(1.78)	(-0.07)
Government effectiveness		0.053***				0.112***		0.032*				0.031
		(3.31)				(3.45)		(1.85)				(0.97)
Control of corruption			0.025*			-0.015			0.020			-0.001
			(1.68)			(-0.52)			(1.41)			(-0.05)
Log of tertiary school enrolment rate		0.083	0.488			0.719		-0.070	0.073			-0.137
		(0.24)	(1.16)			(1.54)		(-0.16)	(0.18)			(-0.28)
Log of the number of scientific journal articles					0.508***	-0.893**					0.602***	-0.066
					(2.72)	(-2.63)					(3.56)	(-0.20)
Log of FDI inflows				0.803***		0.580				0.911***		0.481*
				(2.65)		(1.48)				(3.28)		(1.82)
Log of ODA received				0.469	0.568	0.168				0.729*	0.724	0.431
				(1.13)	(1.29)	(0.47)				(1.75)	(1.64)	(1.05)
Former British colony dummy	-0.886	-1.562**	-1.001	-0.575	-0.794	-2.513***	-1.040	-1.494**	-1.268*	-1.753	-1.470*	-1.899**
	(-1.29)	(-2.27)	(-1.28)	(-0.61)	(-0.90)	(-3.47)	(-1.62)	(-2.17)	(-1.78)	(-1.54)	(-1.71)	(-2.13)
Observations	125	101	101	89	95	72	125	101	101	89	95	72
Log pseudo likelihood	-60.5	-50.4	-53.0	-41.8	-43.0	-29.2	-58.8	-52.3	-53.1	-34.9	-37.3	-32.6
Pseudo R-squared	0.288	0.349	0.315	0.257	0.248	0.417	0.301	0.321	0.310	0.291	0.293	0.299

Values in parentheses are t statistics.

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

Table 4-14 Estimation Results of Cross-Country Data Analysis in 2009&2010

Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables	Log of the number of CDM projects registered in 2009						Log of the number of CDM projects registered in 2010					
Independent variables												
Log of CO_2 emissions	1.249***	1.116***	1.263***			1.222***	1.244***	1.143***	1.190***			1.964***
	(10.36)	(10.34)	(9.77)			(4.82)	(11.12)	(10.68)	(9.96)			(4.47)
Log of GDP per capita	-0.119			-0.089	0.159	-0.884*	-0.548***			-0.303	-0.371	-3.757***
	(-0.60)			(-0.14)	(0.30)	(-1.80)	(-2.88)			(-0.52)	(-0.68)	(-6.98)
Government effectiveness		0.046***				0.059***		0.033***				0.048***
		(3.01)				(4.03)		(2.71)				(6.40)
Control of corruption			0.022			0.003			0.005			0.025
			(1.55)			(0.20)			(0.36)			(1.60)
Log of tertiary school enrolment rate		-0.344	0.067			-0.271		-0.683**	-0.300			2.242***
		(-1.28)	(0.19)			(-0.73)		(-2.57)	(-0.99)			(3.78)
Log of the number of scientific journal articles					0.961***	-0.640***					1.069***	-0.631***
					(3.78)	(-2.91)					(5.05)	(-3.23)
Log of FDI inflows				1.380***		0.750***				1.487***		1.214***
				(4.34)		(3.96)				(5.33)		(7.92)
Log of ODA received				0.399	0.545	0.116				-0.239	-0.232	0.443***
				(1.00)	(1.05)	(0.50)				(-0.66)	(-0.49)	(3.52)
Former British colony dummy	0.348	-0.287	0.253	0.564	-0.069	-0.858	0.037	-0.315	0.079	-0.085	-0.019	-0.355*
	(0.66)	(-0.52)	(0.39)	(0.71)	(-0.08)	(-1.66)	(0.08)	(-0.65)	(0.15)	(-0.09)	(-0.02)	(-1.96)
Observations	125	101	101	89	92	69	125	101	101	87	91	72
Log pseudo likelihood	-64.9	-49.7	-52.8	-40.5	-44.8	-19.5	-54.2	-47.9	-50.5	-25.1	-25.8	-14.7
Pseudo R-squared	0.362	0.417	0.381	0.333	0.268	0.601	0.426	0.424	0.394	0.402	0.391	0.741

Values in parentheses are t statistics.

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

Table 4-15 Estimation Results of Pooled and Panel Tobit Models (2005-2010)

Models	Pooled Tobit						Panel Tobit (random effect)					
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables	Log of the number of CDM projects registered in 2005-2010						Log of the number of CDM projects registered in 2005-2010					
Independent variables												
Log of CO_2 emissions	1.083***	0.941***	1.014***			0.925***	1.013***	0.877***	0.924***			0.722***
	(15.75)	(12.98)	(13.30)			(5.90)	(12.00)	(11.56)	(11.00)			(3.01)
Log of GDP per capita	-0.081			0.060	0.440**	-0.919***	0.052			-0.271	0.080	-0.798**
	(-0.83)			(0.28)	(2.34)	(-3.64)	(0.38)			(-1.34)	(0.47)	(-2.32)
Government effectiveness		0.033***				0.063***		0.027***				0.054***
		(4.62)				(4.32)		(2.63)				(2.76)
Control of corruption			0.014**			-0.007			0.006			-0.014
			(2.26)			(-0.54)			(0.73)			(-0.56)
Log of tertiary school enrolment rate		-0.083	0.159			0.158		0.042	0.283			0.048
		(-0.51)	(0.93)			(0.66)		(0.19)	(1.29)			(0.17)
Log of the number of scientific journal articles					0.766***	-0.336**					0.835***	-0.062
					(8.16)	(-2.29)					(11.72)	(-0.27)
Log of FDI inflows				1.077***		0.553***				0.793***		0.411**
				(7.36)		(3.92)				(4.54)		(2.16)
Log of ODA received				0.363**	0.422**	0.109				-0.026	0.026	-0.032
				(2.18)	(2.28)	(0.65)				(-0.17)	(0.22)	(-0.17)
Former British colony dummy	-0.435*	-0.929***	-0.593*	-0.385	-0.807**	-1.694***	-0.542**	-0.934**	-0.584*	-0.707**	-1.165***	-1.818***
	(-1.66)	(-3.20)	(-1.94)	(-0.97)	(-2.20)	(-4.44)	(-2.21)	(-2.50)	(-1.90)	(-2.35)	(-3.68)	(-5.63)
Observations	748	612	612	539	563	433	748	612	612	539	563	433
Log pseudo likelihood	-374.0	-324.0	-331.3	-247.5	-251.9	-193.0	-332.5	-292.5	-295.1	-217.3	-214.6	-181.1
Pseudo R-squared	0.279	0.297	0.281	0.242	0.244	0.339						
Wald test: Prob>chi2							0.000	0.000	0.000	0.000	0.000	0.000
sigma_u							1.536	1.415	1.509	1.898	1.819	1.293
sigma_e							1.278	1.253	1.254	1.167	1.16	1.188
Rho							0.591	0.561	0.591	0.726	0.711	0.542

Values in parentheses are t statistics; *p<0.10, **p<0.05, ***p<0.01

5. Conclusions

5.1 Research Summary

The latest integrated assessment report on climate change (IPCC, 2013) alleges that "It is extremely likely that human activities caused more than half of the observed increase in global average surface temperature from 1951 to 2010." IPCC (2013) estimates that climate change influences human lives in various ways, not just in temperature rises, but also in changes in sea levels, change in rainfall patterns and changes in frequency of droughts, heat waves, cold waves, and typhoons. It is extremely important to avoid the serious repercussions of climate change by ensuring a temperature rise of no more than 2°C which has emerged as the principal focus of international consensus (Anderson and Bows, 2008).

UNEP (2011) argues that reducing GHG emissions to the level that can hold a temperature rise within 2°C is technologically and economically feasible. To realize this goal, it is necessary to undertake immediate and pertinent actions with the international community (UNEP, 2010b). Theoretically speaking, it may be possible to take immediate actions and prevent from rapid temperature rises. However, in reality, it is highly unlikely for this to be actualized this considering the current human activities, such as increasing global economic activities and the sluggish pace of the agreements about the details of the post-Kyoto Protocol. In this social context, the CDM, the world's first innovative financial mechanism enabling GHG reductions internationally in a cost-effective manner, was put into force in 2005. The CDM has played an important role in the international GHG reduction activities (e.g., Sutter and Parreño, 2007) for the first several years after its initiation but it is currently nearly defunct due to due to the deterioration of the market condition. There are three major reasons why the CER market has an imbalance of demand versus supply: first is the issue of equality on legally binding targets, as the targets were set with on the basis of inadequate evidence and inequitably. Due to this, Russia, Canada, and Japan did not join the second commitment period of the Kyoto Protocol; the second reason is the lower GHG emissions in Annex I countries as the Lehman Brother's fall in 2008 caused economic stagnation and many Annex I countries, especially within the EU, did not have much demand for CERs to fulfil their targets; and third, the increasing amount of CER issuance as this accelerated the sharp depreciation of CER price. Aside from the rapid decrease of the CER price, the skewed distribution of CDM projects has been a controversial issue (e.g., Muller, 2007; Boyd *et al*., 2009; Flamos, 2010). The majority of LDCs have not reaped benefits from the CDM, whereas the major GHG emitters, especially China and India, have been receiving a lot of fund flows from Annex I countries (Kasai, 2013) which have had a variety of positive side effects, such as technology transfers, electricity generated from clean renewable sources, and the promotion of SD in their own countries, in various ways. Hence, considering the current distributional imbalance of CDM projects, this study was conducted aiming to identify the determinants of CDM project hosting in order to recommend promising approaches for LDCs based on empirical evidence.

Prior to conducting empirical analyses, the effect of the CDM on the host country's GHG emission tax rate and GHG reduction policies were investigated by examining the effects of increased environmental awareness in the Annex I country using the two-country model created by Hatzipanayotou *et al*. (2002) in Chapter 2. This macroeconomic analysis shows that, in a Nash equilibrium where the Annex I country chooses the amount of CDM investment and the host sets the proportion of CDM revenue used in GHG reduction activities and GHG emission tax rate, a rise in environmental awareness of the Annex I country increases the CDM investment, does not affect the GHG emission tax rate, and plausibly reduces GHG emissions of the host country. These results are similar to those obtained in Hatzipanayotou *et al*. (2002). Of special note, however, the results indicate that the degree of effectiveness of CDM projects in reducing GHG emissions affects the behavior of the Annex I country. This means that, in a plausible case, the more effective the CDM investment is, the greater the reduction of GHG emissions in the host country is. If the effectiveness reflects the recipient country's ability to adopt advanced technologies (e.g., education levels or human capital stock of the country), the Annex I country tends to undertake CDM investments in such countries with greatest human capital. This prediction arises from our theoretical consideration.

Following the theoretical analysis above, cross-country empirical analyses were carried out to identify the determinants of CDM project hosting in Chapter 3. These analyses focused mainly on two factors: 1) the qualities of the business environment and 2) scientific levels in the host countries. The reasons are that: 1) although many previous studies have analyzed the significance of a business environment, their results were not homogenous. Further, their notions of business environment seemed to be narrow and limited; 2) no previous studies attempted to verify the significance of scientific levels. Consequently, the results of cross-country analyses indicate that several factors regarding a business environment (i.e., "ease of registering property," "ease of getting credit," and "ease of trading across borders") are significant for both bilateral and unilateral CDM projects. Similarly, the scientific and technical levels were found to be significant, but only for unilateral CDM projects (Kasai, 2012a).

