The correlated factors of the uneven performances of the CDM host countries

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Received 4 October 2011
Accepted for publication 18 January 2012
Published 1 February 2012
Online at stacks.iop.org/ERL/7/014015

Abstract

The Kyoto Protocol’s Clean Development Mechanism (CDM) has experienced a rapid growth. Up to 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 literature suggested that economic and investment conditions, energy intensity, energy structure, the share of annual carbon credits from high global warming potential (GWP) greenhouse 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 GWP 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 that other countries will boost their carbon credit outputs.

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

1. 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) greenhouse gas (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 (Capor and Ambrosi 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 and Breustedt 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 and Michaelowa 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 CO₂ emission, which factors are also known as Kaya identities (Kaya and Yokobori 1997).

Among the GHGs regulated by the Kyoto Protocol, several non-CO₂ GHGs have high GWP (IPCC 1996). Consequently, large shares of carbon credits (Wara 2008) can be produced by reducing the non-CO₂ GHGs at relatively lower costs (Zhang and Wang 2010), which is 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 GHGs may influence the performance of a CDM host country (Song 2010).

Moreover, domestic CDM governance made especially for promoting CDM, which varies in different countries (Fuhr and Lederer 2009), is usually remarked on 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, capacity building had started in African countries (Dayo 2005) even before China entered the CDM market, but the progress in these countries was still modest until very recently.

Although possible factors are suggested to explain 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 a 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.

2. Data

This study is based on the 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 2004–10 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 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 on the CDM host countries are collected as follows: the amount of 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 2005–8 (US EIA 2011), the average primary energy consumption per unit of GDP during 2005–8 (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 2004–10 are not included in this analysis.

3. Methods

Methodologically, the positive law and economic discipline are employed, which rely 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 are 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 credit output, rather than the number of CDM projects, is a better indicator to reflect the scale of a country’s CDM industry, as 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 GHGs. These variables reflect the widely concerned factors that may influence a country’s CDM performances. FDI per area of land is chosen because the CDM is essentially a kind of foreign investment, which deserves to be directly highlighted. Additionally, the CDM performance is measured per area of land, so FDI is also measured 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 and Breustedt 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. The energy intensity of GDP and carbon intensity of energy consumption are necessary variables, as a country’s GHG emission is usually dominated by CO\textsubscript{2} emission from the energy sector. The share of the high GWP GHGs in the annual carbon credit output is to reflect the role played by the non-CO\textsubscript{2} GHGs. Among the four Kaya identities (Kaya and Yokobori 1997) (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. 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 into account a country’s general economic conditions, which involve the GDP per capita and growth rate of GDP per capita in the regression (equation (2)). In the third step, carbon intensity per unit of energy consumption was further included, which indicates a country’s energy structure (equation (3)). Then, in the fourth step, energy intensity per unit of GDP was considered, indicating a country’s industrial structure in terms of energy intensity (equation (4)). Lastly, the share of high GPW GHGs in the annual carbon credits was taken into consideration (equation (5)). The same analysis was run another two times, but excluding high value outliers (China and India) and low value outliers (Laos and Paraguay) respectively, to ensure that the result was robust and advisable for other host countries.

\[
\ln(\text{annual carbon credits per square kilometre}) = \beta_1 \times \ln(\text{FDI per square kilometre of land area}) + \beta_2 \times \ln(\text{GDP per capita}) + \beta_3 \times \ln(\text{growth rate of GDP per capita}) + \beta_4 \times \ln(\text{carbon intensity of energy consumption}) + \beta_5 \times \ln(\text{energy intensity of GDP}) + \mu
\] (1)

\[
\ln(\text{annual carbon credits per square kilometre}) = \beta_1 \times \ln(\text{FDI per square kilometre of land area}) + \beta_2 \times \ln(\text{GDP per capita}) + \beta_3 \times \ln(\text{growth rate of GDP per capita}) + \beta_4 \times \ln(\text{carbon intensity of energy consumption}) + \mu
\] (2)

\[
\ln(\text{annual carbon credits per square kilometre}) = \beta_1 \times \ln(\text{FDI per square kilometre of land area}) + \beta_2 \times \ln(\text{GDP per capita}) + \beta_3 \times \ln(\text{growth rate of GDP per capita}) + \beta_4 \times \ln(\text{carbon intensity of energy consumption}) + \beta_5 \times \ln(\text{energy intensity of GDP}) + \mu
\] (3)

