FOREIGN DIRECT INVESTMENT AND THE CLEAN DEVELOPMENT MECHANISM: A STRONG RELATHIONSHIP?

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ABSTRACT

The Kyoto Protocol introduced three mechanisms that allow for flexibility in achieving GHG emission reductions, namely international emissions trading, joint implementation (JI) and the clean development mechanism (CDM). In this research we focus on the CDM projects. These projects involve investment flows and technology transfers between investors and receiving countries. We describe the CDM projects currently underway and we analyze their economic effects in both the investor and the host countries. Particularly, we focus on the relathionship between foreign direct investment flows and CDM projects.

Keywords: Kyoto Protocol, CDM projects, foreign direct investment.

JEL Codes: Q55, Q56, F21.

[1] Funding from Projects ECO2008-05908-CO2-01 and the Spanish Ministry of Education SEJ2007-67548 in support of this work is gratefully acknowledged.

1. INTRODUCTION

The Kyoto Protocol introduced three innovative mechanisms that allow for flexibility in achieving the emissions reduction targets: international emissions trading (Article 16 bis), joint implementation (Article 6) and the clean development mechanism (Article 12). The three mechanisms enable Parties to access cost-effective opportunities to reduce emissions or to remove carbon from the atmosphere in other countries, providing for transfers of emission rights or emission reduction credits between nations.

International Emissions Trading is based on the trading of emission "rights" or allowances between Annex B countries. The Joint Implementation Mechanism (JI) is based on agreements between two Annex I countries (industrialised countries). Discrete emission reduction units (ERUs) can be credited to an investor country for reduction projects undertaken in a host country. Reduction credits will be based on actual, project-related avoidance, reduction, or sequestration of any greenhouse gas. The Clean Development Mechanism (CDM) is based on agreements between Annex I and non-Annex I countries, in other words, industrialised and developing countries, respectively. The emission reductions in this case are referred to as "certified emission reductions" (CER).

In this research we focus on the CDM projects. These projects have increased rapidly last year. On March 2008 there were 900 CDM underway; currently (February 2009) there are 1,406 registered projects with 1,460,000,000 expected CERs until the end of 2012. The CDM projects involve investment flows and technology transfers between countries. As Ellis *et al.* (2007) note, although this flow of investment still represents a small share of the whole foreign direct investment (FDI), it may stimulate the ongoing FDI flows in a country and the transfer of low GHG emitting technologies.

In order to explain the distribution of CDM projects across host countries, we have conducted an econometric analysis to investigate the relationship between FDI, ODA and the number of CDM projects. The paper is structured as follows. ~~The first~~S ~~s~~ections two and three describe the CDM projects currently underway, particularly their distribution across sectors and countries. ~~second~~ Section 4 focuses on the potential effects that CDM projects could have on host countries as well as the collateral effects for the investor countries. Section 5 exposes the results of the econometric analysis and section 6 concludes.

2. DESCRIPTIVE ANALYSIS OF CDM PROJECTS

CDM and JI projects may be implemented in any sector of the economy and must be aimed at reducing the green house gases (GHG) listed in Annex A of the Kyoto Protocol[2]. Carbon dioxide accounts for most GHG emissions (80%) and has been taken as the basis for measuring global warming potential (GWP)[3] and also for measuring ERUs and CERs.

2.1 The Management of CDM Projects

2.1.1 Eligibility Requirements

To participate in CDM projects, Annex I Parties must meet, among others, certain eligibility requirements, namely:

- They must have ratified the Kyoto Protocol.
- They must have calculated their assigned amount of emissions, as referred to in the Kyoto Protocol, in terms of tonnes of CO2-equivalent.

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[2] Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6).

[3] The definition of GWP for a particular greenhouse gas is the ratio of heat trapped by one unit mass of the greenhouse gas to that of one unit mass of CO2 over a specified time period. GWP is expressed in tonnes of CO2 equivalent.

- They must have in place a national system for estimating emissions and removals of greenhouse gases within their territory.
- They must have a national registry to record and track the creation and movement of ERUs, CERs and market trading allowances; they must report such information to the Convention secretariat annually.
- They must annually report information on emissions and removals to the Convention secretariat.