In Chapter 4, panel data analyses were carried out to obtain more sophisticated estimated results utilizing panel Tobit models with four categories of independent variables (i.e., GHG reduction potentials, socioeconomic factors, human capital, and ties to advanced countries) towards the dependent variable, the number of CDM projects. By running random effects panel Tobit models, several significant decisive factors have been identified (see Table 5-1). Although it was expected that all independent variables would be found to be significant in the analytical results, four variables, namely "GDP per capita," "control of corruption," "tertiary school enrolment rate," and "ODA received," were found to be statistically insignificant. Furthermore, contrary to the expectations, it was confirmed that the "former British colony dummy" has negative significant effects on CDM project hosting. This implies that CDM investors in the U.K. have not utilized networks with former colonies in their CDM business. On the other hand, as expected, the analytical results reveal four important factors that have a significant and positive impact on CDM project hosting. They are: "GHG reduction potentials," "government effectiveness," "science and technology levels," and "economic ties with advanced countries in the private sector." This empirical evidence is in accordance with expectations from a theoretical point of view (Kasai, 2012b).

Table 5-1 Summary Table of Estimation Results

Categories	Factors	Control Possibility[a]	Regression Result	Effects
GHG reduction potentials	**CO_2 emissions**	**Low**	**Significant**	**Positive**
Socioeconomic factors	GDP per capita	Medium	Insignificant	N/A
	Government effectiveness	***High***	***Significant***	***Positive***
	Control of corruption	Medium	Insignificant	N/A
Human capital	Tertiary school enrolment rate	High	Insignificant	N/A
	Number of scientific journal articles	***High***	***Significant***	***Positive***
Links to advanced countries	ODA received	Medium	Insignificant	N/A
	FDI inflows	***Medium***	***Significant***	***Positive***
	Former British colony dummy	n/a	Significant	Negative

[a] Control possibility shows the ease of control of a factor by host countries.

5.2 Policy Implications

It is considered to be appropriate that LDCs' future concerning the CDM and other similar mechanisms will depend on how successfully they can utilize the findings of this paper in a factual manner. The important point to note is that some determinants can be controlled by host countries, but other determinants cannot. It is impossible to boost the past GHG emission levels in the base year. LDCs, hence, should focus exclusively on improving factors that they can control (i.e., "business environment," "government effectiveness," "science and technology levels," and "economic ties between host and Annex I countries in the private sector") (Kasai, 2012a and Kasai, 2012b). If this is actually achieved, LDCs will have better conditions for attracting CDM investors.

Alternatively, by taking a different perspective on a promising approach for LDCs, it seems feasible to develop the programmatic CDM (see Appendix III). Because LDCs have a serious disadvantage in their lower GHG reduction potentials, they cannot be expected to simulate the major GHG emitters, such as China (Kasai, 2012a). The programmatic CDM allows a collection of a vast number of small-scale interventions (e.g., the use of energy-saving fluorescent bulbs and clean cookstoves) to be grouped, registered, and verified as a single CDM program. This is intended to reduce the transaction costs of processing a number of small-scale activities and these are generally the types of projects that have a direct impact on community development (ACP, 2014). In recent years, several international organizations have assisted in disseminating the programmatic CDM in LDCs. As a result, the number of CDM activities in LDCs has been increasing slowly but steadily. As of February 28, 2014, there were 247 registered programmatic CDM activities (UNFCCC, 2014). Using this case as a good example, it is hoped that more promising and useful new market-based mechanisms will be developed by international organizations, such as UNFCCC.

In addition, as a more realistic suggestion, LDCs should continue to request financial assistance from the international society. When looking at negotiation circumstances at COPs, LDCs basically have cooperated with articulating common needs. However, it also appears that specific countries may have been affected by particular world powers, whereas others have not been greatly interested in the issue. It is not imperative that LDCs always work together. However, by working together, they probably would be able to obtain greater proportion of the assistance that they require. Thus, LDCs should consider working together more closely to explain and elaborate their strategies. From a theoretically point of view, a rise in the level of citizens' environmental awareness in the Annex I country reduces GHG emissions in the host country and increases the amount of investment required in CDM activities. This is confirmed by the macroeconomic analysis of the effects of the CDM in Chapter 2. LDCs should raise the environmental awareness level not only by enhancing political dialogues, but also implementing various activities at the grassroots level in cooperation with international organizations and NGOs. This is because, from a standpoint of equality, LDCs have a right to receive more financial assistance from developed countries and some emergent nations.

In summary, an effective strategy to promote CDM activities in LDCs is constructed with three dimensions. The first is the effort made by the host country. LDCs should improve the significant factors that they can control by themselves and attempt to implement the programmatic CDM. The second aspect focuses on the effort of international organizations, especially UNFCCC, as it would be helpful to improve and/or simplify the CDM policies/rules and create new mechanisms, such as the programmatic CDM. The third dimension is the effort by the international community, particularly developed countries, which are responsible for a vast amount of GHG emissions that are of concern in the climate change discussion. Their further efforts are absolutely necessary to provide funds, subsidiaries, technical assistance, capacity development programs and other forms of assistance.

5.3 Remaining Challenges

With respect to empirical analyses of the determinants of CDM project hosting, the findings of this papers is based on the limited data for the period between 2005 and 2010 due to data unavailability. It is hoped that further empirical studies will be carried out utilizing data that has been collected after 2011. Furthermore, it is worth applying other analytical models and/or independent variables if there are better models and/or variables for a panel data analysis. More specifically, it might be interesting to add regional dummies in an empirical model because the significance and effects of each variable may be different according to the region where the eligible host countries are situated. This method appears to help LDCs identify more useful and practical approaches.

5.4 Concluding Statement

The CDM is a mechanism, utilized not only for alleviating the impacts of global warming, but also for enhancing sustainable development in host countries and, furthermore, it can generate a new type of fund flows as it has similar features to subsidies. Assuming that the CDM will be continuously developed as a GHG reduction mechanism under the post-Kyoto Protocol after 2020, this paper underscores the importance of aggressively pressing ahead with the development of CDM projects activities for the sake of improving their quality of life as well as reducing the impacts of global warming.

Having said this, in light of the current status of international climate negotiations, it feels challenged to have all major countries agree to the legally binding targets at COP21 to be held in Paris, France in 2015. As mentioned before, though the CDM market functioned well until 2008, as the market got an imbalance of demand versus supply, the CER price started falling down in 2009 and the current secondary CER price is extremely low at less than one Euro/ton (ICE, 2014). This might be considered a typical fate of a financial commodity which relies on the market mechanism. Thus, learning from a lesson from the CDM, LDCs might want to seek other possibilities including subsidiary programs as well as promising market-based mechanisms (e.g., VCS[12], NAMA[13], JCM[14], REDD+[15]) while carefully watching developments of the CDM at CDM EB meetings and COPs.

Looking back over history, humankind has improved the quality of life by making innovations happen such as the industrial and green revolutions (Kasai, 2012b). Hence, it is hoped that both the Annex I and non-Annex I countries tackle the climate change issue while stimulating the effective use of innovative mechanisms including the CDM and make innovations happen in terms of both sustainable socioeconomic systems and technology advancement for the future generations.

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[12] The Verified Carbon Standard (VCS) is the world's leading voluntary GHG reduction scheme which was founded by a collection of business and environmental leaders who saw a need for greater quality assurance in voluntary carbon markets.

[13] Nationally Appropriate Mitigation Action (NAMA) refers to a set of policies and actions that countries undertake as part of a commitment to reduce GHG emission. The term recognizes that different countries may take different nationally appropriate action on the basis of equity and in accordance with common but differentiated responsibilities and respective capabilities. It also emphasizes financial assistance from developed countries to developing countries.

[14] The Joint Crediting Mechanism (JCM) is a program in which Japan's contribution to the reduction of GHG emissions in partner countries through transferring low-carbon technology and products. Currently, bilateral agreements on the JCM have been signed by twelve countries (i.e., Mongolia, Bangladesh, Ethiopia, Kenya, Maldives, Viet Nam, Laos, Indonesia, Costa Rica, Palau, Cambodia, and Mexico).

[15] Reducing Emissions from Deforestation and forest Degradation plus (REDD+) is a mechanism that has been under negotiation by the UNFCCC since 2005, with the twin objectives of mitigating climate change through reducing emissions of GHG and removing GHG through enhanced forest management in developing countries.

Last but not least, time is limited but it is unquestionable that our possibilities are unlimited. The author strongly hopes that this dissertation will be read by as many people as possible in order for LDCs to utilize “latecomer’s advantages” to realize sustainable development by implementing various multi-benefit type projects/programs in their countries.

Bibliography

ACP (2014), *Asian Co-benefits Partnership White Paper 2014: Bringing Development and Climate Together in Asia*, Tokyo, The Ministry of the Environment, Japan.

Alexeew, J., Bergset, L., Meyer, K., Petersen, J., Schneider, L., & Unger, C. (2010), "An analysis of the relationship between the additionality of CDM projects and their contribution to sustainable development", *International Environmental Agreements: Politics, Law and Economics*, 10, pp. 233–248.

Amemiya, T. (1984), "Tobit models: A survey", *Journal of Econometrics*, 24, pp.3-61.

Anderson, K. and A. Bows (2008), "Reframing the climate change challenge in light of post-2000 emission trends", *Philsohical Transitions of The Royal Society* 366 (1882), pp.3863-3882.

Begg, K., Wilkinson, R., Theuri, D., & Gitonga, S. (2003), *Encouraging CDM energy projects to aid poverty alleviation*, Guildford, Centre for Environmental Strategy, University of Surrey.

Boston, J. (2008), "Global Climate Change Policies: From Bali to Copenhagen and Beyond", *Policy Quarterly* 4 (1), pp.50-63.

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*, 12 (7), pp.820-831.

Brohan, P., J. J. Kennedy, I. Harris, S. F. B. Tett, and P. D. Jones (2006), "Uncertainty estimates in regional and global observed temperature changes: A new data set from 1850", *J. Geophys. Res.*, 111, D12106, doi:10.1029/2005JD006548.

Christensen, J., B. Hewitson, A. Busuioc, A. Chen, X. Gao, R. Held, R. Jones, R. Kolli, W.

Kwon, R. Laprise, V. Magana Rueda, L. Mearns, C. Menendez, J. Räisänen, A. Rinke, A. Sarr, P. Whetton, R. Arritt, R. Benestad, M. Beniston, D. Bromwich, D. Caya, J. Comiso, R. de Elia, and K. Dethloff (2007), *Climate Change 2007: The Physical Science Basis: Contribution of Working group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, Cambridge University Press.

Dinar, A., S. Mahfuzur, D. Larson, and P. Ambrosi (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*, 12 (1), pp. 89-102.

Flues, F. (2010), "Who Hosts the Clean Development Mechanism? Determinants of CDM Project Distribution", *CIS Working Paper 53.*

Goodman, J. (2009), "The Changing Face of Political Ideologies in the Global Age", *New Political Science,* 31(4), pp. 499-514.

Gupta, S., D. Harnid, A.T. Rosa (2002), "Does corruption affect income inequality and poverty?", *Economics of Governance*, 3 (1), pp. 23-45.

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.

Hatzipanayotou, P., S. Lahiri, and M.S. Michael (2002), "Can cross-border pollution reduce pollution?", *Canadian Journal of Economics*, Vol. 35, No. 4, pp. 805-818.

