# An Econometric Analysis on the CER Issuance Rates of CDM Projects

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**Keywords**: CDM(Clean Development Mechanism) Projects, CER(Certified Emissions Reduction), Issuance Rates, Quantile Regression

**Overview**

This paper econometrically analyses the CER(Certified Emissions Reduction) issuance rates of CDM(Clean Development Mechanism) projects. The CER issuance rate is important because it contributes much to the overall profitability of the CDM projects, without which the projects will not be considered as investable. It is known that the issuance of CER generally must follow detailed verification and other processes. Seen from the investors' side, these processes add uncertainty to the project profitability, and hence deserve a careful examination. In this paper, we examine the factors that affect the issuance rate by undertaking a regression analysis.

Earlier research[1)] investigated the profitability and the greenhouse gas (GHG) mitigation effect of CDM projects per invested capital, and found that project type is among the key determinants of both the profitability and the GHG mitigation effect. Their result implied that methane-related projects and sewage projects can be relatively more effective in those two indices than other project types. Motivated by the same line of interest, our prior study[2)] used PDD (project design document) data to assess the *ex-ante* profitability across different types of projects. There, we found that landfill projects and other methane-recovery-type projetcs are on average more profitable, at least by the *ex-ante* profitability, similar to what Schneider *et al*.(2010) had uncovered.

In contrast, in this study, we attempt to characterize the *ex-post* profitability by examining the issuance rate, controlling for the project investment scale variables. Specifically, this paper's interest lies in estimating the level and the direction (positve or negative) of impacts from different host country and project type circumstances, and potentially derive implications on project investments.

## 1. Introduction

### 1.1 CDM projects and their usage

CDM projects are now widely used as a means for greenhouse gas (GHG) abatement in developing countries, under the Kyoto Protocol. Projet types range from conventional power generation technologies such as hydro, to relatively new technologies like wind and photovoltaic, as well as energy conservation / energy efficiency (EE) technologies and others. To date, thousands of projects have been planned, among which some of them are registered and operated.

Generally, CDM projects have to go through multiple steps before the project bears CER credit that carries credit-related profits to the investor. **Figure l** illustrates such a process. First, a typical project will be identified and be developed (the top left box in the figure), then it acquires the approval from the host country. Then there will be Project Validation, in which the validity of the project is thoroughly examined at the UNFCCC committee. This is where the project must show that it complies with the concept of additionality. Under the additionality concept, projects must *not* be profitable without the aid from CER credit revenues, because a profitable project will be commercially viable even without the aid from CER, thus constituting a pure profit-making investment.

After the project goes through the Validation, it earns the Registered status (the top second

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box from the right), when the facility in question is installed, commissioned and starts its operation at site. After some period of actual operation, the project is verified for the exact amount of CERs to be issued (the bottom right box). The sale of CERs will not be realized until all those steps have been taken, which can take months in some cases in recent years.

### 1.2 Challenges in investment decisions of CDM projects

This puts a chellenge to the project investors, because they must ensure that the project, a power generation project, for example, is *not* profitable *without* its associated CER credits, but be profitable once the credit revenues are granted. Hence, due to this additionality constraint, a great deal of care is required to aseess the profitability by the investor. For example, for a hydro-power generation project, the revenue that comes from the power generation must not fulfill the project's initial investment and operating costs in the first place, but *only after* the revenue from selling the CER credits the gross profitability turns to positive.

The investor usually has some level of experience in the generation-related technologies, providing them with some level of capability to assess generation-related revenues. However, it is not always the case for credit-related revenues. Part of it is due to the fact that the credit investment itself is relatively historically new, after ratification of Kyoto Protocol. Other reasons include some GHG abatement technologies are not technically mature, and there are not very strong measures to control financial risk associated with those technologies.

Based on this, we view that the tools to assess the credit-related profit is critical for the CDM project investors, but such tools are not well developed, so investors may face difficulties in making investment decisions.

## 2. Litereature Review

There are many research articles about the CDM concept and the projects under it. Studies that deal with instutional and policy issues seek for remedies against over-concentration of host countries, malfunction of Designated Operational Entities (DOEs), and lengthy examination processes[3)4)]. Policy issues include how technology transfers to developing countries and/or GHG emissions reduction be effectively substantiated[5)].

