IEL PAPER IN COMPARATIVE ANALYSIS OF
INSTITUTIONS, ECONOMICS AND LAW NO. 10

The Correlated Factors of the Uneven Performances of the CDM Host Countries

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March 2012

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Abstract

The Kyoto Protocol's Clean Development Mechanism (CDM) has experienced a rapid growth. Until 2010, 2763 projects have been registered, standing for about 433 million ton CO_2 equivalent (CO_2-eq.) of annual carbon credits. However, the performances of CDM host countries are remarkably unbalanced. Previous literatures suggested that economic and investment conditions, energy intensity, energy structure, the share of annual carbon credits from high Global Warming Potential (GWP) Green House Gas (GHG), capacity and institutional buildings of domestic CDM governance can play important roles in promoting CDM. This quantitative analysis shows that domestic economic and investment conditions are the most decisive factors determining the performance of the CDM host countries. Additionally, the influence of carbon intensity of energy consumption is relatively modest, and energy intensity of GDP as well as the share of annual carbon credits from high Global Warming Potential (GWP) Green House Gas (GHG) is less significant. Moreover, several leading CDM countries are not as successful as they seem to be, when the influences of their vast territories, distinguished economic and investment conditions are excluded. Therefore, to simply transplant the CDM governances of these countries can hardly guarantee other countries in boosting their carbon credits outputs.

Keywords: CDM, econometrics, law and economic, empirical study, efficiency, equity

Introduction

Although the Kyoto Protocol's Clean Development Mechanism (CDM) has experienced a rapid growth, CDM performances are uneven across the CDM host countries. Both China and India hold remarkable shares in the international CDM market. Latin American and Southeast Asia are also active in the CDM practice. Central Asia and the Caucasus region have participated fairly as well. However, African countries have been largely left behind. The performance of a CDM host country can be influenced by various factors, including attractiveness to foreign investment, stage and momentum of economic development, energy and carbon intensities of the economic

body, share of carbon credits from high Global Warming Potential (GWP) GHG in the CDM practices, and domestic CDM governances.

The countries' attractiveness and economic development are relevant factors, because the CDM project is in principle a kind of Foreign Direct Investment (FDI) (MDSP, 2001), which requires "stable political regimes, strong legal environments for contracts and proven enforcement capabilities, macro-economic stability, availability of pools of skilled workers, institutional capacities and other sources of human capital (Ellis, et al., 2007)." Olawuyi (2009) argues that the distinct differences of "economic, social and administrative conditions among developing countries" determine the uneven attractiveness of the CDM host countries. A World Bank report holds that a country's size, economic scale, and investment climate all contribute to the CDM performance (Capoor, et al., 2008). In practice, Schatz (2008) observed that advanced developing nations are more preferred by investors. A country's investment attractiveness can be measured by FDI, as done in previous empirical and econometric studies (Jung, 2006; Ellis, et al., 2007; Larson, et al., 2007; Dechezlepretre, et al., 2008; Song, 2010). Moreover, a country's general static and dynamic economic conditions, which are reflected by GDP per capita, and GDP growth rate, can also influence its attractiveness.

Carbon and energy intensities have also been regarded as relevant factors. Projections have been made that those countries "where the major energy users (e g, power plants and heavy industries) are relatively energy-intensive and inefficient would have the greatest potential for large and cheap CDM projects" (Jotzo, et al., 2002) and are likely to have a "relatively large share of the CDM market" (Gupta, 2003). Gupta (2003) further inferred that China and India would "play an important role" in CDM practice, due to their coal-based energy structure, that is, carbon intensity of energy. Moreover, together with GDP per capita and population, carbon intensity of energy consumption and energy intensities of GDP are components of a country's entire CO_2 emission, which factors are also known as Kaya identities (Kaya, et al., 1997).

Among the GHG regulated by the Kyoto Protocol, several non-CO_2 GHGs have high GWP (IPCC, 1996). Consequently, large shares of carbon credits (Wara, 2008) can be produced by reducing the non-CO_2 GHG at relatively lower costs (Zhang, et al., 2010), which are more attractive to investors. These carbon credits result in a windfall for the countries hosting these

projects (Schatz, 2008; Schroeder, 2009). In this sense, it is reasonable to suspect that the share of high GWP GHG may influence the performance of a CDM host country (Song, 2010).

Moreover, domestic CDM governance made especially for promoting CDM, varying in different countries (Fuhr, et al., 2009), are usually remarked and presumably regarded as an important factor influencing countries' CDM performances. Theoretically, the concepts of "capacity building" and "institutional building" are usually advised as the solutions to improve the performances of CDM host countries (Zhang, 2009; Gupta, 2003; Morera, et al., 2003; MDSP, 2001), where capacity building refers to raising the awareness, strengthening the market confidence and providing necessary technical support, and institutional building refers to streamlining the application procedures of the CDM projects and imposing national requirements on CDM projects considered by the national government as helpful to domestic development. Zhang (2009) firmly regards capacity building as one key reason for China's success in CDM and makes it a recipe for other CDM host countries with modest performances. Interestingly, the capacity building had started in African countries (Dayo, 2005) even before China entered CDM market, but the progress in these countries was still modest until very recently.