Hensel, P. R. (2006), ICOW colonial history data 0.4 [Online], Available from: <http://www.paulhensel.org/Data/colhist.zip>.

Hourcade, J. C. and M. Toman (1999), "Policies for the design and operation of the clean Development Mechanism", *Paper presented at the Multinational Workshop*.

Huang, Y. and T. Barker (2008), "The Clean Development Mechanism and Sustainable Development: A Panel Data Analysis", *Working Paper, University of Cambridge 39*.

ICE (2014), CER FUTURES - EMISSIONS CER INDEX [Online], Available at: <https://www.theice.com/marketdata/reports/icefutureseurope/ECXCERIndex.shtml>.

IGES (2010), *Towards CDM reform*. Kanagawa, Japan, IGES.

IGES (2011), IGES CDM project database [Online]. Available at <http://www.iges.or.jp/jp/cdm/report_cdm.html>.

IGES (2012), IGES CDM project database [Online], Available at <http://www.iges.or.jp/en/cdm/report_cdm.html>.

IPCC (2007), *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Geneva: IPCC.

IPCC (2013), *Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)], Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press.

Jahn, M., A. Michaelowa, S. Raubenheimer, and H. Liptow (2004), "Measuring the potential of unilateral CDM - a pilot study", *HWWA Discussion Paper 263*.

Jung, M. (2006), "Host county attractiveness for CDM non-sink projects", *Energy Policy*, 34, pp. 2173-2184.

Kasai, Katsuya (2011), "Skewed distribution of benefits from Clean Development

Mechanism (CDM): determinants of CDM projects hosting", *ADR Research Paper*, National Graduate Institute for Policy Studies.

Kasai, Katsuya (2012a), "A cross-country empirical analysis of determinants of Clean Development Mechanism (CDM) projects", *Journal of Environmental Information Science*, 40 (5), pp.1-10.

Kasai, Katsuya (2012b), "How can LDCs benefit from the CDM?: A panel data analysis of determinants of CDM project hosting", *MPRA Paper* 52137, University Library of Munich, Germany. 50pp.

Kasai, Katsuya (2013), "Factors Affecting the Distribution of CERs: A Cross-Sectional Empirical Analysis", *Journal of Environmental Information Science*, 41 (5), pp. 37-46.

Kitamura, Y. (2006), "The purpose of panel data and for its use (Panel data no igi to sono katsuyou)", *Japanese Journal of Labour Studies (Nihon Roudou Kenkyu Zasshi)*, 551, pp. 6-16.

Lecocq F, and P. Ambrosi (2007), "The Clean Development Mechanism: history, status, and prospects", *Rev Environ Econ Policy*, 1 (1), pp. 134-151.

Mauro. P. (1995), "Corruption and Growth", *The Quarterly Journal of Economics*, 110 (3), pp. 681-712.

Mendelsohn, Robert, Norehaus, William D., and Shaw, Daigee (1994), "The Impacts of Global Warming on Agriculture: A Ricardian Analysis", *American Economic Review* 89 (4), pp. 753-771.

Michaelowa, A. (2007), "Unilateral CDM - can developing countries finance generation of greenhouse gas emission credits on their own?", *International Environmental Agreements*, 7 (18), pp. 17-34.

Michaelowa, A. and K. Michaelowa (2007), "Climate or development: is ODA diverted from its original purpose?", *Climatic Change*, 84 (1), pp. 5–22.

Muller, A. (2007), "How to Make the Clean Development Mechanism Sustainable - The Potential of Rent Extraction", *Energy Policy*, 35 (6), pp. 3203-3212.

Niederberger, A. and R. Saner (2005), "Exploring the relationships between FDI flows and CDM potential", *Transnational Corporations*, 14 (1), pp. 1-40.

Olawuyi, D. S. (2009), "Achieving Sustainable Development in Africa Through the Clean Development Mechanism: Legal and Institutional Issues Considered", *African J. Int. law Comp. Law*, 17, pp. 270-301.

Osbahr, H., Twyman C., Adger, W. N. and Thomas, D. S. G. (2008), "Effective livelihood adaptation to climate change disturbance: Scale dimensions of practice in Mozambique", *Geoforum*, 39 (6), pp. 1951-1964.

Paulsson, E. (2009), "A review of the CDM literature: from fine-tuning to critical scrutiny?", *International Environ Agreements*, 9, pp. 63-80.

Seo, N, R. Mendelsohn, and M. Munasinghe (2005), "Climate change and agriculture in Sri Lanka: a Ricardian valuation", *Environment and Development Economics*, 10, pp.581-596.

Sirohi, S. (2007), "CDM: Is it a "win–win" strategy for rural poverty alleviation in India?", *Climatic Change*, 84(1), pp. 91–110.

Sutter, C. and J. Parreño (2007), "Does the Current Clean Development Mechanism (CDM) Deliver its Sustainable Development Claim? An Analysis of Officially Registered CDM Projects", *Climate Change*, 84 (1), pp. 75-90.

Tobin, J. (1958), "Estimation of relationships for limited dependent variables", *Econometrica*, 26, pp.24~36.

UNDP (2007), *Human Development Report 2007/2008: Fighting climate change: Human* *solidarity in a divided world*, New York, UNDP.

UNEP (2010a), *How Close Are We to the Two Degree Limit?*, Nairobi, Kenya, UNEP.

UNEP (2010b), *Are the Copenhagen Accord pledges sufficient to limit global warming to 2°C or 1.5°C?*, *The Emissions Gap Report*, Nairobi, Kenya, UNEP.

UNEP (2011), *Bridging the Emissions Gap to Meet 2-Degree Target Doable*, Nairobi, Kenya, UNEP.

UNEP Risø Centre (2008), *A reformed CDM – including new Mechanisms for Sustainable Development*, Roskilde, UNEP Risø Centre.

UNEP Risø Centre (2012), CDM Pipeline overview [Online], Available at <http://unep risoe.org/>.

UNFCCC (1992), United Nations Framework Convention on Climate Change [Online], Available at <http://unfccc.int/resource/docs/convkp/conveng.pdf>.

UNFCCC (1998), Kyoto Protocol [Online], Available at <http://unfccc.int/resource/docs/convkp/kpeng.pdf>.

UNFCCC (2001), Decision 17/CP.7: Modalities and procedures for a CDM as defined in Article 12 of the Kyoto Protocol [Online], Available at <http://unfccc.int/files/meetings/workshops/other_meetings/application/pdf/17cp7.pdf>.

UNFCCC (2009), The Copenhagen Accord [Online], Available at <http://unfccc.int/resource/docs/2009/cop15/eng/l07.pdf>.

UNFCCC (2011), CDM Maps [Online], Available at <http://cdm.unfccc.int/CDMMaps/displayDNAsMap>.

UNFCCC (2012a), Least Developed Countries [Online], Available at <http://unfccc.int/cooperation_and_support/ldc/items/2666.php>.

UNFCCC (2012b), Designated National Authorities (DNAs) [Online], Available at <http://cdm.unfccc.int/Statistics/Registration/RegisteredDNAPieChart.html>.

UNFCCC (2012c), Registered project activities by host party [Online], Available at <http://cdm.unfccc.int/Statistics/Registration/NumOfRegisteredProjByHostPartiesPieChart.html>.

UNFCCC (2012d), CERs issued by host party [Online], Available at <http://cdm.unfccc.int/Statistics/Issuance/CERsIssuedByHostPartyPieChart.html>.

UNFCCC (2012e), Global Warming Potentials [Online], Available at <http://unfccc.int/ghg_data/items/3825.php>.

UNFCCC (2012f), Benefits of the Clean Development Mechanism 2012 [Online], Available at http://cdm.unfccc.int/about/dev_ben/ABC_2012.pdf.

UNFCCC. (2014a), CDM Insights - intelligence about the CDM at the end of each month [Online], Available at <http://cdm.unfccc.int/Statistics/Public/index.html>.

UNFCCC (2014b), Programmes of Activities – Registered [Online], Available at <http://cdm.unfccc.int/ProgrammeOfActivities/registered.html>.

Wang, H. and J. Firestone (2010), "The analysis of country-to-country CDM permit trading using the gravity model in international trade", *Energy for Sustainable Development*, 14 (1), pp. 6~13.

Winkelman, A. and M. Moore (2011), "Explaining the differential distribution of Clean Development Mechanism projects across host countries", *Energy Policy*, 39 (3), pp.1132~1143.

World Bank (2011a), World Development Indicators [Online], Available at <http://data.worldbank.org/data-catalog/world-development-indicators>.

World Bank (2011b), Doing Business [Online]. Available at <http://doingbusiness.org/>.

World Bank (2012), The Worldwide Governance Indicators (WGI) project [Online], Available at: <http://info.worldbank.org/governance/wgi/index.asp>.

Wooldridge, J. (2002), *Econometric Analysis of Cross Section and Panel Data*, Massachusetts, The MIT Press.

World Resources Institute (2011), The Climate Analysis Indicators Tool (CAIT) - UNFCCC4.0 [Online], Available at <http://cait.wri.org/>.

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Appendix I: Global Warming Potentials (GWPs)

GWPs referenced to the updated decay response for the Bern carbon cycle model and future CO2 atmospheric concentrations held constant at current levels.

Table A-1 List of GWPs

Species	Chemical formula	Lifetime (years)	GWPs (Time horizon)		
			20 years	100 years	500 years
CO_2	CO_2	5 – 200[b]	1	1	1
Methane [a]	CH_4	12±3	56	21	6.5
Nitrous oxide	N_2O	120	280	310	170
HFC-23	CHF_3	264	9100	11700	9800
HFC-32	CH_2F_2	5.6	2100	650	200
HFC-41	CH_3F	3.7	490	150	45
HFC-43-10mee	$C_5H_2F_{10}$	17.1	3000	1300	400
HFC-125	C_2HF_5	32.6	4600	2800	920
HFC-134	$C_2H_2F_4$	10.6	2900	1000	310
HFC-134a	CH_2FCF_3	14.6	3400	1300	420
HFC-152a	$C_2H_4F_2$	1.5	460	140	42
HFC-143	$C_2H_3F_3$	3.8	1000	300	94
HFC-143a	$C_2H_3F_3$	48.3	5000	3800	1400
HFC-227ea	C_3HF_7	36.5	4300	2900	950
HFC-236fa	$C_3H_2F_6$	209	5100	6300	4700
HFC-245ca	$C_3H_3F_5$	6.6	1800	560	170
Sulphur hexafluoride	SF_6	3200	16300	23900	34900
Perfluoromethane	CF_4	50000	4400	6500	10000
Perfluoroethane	C_2F_6	10000	6200	9200	14000
Perfluoropropane	C_3F_8	2600	4800	7000	10100
Perfluorobutane	C_4F_{10}	2600	4800	7000	10100
Perfluorocyclobutane	$c\text{-}C_4F_8$	3200	6000	8700	12700
Perfluoropentane	C_5F_{12}	4100	5100	7500	11000
Perfluorohexane	C_6F_{14}	3200	5000	7400	10700

[a] The GWP for methane includes indirect effects of tropospheric ozone production and stratospheric water vapour production.

[b] No single lifetime can be defined for CO_2 due to the different rates of uptake by different removal processes.