Some recent studies make proposals to post-Kyoto framework and policy design that try to improve, modify or replace the Kyoto mechanism[6)]. Also, like this article, there are some studies motivated by the uncertainties in the project profitability. Some of them deal with conceptual analysis on what factors improve or damage the profitability[7)], while others try to quantify the attaractiveness of project investment for different host countries[8)], as well as the ones that try to assess profitability by project types and by investing countries[9)].

Among them, Schneider *et al.*(2010)[1)] calculates the estimated range of profitability (return on the invested capital) and GHG reduction capability (GHG reduction per invested capital) for six technology types: photovolatic power, wind power, biomass power, sewage and landfill projects. Plugging the project parameters sourced from actual project examples and expert hearings, and also doing a variety of sensitivity analyses, they derive that there can be a tendency in the expected profitability and GHG reduction capability depending on the project type. For example, photovoltaic power is not profitable under almost any combination of parameters, while methane recovery-type projects like landfill can almost always outperform five other technologies, though it depends on the parameter values of the international CER prices and the host country environment, including load factor, grid power price and the GHG intensity of the electric grid. However, the study basically calculates the ranges of profitability and GHG reduction capabilities, but does not well give insights on in which country profitable conditions are more ealisy met, or to what extent it is different by

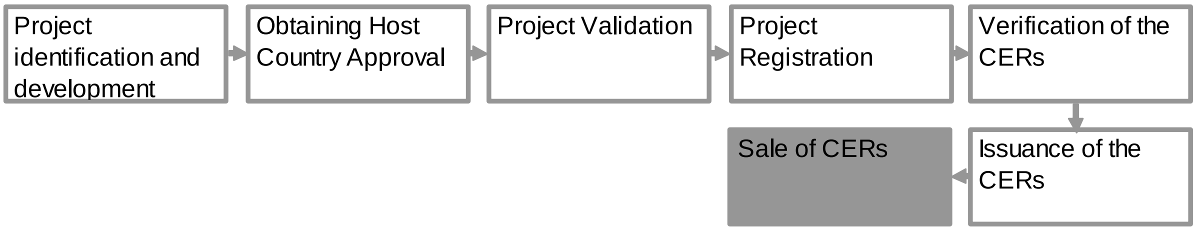


**Figure 1**. Process that typical CDM project must go through before sale of CERs. (Source: own elaboration)

generation technologies. We view that this limitation comes from their approach, where they prepare typical project models and then plug project parameters there to proceed to the sensitivity analysis.

Motivated by the same line of interest, Ofuji and Tatsumi (2011)[2)] built a multiple regression model and studied the *ex-ante* profitability, and confirmed that methane recovery-type projects tend to yield the greatest profitability among all project types, conrolling host country and other conditions. But the study still failed to relate it to the actual, *ex-post* profitability tendencies by seeing how much reliable the *ex-ante* profitability figures are on the PDD in forecasting the *ex-post* profitability. In this paper, we take the similar approach with Ofuji and Tatsumi(2011)[2)] but examine the *ex-post* CER issuance rates as the dependent variable in the regression analysis.

## 3. Method

### 3.1 Data source

As the *ex-post* CER issuance data, we used the "Project Pipepine" database in the CD4CDM.org website, maintained by the Risoe Institute of Denmark. We downloaded the data file on August 17, 2011. It contained the data up to August 1, 2011. It included 1,132 samples as the registered projects verified for CER issuance.

### 3.2 Analysis framework and the model

We run a regression taking the CER issuance rate as the dependent variable, which is defined here as the *ex-post*, issued CER credit volume in kilo-tonnes up to August 1, 2011, divided by the expected, *ex-ante* CER credit volume in kilo-tonnes on the PDDs. We attempt to examine the direction and the maginude of impacts on the issuance rate from especially the host country and the project type conditions.

The regression equation is $y_i = \mathbf{x}_i\beta + \varepsilon_i$, where $y_i$ is the CER issuance rate for project $i$, $\mathbf{x}_i$ is the set of independent variables for project $i$, $\beta$ is the coefficient vector, and $\varepsilon_i$ is the random error term for project $i$, assumed to be normally distributed around zero.

### 3.3 Dependent variable: CER issuance rate

**Figure 2** shows the histogram of the dependent variable, or the CER issuance rate. The issuance rate of 1.00 means the issued, *ex-post* CER volume is exactly equal to the planned, *ex-ante* CER volume. Any issuance rate below 1.00 means that the actual issuance was smaller than what was plannned and presented on the PDD. It is seen on the figure and the box to the right that the mean is 0.819 and the median 0.835, slightly larger than the mean, meaning that on average, a project tends to yield only slightly over 80% of what was originally planned. Likewise, looking at the issuance rate distribution, the projects with the issuance rate below 1.00 are as many as 831, or 73.4% of the subsamples. One can say that 73.4% of the entire projects provide smaller amount of CERs than originally planned on their PDDs.