Although possible factors are suggested explaining the uneven performances of the CDM host countries, quantitative analysis is still rare. The most recent research (Song, 2010) can only partly explain (Pseudo R^2: 0.2370) these countries' inconsistencies. The present study, however, can explain about 60% of CDM host countries' performances (adjusted-R^2: 58%), thanks to the more properly chosen indicators. It shows that the most decisive factors determining the performances of the CDM host countries are the domestic economic and investment conditions, which can be measured by the foreign direct investment (FDI), GDP per Capita, and GDP per Capita growth rate. The carbon intensity of energy consumption is relatively less significant factor. So are the influences of energy intensity of GDP and the share of annual carbon credits from high Global Warming Potential (GWP) GHG. Moreover, several leading CDM countries are not as successful as they seem to be, when the influences from their economic and investment conditions are excluded. Therefore, this finding rebuts the claim that the CDM governances of these countries are decisive in promoting their CDM performances. For the same reason, it is implausible to heavily rely on the transplantations of the CDM governances from these countries to help other countries in boosting their carbon credit outputs.

Data

This study is based on Project Design Documents (PDDs) of the registered CDM projects, which are posted on the web page of the United Nations Framework Convention on Climate Change (UNFCCC) and are available to the public. Each PDD describes a CDM project registered at the CDM Executive Board (EB), the international CDM authority. It includes the project's detailed information, such as host country, methodology applied, and expected annual GHG mitigation, which are the data sources of this empirical study.

This empirical research reflects all 2763 projects worldwide registered during 2004-2010 and posted online by 4 April 2011 (UNFCCC, 2005-2010). Although 152 countries (UNFCCC, 2011), known as non-Annex-I countries, are qualified to host CDM projects, only 69 among them have the CDM projects registered by the end of 2010 (UNFCCC, 2005-2010).

Apart from expected output of countries' annual carbon credits and the shares of high GWP GHG in the annual carbon credits (UNFCCC, 2005-2010), which are traceable from the CDM PDDs, background data of the CDM host countries are collected as follows: the amount of the inward FDI in year 2007 (UNCTAD, 2008), the GDP per capita in 2005 (UN, 2010a), the average growth rate of GDP per capita during 1990-2008 (UN, 2010b), the average carbon intensity per unit of primary energy consumption during 2005-2008 (US EIA, 2011), the average primary energy consumption per unit of GDP during 2005-2008 (US EIA, 2011), and the land area of these countries (US CIA, 2011). Since the scope of this research is to identify and evaluate factors influencing the CDM performance of the CDM host countries that have been active in the CDM business, countries without any projects registered during 2004-2010 are not included in this analysis.

Methods

Methodologically, the positive law and economic discipline is employed, which relays on the result of objective and systemic economic analysis to explain why the performances of CDM host countries are unbalanced. Technically, econometrics is employed to develop regression models so that the actual decisive factors influencing a country's CDM performance can be

qualitatively identified. A country's CDM performance is influenced by both general domestic conditions and the specific efforts made in CDM governance, but the latter is hard to measure quantitatively (Song, 2010). Hence, the performance of a country's CDM performance in terms of promoting more carbon credits output is assessed by stepwise measuring and excluding the more measurable factors.

In the following regression analysis, the explained variable is a country's annual carbon credit output from the registered projects divided by the country's land area. The explained variable is chosen for three reasons: the countries' territorial areas vary dramatically and have little applied significance in the policy making; projects waiting for registration have neither any guarantee of registration nor an identical registration rate across countries (Song, 2010); the annual carbon credits output, rather than the number of CDM projects, are better indicator reflecting the scale of a country's CDM industry, for CDM projects can have different sizes, and have even been bundled in practice.

The explaining variables are FDI per area of land, GDP per capita, growth rate of GDP per capita, energy intensity of GDP, carbon intensity of energy consumption, and the share of the annual carbon credits from high GWP GHG. These variables reflect the widely concerned factors that may influence a country's CDM performances. FDI per area of land is chosen because CDM is essentially a kind of foreign investment, which deserves a direct highlight. Additionally, the CDM performance is measured by per area of land, so FDI is also measured by per area of land. With these considerations, FDI per area of land, rather than FDI (Song, 2010) or FDI as a share of GDP (Larson, et al., 2007; Dechezlepretre, et al., 2008), is chosen. GDP per capita, rather than GDP per land area, is chosen, as the former is a more common measurement of a country's static prosperity. The growth rate of GDP per capita is needed to reflect a country's dynamic development. Energy intensity of GDP and carbon intensity of energy consumption are necessary variables, as a country's GHG emission is usually dominated by CO_2 emission from the energy sector. The share of the high GWP GHG in the annual carbon credits output is to reflect the role played by the non-CO_2 GHG. Among the four Kaya (1997) Identities (population, GDP per capita, energy intensity of GDP, and carbon intensity of energy), only population is not included, as it has limited applied significance in CDM policy-making. In addition, should the indicators be correlated, a correlation analysis for all the explaining variables is conducted.