\[
\ln(\text{annual carbon credits per square kilometre}) = \beta_1 \times \ln(\text{FDI per square kilometre of land area}) + \beta_2 \times \ln(\text{GDP per capita}) + \beta_3 \times \ln(\text{growth rate of GDP per capita}) + \beta_4 \times \ln(\text{carbon intensity of energy consumption}) + \beta_5 \times \ln(\text{energy intensity of GDP}) + \beta_6 \times \ln(\text{share of annual carbon credits from high GWP GHGs}) + \mu
\] (4)

\[
\ln(\text{annual carbon credits per square kilometre}) = \beta_1 \times \ln(\text{FDI per square kilometre of land area}) + \beta_2 \times \ln(\text{GDP per capita}) + \beta_3 \times \ln(\text{growth rate of GDP per capita}) + \beta_4 \times \ln(\text{carbon intensity of energy consumption}) + \beta_5 \times \ln(\text{energy intensity of GDP}) + \beta_6 \times \ln(\text{share of annual carbon credits from high GWP GHGs}) + \mu
\] (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 they exclude the generally decisive background conditions of CDM host countries. Apart from the regression result, this study will provide two types of ranking: the first type of ranking is based on the expected annual carbon credit output per area of land of a CDM host country, which excludes 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
\[ = f(\text{decisive factor}_1, \ldots, \text{decisive factor}_i), \]
where \( i = 1, 2, 3, 4, 5, \) or 6

Ratio \[ = \frac{\text{real annual carbon credits per unit area}}{\text{expected carbon credits per unit area}}. \]

4. 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 \( R^2 \)) 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 statistically significant at 1% level. When the carbon intensity of energy consumption is further added, the adjusted \( R^2 \)-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 joint statistical significance even at 10% level. No combination among the share of annual carbon credits from high GWP GHGs, carbon intensity of energy consumption and energy intensity of GDP is jointly statistically significant at 10% level.

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 the 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 is significant at 10% level. However, the energy intensity of GDP and share of annual carbon credits from high GWP GHGs are not statistically significant even at 30% level.

When simple regressions are made to the FDI per unit area 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 their respective adjusted-\( R^2 \) values. This means the FDI per unit area is the most decisive factor for a country’s performance in the CDM. Moreover, FDI per unit area 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 performances of CDM host countries mainly depend on the domestic economic and investment conditions.

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 five countries are Qatar, Republic of Korea, Singapore, Israel and El Salvador, followed by China and India. Moreover, Brazil is only listed in the middle range of CDM host countries, behind not only most Latin American countries, but behind several African countries as well.

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 second least annual carbon credit outputs per unit land area (figure 1) become the best and second best CDM host countries in terms of their ranking when we exclude

### Table 1. Results of estimated equations with different explaining variables (standard errors are reported in parentheses). (Note: ‘ln’ refers to the natural logarithm value.)

| Equation considered | Independent variables | (1) | (2) | (3) | (4) | (5) |
|--------------------|----------------------|-----|-----|-----|-----|-----|
| ln(FDI per unit of land area) | 1 | 0.6777 (0.0877) | 0.4252 (0.1112) | 0.3868 (0.1116) | 0.3829 (0.1114) | 0.3547 (0.1148) |
| ln(GDP per capita) | 2 | 0.4395 (0.1841) | 0.4592 (0.1816) | 0.4604 (0.1812) | 0.4769 (0.1819) |
| GDP per capita growth rate | 3 | 0.2841 (0.084) | 0.2856 (0.0827) | 0.2782 (0.0828) | 0.2878 (0.0833) |
| ln(CO₂ emission per unit primary energy consumption) | 4 | 0.7131 (0.4055) | 0.8269 (0.4174) | 0.7833 (0.4194) |
| ln(ROI GHGs) | 5 | | | | | |
| Share of high GWP GHGs in annual carbon credits | 6 | | | | | |
| Intercept | 7 | 2.9624 (0.3436) | −1.8638 (1.6655) | 4.8534 (4.1566) | 3.3706 (4.3563) | 2.7793 (4.3933) |
| R-square | 8 | 0.4710 | 0.5869 | 0.6059 | 0.6135 | 0.6199 |
| Adjusted R-square | 9 | 0.4631 | 0.5678 | 0.5813 | 0.5829 | 0.5831 |

| Dependent variable: ln(annual carbon credits per square kilometre) |
Table 2. Correlations among the explaining variables. (Note: the variables with * are taken in the form of natural logarithm values.)