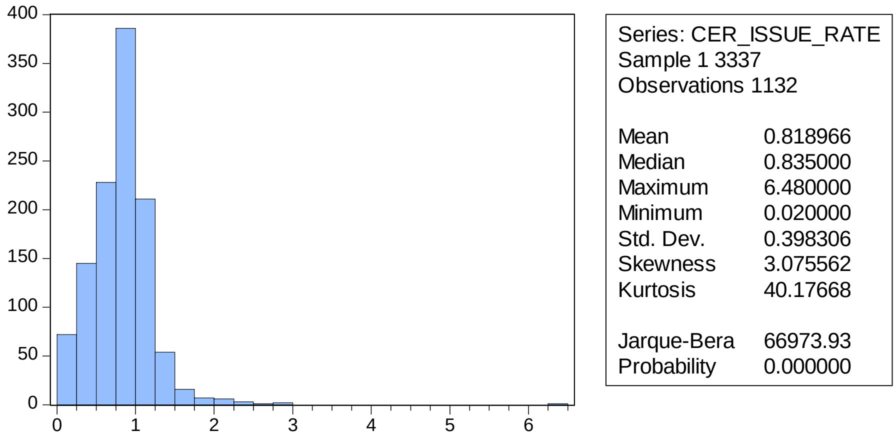


**Figure 2**. Histogram of CER issuance rates (dependent variable).
The dataset included 1,132 valid subsamples out of the entire 3,337 samples.
The mean was 0.819, and the median 0.835. 73.4% of the subsamples had the issuance rate of smaller than 1.00, meaning that the actual, *ex-post* issuance volume was smaller than the planned, *ex-ante* volume on the PDDs.

### 3.4 Independent variables:

The independent variables are the project type dummy variables (takes the value of one for each different technology and zero otherwise) and the host country dummy variables (takes the value of one for each host counry and zero otherwise). We also use control variables, namely investment for power capacity, investment for CO2 abatement, CER's planned volume in the first phase, to control for the economic scale and the time lengths of projects. See **Table 1** for the descriptive statistics of all the variables involved.

The host country dummy variables include eight countries: Brasil, China, India, Indonesia, Malaysia, Mexico, Philippines, and Vietnam. The project type dummy variables include seven project types: biomass energy, wind power, energy efficiency at own generation, fossil fuel switch, hydropower, landfill gas, and methane avoidance. These eight countries and seven technologies are among the most freqently chosen for the CDM projects considered here. We call those variables as the impact variables, meaning we wish to examine the impacts from them on the CER issuance rates.

In addition, there are three control variables: the expected CER issuance in kilo-tonne by the year 2012 period, and the monetary investment in US dollar (USD) terms per megawatt (MW) of power generation capacity, and the USD investment per tonne of planned CO2 emissions reduction. In contrast with the impact variables, these three control variables are to control for the project size, or investment size, to see if there is some kind of scale of economy existing in the issuance rate.

### 3.5 Estimation methods

In terms of the estimation methods, we used quantile regression (QREG, Koenker and Hallock (2001)[10)]), in addition to the ordinary least squares (OLS). This was because, as seen in **Figure 2** and **Table 1**, the issuance rate is somewhat skewed with some outliers, with its median larger than its average. Hence, by using QREG in additon to OLS, we expected to consider not only the average statistical properties but also how such property may differ around the median of the dependent variable. In fact, practitioners interested in investing in CDM projects may tend to pay attention not only to the plain avaerage but also to the median, or the most frequent outcome, of the issuance rate when making investment decisions.

**Table 1**. Descriptive statistics of the variables used.
All data were sourced from the *CDM Pipeline* Database on the *CD4CDM.org* website, downloaded August 17, 2011. The data was as of August 1, 2011. For the continuous variables, mean, median, max, min and standard deviation values are shown. For the dummy variables, mean and the number of "1"s are shown (N=642, common samples). Note: "EE" = Energy Efficiency, "INV" = Investment.