To identify the significant variables that influence the performances of CDM host countries, a sequential model has been constructed. At first, a simple regression was carried out, which takes FDI per square kilometre as the unique variable to explain the annual carbon credits per square kilometre in a CDM host country (Equation 1). The second step took in account of country's general economic conditions, which involves the GDP per capita and growth rate of GDP per capita in the regression (Equation 2). In the third step, carbon intensities per unit of energy consumption was further included, which indicates country's energy structure (Equation 3). Then, in the fourth step, energy intensity per unit of GDP will be regarded, indicating country's industrial structure in terms of energy intensity (Equation 4). At last, share of high GPW GHG in annual carbon credits was taken into consideration (Equation 5). The same analysis is run for another two times, but excluding high value outliers (China, and India) and low value outliers (Lao and Paraguay) respectively, to ensure that the result is robust and advisable to other host countries.

$$\ln(\text{annual carbon credits per square kilometre})$$

$$= \beta_1 \times \ln(FDI\ per \text{ per square kilometre of } land\ area)$$

$$+\mu$$

Equation 1

$$\ln(\text{annual carbon credits per square kilometre})$$

$$= \beta_1 \times \ln(FDI\ per \text{ per square kilometre of } land\ area)$$

$$+\beta_2 \times \ln(GDP\ per\ capita)$$

$+\beta_3 \times \ln(growth\ rate\ of\ GDP\ per\ capita)$

$+\mu$

Equation 2

$\ln(\text{annual carbon credits per square kilometre})$

$= \beta_1 \times \ln(FDI\ per$ per square kilometre of $land\ area)$

$+\beta_2 \times \ln(GDP\ per\ capita)$

$+\beta_3 \times \ln(growth\ rate\ of\ GDP\ per\ capita)$

$+\beta_4 \times \ln(carbon\ intensity\ of\ energy\ consumption)$

$+\mu$

Equation 3

$\ln(\text{annual carbon credits per square kilometre})$

$= \beta_1 \times \ln(FDI\ per$ per square kilometre of $land\ area)$

$$+\beta_2 \times \ln(GDP\ per\ capita)$$

$$+\beta_3 \times \ln(growth\ rate\ of\ GDP\ per\ capita)$$

$$+\beta_4 \times \ln(carbon\ intensity\ of\ energy\ consumption)$$

$$+\beta_5 \times \ln(energy\ intenstiy\ of\ GDP)$$

$$+\mu$$

Equation 4

$$\ln(\text{annual carbon credits per square kilometre})$$

$$= \beta_1 \times \ln(FDI\ per\ \text{per square kilometre of}\ land\ area)$$

$$+\beta_2 \times \ln(GDP\ per\ capita)$$

$$+\beta_3 \times \ln(growth\ rate\ of\ GDP\ per\ capita)$$

$$+\beta_4 \times \ln(carbon\ intensity\ of\ energy\ consumption)$$

$$+\beta_5 \times \ln(energy\ intenstiy\ of\ GDP)$$

$$+\beta_6 \times share\ of\ annual\ carbon\ credits\ from\ high\ GWP\ GHG$$

$$+\mu$$

Equation 5

The results of the series of statistical models are used to identify which variables considered above are the most decisive factors for the performances of CDM host countries. The most decisive factors are further employed to build up an equation to calculate the estimated values of annual carbon credits per unit area (Equation 6). The ratio between a country's real annual carbon credits and the estimated annual carbon credits per unit area will be calculated by Equation 7 and ranked. These ratios are so made that excludes the generally decisive background conditions of CDM host countries. Apart from the regression result, this study will provide two types of rankings: First type of ranking is based on the expected annual carbon credit output per area of land of a CDM host country, which exclude the influence of the various country sizes; the second type of ranking excludes not only the influence of their land sizes but also the influences of other decisive background factors that will be identified in the regression analysis.

$$expected\ carbon\ credits\ per\ unit\ area = f(decesive\ factor_1, \dots, decesive\ factor_i)$$

,

$$where\ i = 1,2,3,4,5,or\ 6$$

Equation 6

$$ratio = \frac{real\ annual\ carbon\ credits\ per\ unit\ area}{expected\ carbon\ credits\ per\ unit\ area}$$

Equation 7

Results

The regression equations with different variables included are given in Equations 1-5. A simple regression made to FDI per unit area shows that this variable alone, significant at 1% level, can explain more than 46% (Table 1: the adjusted R-square) of the explained variable. After adding the GDP per capita and growth rate of GDP per capita, F-tests show that these two variables are jointly statistical significant at 1% level. When the carbon intensity of energy consumption is further added, the adjusted R-square increases another 2%. However, when carbon intensity of energy consumption and energy intensity of GDP are regarded together, the F-test can reject their jointly statistical significance even at 10% level. Neither any combination among the share of annual carbon credits from high GWP GHG, carbon intensity of energy consumption and energy intensity of GDP is jointly statistically significant at 10% level.