The eligibility of each Annex I Party is initially determined by their submitting a report with the above information to the secretariat. CDM projects will only be considered eligible if they meet the requirements of additionality and supplementarity established by the Kyoto Protocol. The condition of additionality is set out in Article 12 of the Kyoto Protocol: "*Reductions in emissions that are additional to any that would occur in the absence of the certified project activity*". (Article 12, 5c).

Paragraph 43 of the 2001 Marrakesh Accords of the Kyoto Protocol provides the following explanation of additionality: "*A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity*".

Therefore, a project is eligible when it reduces or prevents the emissions of any GHGs, such as carbon dioxide or methane, relative to what would have been emitted under a "business as usual" scenario.

The question of additionality is a major controversial issue. Apart from the difficulty in demonstrating its fulfilment by project developers, criticisms have also been made about its misinterpretation. For instance, Pearson and Loong (2003) consider that the undermining of additionality dilutes the potential benefit of the CDM to developing countries. These authors state that a credible additionality test could lead to extra investment directed to new projects that otherwise would not have happened; however, a test that allows "business as usual" projects will merely provide a top-up to existing projects that were going ahead anyway.

The condition of supplementarity is set out in Article 12 of the Kyoto Protocol: *"Parties included in Annex I may use the certified emission reductions ... to contribute to compliance with part of their quantified emission limitation."* (Article 12, 3b).

CDM projects have an additional requirement: they must contribute to sustainable development in their host countries. This is another controversial issue due to the lack of a common accepted methodology to assess this effect. Moreover, Bréchet and Lussis (2006) question the potential of CDM projects as an instrument to alleviate poverty in developing countries, since the most appealing projects are usually large-scale industrial projects with large amounts of carbon credits, while actions favouring human development are essentially small-scale projects.

The Marrakesh Accords provide for businesses, non-governmental organisations and other entities to participate in JI and CDM projects, under the authority and responsibility of governments. Different structures are envisaged for CDM project funding; a project may be financed by a partner from an industrialised country, by a partner from a developing country or by funding that includes financial contributions from several industrialised countries. These accords encourage more players to move into the emerging CDM markets.

Within the detailed rules for the implementation of the flexibility mechanisms established at COP 7 (Marrakesh, 2001), an explicit technology transfer requirement was added to CDM projects. Haites *et al.* (2006) find that technology transfers occur in one third of the projects, mostly in larger projects and projects with foreign participants. Dechezleprête *et al.* (2007) also find that technology transfer increases with the size of the projects.

The UNFCCC provided in 2005 new guidance for CDM projects, hence a project may be registered as a programme of activities. This option allows for a CDM project that involves several activities from different sectors and located in different places.

2.1.2 The CDM Cycle

The implementation of CDM and JI projects involves complex steps since several actors have to interact in order to validate the project design with an independent auditor and to receive the host-country approval. According to the UNCTAD (2003) guidelines, a CDM project cycle has the following basic steps:

1. Project design and formulation
2. National approval by the host country's Designated National Authority (DNA)
3. Project validation by a Designated Operational Entity (DOE)
4. Registration by the Executive Board
5. Monitoring by the project participants
6. Verification and certification by a DOE
7. CER issuance by the Executive Board

All these steps involve a great deal of bureaucracy, which leads to long time periods from the first proposal to project closure. The time required to complete a CDM project cycle is expected to be about 6-12 months.

The project design includes a detailed description of the project with the well-documented baseline reference and additionality requirement, as well as its contribution to sustainable development in the host country. All this information is reported in the PDD (Project Design Document). Project participants (PP) use the PDD to submit information on their proposed CDM project activity.

The next step consists of the project submission to a Designated National Authority (DNA) for approval. The absence of these entities has sometimes prevented a project from being carried out. Today, there are 128 DNAs, most of them belonging to Non-Annex I countries (102, 80% of the total). Annex I countries account for 26 DNA (20% of the total). Among Non-Annex I countries, the DNAs are distributed as follows: 35 in Africa, 34 in Asia-Pacific, 26 in Latin America and the Caribbean and 7 in other regions.