Source: UNFCCC (2012e)

Appendix II: Registered CDM Projects by Host Countries (2005-2010)

Table A-2 List of CDM Projects by Host Countries

Eligible host country (* indicates LDCs)	The number of registered CDM projects						
	Sum	2005	2006	2007	2008	2009	2010
Albania	1	0	0	0	0	0	1
Algeria	0	0	0	0	0	0	0
Angola *	0	0	0	0	0	0	0
Antigua and Barbuda	0	0	0	0	0	0	0
Argentina	20	2	4	4	4	2	4
Armenia	5	1	1	1	1	1	0
Azerbaijan	0	0	0	0	0	0	0
Bahamas	0	0	0	0	0	0	0
Bahrain	0	0	0	0	0	0	0
Bangladesh *	2	1	1	0	0	0	0
Barbados	0	0	0	0	0	0	0
Belize	0	0	0	0	0	0	0
Benin *	0	0	0	0	0	0	0
Bhutan *	2	1	0	0	0	0	1
Bolivia	4	1	0	1	0	1	1
Bosnia and Herzegovina	0	0	0	0	0	0	0
Botswana	0	0	0	0	0	0	0
Brazil	186	5	83	25	35	18	20
Burkina Faso *	0	0	0	0	0	0	0
Burundi *	0	0	0	0	0	0	0
Cambodia *	4	0	1	0	2	1	0
Cameroon	1	0	0	0	0	0	1
Cape Verde	0	0	0	0	0	0	0
Chad *	0	0	0	0	0	0	0
Chile	42	6	8	8	5	9	6
China	1,229	3	33	114	222	353	504
Colombia	26	0	5	2	6	7	6
Comoros *	0	0	0	0	0	0	0
Congo, Dem. Rep. *	0	0	0	0	0	0	0
Costa Rica	6	1	1	3	1	0	0
Cote d'Ivoire	2	0	0	0	0	1	1
Cuba	2	0	0	1	0	1	0
Cyprus	6	0	2	0	0	3	1

Eligible host country (* indicates LDCs)	The number of registered CDM projects						
	Sum	2005	2006	2007	2008	2009	2010
Djibouti *	0	0	0	0	0	0	0
Dominican Republic	2	0	1	0	0	0	1
Ecuador	14	0	8	1	4	0	1
Egypt	7	0	2	1	1	0	3
El Salvador	6	0	2	3	0	0	1
Equatorial Guinea *	0	0	0	0	0	0	0
Eritrea *	0	0	0	0	0	0	0
Ethiopia *	1	0	0	0	0	1	0
Fiji	1	1	0	0	0	0	0
Gabon	0	0	0	0	0	0	0
Gambia *	0	0	0	0	0	0	0
Georgia	2	0	0	1	0	1	0
Ghana	0	0	0	0	0	0	0
Grenada	0	0	0	0	0	0	0
Guatemala	11	1	4	0	3	3	0
Guinea *	0	0	0	0	0	0	0
Guinea-Bissau *	0	0	0	0	0	0	0
Guyana	0	0	0	0	0	0	0
Haiti	0	0	0	0	0	0	0
Honduras	16	5	5	3	1	1	1
India	612	17	124	161	82	94	134
Indonesia	58	0	8	4	9	21	16
Iran (Islamic Republic of)	1	0	0	0	0	1	0
Israel	18	0	1	6	6	3	2
Jamaica	1	0	1	0	0	0	0
Jordan	2	0	0	0	1	1	0
Kenya	3	0	0	0	1	0	2
Korea, Dem. Rep.	0	0	0	0	0	0	0
Korea, Rep.	53	2	5	10	4	14	18
Kuwait	0	0	0	0	0	0	0
Kyrgyzstan	0	0	0	0	0	0	0
Lao PDR *	1	0	0	1	0	0	0
Lebanon	0	0	0	0	0	0	0
Lesotho *	0	0	0	0	0	0	0
Liberia *	1	0	0	0	0	0	1
Libyan Arab Jamahiriya	0	0	0	0	0	0	0
Macedonia, FYR	1	0	0	0	0	1	0
Madagascar *	1	0	0	0	0	0	1

Eligible host country (* indicates LDCs)	The number of registered CDM projects						
	Sum	2005	2006	2007	2008	2009	2010
Malawi *	0	0	0	0	0	0	0
Malaysia	87	0	12	14	9	43	9
Maldives *	0	0	0	0	0	0	0
Mali	1	0	0	0	0	0	1
Malta	0	0	0	0	0	0	0
Mauritania *	1	0	0	0	0	0	1
Mauritius	0	0	0	0	0	0	0
Mexico	125	3	69	28	10	10	5
Moldova, Rep.	4	0	3	0	0	1	0
Mongolia	3	0	1	2	0	0	0
Montenegro	0	0	0	0	0	0	0
Morocco	5	2	1	1	0	1	0
Mozambique *	0	0	0	0	0	0	0
Myanmar *	0	0	0	0	0	0	0
Namibia	0	0	0	0	0	0	0
Nepal *	3	2	0	0	0	0	1
Nicaragua	4	0	2	1	0	1	0
Niger *	0	0	0	0	0	0	0
Nigeria	5	0	1	0	0	2	2
Oman	0	0	0	0	0	0	0
Pakistan	11	0	1	0	0	4	6
Panama	6	3	1	1	0	1	0
Papua New Guinea	1	0	1	0	0	0	0
Paraguay	2	0	0	0	0	1	1
Peru	23	2	1	5	8	5	2
Philippines	46	0	7	8	5	20	6
Qatar	1	0	0	1	0	0	0
Rwanda *	1	0	0	0	0	0	1
Samoa *	0	0	0	0	0	0	0
Saudi Arabia	0	0	0	0	0	0	0
Senegal *	2	0	0	0	0	0	2
Serbia	0	0	0	0	0	0	0
Sierra Leone *	0	0	0	0	0	0	0
Singapore	2	0	0	0	1	0	1
Solomon Islands *	0	0	0	0	0	0	0
South Africa	19	1	4	7	2	3	2
Sri Lanka	7	3	1	0	0	2	1
St. Lucia	0	0	0	0	0	0	0

Eligible host country (* indicates LDCs)	The number of registered CDM projects						
	Sum	2005	2006	2007	2008	2009	2010
Sudan *	0	0	0	0	0	0	0
Suriname	0	0	0	0	0	0	0
Swaziland	0	0	0	0	0	0	0
Syrian Arab Republic	2	0	0	0	0	2	0
Tajikistan	0	0	0	0	0	0	0
Tanzania, United Rep. *	1	0	0	1	0	0	0
Thailand	42	0	0	5	5	20	12
Togo *	0	0	0	0	0	0	0
Trinidad and Tobago	0	0	0	0	0	0	0
Tunisia	2	0	2	0	0	0	0
Turkmenistan	0	0	0	0	0	0	0
Uganda *	2	0	0	1	0	1	0
United Arab Emirates	4	0	0	0	0	4	0
Uruguay	4	0	0	1	2	0	1
Uzbekistan	10	0	0	0	0	7	3
Viet Nam	47	0	2	0	0	18	27
Yemen *	0	0	0	0	0	0	0
Zambia *	1	0	0	0	0	0	1
Zimbabwe	0	0	0	0	0	0	0

Source: IGES (2012)

Appendix III: The programmatic CDM (PoA)

Background

The CMP at its first session decided that a local/regional/national policy or standard cannot be considered as a clean development mechanism project activity, but that project activities under a programme of activities can be registered as a single clean development mechanism project activity provided that approved baseline and monitoring methodologies are used that, inter alia, define the appropriate boundary, avoid double counting and account for leakage, ensuring that the net anthropogenic removals by sinks and emission reductions are real, measurable and verifiable, and additional to any that would occur in the absence of the project activity.

32nd Meeting of the CDM Executive Board (EB32)

The EB adopted procedures at its 32nd meeting regarding the registration of a programme of activities as a single CDM project activity and issuance of certified emission reductions for a programme of activities. DOEs may now publish documentation related to programmes for global stakeholder consultation during validation. Such documentation will be made available via this webpage. As the process of registering programme of activities evolves further information will be made available on this section of the CDM website.

33rd Meeting of the CDM Executive Board (EB33)

The Board, at its thirty-third meeting, approved the CDM Programme of Activities Design Document form (PoA-DD), CDM Programme Activity Design Document form (PoA-CPA- DD), Small-Scale CDM Programme of Activities Design Document form (SSC-PoA-DD) and Small-Scale CDM Programme Activity Design Document form (PoA-CPA-SSC-DD).

The Board clarified that the registration fee for a PoA is based on the total expected annual emission reductions of the CPAs that will be submitted together with the request for registration of the PoA. The calculation of the amount to be paid and the procedures for payment will follow mutatis mutandis the existing rules for the payment of a registration fee (annex 35 to 'EB 23 Report'). For each CPA which is included subsequently, no fee is to be paid. Fees are to be paid by the coordinating/managing entity to the secretariat.

(Source: UNFCCC website)

Advantages of the Programmatic CDM

The procedures for the CDM Programme of Activities (PoA) were adopted in the EB meeting in June 2009. The new programme has some specific advantages over the normal CDM. One of them is the existence of the Coordinating or Managing Entity (CME) of a PoA. CME coordinates the projects under a PoA, or CDM Programme Activities (CPAs), and manages their operations and CER issuances.

In addition to the existence of a CME, the PoA has other interesting original features. There is no limit on the number of CPAs under a PoA and no requirement for additional registration fees after the registration of its first CPA. Also, each CPA can set its own crediting period. This individual crediting period may reduce losses of CERs issued out of the uniformly-set crediting period for a bundled normal CDM project and be more beneficial to a CME (IGES, 2010) (see Figure A-1).

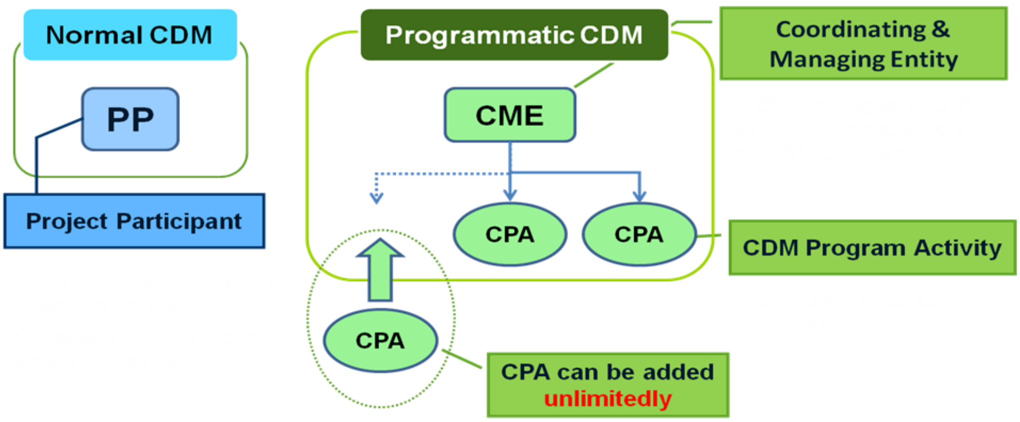
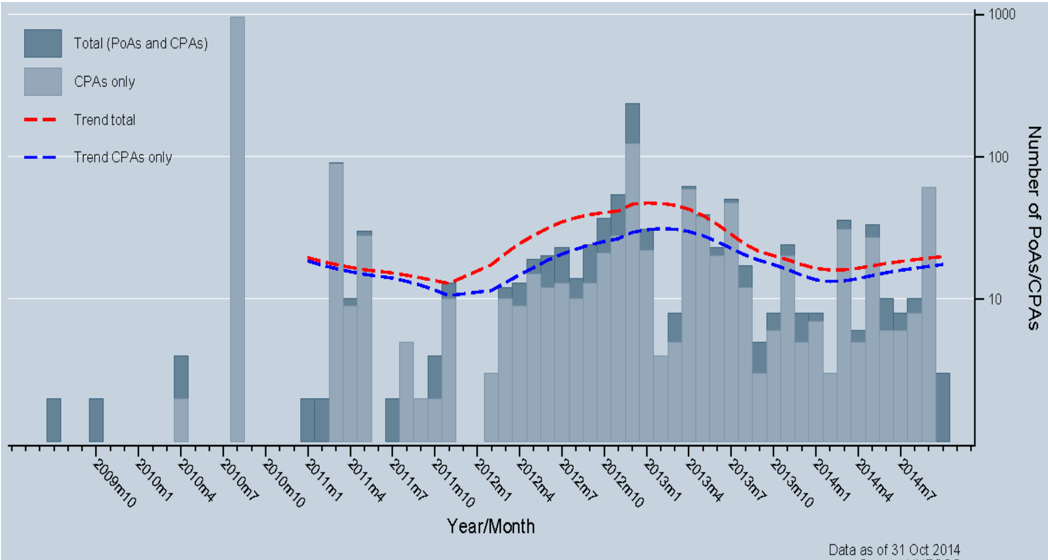


Figure A-1 Comparison of the Project Based CDM and the PoAs

Note: CMEs are entities which manage a number of CPAs which can be added after the registration of programmatic CDM activities (PoAs).