Table 1 Results of estimated equations with different explaining variables (standard errors are reported in parenthesis)

	dependent variable: ln(annual carbon credits per square kilometer)				
Equation in regard	1	2	3	4	5
independent variables	1	3	4	5	6
ln(FDI per unit of land area)	0.6777 (0.0877)	0.4252 (0.1112)	0.3868 (0.1116)	0.3829 (0.1114)	0.3547 (0.1148)
ln(GDP per Capita)		0.4395 (0.1841)	0.4592 (0.1816)	0.4604 (0.1812)	0.4769 (0.1819)
GDP per Capita growth rate		0.2841 (0.084)	0.2856 (0.0827)	0.2782 (0.0828)	0.2878 (0.0833)
ln(CO2 emission per unit primary energy consumption)			0.7131 (0.4055)	0.8269 (0.4174)	0.7833 (0.4194)
ln(primary energy consumption per unit GDP)				0.2738 (0.2454)	0.2509 (0.2464)
Share of high GWP GHG in annual carbon credits					0.4887 (0.4789)
Intercept	2.9624 (0.3436)	-1.8638 (1.6655)	4.8534 (4.1566)	3.3706 (4.3563)	2.7793 (4.3933)
R-square	0.4710	0.5869	0.6059	0.6135	0.6199
adjusted R-square	0.4631	0.5678	0.5813	0.5829	0.5831

The regression result of equation 5, where all the six variables are included, shows that the economic and investment factors, namely, GDP per capita, growth rate of GDP per capita, and FDI per unit of land area, are much more influential than other factors. The growth rate of GDP per capita and FDI per unit of land area are significant at 1% level respectively, and GDP per capita is significant at 5% level. Meanwhile, the carbon intensity of energy consumption is not significant at 5% level but significant at 10% level. However, the energy intensity of GDP and share of annual carbon credits from high GWP GHG are not statistically significant even at 30% level.

When simple regressions are made to the FDI per unit of area, GDP per capita, or growth rate of GDP per capita individually, they can explain about 46%, 39% and 18% of the annual carbon credits per unit of area respectively, according to the respective adjusted-R^2. This means the FDI per unit area is the most decisive factor for a country's performance on CDM. Moreover, FDI per unit of area, GDP per capita and growth rate of GDP per capita are correlated to each other (Table 2). According to the adjusted-R^2 (Table 1), these three factors can explain about 57% of the annual carbon credits per unit of area. In short, the performance of CDM host countries mainly depends on the domestic economic and investment conditions.

Table 2 correlations among the explaining variables

correlations	FDI per unit of land area*	GDP per Capita 2005*	GDP per Capita growth rate	CO2 emission per unit primary energy consumption*	primary energy consumption per unit GDP*	Share of high GWP GHG in annual carbon credits
FDI per unit of land area*	1.0000					
GDP per Capita 2005*	0.6992	1.0000				
GDP per Capita growth rate	0.2481	0.2176	1.0000			
CO2 emission per unit primary energy consumption*	0.2133	0.1055	0.0394	1.0000		

primary energy consumption per unit GDP*	0.0052	0.0141	0.0802	-0.2381	1.0000	
Share of high GWP GHG in annual carbon credits	0.2561	0.1108	-0.0392	0.1392	0.0572	1.0000

China, India and Brazil are impressive CDM host countries in terms of their remarkable market shares, total number of projects registered and the total annual carbon credits expected. However, with respect to the expected annual carbon credits of each unit of land area, China, India, and Brazil are no longer leading players. The ranking of annual carbon credits per unit of area (Figure 1) shows that the top 5 countries are Qatar, Republic of Korea, Singapore, Israel, and El Salvador, followed by China and India. Moreover, Brazil is only listed at the middle range of CDM host countries, behind not only most Latin American countries, but behind several African countries as well.