Pairwise samples (N=642)

| Variable | Mean | Median | Max. | Min. | Std.Dev. | # of "1" | Obs. |
|---|---|---|---|---|---|---|---|
| ***Dependent Variable*** | | | | | | | |
| CER_ISSUE_RATE | 0.81956 | 0.84 | 2.27 | 0.02 | 0.30963 | | 642 |
| ***Independent Variables*** | | | | | | | |
| ***(Dummy Variables)*** | | | | | | | |
| PJT_BIOMASS_ENERGY | 0.06231 | | | | 0.2419 | **40** | 642 |
| PJT_WIND | 0.33333 | | | | 0.47177 | **214** | 642 |
| PJT_EE_OWN_GENERATION | 0.07477 | | | | 0.26322 | **48** | 642 |
| PJT_FOSSIL_FUEL_SWITCH | 0.03427 | | | | 0.18206 | **22** | 642 |
| PJT_HYDRO | 0.42679 | | | | 0.495 | **274** | 642 |
| PJT_LANDFILL_GAS | 0.03271 | | | | 0.17802 | **21** | 642 |
| PJT_METHANE_AVOIDANCE | 0.00935 | | | | 0.0963 | **6** | 642 |
| HOST_BRASIL | 0.01869 | | | | 0.13554 | **12** | 642 |
| HOST_CHINA | 0.72274 | | | | 0.44799 | **464** | 642 |
| HOST_INDIA | 0.17601 | | | | 0.38113 | **113** | 642 |
| HOST_INDONESIA | 0.00312 | | | | 0.05577 | **2** | 642 |
| HOST_MALAYSIA | 0.0109 | | | | 0.10393 | **7** | 642 |
| HOST_MEXICO | 0.00935 | | | | 0.0963 | **6** | 642 |
| HOST_PHILIPPINES | 0.00467 | | | | 0.06825 | **3** | 642 |
| HOST_VIETNAM | 0.00312 | | | | 0.05577 | **2** | 642 |
| ***(Control Variables)*** | | | | | | | |
| INV_MW | 1256.32 | 1083.65 | 85328.5 | 8.5 | 3363.03 | | 642 |
| INV_TCO2 | 459.517 | 349 | 36173 | 5 | 1443.25 | | 642 |
| CER_PLAN_2012 | 707.639 | 355.5 | 15151 | 10 | 1256.93 | | 642 |

## 4. Results and discussion

**Table 2** presents the estimation results, both in OLS and in QREG. The QREG result is given only for the regression parameter $\tau$=0.50 (median) case. We ran the QREG regression by two other cases: 0.25 (the first quartile), and 0.75 (the third quartile). For simplicity of interpretation, we only present the results for $\tau$=0.5 (median) in the following discussion[2].

In the Table, variables that showed stronger than or equal to the 10% significance level are in the boldface letters (excluding the constant term). The estimated coefficients can be interpreted as the actual contribution values to the issuance rates. For example, a coefficient of 0.233 means a positive impact to the issuance rate by 23.3 %.

### 4.1 Impact variables (Project type dummy variables and Host country dummy variables)

#### 4.1.1 Project type dummy variables

Looking at both the OLS result and the QREG result, one can tell that Biomass Energy carries a positive impact of 23% (under OLS), and Wind power 17% (QREG) to 30% (OLS), EE Own Generation 15%(QREG) to 21%(OLS), and Hydropower 225(OLS). The only statistically significant variable that negatively impacts the issuance rate is Landfill Gas(-26%(QREG)). The coefficients to these five variables all have a more conservative (smaller positive impact or greater negative impact to the issuance rate) tendency.

**Figure 3** represents relative frequency distributions of the issuance rates, across different project types. From this, it is understood that the positive-impact project types, namely

[2] The results for the other two cases can be obtained from author on request.

**Table 2**. Regression results – by Ordinary least squares (OLS) and Quantile regression (QREG). Hatched cells in yellow indicate the statistically significant dummy variables (*Host country* and *Project type*) under quantile regression (QREG).
QREG results are shown in each of the following three quartiles: τ = 0.25, 0.5(median), and 0.75.