Source: Kasai (2011)

As Figure A-2 shows, the number of programmatic CDM activities has been keeping increasing different from the project-based CDM projects. There are 270 registered PoAs as of November 13, 2014 (Table A-3).



Notes: Trend is a locally weignted regression at a bandwidth of 0.5. PoAs/CPAs entering registration can be discontinued at any stage.

Figure A-2 PoAs/CPAs included/registered and registering

Source: UNFCCC (2014a)

Table A-3 List of Registered CDM Programme of Activities (PoAs)

As of 13 November 2014, 270 CDM programme activities have been registered.

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
12 Aug 14	Production of biogas from animal manure for rural household	Sudan		AMS-I.E. ver. 5	55890	10018
01 Aug 14	Transport Programme of Activities in the Cement Industry, Chile	Chile		AM0090	5671	9801
22 Jul 14	Up Energy Improved Cookstove Programme, Uganda	Uganda		AMS-II.G. ver. 5	44874	9956
18 Jul 14	Programme for Promotion of Access to Domestic Biogas in Rural Bangladesh	Bangladesh	Japan	AMS-I.E. ver. 5	662	9992
24 Jun 14	West African Biodigester Programme of Activities	Benin Burkina Faso		AMS-I.E. ver. 5	22561	9977
19 Jun 14	Installation of Energy Efficient Transformers (IEET)	Kenya	The U.K.and Northern Ireland	AM0067 ver. 2	23021	9164
18 Jun 14	Man and Man Enterprise Improved Cooking Stoves Programme in Togo	Togo	The U.K.and Northern Ireland	AMS-II.G. ver. 5	48001	9815
05 Jun 14	Demand side energy efficiency measures in building lighting systems	Singapore		AMS-II.C. ver. 14	6291	9593
21 May 14	Programme of Activities for Local Improved Cookstoves in West Africa	Mali Benin		AMS-II.G. ver. 5	105362	9941
21 May 14	Promotion of Energy Efficient Cook Stoves within Southern African Development Community (SADC)	Malawi Zambia		AMS-II.G. ver. 5	40653	9780
16 May 14	Landfill gas capture, flaring and utilization program in Africa	Ghana		ACM0001 ver. 15	103249	9136
08 May 14	Tanzania Renewable Energy Programme	United Republic of	Sweden	AMS-I.F. ver. 2	28321	9904

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
		Tanzania		AMS-I.D. ver. 17		
01 May 14	Energy and Water Saving Promotion Programme for Textile Dyeing Process of Bangladesh Textile and Garment Industries	Bangladesh	Japan	AMS-II.D. ver. 12	908	9940
01 May 14	Impact Carbon Global Safe Water Programme of Activities (PoA)	Rwanda Uganda		AMS-III.AV. ver. 4	26438	9948
16 Apr 14	CDM Africa Sustainable Energy Programme	Malawi Zambia	Sweden	AMS-I.E. ver. 5	49601	9934
28 Mar 14	Advanced Energy Solutions for Buildings. Programme of Activities (PoA)	Saudi Arabia, Oman, Egypt	Ireland	AMS-II.K. ver. 2	6014	9153
20 Mar 14	Run of River Hydro Power Plants in Chile	Chile		ACM0002 ver. 14	10989	9797
13 Mar 14	Improved Cookstoves Program for Malawi and cross-border regions of Mozambique	Malawi	Netherlands	AMS-II.G. ver. 5	38857	9558
10 Mar 14	Programmatic CDM for Promotion of Solar Power Generation in India	India		AMS-I.D. ver. 17	7905	9908
03 Mar 14	Biomass residues power generation Programme	South Africa		ACM0006 ver. 12	269952	8486
17 Jan 14	Micro Hydro Power Plant Promotion Programme in Regions on the Upper Reaches of the Yangtze River, China	China	Japan	AMS-I.E. ver. 5	848	9423
06 Dec 13	Implementation of Grid connected Solar Photovoltaic Power Projects in Chile	Chile		ACM0002 ver. 13	134895	9683
02 Dec 13	Renewable biomass fired improved cookstoves programme for households in Burundi by BQS	Burundi	Switzerland	AMS-I.E. ver. 5	217458	9634
29 Nov 13	Power generation using biogas from state-owned palm oil mills in the Republic of Indonesia	Indonesia	Japan	AMS-III.H. ver. 16 AMS-I.D. ver. 17	18372	8389

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
21 Nov 13	DelAgua Public Health Program in Eastern Africa	Rwanda		AMS-III.AV. ver. 4 AMS-II.G. ver. 5	67656	9626
19 Nov 13	Improved Cook Stove Programme with Carbon Finance (ICF), Nepal	Nepal	The U.K.and Northern Ireland	AMS-II.G. ver. 5	41587	9811
15 Nov 13	Animal Manure Treatment Programme in Shanxi Province, Guizhou Province and Inner Mongolia Autonomous Region	China	The U.K.and Northern Ireland	AMS-III.D. ver. 18	4217	8025
17 Oct 13	Energy Efficient Stoves Program (EESP)	Ethiopia	Sweden, Australia, The U.K.and Northern Ireland	AMS-II.G. ver. 5	46528	9769
01 Oct 13	CarbonSoft Open Source PoA, LED Lighting Distribution: Pan Africa	Malawi		AMS-III.AR.ver. 3	41850	7821
11 Sep 13	FIRA AWMS Programme Mexico	Mexico		AMS-III.D. er. 18 AMS-III.F. ver. 11 AMS-I.F. AMS-I.D. ver. 17	2214	9337
06 Sep 13	Energy Efficiency through Micro irrigation system - India	India		AMS-II.F. ver. 10	3473	9731
22 Aug 13	Anaerobic Digestion and Renewable Energy Generation in South Africa	South Africa		AMS-III.D.ver. 18 AMS-I.C. ver. 19 AMS-III.AO.	3083	9219
06 Aug 13	Programme of Activities for Small Scale Hydropower CDM in Sri Lanka	Sri Lanka	Republic of Korea	AMS-I.D. ver. 17	3179	9705
05 Aug 13	Standard Bank Energy Efficient Commercial Lighting Programme of Activities	South Africa, Kenya, Botswana	The U.K.and Northern Ireland	AMS-II.C. ver. 13	2422	7398
01 Aug 13	Efficient Cook Stove Programme: Malawi	Malawi	The U.K.and Northern Ireland	AMS-II.G. ver. 5	52877	9706
26 Jul 13	Replacement of traditional charcoal stoves with efficient	Haiti	Italy	AMS-II.G. ver. 4	41227	9698

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
	EcoRecho stoves in Haiti					
01 Jul 13	Paradigm Sub Saharan Africa Cook Stove Programme	Ethiopia Rwanda		AMS-II.G. ver. 5	64998	9672
24 Jun 13	Promoting Efficient Stove Dissemination and Use in West Africa.	Togo, Burkina Faso, Ghana, Mali, Senegal	Sweden	AMS-II.G. ver. 4	45193	9666
12 Jun 13	Green Commercial Vehicles Projects	Malaysia	Netherlands	AMS-III.S. ver. 3	2917	8678
07 Jun 13	Energy Efficiency Program in Rural Bangladesh	Bangladesh		AMS-III.AV. ver. 3	55198	9276
15 May 13	Southern African Solar Thermal Energy (SASTE) programme	South Africa, Lesotho, Botswana, Mozambique, Namibia , Swaziland		AMS-I.C. ver. 19	26440	7885
26 Apr 13	Small-scale Hydropower Programme of Activities in Guizhou Province	China		AMS-I.D. ver. 17	3977	9617
25 Apr 13	Distribution of Improved Cook Stoves in Sub-Saharan Africa	Senegal , Ghana, Nigeria	Netherlands	AMS-II.G. ver. 4	39114	9007
17 Apr 13	Coal Mine Methane Utilisation and Destruction Programme in DPR Korea	Democratic People's Republic of Korea		ACM0008 ver. 7	137270	7881
28 Mar 13	Methane Utilisation and Destruction Programme from Industrial Wastewater in DPR Korea	Democratic People's Republic of Korea		AMS-III.H.ver. 16	22772	8990
25 Mar 13	Tepeu Wind Programme of Activities	Nicaragua Peru	Netherlands Germany	ACM0002 ver. 12	107375	7274
18 Mar 13	Heat Retention Cooking in Less Developed Countries	Rwanda	The U.K.and Northern Ireland	AMS-II.G. ver. 3	283179	9596
31 Jan 13	Yemen Electricity Distribution Loss Reduction Programme	Yemen	Netherlands	AMS-II.A. ver. 10	6710	9557
31 Jan 13	Nepal Biogas Support Program-PoA	Nepal		AMS-I.E. ver. 4	61510	9572

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
29 Jan 13	Efficient Cook Stove Programme: Rwanda	Rwanda	The U.K.and Northern Ireland	AMS-II.G. ver. 3	51819	7247
29 Jan 13	FIRA Wastewater Treatment System, Methane Capture and Utilisation Programme in Mexico	Mexico		AMS-III.H.ver. 16 AMS-I.C. ver. 19	5243	8132
28 Jan 13	Fuel Efficient Stoves in Zambia	Zambia		AMS-II.G. ver. 3	40684	6864
28 Jan 13	SKG Sangha Biodigester PoA	India	Switzerland	AMS-I.C. ver. 19 AMS-III.R. ver. 2 AMS-I.E. ver. 4	54217	9507
25 Jan 13	Hebei Animal Manure Management System (AMMS) GHG Mitigation Programme	China		AMS-III.D.ver. 18 AMS-I.C. ver. 19 AMS-I.F. ver. 2	21882	8019
25 Jan 13	Southern African Renewable Energy (SARE) Programme	South Africa , Botswana, Lesotho, Mozambique, Namibia, Swaziland		ACM0002 ver. 13	51775	7676
11 Jan 13	Vietnam National Biogas Programme	Viet Nam		AMS-I.C. ver. 18	28455	5816
31 Dec 12	Kenya Improved woodstoves project	Kenya	France	AMS-II.G. ver. 3	42257	9384
31 Dec 12	Argentinean Wind Power Programme (AWPP)	Argentina	Germany	ACM0002 ver. 13	24110	9393
31 Dec 12	Residential Hot Water Efficiency Programme in South Africa	South Africa		AMS-I.J. AMS-II.C. ver. 13	28808	9146
31 Dec 12	Greenlight Solar PV Lighting India	India	The U.K.and Northern Ireland	AMS-III.AR.ver. 3	56397	9488
31 Dec 12	Programme of activities for the recovery and use of associated petroleum gas, normally combusted in flare stacks in oil-producing fields	Colombia		AM0009 ver. 6	159640	8659
31 Dec 12	Promotion of renewable energy generation in India-	India		ACM0002 ver. 13	48585	9416