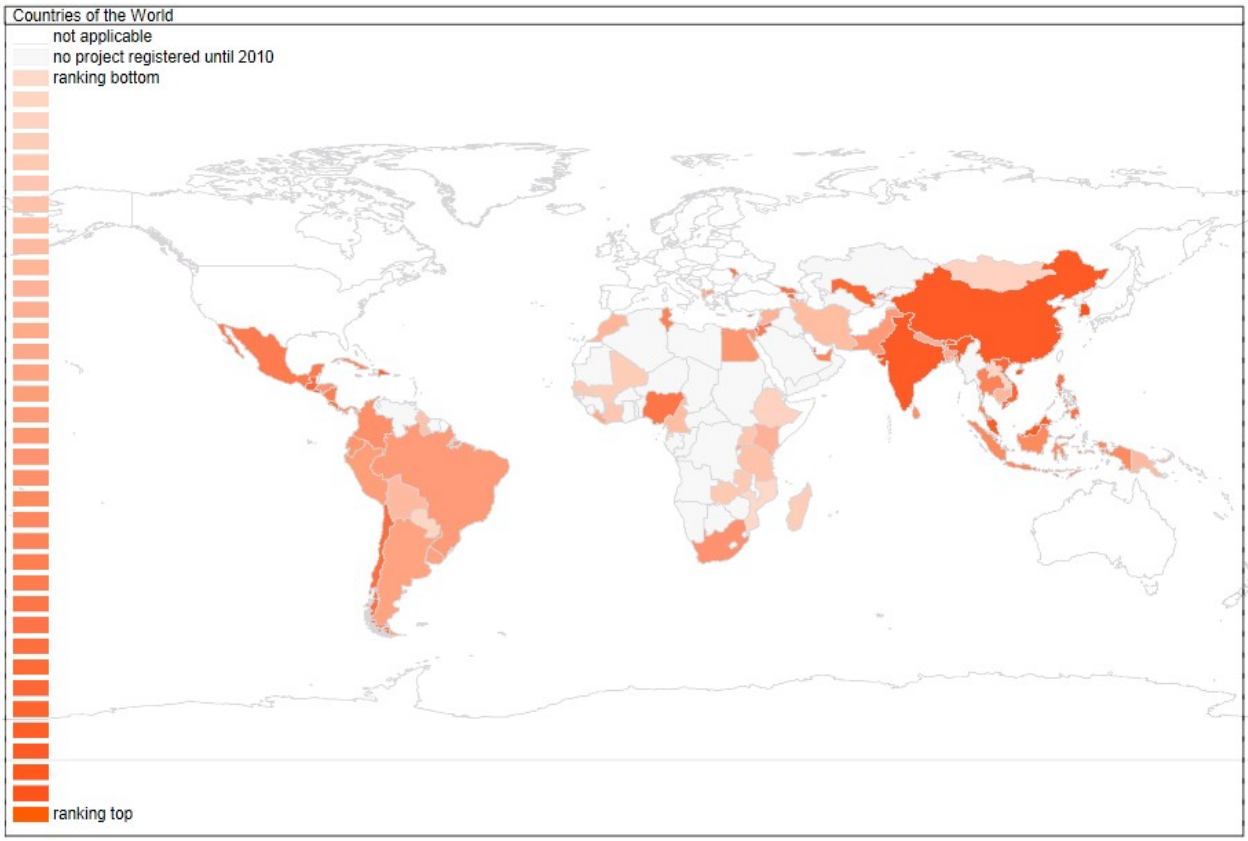

Figure 1 Ranking according to annual carbon credits per unit of land area of the CDM host countries

When a country's land area, domestic economic and investment conditions, the most decisive aspects influencing CDM performances, are further excluded, the ranking of the host countries' performances in promoting CDM varies even more dramatically. Paraguay and Laos, with the least and 2nd least annual carbon credits output per unit land area (Figure 1) become the 1st and 2nd best CDM host countries in terms of their ranking when we exclude the influences of national land area, domestic economic and investment conditions (Figure 2). Conversely, China and India shift from the group of leading countries in the first type of ranking (Figure 1) to countries at the bottom in the second type of ranking (Figure 2). This result reaffirms that China and India's successes are mainly attributable to their economic and investment conditions and their vast land areas. Contrarily, several African countries, including Morocco, Ethiopia and Uganda get good positions in the ranking excluding the influences of land areas, economic and investment conditions (Second type of ranking, Figure 2), implying their effective promotion of CDM despite their less advantageous economic and investment climate and moderate country sizes.

Therefore, neither is it fair to assert that African countries completely failed to carry out sufficient capacity and institutional building in the CDM governances.