| Independent Variables | Ordinary Least Squares (OLS) coefficient | p-value | | Quantile Regression (QREG) (at tau=0.50 : Median) coefficient | p-value | |
|---|---|---|---|---|---|---|
| Constant term | 0.580 | 0.000 | *** | 0.648 | 0.000 | *** |
| *Dummy Variables: Project Type* | | | | | | |
| Project type is Biomass Energy | **0.233** | **0.008** | *** | 0.083 | 0.526 | |
| Wind Power | **0.297** | **0.000** | *** | **0.172** | **0.054** | * |
| EE - Own Generation | **0.207** | **0.015** | ** | **0.151** | **0.096** | * |
| Fossil Fuel Switch | 0.093 | 0.375 | | -0.094 | 0.402 | |
| Hydro Power | **0.219** | **0.006** | *** | 0.101 | 0.252 | |
| Landfill Gas | -0.125 | 0.203 | | **-0.259** | **0.046** | ** |
| Methane Aviodance | **0.249** | **0.083** | * | 0.129 | 0.409 | |
| *Dummy Variables: Host Country* | | | | | | |
| Host country is Brazil | 0.129 | 0.193 | | **0.201** | **0.053** | * |
| China | 0.037 | 0.502 | | **0.108** | **0.051** | * |
| India | 0.064 | 0.284 | | 0.073 | 0.227 | |
| Indonesia | 0.090 | 0.677 | | 0.052 | 0.692 | |
| Malaysia | **-0.217** | **0.082** | * | **-0.277** | **0.086** | * |
| Mexico | -0.123 | 0.343 | | 0.044 | 0.747 | |
| Phillipines | -0.130 | 0.463 | | **-0.334** | **0.000** | *** |
| Vietnam | -0.002 | 0.992 | | -0.059 | 0.666 | |
| *Continuous Variables: (Control Variables)* | | | | | | |
| INV_MW ( Investment in US$/MW power capacity ) | -8.06E-06 | 0.768 | | -2.07E-05 | 0.492 | |
| INV_TCO2 ( Investment in US$/ton of CO2 ) | 1.96E-05 | 0.760 | | 5.05E-05 | 0.477 | |
| CER_PLAN_2012 (Planned CER volume by 2012) | **-2.90E-05** | **0.010** | *** | **-2.10E-05** | **0.094** | * |
| Adjusted R-Squared. | **0.127** | | | **0.066** | | |

Significance level = *** : 1%, ** : 5%, * : 10%

Biomass, Wind, EE own generation and Hydro, are all alike in having its peak around 1.00, or 100%, of the issuance rate. In contrast, Landfill, the negative-impact project type, carries its peak around the issuance rate of 0.1 – 0.2 (10 to 20 %), or 0.5(50%). Those peaks are far below the distributions of the positive-impact project types. There is a clear difference in the issuance rates between the positive- and the negative-impact project types.

In our earlier research (Ofuji and Tatsumi(2011)), it was shown that methane-related project types, including landfill gas, tend to have a higher ex-ante profitability values than other project types, across all host countries. However, this result adds a caveat that the ex-post issuance rate, and subsequent credit-related profits, can be substantially lower than the expected profitability figures laid out on the PDDs. This may provide project investors with an implication for investing decision making.

4.1.2 Host country dummy variables

Let us go back to **Table 2**. Similarly, Brazil and China appear to positively affect the issuance rates (20% for Brazil, 11% for China (both under QREG)), while Malaysia and the Philippines appear to negatively affect the issuance rates (-22% (OLS) to -28%(QREG) for Malaysia, and -33%(QREG) for the Philippines).

**Figure 4** shows relative frequency distributions of the issuance rates, across different host countries. From this, it is understood that the positive-impact host countries, namely Brazil and China, have a low peak and long tails due to relatively abundant number of projects in the two