| 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 GHGs 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*        | 0.2561                    | 0.1108               | −0.0392                   | 0.1392                                           | 0.0572                                  | 1.0000                                        |

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

| Country with LULUCF projects | Share of LULUCF projects in the country (%) | The year the first LULUCF project was 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                                          |

The regression analysis without high value outliers (China and India) or without low value outliers (Laos and Paraguay), does not show a significant difference (see appendix tables A.1–A.4), compared with the above result. Actually, without high or low value outliers, the $R$-square is very close to the result with all samples, and so are the values of the explaining variables. The second type of ranking does not change dramatically either. Hence, the research is robust in this aspect.

5. Discussion

This research, with a significant and much higher $R$-square value, has better explained the performances of the CDM host countries than the most recent previous study (Song 2010), compared to which the samples here are exclusively collected from successfully registered projects, and with a longer time duration (2005–10). 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 intensively addressed. Nevertheless, neither the energy structure nor the share of non-CO₂ GHGs 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 the idea that the CDM arrangement is market-oriented and favours 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 can new CDM methodologies be proposed over time, but the same methodologies and tools can also 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 projects of this kind, which had not emerged until 2009, except for one registered in China in 2006 (table 3). Although LULUCF projects hold no or small shares in most CDM host countries, they are very important for countries like Albania and Ethiopia. For the sake of the countries with a special type of potential in GHG mitigation, when the relevant rules and methodologies can be provided or improved, their performances in the CDM practice can also be enhanced.

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

Figure 2. Ranking of CDM host countries’ performances excluding the influences of the general economic and investment conditions and the countries’ sizes.

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.

6. 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 Niederberger and Saner (2005). Although previous literature suggested that energy structure (Gupta 2003), the share of annual carbon credits from high GWP GHGs (Zhang and Wang 2010), capacity building and institutional building of CDM governance (Zhang 2009) can play important roles in promoting the CDM, the present analysis weakens these arguments. Moreover, Song (2010) has suggested that 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 perfectly as they seemed 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 the 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 or India’s CDM governance would be a promising solution to boost the carbon credit output of other CDM host countries. Nevertheless, capacity building and CDM governance can still be relevant factors, as long as their effects are not over-predicted. In addition, if the relevant CDM methodologies and tools could 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 have largely determined the uneven performances of the CDM host countries, as 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 broader sense, as this is a classic paradox between efficiency and equity, it is contradictory to expect a market-based mechanism like the CDM to achieve both efficiency and equity simultaneously without compromising one another, which is the advisable lesson learnt from the CDM for future climatic policy-making.

Appendix

| Table A.1. Results of estimated equations with different explaining variables; standard errors are reported in parentheses (without the high value outliers China and India.) (Note: ‘ln’ refers to the natural logarithm value.) |
|-----------------------------------------------|
| **Equation considered** | 1 | 2 | 3 | 4 | 5 | 6 |
| Independent variables | 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) | 0.4827 (0.1862) | 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) | 0.2313 (0.2508) |
| Share of high GWP GHGs in annual carbon credits | 0.4601 (0.4808) |
| Intercept | 2.8990 (0.3350) | −2.0572 (1.662) | 3.9031 (4.2074) | 2.7600 (4.3884) | 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 |

| Table A.2. Correlations among the explaining variables, without the high value outliers China and India. (Note: the variables with * are taken in the form of natural logarithm values.) |
|-----------------------------------------------|
| **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 GHGs in annual carbon credits |
| FDI per unit of land area* | 1.0000 | 0.7002 | 0.2774 | 0.2177 | 0.0071 | 0.2514 |
| GDP per capita 2005* | 0.7002 | 1.0000 | 0.2525 | 0.1143 | 0.0201 | 0.1094 |
| GDP per capita growth rate | 0.2774 | 0.2525 | 1.0000 | −0.0184 | 0.0194 | −0.0627 |
| CO2 emission per unit primary energy consumption* | 0.2177 | 0.1143 | −0.0184 | 1.0000 | 0.2651 | 0.1323 |
| Primary energy consumption per unit GDP* | 0.0071 | 0.0201 | 0.0194 | −0.2651 | 1.0000 | 0.0517 |
| Share of high GWP GHGs in annual carbon credits | 0.2514 | 0.1094 | −0.0627 | 0.1323 | 0.0517 | 1.0000 |
Table A.3. Results of estimated equations with different explaining variables; standard errors are reported in parentheses (without low value outliers Laos and Paraguay). (Note: ‘ln’ refers to the natural logarithm value.)