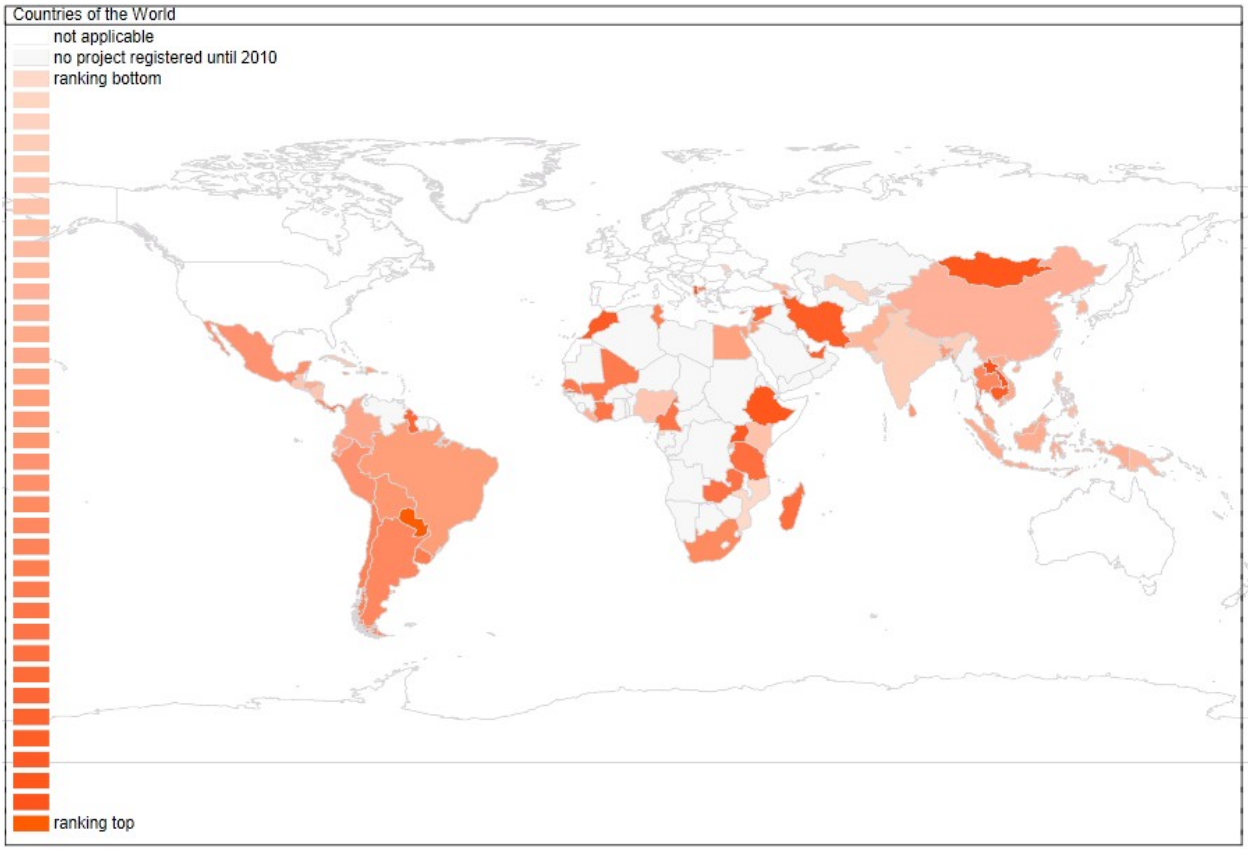

Figure 2 Ranking of CDM host countries' performances excluding the effluences of the general economic and investment conditions and countries' sizes

The regression analysis without high value outliers (China and India) or without low value outliers (Lao and Paraguay), does not show a significant difference (see Appendix Table 1, 2, 3 and 4), compared with the above result. Actually, without high or low value outliers, the R-square is very close to the study with all samples, so are the values of the explaining variables. Neither does the second type of ranking change dramatically. Hence, the research is robust in this aspect.

Discussion

This research, with a significant and much higher R-square value, has better explained the performances of CDM host countries than the most recent study (Song, 2010), compared to which the samples here are exclusively collected from successfully registered projects, and with a longer time duration (2005-2010). The indicators chosen have been proven as better explanatory ones. However, as this study concerns the economic factors, the technological factors, such as CDM projects relying on different methodologies and technologies, have not been intensely addressed. Nevertheless, neither the energy structure nor the share of non-CO_2 GHG shows as a decisive factor in a country's CDM performance. On the contrary, the strong correlation between a country's CDM performance and its economic conditions supports that the CDM arrangement is market-oriented and prefers countries with the better economic and investment conditions, although it has not evenly benefited all CDM host countries.

This study is a static analysis, however, the CDM practice, though with a relatively short duration, is a dynamic one. Not only new CDM methodologies can be proposed over time, but also can the same methodologies and tools be revised into new versions. For instance, the changing CDM rules on the land use, land use change and forestry (LULUCF) projects may contribute to the projects in this kind, which had delayed its mergence until 2009, save one registered in China, 2006 (Table 3). Although LULUCF projects hold none or small shares in most CDM host countries, it is very important for countries like Albania and Ethiopia. For the sake of the countries with a special type of potential in the GHG mitigation, when the relevant rules and methodologies can be provided or improved, their performances in the CDM practice can also be enhanced.

Table 3 land use, land use change and forestry (LULUCF) projects

Country with LULUCF projects	Share of LULUCF projects in the regarded country	the year the first LULUCF project has been registered
Albania	100.00%	2010
Bolivia	0.77%	2009
Brazil	0.35%	2010
Chile	0.19%	2010
China	0.04%	2006
Colombia	1.13%	2010

Ethiopia	100.00%	2009
India	0.01%	2009
Paraguay	8.14%	2009
Peru	1.93%	2009
Moldova	1.05%	2009
Uganda	13.32%	2009
Uruguay	8.04%	2010
Vietnam	0.09%	2009

Moreover, although the economic conditions are decisive, capacity building may still be a relevant factor. Jung (2006) has mentioned that a huge amount of financial resources have been used for Cambodia's capacity building but that this investment has largely been in vain. However, when the most decisive factors are excluded, Cambodia has performed fairly (Figure 2). Therefore, the role of capacity building should neither be over-exaggerated nor ignored.

Conclusion

Years of CDM practice show that the developing countries did not evenly benefit from the CDM. This study shows that the uneven performances are mainly attributable to domestic economic and investment conditions, among which FDI is a very influential factor, a similar finding to Song (2010) but directly contradicting to Niederberger (2005). Although previous literature suggested that energy structure (Gupta, 2003), the share of annual carbon credits from high GWP GHG (Zhang, et al., 2010), capacity building and institutional building of CDM governance (Zhang, 2009) can play important roles in promoting CDM, the present analysis weakens these arguments. Moreover, Song (2010) has suggested a country's total GHG emission as an important factor. This study supports this point, and further shows that it is mainly due to a country's GDP per capita rather than its carbon intensity. Moreover, the analysis also reveals that large countries, such as China and India, which are commonly regarded as leading CDM host countries did not perform as perfect as they seem to be. If the contributions of domestic economic and investment conditions as well as vast national land areas are excluded, neither China nor India provides an excellent example in promoting CDM. This result suggests that the contribution of the CDM governance in China and India may be exaggerated. Hence, it

challenges whether the transplantation of China's or India's CDM governance would be a promising solution to boost the carbon credit output of other CDM host countries. Nevertheless, the capacity building and CDM governance can still be the relevant factors, as long as their effects are not over-expected. In addition, could the relevant CDM methodologies and tools be provided or improved targeting on certain types of projects, it would benefit countries rich in such projects. Generally speaking, the uneven economic and investment conditions has largely determined the uneven performances of the CDM host countries, for the investors rationally prefer countries with better infrastructure and promising prospects, where the GHG mitigation can be achieved more efficiently, this is also, the implication of initial CDM design. In a boarder sense, as is a classic paradox between efficiency and equity, it is contradictory to expect a market-based mechanism like CDM to achieve both efficiency and equity simultaneously without compromising each other, which is the advisable lesson learnt from the CDM for the future climatic policy-making.