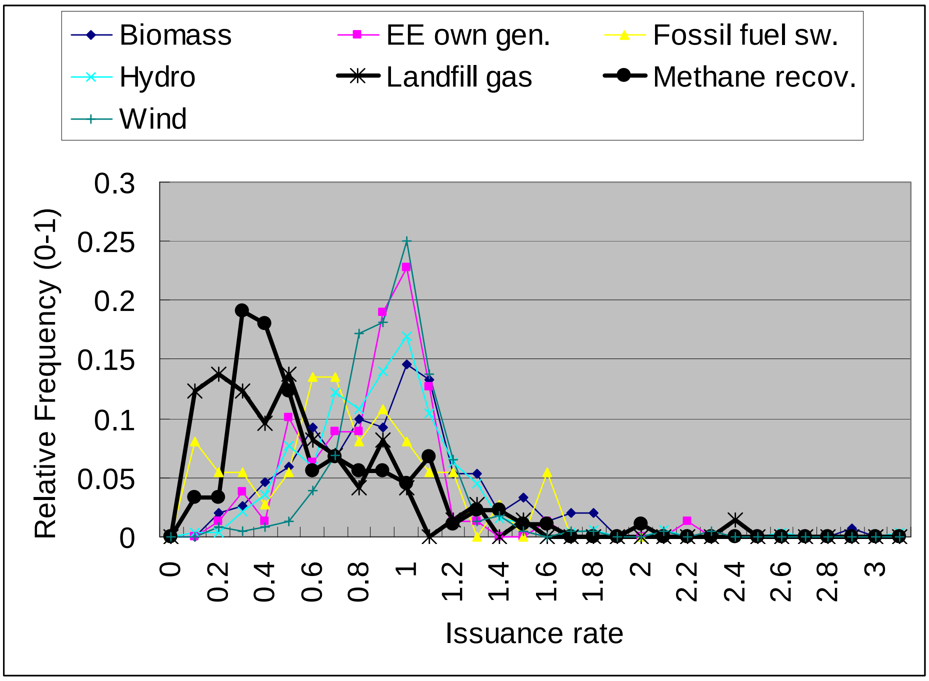


**Figure 3**. Relative frequency distributions of the issuance rates, across different project types.
X-axis: the issuance rate. "1" means a 100% *ex-post* issuance with respect to the *ex-ante* planned amount.
Y-axis: relative frequency from 0 to 1 of the issuance rate by project types.

countries. In Brazil, there is a peak around the issuance rate of 0.9(90%) to 1.3(130%), while in China, the peak is around 0.9(90%) to 1.0(100%). These percentages are interpreted that the projects in those two countries tend to yield a fairly close *ex-post* issuance amount to the original *ex-ante* amount. Meanwhile, Malaysia and the Philippines, or the negative-impact host countries, have a zig-zagged distribution due to rather small number of projects, with their peak staying around a modest 0.4(40%) to 0.8(80%) range.

Next question will be what types of projects are executed in Malaysia and the Philippines. Looking into the database, we found six projects that had lower than the issuance rate of 0.5 (50%), in which three are Biomass Energy projects, two Methane recovery projects, and one EE own generation project. Because Malaysia and the Philippines collectively have only fifteen projects with non-zero CER issued, care must be taken in reading the frequency distribution, but at least there seems to be a certain degree of variety in the types of projects, and it may better be attributed to the project execution environment in each host country.

On the contrary, both Brazil and China, or the positive-impact host countries, have a relatively large number of projects (114 projects with non-zero CER issued in Brazil, and 475 in China: see **Table 4** for details). The project types most commonly oberved in those countries are Biomass Energy, Wind, and Hydropower. These are the project types that have relatively high issuance rates as we saw in **Figure 3**. As a result, the average issuance rates from Brazilian and Chinese projects are as high as 79% to 82%, as listed in the bottom part of **Table 3**. This is comparable with India, another host country with a high issuance rate of 89% on average[3].

**Table 4** gives a cross reference of the project types across the host countries. It is seen that in Brazil, there are 33 biomass projects, 29 methane avoidance, 25 hydro, all of these only three kinds add up to more than 70% of projects (in number) executed in this country. Likewise, in China, there are 235 hydro and 155 wind projects, only these two types of project

[3] Vietnam also has an 86% average but it should be noted that it has only four projects with non-zero CER.