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
	Programme of Activities					
31 Dec 12	TATS Solar Lantern Programme of Activities	Kenya		AMS-III.AR.ver. 4	13823	9071
31 Dec 12	Henan Province Zhoukou City Rural Household Biogas Development Programme (2007-2010)	China	The U.K.and Northern Ireland	AMS-I.C. ver. 19	465	8390
31 Dec 12	Small Hydropower Programme of Activities in Albania and Serbia	Albania	Austria	AMS-I.D. ver. 17	9130	6825
31 Dec 12	Renewable Energy based PoA in Pakistan	Pakistan		ACM0002 ver. 13	54640	9442
31 Dec 12	Energy Efficiency of Nigeria's Residential Lighting Stock by Distributing up to 40 Million Compact Fluorescent Lamps (CFLs) to Residential Households Connected to the National Grid	Nigeria	The U.K.and Northern Ireland	AMS-II.J. ver. 4	28892	9441
31 Dec 12	Cogeneration and/or trigeneration at commercial sites	South Africa		AMS-II.K.	4742	9437
31 Dec 12	Chilean small scale renewable energy programme of activities	Chile		AMS-I.D. ver. 17	18091	9411
31 Dec 12	Macedonian Microscale Grid-connected Hydroelectricity Programme	The former Yugoslav Republic of Macedonia	Netherlands	AMS-I.D. ver. 17	10590	9477
31 Dec 12	Southern African Solar LED Programme	South Africa , Namibia, Zambia		AMS-III.AR.ver. 3	12236	9497
31 Dec 12	SoWiTec Wind PoA in the Caribbean, Central and South America ("SoWiTec-PoA")	Uruguay	Germany	ACM0002 ver. 13	190135	8964
31 Dec 12	BWC Sustainable Landfill Gas Recovery Programme of Activities in Indonesia	Indonesia	Netherlands	ACM0001 ver. 12	11591	8866
31 Dec 12	Chilean Programme of Activities for integrated Non Conventional Renewable Energies	Chile		ACM0002 ver. 12	191134	9431

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
31 Dec 12	PoA on RE	India		AMS-I.D. ver. 17	7557	9502
31 Dec 12	Solar Water Heater Program in India	India	Netherlands Germany	AMS-I.C. ver. 19	31500	8855
31 Dec 12	Petrotrin Oil Fields Associated Gas Recovery and Utilization PoA	Trinidad and Tobago		AM0009 ver. 6	82282	9358
31 Dec 12	ONE Wind Program of Activity, Morocco	Morocco		ACM0002 ver. 13	653608	9491
30 Dec 12	Sustainable Deployment of the LifeStraw® Family in rural Indonesia	Indonesia	Switzerland	AMS-III.AV. ver. 2	52674	7067
30 Dec 12	Improved Cook stoves Programme – India	India		AMS-II.G. ver. 3	11005	7997
30 Dec 12	LNG Bus Promoting Programme in Guangdong Province	China		AMS-III.AY.	3346	9421
30 Dec 12	Water Purifiers Programme in India	India		AMS-III.AV. ver. 2	899	9432
29 Dec 12	Energy Efficiency Improvements in Furnaces used in SME Steel industry clusters in India	India		AMS-II.D. ver. 12	3006	9387
29 Dec 12	Rural Household Biogas Development Programme in Guangxi Zhuang Autonomous Region and Hebei Provinces	China	The U.K.and Northern Ireland	AMS-I.C. ver. 19 AMS-III.R. ver. 3	7880	9399
28 Dec 12	CFL Distribution Programme in Inner Mongolia Autonomous Region	China		AMS-II.J. ver. 4	37463	8384
28 Dec 12	Methane Capture, Combustion and Possible Electricity Generation from AWMS in Mexico	Mexico		AMS-III.D.ver. 18 AMS-III.F. ver. 10 AMS-I.D. ver. 17	1581	6142
28 Dec 12	Promotion of POME and EFB Co-Composting	Ecuador		AMS-III.H.ver. 16 AMS-III.F. ver. 10	14236	9354
28 Dec 12	CFL Distribution Programme in Guizhou Province	China		AMS-II.J. ver. 4	28912	6422

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
28 Dec 12	Renewable Energy Carbon Programme for Africa (RECPA)	South Africa		ACM0002 ver. 13	132526	6386
28 Dec 12	CFL Distribution Programme in Hebei Province	China		AMS-II.J. ver. 4	33673	7730
28 Dec 12	CFL Distribution Programme in Shanxi Province	China		AMS-II.J. ver. 4	36550	7068
28 Dec 12	CFL Distribution Programme in Shaanxi Province	China		AMS-II.J. ver. 4	34845	8462
28 Dec 12	CFL Distribution Programme in Hunan Province	China		AMS-II.J. ver. 4	30961	8463
28 Dec 12	CFL Distribution Programme in Jiangxi Province	China		AMS-II.J. ver. 4	30808	6424
28 Dec 12	Small Scale Renewable Energy Carbon Programme (SRECP)	South Africa		AMS-I.D. ver. 17	23353	9059
28 Dec 12	PV Project Development in Chile	Chile		ACM0002 ver. 12	80207	9251
28 Dec 12	CFL Distribution Programme in Sichuan Province	China		AMS-II.J. ver. 4	30818	9020
28 Dec 12	CFL Distribution Programme in Liaoning Province	China		AMS-II.J. ver. 4	34257	8387
28 Dec 12	South African Large Scale Grid Connected Solar Park Programme	South Africa		ACM0002 ver. 12	65597	9296
28 Dec 12	CFL Distribution Programme in Heilongjiang Province	China		AMS-II.J. ver. 4	38448	8497
28 Dec 12	PoA for fuel switching at micro and small-sized enterprises in Egypt	Egypt		AMS-III.B.ver. 16 AMS-III.Z. ver. 4	155	9339
28 Dec 12	Wind Energy Project PoA	India		AMS-I.D. ver. 17	19879	9292
28 Dec 12	National Programme for Improved Cookstoves in India	India		AMS-II.G. ver. 3	468140	8949
28 Dec 12	CFL Distribution Programme in Henan Province	China		AMS-II.J. ver. 4	29555	8498
28 Dec 12	Renewable Energy Programme of Activities in Middle East and North Africa	Saudi Arabia, Oman, Egypt	Ireland	ACM0002 ver. 12	1259	9299

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
27 Dec 12	Programme of Activities to introduce renewable energy system into collective housing, Republic of Korea	Republic of Korea		AMS-I.F. ver. 2	1326	9247
27 Dec 12	The programme to introduce renewable energy system into Seoul	Republic of Korea		AMS-I.F. ver. 2	20	9260
27 Dec 12	Energy efficiency programme for ceramic kilns in Liaoning Faku Economic Development Zone	China	The U.K.and Northern Ireland	AMS-II.D. ver. 12	19542	9174
27 Dec 12	CFL Distribution Programme in the Guangxi Zhuang Autonomous Region	China		AMS-II.J. ver. 4	28125	8029
27 Dec 12	Animal Manure Treatment Programme in Gansu Province	China	France The U.K.and Northern Ireland	AMS-III.D.ver. 18	3023	8139
27 Dec 12	RE2Grid PoA	Philippines	Sweden	ACM0002 ver. 13	53543	9206
27 Dec 12	UpEnergy Open Access Improved Cookstoves Program in Latin America	Mexico, El Salvador, Nicaragua		AMS-II.G. ver. 3	43646	9218
27 Dec 12	MicroEnergy Credits – Microfinance for Clean Energy Product Lines – India	India		AMS-II.G. ver. 3 AMS-III.AV. ver. 2 AMS-I.A. ver. 14	35131	9181
27 Dec 12	AeroPod Composting and Co-composting Programme in Malaysia.	Malaysia	Netherlands	AMS-III.F. ver. 10	16681	9217
27 Dec 12	Solar PV Power Development Programme in Shandong Province	China	The U.K.and Northern Ireland	AMS-I.F. ver. 2 AMS-I.D. ver. 17	8938	9160
27 Dec 12	Qinghai Province Solar PV Power Generation Programme	China	The U.K.and Northern Ireland	ACM0002 ver. 13	30807	9188
27 Dec 12	Top Third Ventures Stove Programme	Kenya		AMS-II.G. ver. 4	34765	9265
26 Dec 12	Wind and solar PoA in South Africa	South Africa	France	ACM0002 ver. 12	16477	7467

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
25 Dec 12	Animal Manure Treatment Programme in Hubei Province	China	Sweden, The U.K. and Northern Ireland	AMS-III.D.ver. 18	3663	8147
25 Dec 12	Rural Household Biogas Digester Programme in Seven Regions of Sichuan Province	China	Switzerland	AMS-III.R. ver. 2 AMS-I.I. ver. 3	6800	9169
25 Dec 12	Sichuan Province Rural Efficient Biomass Cooking Stoves Programme Project	China		AMS-II.G. ver. 4	9761	9191
24 Dec 12	Sustainable Development Programme of Rural Electrification by Husk Power Systems	India		AMS-I.L.	215	8864
24 Dec 12	Small Scale Grid-connected Solar Power Programme	South Africa	The U.K.and Northern Ireland	AMS-I.D. ver. 17	11191	9126
24 Dec 12	PoA Solar PV in Pakistan	Pakistan		ACM0002 ver. 13	32070	9094
24 Dec 12	CarbonSoft Open Source PoA, LED Lighting Distribution: Emerging Markets	India		AMS-III.AR.ver. 3	3968	7889
24 Dec 12	African Clean Energy Switch – Biogas (ACES-Biogas)	Kenya, Uganda, Rwanda, Ethiopia		AMS-I.E. ver. 5	63934	8239
24 Dec 12	BWC Sustainable Biogas Recovery Programme of Activities in Indonesia	Indonesia	Netherlands	AMS-III.H.ver. 16 AMS-I.D. ver. 17	19844	9096
22 Dec 12	Animal Manure Treatment Programme in Anhui Province, Jiangsu Province and Yunnan Province	China		AMS-III.D.ver. 18 AMS-I.C. ver. 19 AMS-I.F. ver. 2 AMS-I.D. ver. 17	3882	9103
21 Dec 12	Programme for the Capture and Destruction or Utilization of Landfill Gas in Colombia	Colombia		AMS-III.G. ver. 7	20998	8856
21 Dec 12	Standard Bank MSW Composting Programme	Ghana		AM0025 ver. 13	27889	7893