Appendix:

Appendix Table 1 results of estimated equations with different explaining variables; standard errors are reported in parenthesis (without high value outliers China and India samples)

	dependent variable: ln(annual carbon credits per square kilometer)				
Equation in regard	1	2	3	4	5
independent variables	1	3	4	5	6
ln(FDI per unit of land area)	0.6801 (0.0853)	0.4248 (0.1107)	0.3897 (0.1119)	0.3850 (0.1121)	0.3580 (0.1157)
ln(GDP per Capita)		0.4749 (0.1841)	0.4884 (0.1823)	0.4872 (0.1826)	0.5018 (0.1833)
GDP per Capita growth rate		0.2355 (0.0926)	0.2468 (0.0919)	0.2472 (0.0920)	0.2588 (0.0928)
ln(CO2 emission per unit primary energy consumption)			0.6317 (0.4105)	0.7395 (0.4270)	0.7041 (0.4289)
ln(primary energy consumption per unit GDP)				0.2318 (0.2498)	0.2131 (0.2508)
Share of high GWP GHG in annual carbon credits					0.4601

					(0.4808)
Intercept	2.8990 (0.3350)	-2.0572 (1.662)	3.9031 (4.2074)	2.7600 (4.3886)	2.2334 (4.4260)
R-square	0.4950	0.5886	0.6038	0.6093	0.6152
adjusted R-square	0.4873	0.5691	0.5782	0.5773	0.5767

Note: "ln" refers to the natural logarithm value.

Appendix Table 2 Correlations among the explaining variables, without high value outliers China and India samples

correlations	FDI per unit of land area*	GDP per Capita 2005*	GDP per Capita growth rate	CO2 emission per unit primary energy consumption*	primary energy consumption per unit GDP*	Share of high GWP GHG in annual carbon credits
FDI per unit of land area*	1.0000					
GDP per Capita 2005*	0.7002	1.0000				
GDP per Capita growth rate	0.2774	0.2525	1.0000			
CO2 emission per unit primary energy consumption*	0.2177	0.1143	-0.0184	1.0000		
primary energy consumption per unit GDP*	0.0071	0.0201	0.0194	-0.2651	1.0000	
Share of high GWP GHG in annual carbon credits	0.2514	0.1094	-0.0627	0.1323	0.0517	1.0000

Note: the variables with * are taken in the forms of the natural logarithm values.

Appendix Table 3 results of estimated equations with different explaining variables; standard errors are reported in parenthesis (without low value outliers Lao and Paraguay samples)

	dependent variable: ln(annual carbon credits per square kilometer)

Equation in regard	1	2	3	4	5
independent variables	1	3	4	5	6
ln(FDI per unit of land area)	0.6181 (0.0778)	0.2640 (0.0935)	0.3766 (0.0949)	0. 3715 (0. 0933)	0. 3534 (0. 0965)
ln(GDP per Capita)		0.4450 (0.1547)	0.4399 (0.1551)	0.4492 (0.1526)	0. 4557 (0. 1537)
GDP per Capita growth rate		0.2806 (0.0715)	0.2760 (0.0718)	0.2619 (0.0711)	0. 2683 (0. 0718)
ln(CO2 emission per unit primary energy consumption)			-0.3573 (0.4164)	-0.2614 (0.4133)	-0.2761 (0.4151)
ln(primary energy consumption per unit GDP)				0.3659 (0.2086)	0.3500 (0. 2103)
Share of high GWP GHG in annual carbon credits					0. 3158 (0. 4040)
Interception	2.8964 (0.3011)	-1.9676 (1.3948)	-5.3702 (4.2045)	-7.9112 (4.3821)	-8.156 (4.407)
R-square	0.4923	0.6369	0.6438	0.6609	0.6643
adjusted R-square	0.4845	0.6224	0.6208	0.6331	0. 6307

Note: “ln” refers to the natural logarithm value.

Appendix Table 4 Correlations among the explaining variables, without low value outliers Lao and Paraguay samples

correlations	FDI per unit of land area*	GDP per Capita 2005*	GDP per Capita growth rate	CO2 emission per unit primary energy consumption*	primary energy consumption per unit GDP*	Share of high GWP GHG in annual carbon credits
FDI per unit of land area*	1.0000					
GDP per Capita 2005*	0.6961	1.0000				
GDP per Capita growth rate	0.2495	0.2317	1.0000			
CO2 emission per unit	0.1611	0.0806	-0.0338	1.0000		

primary energy consumption*						
primary energy consumption per unit GDP*	0.0338	0.0213	0.1258	-0.1328	1.0000	
Share of high GWP GHG in annual carbon credits	0.2331	0.0913	-0.0491	0.0812	0.0833	1.0000

Note: the variables with * are taken in the forms of the natural logarithm values.