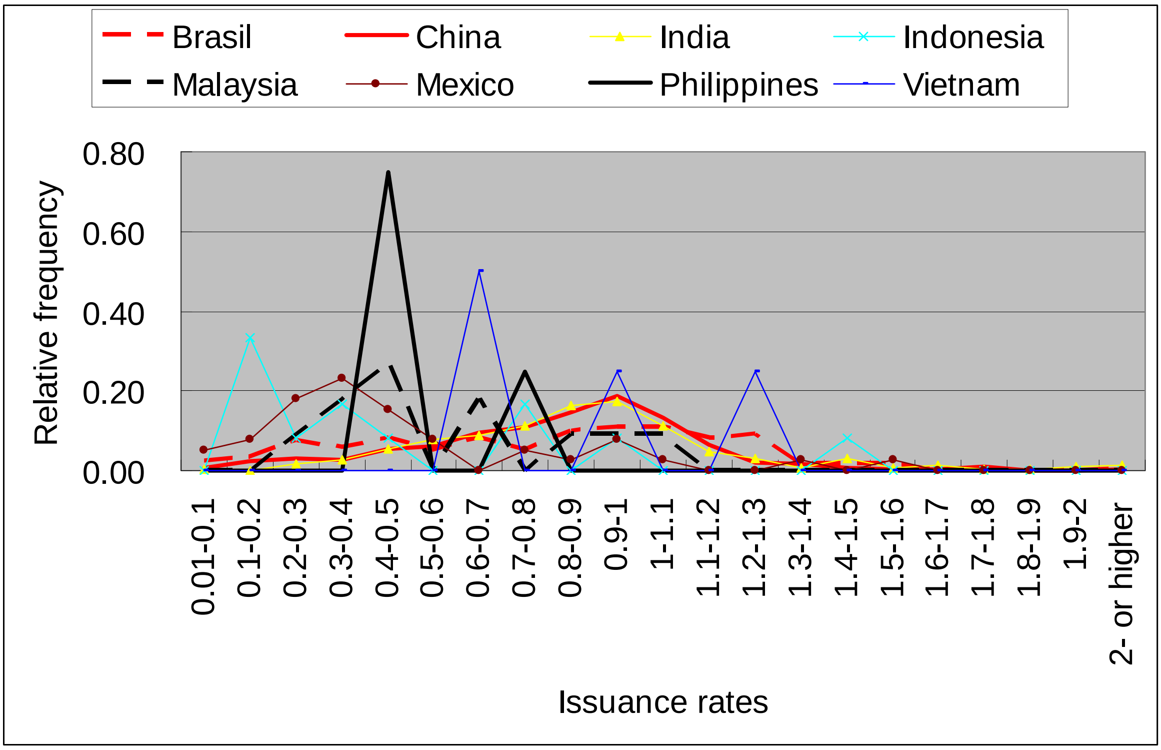


**Figure 4**. Relative frequency distributions of the issuance rates, across different host countries. X-axis: the issuance rate. "1" means a 100% *ex-post* issuance with respect to the *ex-ante* planned amount. Y-axis: relative frequency from 0 to 1 of the issuance rate by host countries

**Table 3**. Frequency distributions of the issuance rates, across different host countries. Down: the issuance rate. "1" means a 100% *ex-post* issuance with respect to the *ex-ante* planned amount. Across: host countries.

**Frequency distribution of issuance rates**

| *Range* | Brasil | China | India | Indonesia | Malaysia | Mexico | Philippines | Vietnam |
|---|---|---|---|---|---|---|---|---|
| *0.01-0.1* | 3 | 3 | 1 | 0 | 0 | 2 | 0 | 0 |
| *0.1-0.2* | 4 | 13 | 0 | 4 | 0 | 3 | 0 | 0 |
| *0.2-0.3* | 9 | 16 | 5 | 1 | 1 | 7 | 0 | 0 |
| *0.3-0.4* | 7 | 14 | 7 | 2 | 2 | 9 | 0 | 0 |
| *0.4-0.5* | 10 | 28 | 15 | 1 | 3 | 6 | 3 | 0 |
| *0.5-0.6* | 6 | 31 | 21 | 0 | 0 | 3 | 0 | 0 |
| *0.6-0.7* | 10 | 49 | 24 | 0 | 2 | 0 | 0 | 2 |
| *0.7-0.8* | 6 | 57 | 31 | 2 | 0 | 2 | 1 | 0 |
| *0.8-0.9* | 12 | 75 | 45 | 0 | 1 | 1 | 0 | 0 |
| *0.9-1* | 13 | 96 | 47 | 1 | 1 | 3 | 0 | 1 |
| *1-1.1* | 13 | 69 | 31 | 0 | 1 | 1 | 0 | 0 |
| *1.1-1.2* | 10 | 34 | 13 | 0 | 0 | 0 | 0 | 0 |
| *1.2-1.3* | 11 | 11 | 8 | 0 | 0 | 0 | 0 | 1 |
| *1.3-1.4* | 2 | 8 | 2 | 0 | 0 | 1 | 0 | 0 |
| *1.4-1.5* | 2 | 4 | 8 | 1 | 0 | 0 | 0 | 0 |
| *1.5-1.6* | 2 | 1 | 2 | 0 | 0 | 1 | 0 | 0 |
| *1.6-1.7* | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 |
| *1.7-1.8* | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 0 |
| *1.8-1.9* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| *1.9-2* | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| *2- or higher* | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 0 |
| total | 121 | 517 | 273 | 12 | 11 | 39 | 4 | 4 |
| average | 0.79 | 0.82 | 0.89 | 0.49 | 0.59 | 0.48 | 0.54 | 0.86 |
| maximum | 2.48 | 2.27 | 2.82 | 1.43 | 1.08 | 1.57 | 0.73 | 1.25 |

Note: These numbers include other project types than biomass, wind, EE own generation, Fossil fuel switch, hydro, landfill gas, and methane avoidance.

exceeds 80% (in number) of all projects in China. It is worth remembering that these project types are all relatively advantageous in the issuance rates as we saw in **Figure 3**.