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
21 Dec 12	SimGas Biogas Programme of Activities	Kenya	Netherlands	AMS-III.R. ver. 2 AMS-I.E. ver. 4 AMS-I.I. ver. 3	45156	7734
21 Dec 12	BWC Wind Farm Power Programme of Activities in Viet Nam	Viet Nam	Netherlands	ACM0002 ver. 13	48969	8963
21 Dec 12	China Coal Mine Ventilation Air Methane Oxidization Programme	China	Japan	ACM0008 ver. 7	413219	7654
21 Dec 12	NuPlanet Small Scale Hydropower PoA	South Africa		AMS-I.D. ver. 17	24353	7887
20 Dec 12	Guacamaya Small Scale Hydropower Programme of Activities	Honduras, Nicaragua, Costa Rica	Netherlands Germany	AMS-I.D. ver. 17	5762	8950
20 Dec 12	Development of Programmatic CDM Project for SWH installation under MNRE, UNDP/GEF Global Solar Water Heating Market Transformation and Strengthening Initiatives: India Country Programme	India		AMS-I.J.	8832	8919
20 Dec 12	The National CFL Project, Pakistan	Pakistan		AMS-II.J. ver. 4	550134	7811
20 Dec 12	Programme for SSC Hydropower Plants in rural areas	China		AMS-I.D. ver. 17	18228	8824
19 Dec 12	Côte d'Ivoire and Cameroon Efficient Cookstoves Program	Côte d`Ivoire Cameroon		AMS-II.G. ver. 4	46716	8696
19 Dec 12	East Africa Renewable Energy Programme (EA-REP)	Kenya Rwanda		AMS-I.D. ver. 17	18442	8777
19 Dec 12	Distribution of ONIL Stoves—Guatemala	Guatemala	Netherlands	AMS-II.G. ver. 3	42773	8480
19 Dec 12	Mexico Water, Energy, & Emissions Efficiency Residential Program	Mexico	Switzerland	AMS-II.M.	439	7767
19 Dec 12	Vietnam Renewable Energy Development Program (REDP)	Viet Nam	Sweden	ACM0002 ver. 13	30115	6810

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
19 Dec 12	Sustainability CFL Replacement Programme of Activities in South Africa	South Africa	France	AMS-II.J. ver. 4	29518	7479
18 Dec 12	Solar Energy Programme for South Africa	South Africa		ACM0002 ver. 13	347557	8535
18 Dec 12	Grid Connected Photovoltaic (PV) Renewable Electricity Generating Facilities PoA	South Africa		ACM0002 ver. 13	18241	8630
18 Dec 12	Landfills' gas capture, flaring and use program in Morocco	Morocco	Sweden	ACM0001 ver. 12	138377	6568
18 Dec 12	South African Wind Power Projects	South Africa		ACM0002 ver. 13	93093	8742
18 Dec 12	Grid Connect Solar PV Power Generation Plant Programme	China	Japan	ACM0002 ver. 12	13215	8868
17 Dec 12	Programme of activities to switch from residual fuel oil to LPG in manufacturing industries in Peru	Peru		AMS-III.B.ver. 16	209	6826
17 Dec 12	India Wind Energy Programme of Activities	India	Netherlands Germany	ACM0002 ver. 12	38414	8734
14 Dec 12	Ecoener Small Hydro Programme of Activities	Guatemala		AMS-I.D. ver. 17	24135	8655
14 Dec 12	BWC Sustainable Small Hydropower Programme of Activities in Viet Nam	Viet Nam	Netherlands	AMS-I.D. ver. 17	28590	8627
14 Dec 12	Green Power for South Africa	South Africa	The U.K.and Northern Ireland	ACM0002 ver. 12	80907	7167
13 Dec 12	South African Grid Connected Wind Farm Programme	South Africa		ACM0002 ver. 12	57847	7849
13 Dec 12	Sichuan Animal Farms GHG Mitigation Programme	China	The U.K.and Northern Ireland	AMS-III.D.ver. 18	5093	8733
12 Dec 12	Grid connected electricity generation from wind source under Programme of Activities in Brazil	Brazil		ACM0002 ver. 12	38979	8432
12 Dec 12	Malaysia Biomass Power Plant Project	Malaysia	The U.K.and	ACM0018 ver. 2	123449	5758

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
			Northern Ireland			
12 Dec 12	Green Light for Africa	Kenya Zimbabwe	Switzerland	AMS-II.J. ver. 4	31099	8637
12 Dec 12	Energy Efficient Cook stoves in South Africa	South Africa		AMS-II.G. ver. 3	31576	8640
11 Dec 12	Philippines Mini-Hydro PoA.	Philippines	Germany	AMS-I.D. ver. 17	2000	8674
07 Dec 12	Distribution of ONIL Stoves—Mexico	Mexico	Netherlands	AMS-II.G. ver. 3	40090	8521
06 Dec 12	African Improved Cooking Stoves Programme of Activities	Ghana, Nigeria, Liberia	The U.K.and Northern Ireland	AMS-II.G. ver. 3	15477	5342
06 Dec 12	Improved Cooking Stoves Programme of Activities in Africa	Kenya South Africa	The U.K.and Northern Ireland	AMS-II.G. ver. 3	13556	5341
05 Dec 12	LED's kick-off	South Africa	Netherlands	AMS-II.C. ver. 13	48434	7078
04 Dec 12	Renewable energy utilization in the new and existing buildings in Henan Province	China	The U.K.and Northern Ireland	AMS-I.C. ver. 19 AMS-II.C. ver. 13	896	8526
03 Dec 12	Project to replace fossil fuel based lighting with Solar LED lamps in Africa	Kenya		AMS-III.AR.ver. 3	21393	7489
03 Dec 12	Omega Energia CDM Programme of Activities for the Promotion of Small Hydropower Plants in Brazil	Brazil		ACM0002 ver. 12	21818	7062
30 Nov 12	PoA for the Reduction of emission from non-renewable fuel from cooking at household level	Madagascar, Ethiopia, Kenya, Malawi, Mozambique, Nigeria, Uganda, Zambia, Chad, Dominican Republic Côte d`Ivoire, Liberia, Rwanda, Sierra Leone, Namibia, Zimbabwe, Ghana, South Africa	Norway	AMS-I.E. ver. 4	51385	7359

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
30 Nov 12	Clean Cook Stoves in Sub-Saharan Africa by ClimateCare Limited	Ghana		AMS-II.G. ver. 4	136734	8438
29 Nov 12	GRT Energy Small Scale Solar PV (PoA)	Thailand	Sweden	AMS-I.D. ver. 17	3338	8457
29 Nov 12	Implementation of Grid connected Wind Farm Projects in Chile	Chile		ACM0002 ver. 13	41948	8331
29 Nov 12	India Small Scale Solar PV Programme of Activities	India	Netherlands	AMS-I.D. ver. 17	1340	8426
28 Nov 12	Zhongying Changjiang Small-scale Hydropower Programme of Activities	China		AMS-I.D. ver. 17	22001	8259
26 Nov 12	Small-scale solar electrical programme, South Africa	South Africa		AMS-I.F. ver. 2 AMS-I.D. ver. 17	15022	7484
23 Nov 12	Programme of Activities (PoA) for Sustainable Renewable Energy Power Generation in Papua New Guinea (PNG)	Papua New Guinea		AMS-I.A. ver. 16 AMS-I.F. ver. 2 AMS-I.D. ver. 17	15724	8383
23 Nov 12	Grid Connect SSC Solar PV Power Generation Plant Programme	China	Japan	AMS-I.D. ver. 17	14449	8232
21 Nov 12	CDM Africa Wind and Solar Programme of Activities for South Africa	South Africa		ACM0002 ver. 12	352654	8260
20 Nov 12	Biogas Development Programme at household/ small farm level in Gansu Province	China	The U.K.and Northern Ireland	AMS-I.I. ver. 4 AMS-III.R. ver. 3	8082	8301
19 Nov 12	Welspun Renewable Energy Program	India		ACM0002 ver. 12 AMS-I.D. ver. 17	37739	8261
19 Nov 12	Livestock Farms Methane Engineering Programme in Jiangxi Province	China	The U.K.and Northern Ireland	AMS-III.D.ver. 18 AMS-I.C. ver. 19	1587	3143
19 Nov 12	Biomass Power Development Programme in Thailand	Thailand		AMS-I.D. ver. 17	37941	8088

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
16 Nov 12	International water purification programme	Ethiopia, El Salvador, Chile, Egypt, Kenya, Gambia, Madagascar, Nicaragua, Mexico, South Africa, Uganda, Viet Nam, Iran	Switzerland	AMS-III.AV.	6254	5962
14 Nov 12	EN BADEN Large-Scale Hydro PoA in Peru	Peru		ACM0002 ver. 13	36222	7959
13 Nov 12	Household Biogas Development Programme in Hubei Province	China	Sweden, The U.K. and Northern Ireland	AMS-I.I. ver. 4 AMS-III.R. ver. 2	8318	2901
13 Nov 12	Shinsung Solar Energy Grid Connected Photovoltaic Power Generation PoA	Republic of Korea		AMS-I.D. ver. 17	78	8188
13 Nov 12	Pakistan Domestic Biogas Programme, CDM Programme of Activities	Pakistan		AMS-I.E. ver. 4	27881	8024
12 Nov 12	MicroEnergy Credits – Microfinance for Clean Energy Product Lines - Mongolia	Mongolia	The U.K.and Northern Ireland	AMS-II.E. ver. 10	50133	8142
09 Nov 12	Thailand Small Scale Livestock Waste Management Program	Thailand	Portugal	AMS-III.D.ver. 18	55771	8027
07 Nov 12	Distribution of fuel-efficient improved cooking stoves in Nigeria	Nigeria	Sweden Netherlands	AMS-II.G. ver. 3	46717	6283
07 Nov 12	Improved Cookstoves Program for Zambia	Zambia	Netherlands	AMS-II.G. ver. 3	41046	8060
07 Nov 12	Regional Biogas PoA	Malaysia	France	AMS-III.H.ver. 16 AMS-I.C. ver. 19 AMS-I.F. ver. 2 AMS-I.D. ver. 17 AMS-I.A. ver. 14	27646	7892
06 Nov 12	HuaQi Livestock Farms Methane Engineering Programme of Activities	China		AMS-III.D.ver. 18 AMS-I.C. ver. 19	5345	8058

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
				AMS-I.F. ver. 2		
06 Nov 12	Thailand energy efficiency improvement for street lightings	Thailand	Sweden	AMS-II.L.	23	8055
30 Oct 12	"LED's save energy"	India	Netherlands Germany	AMS-II.C. ver. 13	6258	7897
30 Oct 12	Hydro Alliance Programme of Activities	Guatemala El Salvador	Switzerland	AMS-I.D. ver. 17	3642	7883
29 Oct 12	Recovery and Avoidance of Methane from Industrial Wastewater Treatment Projects	Indonesia		AMS-III.H.ver. 16	38913	7864
29 Oct 12	Programme for Grid Connected Renewable Energy in the Mediterranean Region	Egypt, Lebanon, Morocco, Tunisia	France	ACM0002 ver. 12	20883	7847
24 Oct 12	Wind Programme of Activities in Chile	Chile		ACM0002 ver. 12	19000	7763
18 Oct 12	SH Corporation Solar photovoltaic housing complex programme in Republic of Korea	Republic of Korea		AMS-I.F. ver. 2	1417	6913
17 Oct 12	AWMS Composting Project	Brazil		AMS-III.F. ver. 10	3457	7760
15 Oct 12	Hot Water Heating Programme for South Africa	South Africa	Liechtenstein	AMS-I.C. ver. 19 AMS-II.C. ver. 13	12084	7699
15 Oct 12	Manufacture and Distribution of CFLs in India	India		AMS-II.C. ver. 13	13	6694
10 Oct 12	Promotion of Energy-Efficient lighting using Compact Fluorescent Light Bulbs in rural areas in Senegal	Senegal	Italy	AMS-II.C. ver. 13	4173	5927
09 Oct 12	South Africa Renewable Energy Programme (SA-REP)	South Africa	Switzerland	AMS-I.D. ver. 17	24758	7570
09 Oct 12	Solar Power Programme of Activities	Thailand	Netherlands	AMS-I.D. ver. 17	5784	7636
05 Oct 12	Caixa Econômica Federal Solid Waste Management and	Brazil	Spain	ACM0001 ver. 11	794672	6573