Reference:

Capoor, Karan and Ambrosi, Philippe. 2008. *State and Trends of the Carbon market 2008.* (Washington, D.C : World Bank, 2008)

Dayo, Felix B. 2005. *Salient Experiences: CDM Capacity Building Project in Nigeria and Membership of the CDM Methodology Panel. Paper submitted as a CDM methodology expert in the preparatory assitance to 10 Francophone African countries on CDM-A UNIDO funded Program*.

Dechezlepretre, A., Glachant, M. and Meniere, Y. 2008. The Clean Development Mechanism and the international diffusion of technologies: An empirical study. *Energy Policy.* 36:1273–1283.

Ellis, Jane, et al. 2007. CDM: Taking stock and looking forward. *Energy Policy.* 2007, Vol. 35 (1): 15.

Fuhr, Harald and Lederer, Markus. 2009. Varieties of Carbon Governance in Newly Industrializing Countries. *J. Environ. Dev. 18 327–45*

Gupta, Shreekant. 2003. India, CDM and Kyoto Protocol. *Econ. Political Weekly 38 4292–7*

IPCC. 1996. *Climate Change 1995-The Science of Climate Change. IPCC Second Assessment Report.* (Cambridge University Press, 1996)

Jotzo, Frank and Michaelowa, Axel. 2002. Estimating the CDM market under the Marrakech Accords. *Climate Policy 2 179–96*

Jung, Martina. 2006. Host country attractiveness for CDM non-sink projects. *Energy Policy.* 34, 2173.

Kaya, Yoichi and Yokobori, Keiichi. 1997. *Environment, Energy, and Economy: strategies for sustainability.* (Tokyo : United Nations University Press)

Larson, Donald F. and Breustedt, Bunnar. 2007. *Will markets direct investments under the Kyoto Protocol?* (Washington, D.C. : World Bank, Development Research Group, Sustainable Rural and Urban Development Team)

MDSP. 2001. *National Strategy Study for the Participation of Bolivia in the CDM:Executive Summary.* (La Paz : Programa Nacional De Cambios CLIMÁT ICOS, VMARNDF – MDSP)

Morera, Liana, Cabeza, Olga and Black-Arbeláez, Thomas. 2003. *The State of Development of National CDM Offices in Central and South America.* Paris : OECD, 2003.

Niederberger, Anne Arquit and Saner, Raymond. 2005. Exploring the relationship between FDI flows and CDM potential. *Trans.Corp.* 14, 1-40.

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

Schatz, Andrew. 2008. Note Discounting the Clean Development Mechanism. *Georgetown Int. Environ. Law Rev. 20 703–42*

Schroeder, Miriam. 2009. Varieties of Carbon Governance: Utilizing the Clean Development Mechanism for Chinese Priorities. *J. Environ. Dev. 18 371–94*

Song, Jaemin. 2010. *The road to the successful clean development mechanism: lessons from the past. PhD Thesis* Engineering Systems Division, Massachusetts Institute of Technology

UN. 2010a. Per capita GDP at current prices - US dollars (http://data.un.org/Data.aspx?q=GDP+per+capita+2005&d=SNAAMA&f=grID%3a101%3bcurrID%3aUSD%3bpcFlag%3a1%3byr%3a2005 Online 3 10, 2010. Cited: 4 12, 2010.)

UN. 2010b. GDP per capita average annual growth rate. (http://data.un.org/Data.aspx?q=GDP+per+capita&d=SOWC&f=inID%3a93 Online 6 14, 2010. Cited: 4 12, 2011.)

UNCTAD. 2008. Inward FDI stock, by Host Region and Economy, 1980 - 2007. (http://www.unctad.org/Templates/Download.asp?docID=10592&intItemID=2068&lang=1 Online 2008. Cited: 6 9, 2011.)

UNFCCC. 2011. List of Non-Annex I Parties to the Convention. (http://unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php) Online 2011. Cited: 4 30, 2011.

UNFCCC. 2005-2010. Project search (http://cdm.unfccc.int/Projects/projsearch.html)

US CIA. 2011. World Face Book 2011. (https://www.cia.gov/library/publications/the-world-factbook. Online 2011. Cited: 6 9, 2011)

US EIA. 2011. International Energy Statistics[online database]. (http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=91&pid=46&aid=31. Online 2011. Cited: 4 12, 2011)

Wara, Michael. 2008. Measuring the Clean Development Mechanism's Performance and Potential. *UCLA Legal Review.* 759-804

Zhang, Junjie and Wang, Can. 2010. Estimating the Co-benefit of the Clean Development Mechanism (working paper). *SSRN Working Paper Series.* (http://wf2dnvr12.webfeat.org/QWwkN14493/url=http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1530848. Online 01 2010. Cited: 02 26, 2010)

Zhang, Zhongxiang. 2009. Improving the rules on carbon projects. *Science and Development Network.* (http://www.scidev.net/en/opinions/improving-the-rules-on-carbon-projects.html. Online April 8, 2009. Cited: April 25, 2011)

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