Looking into the database, we could confirm that the average issuance rate of Brazilian

**Table 4**. Cross reference of the project types across host countries
Down: the issuance rate. "1" means a 100% *ex-post* issuance with respect to the *ex-ante* planned amount.
Across: host countries.

| Host country \ Project type | Biomass energy | Wind | EE own generation | Fossil fuel switch | Hydro | Landfill gas | Methane avoidance | (subtotal) |
|---|---|---|---|---|---|---|---|---|
| **Brasil** | **33** | 3 | 1 | 5 | **25** | 18 | **29** | 114 |
| **China** | 6 | **155** | 47 | 17 | **235** | 14 | 1 | 475 |
| **India** | 91 | 59 | 29 | 8 | 29 | 4 | 8 | 228 |
| **Indonesia** | 3 | 0 | 0 | 0 | 0 | 0 | 5 | 8 |
| **Malaysia** | 6 | 0 | 0 | 0 | 0 | 1 | 4 | 11 |
| **Mexico** | 0 | 3 | 0 | 0 | 3 | 3 | 27 | 36 |
| **Phillipines** | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 4 |
| **Vietnam** | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| (subtotal) | 139 | 221 | 78 | 30 | 295 | 41 | 75 | 879 |

methance avoidance projects (29 projects) is 45%, that of Brazilian hydro (25 projects) is 100%, and that of Brazilian biomass (33 projects) 97%. In the same way, the average issuance rate of Chinese hydro (235 projects) is 82%, and that of Chinese wind (155 projects) 95%. As these issuance rates show, it is undertood that the projects with relatvely high CER issuance are chosen to be executed in these host countries, raising the average issuance rates of those countries as a result.

### 4.2 Control variables (continuous variables)

Let us once again go back to **Table 2** to discuss the control variables. Among the three control variables, it was only CER_PLAN_2012, or the planned CER issuance volume by the year 2012, that was statistically significant, for both OLS and QREG. It shows that it negatively impacts the issuance rates, meaning that as the planned CER issuance volume increases, the relative realized issuance volume decreases. This is naturally interpreted that the harder it becomes to realize the *ex-post* issuance amount as close to the *ex-ante* value as possible, the higher the *ex-ante* issuance volume itself grows.

Neither of the two other control variables showed statistical significance (INV_MW and INV_TCO2). Both two variables imply the scale of the investment (the power generation capacity and the planned CO2 abatement), so it can be inferred that there is no statistically significant observation that the investment scale positively contributes to the *ex-post* issuance rates, on the basis of both power generation and CO2 abatement scales. Potential existance of scale of economy due to the investment scale on the issuance rate does not seem to be strongly supported.

## 5. Conclusions

We have the following three main conclusions:

a) In terms of project types, biomass, wind, EE own generation and hydro projects relatively give higher issuance rates than other project types. They have a positive impact ranging from 15 to 30% in the issuance rate as compared from other technologies. Contrarily, landfill gas projects can have a negative impact on the issuance rate estimated about -26% compared from the other project types. This was contrary to our earlier analysis of the *ex-ante* profitability, where the landfill gas projects exhibited the highest *ex-ante* issuance rate among all project types. From this, it may be worthwhile to note that landfill projects can have a higher level of *ex-post* issuance risk than other project types.

b) In terms of host countries, Brazilian and Chinese projects can have a positive impact on the issuance rate ranging from 11 to 20%. Conversely, Malaysian and Philippino projects can have a negative impact of -22 to -33 %. Host countries with relatively high issuance rates have a number of projects, with concentrations of biomass energy, methane avoidance, hydro and wind projects.

c) As for the control variables, the higher the *ex-ante* CER issuance amount, the difficult it becomes to realize the *ex-post* issuance amount and bring it close to the *ex-ante* value. The investment scale variables, for both electricity and GHG abatement, do not seem to imply strong "scale of economies" at least in the form of the issuance rates.

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