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
	Carbon Finance Project					
05 Oct 12	“Programme for the promotion and development of grid-connected solar PV projects in Latin America”	Chile		ACM0002 ver. 13	22830	7596
03 Oct 12	Nuru Lighting Programme	Kenya	The U.K.and Northern Ireland	AMS-III.AR ver. 2	34294	7470
02 Oct 12	Standard Bank Renewable Energy Programme	Ghana Kenya Mauritius		ACM0002 ver. 12	1074	7522
27 Sep 12	Animal Manure Treatment Programme in Henan Province and Shaanxi Province	China	France, The U.K.and Northern Ireland	AMS-III.D.ver. 18 AMS-I.C. ver. 19 AMS-I.F. ver. 2 AMS-I.D. ver. 17	6325	7460
24 Sep 12	Renewable Energy PoA in India	India	Switzerland	AMS-I.D. ver. 17	3251	6161
14 Sep 12	South Africa Wind Energy	South Africa	Netherlands Germany	ACM0002 ver. 12	93647	6734
14 Sep 12	KTDA Small Hydro Programme of Activities	Kenya		AMS-I.D. ver. 17	24305	6606
13 Sep 12	Wind Power Programme of Activities in Brazil	Brazil	The U.K.and Northern Ireland	ACM0002 ver. 12	21063	7271
09 Sep 12	Municipal Waste Compost Programme in Sri Lanka	Sri Lanka	Republic of Korea	AMS-III.F. ver. 10	6079	7237
06 Sep 12	TUCANO CDM Programme of Activities for the Promotion of Small Hydropower Plants in Brazil	Brazil	Netherlands	ACM0002 ver. 12	13149	7211
05 Sep 12	Indonesia Biogas Projects	Indonesia	The U.K.and Northern Ireland	AMS-III.H.ver. 16	51947	6209
05 Sep 12	TBEC Biogas Programme for South East Asia	Thailand		ACM0014 ver. 4	21279	6819

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
04 Sep 12	Enlightened Solar PoA	Israel	Sweden	AMS-I.D. ver. 17	3043	7191
04 Sep 12	CFL Distribution Programme in Anhui Province	China		AMS-II.J. ver. 4	16493	6119
31 Aug 12	Omega Wind Power Plants Programme of Activities	Brazil	Switzerland	ACM0002 ver. 12	11229	7156
31 Aug 12	Improved Cook Stoves programme for Rwanda	Rwanda	Germany	AMS-II.G. ver. 3	39790	6207
20 Aug 12	Sustainable Small Hydropower Programme of Activities (PoA) in Viet Nam	Viet Nam	Switzerland	ACM0002 ver. 12	8012	6095
17 Aug 12	Improved Cook Stoves for East Africa (ICSEA)	Uganda, Kenya, Burundi, Rwanda, Lesotho, South Africa		AMS-II.G. ver. 3	40577	7014
27 Jul 12	South East Asia Biogas Programme of Activities	Indonesia	Switzerland Netherlands	AMS-III.H.ver. 16 AMS-I.D. ver. 17	19270	6749
25 Jul 12	Biogas Programme Nicaragua (PBN)	Nicaragua	Netherlands	AMS-III.R. ver. 2 AMS-I.E. ver. 4	10014	6813
25 Jul 12	ETA Solar Water Heater Programme in South Africa	South Africa	Finland	AMS-I.J.	20370	6159
25 Jul 12	Chilean Small Hydroelectric Power Plants Programme of Activities	Chile		AMS-I.D. ver. 17	5988	6285
25 Jul 12	Barefoot Power Lighting Programme	Kenya Uganda		AMS-III.AR.	9749	6110
23 Jul 12	Biomass Heat Generation Development Programme of Activities Managed by INTRACO	Viet Nam		AMS-I.C. ver. 19	23754	6731
20 Jul 12	Landfill gas recovery and combustion with renewable energy generation from sanitary landfill sites under Land Bank of the Philippines Carbon Finance Support Facility	Philippines		ACM0001 ver. 11	469182	6707

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
13 Jul 12	Punjab State Electricity Board: High Voltage Distribution System for Agricultural Consumers in the Rural Areas of the Punjab.	India	Denmark	AMS-II.A. ver. 10	3390	5787
13 Jul 12	Inti Renewable Energy Program of Activities	Peru		ACM0002 ver. 12	89998	6622
04 Jul 12	The programme to introduce renewable energy system into Jeju Island	Republic of Korea		AMS-I.F. ver. 2 AMS-I.D. ver. 17	863	6584
29 Jun 12	Co-composting and Composting Program of Activities for Palm Oil Mills in Indonesia	Indonesia		AMS-III.F. ver. 10	10130	6511
28 Jun 12	Tunki Small Scale Hydropower Program of Activities	Peru	Sweden, Germany, Netherlands	AMS-I.D. ver. 17	8634	6198
26 Jun 12	Installation of Solar Home Systems in Bangladesh	Bangladesh	Denmark	AMS-I.A. ver. 14	45713	2765
21 Jun 12	Mexican Renewable Energy Alliance Programme of Activities (PoA)	Mexico Malaysia	Switzerland	ACM0002 ver. 12	18417	6434
15 Jun 12	CFL Distribution Programme in Jiangsu Province	China		AMS-II.J. ver. 4	29970	5272
12 Jun 12	Solarwave water purification	United Republic of Tanzania	Sweden	AMS-III.AV.	5184	2900
08 Jun 12	Installing Solar Water Heating Systems in the South of Viet Nam	Viet Nam	Japan	AMS-I.J.	57	6337
06 Jun 12	National Solar Power Development Programme, India	India		AMS-I.D. ver. 17	6683	6328
31 May 12	Green Brick Development Programme of Activities Managed by INTRACO	Viet Nam	The U.K.and Northern Ireland	AMS-III.Z. ver. 3	29488	6299
15 May 12	Small-Scale Renewable Energy PoA in Thailand	Thailand	Switzerland Sweden	AMS-I.D. ver. 17	7918	6222
10 May 12	Methane recovery and combustion with renewable energy	Philippines	Spain	AMS-III.D.ver. 17	23105	5979

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
	generation from anaerobic animal manure management systems under the Land Bank of the Philippines's (LBP) Carbon Finance Support Facility					
02 May 12	Sustainable Small Hydropower Programme of Activities (PoA) in Indonesia	Indonesia	Switzerland	AMS-I.D. ver. 17	5321	5616
27 Apr 12	Small hydropower programme in Mexico	Mexico	The U.K.and Northern Ireland	AMS-I.D. ver. 17	4811	5931
24 Apr 12	Standard Bank Low Pressure Solar Water Heater Programme for South Africa	South Africa	The U.K.and Northern Ireland	AMS-I.C. ver. 19	39266	5997
20 Apr 12	Than Thien Small Hydropower Programme of Activities Managed by INTRACO	Viet Nam	Netherlands	AMS-I.D. ver. 17	3386	5324
11 Apr 12	Sichuan Rural Poor-Household Biogas Development Programme	China	The U.K.and Northern Ireland	AMS-I.C. ver. 19 AMS-III.R. ver. 2	1493717	2898
28 Mar 12	First Solar PoA in India by SENES Consultants	India	Switzerland	AMS-I.D. ver. 16	22762	5588
21 Mar 12	Efficient Cook Stove Programme: Kenya	Kenya	The U.K.and Northern Ireland	AMS-II.G. ver. 3	50761	5336
23 Nov 11	Malaysia Biogas Projects	Malaysia	France, The U.K,.and Northern Ireland	AMS-III.H.ver. 15	38139	5034
22 Nov 11	Composting and Co-composting Programme of Activities (PoA) in Indonesia	Indonesia	Switzerland	AMS-III.F. ver. 8	22416	5104
10 Nov 11	Improved Cooking Stoves for Nigeria Programme of Activities	Nigeria		AMS-II.G. ver. 3	8912	5067
25 Oct 11	"Turbococinas", rural cooking stove substitution program in El Salvador	El Salvador	Switzerland	AMS-II.G. ver. 3	46584	5092
19 Oct 11	The programme to promote efficient lightings in local areas	Republic of Korea		AMS-II.C. ver. 13	51	5019

Registered	Title	Host Parties	Other Parties	Methodology *	Reductions **	Ref
19 Jul 11	Improved Cooking Stoves in Bangladesh	Bangladesh	The U.K.and Northern Ireland	AMS-II.G. ver. 3	50233	4791
13 May 11	Efficient Lighting Initiative of Bangladesh (ELIB)	Bangladesh	Denmark	AMS-II.J. ver. 4	17540	4793
11 May 11	Egypt Vehicle Scrapping and Recycling Program	Egypt	Denmark	AMS-III.C. ver. 11	20	2897
13 Apr 11	Solar Water Heater Programme in Tunisia	Tunisia	France	AMS-I.C. ver. 17	7242	4659
12 Mar 11	SASSA Low Pressure Solar Water Heater Programme	South Africa	The U.K.and Northern Ireland	AMS-I.C. ver. 17	76945	4302
12 Feb 11	SGCC In-advance Distribution Transformer Replacement CDM Programme	China	Spain	AMS-II.A. ver. 10	4079	2896
12 Jan 11	Promotion of Biomass Based Heat Generation Systems in India	India	Germany The U.K.and Northern Ireland	AMS-I.C. ver. 16	400000	4041
21 Aug 10	Masca Small Hydro Programme	Honduras	Netherlands	AMS-I.D. ver. 13	4395	3562
29 Apr 10	CFL lighting scheme – "Bachat Lamp Yojana"	India	Netherlands	AMS-II.J. ver. 3	34892	3223
12 Apr 10	Uganda Municipal Waste Compost Programme	Uganda		AMS-III.F. ver. 6	83700	2956
29 Oct 09	Methane capture and combustion from Animal Waste Management System (AWMS) of the 3S Program farms of the Instituto Sadia de Sustentabilidade	Brazil	The U.K.and Northern Ireland	AMS-III.D.ver. 13	591418	2767
31 Jul 09	CUIDEMOS Mexico (Campana De Uso Intelegente De Energia Mexico) - Smart Use of Energy Mexico	Mexico	Switzerland The U.K.and Northern Ireland	AMS-II.C. ver. 9	520365	2535

[a] AM - Large scale, ACM - Consolidated Methodologies, AMS - Small scale

[b] Estimated emission reductions in metric tonnes of CO2 equivalent per annum (as stated by the project participants)

Source: UNFCCC (2014b)