| Equation considered | (1) | (2) | (3) | (4) | (5) |
|---------------------|-----|-----|-----|-----|-----|
| Independent variables |    |     |     |     |     |
| ln(FDI per unit of land area) | 0.6181 (0.0778) | 0.2640 (0.0935) | 0.3766 (0.0949) | 0.3715 (0.093) | 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(annual carbon credits per unit GDP) |     |     |     |     |     |
| Share of high GWP GHGs in annual carbon credits |     |     |     |     |     |
| Intercept | 2.8964 (0.3011) | −1.9766 (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 |

Table A.4. Correlations among the explaining variables, without low value outliers Laos and Paraguay. (Note: the variables with * are taken in the form of natural logarithmic values.)

| 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 GHGs 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 primary energy consumption* | 0.1611 | 0.0806 | −0.0338 | 1.0000 |                                   |                                               |
| Primary energy consumption per unit GDP* | 0.0338 | 0.0213 | 0.1258 | −0.1328 | 1.0000 |                                               |
| Share of high GWP GHGs in annual carbon credits | 0.2331 | 0.0913 | −0.0491 | 0.0812 | 0.0833 | 1.0000 |

References

Capoor K and Ambrosi P 2008 State and Trends of the Carbon Market 2008 (Washington, DC: World Bank)
Dayo F 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 Assistance 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 1273–83
Ellis J et al 2007 CDM: taking stock and looking forward Energy Policy 35 15
Fuh H and Lederer M 2009 Varieties of carbon governance in newly industrializing countries J. Environ. Dev. 18 327–45
Gupta S 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: Cambridge University Press)
Jotzo F and Michaelowa A 2002 Estimating the CDM market under the Marrakech Accords Climate Policy 2 179–96
Jung M 2006 Host country attractiveness for CDM non-sink projects Energy Policy 34 2173
Kaya Y and Yokobori K 1997 Environment, Energy, and Economy: Strategies for Sustainability (Tokyo: United Nations University Press)
Larson D F and Breusteld B 2007 Will Markets Direct Investments Under the Kyoto Protocol? (Washington, DC: 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: Programma Nacional de Cambios CL IMÁT ICOS, VMARNDF—MDSP)
Morera L, Cabeza O and Black-Argeláez T 2003 The State of Development of National CDM Offices in Central and South America (Paris: OECD)
Niederberger A A and Saner R 2005 Exploring the relationship between FDI flows and CDM potential Trans. Corp. 14 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 17 270–301
Schatz A 2007 Note discounting the clean development mechanism Georgetown Int. Environ. Law Rev. 20 703–42
Schroeder M 2009 Varieties of carbon governance: utilizing the clean development mechanism for Chinese priorities J. Environ. Dev. 18 371–94
Song J 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 10 March 2010, cited 12 April 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 14 June 2010, cited 12 April 2011)
UNCTAD 2008 Inward FDI Stock, by Host Region and Economy, 1980–2007 (www.unctad.org/Templates/Download.asp?docID=10592&intItemID=2068&lang=1, online 2008, cited 9 June 2011)
UNFCCC 2005–2010 Project Search (http://cdm.unfccc.int/Projects/projsearch.html)
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 30 April 2011)
US CIA 2011 World Fact Book 2011 (www.cia.gov/library/publications/the-world-factbook, online 2011, cited 9 June 2011)
US EIA 2011 International Energy Statistics (www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=91&pid=46&aid=31, online 2011, cited 12 April 2011)
Wara M 2008 Measuring the clean development mechanism’s performance and potential UCLA Legal Review 55 1759–804
Zhang J and Wang C 2010 Estimating the co-benefit of the clean development mechanism SSRN Working Paper Series (http://wf2dnvr12.webfeat.org/QWwkN14493/url=http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1530848, online January 2010, cited 26 February 2010)
Zhang Z 2009 Improving the rules on carbon projects Science and Development Network (www.scidev.net/en/opinions/improving-the-rules-on-carbon-projects.html, online 8 April 2009, cited 25 April 2011)