Validation is the process of independent evaluation of a project by a DOE. A Designated Operational Entity is either a domestic legal entity or an international organisation accredited and designated by the Executive Board with the following functions: to validate and subsequently request registration of a proposed CDM project, to verify emission reduction of a registered CDM project activity, and to certify as appropriate and request the Board to issue CERs accordingly. The list of accredited DOEs is available on the UNFCCC website, specifying the entities for validation functions and those for verification and certification within sectoral scopes. The Executive Board is appointed by the Parties to the UNFCCC and is made up of ten members from countries that have ratified the Kyoto Protocol.

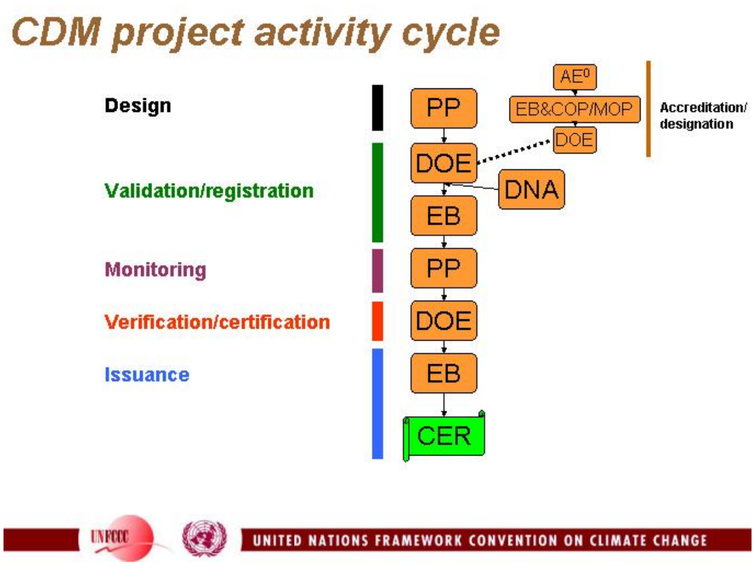
Registration is the formal acceptance by the Executive Board of a validated project as a CDM project activity. Registration is the prerequisite for the verification, certification and issuance of CERs related to the project.

Monitoring is the responsibility of the project participants. They must collect and archive all relevant data necessary for establishing GHG by sources occurring within the project boundary during the crediting period.

Verification is the periodic independent review and *ex post* determination by the DOE of the monitored GHG reductions derived from a registered CDM project. Certification is the written assurance by the DOE that, during a specified time period, a project achieved the GHG reductions as verified.

Finally, CER issuance is the responsibility of the Executive Board. CERs are transferred to the Parties' accounts (See Figure 1 for a description of the CDM cycle).

Figure 1



2.2 The World Bank Carbon Funds

Several agencies and brokers provide services to negotiate a contract for a CDM or a JI project. As stated by Bréchet and Lussis (2006), the World Bank manages various funds that have different goals depending on the type of project, its contribution to sustainable development or to capacity building. Some European governments have also initiated funds in order to obtain their own CDM or JI projects. Below we list the Carbon Funds included in the World Bank Carbon Finance Unit. For a more detailed description, see Bengochea and Martínez-Zarzoso (2008).

a) Prototype Carbon Fund

b) The Netherlands CDM Facility

c) Community Development Carbon Fund

d) BioCarbon Fund

e) Italian Carbon Fund

f) The Netherlands European Carbon Facility

g) Danish Carbon Fund

h) Spanish Carbon Fund

i) Umbrella Carbon Facility

j) Forest Carbon Partnership Facility

k) Carbon Fund for Europe

3. CURRENT CDM PROJECTS

Detailed descriptive statistics concerning the current CDM projects are shown in Tables 1 and 2 and Figures 2 and 3. The data were taken from the UNFCCC and refer to 5 March 2008. Up to this date, 949 CDM projects were registered, with 127,372,872 CERs issued and 1,170 million additional CERs expected to be issued by the end of 2012.

The projects are found in all economic sectors but the energy sector clearly predominates. The size of the projects shows a relatively balanced picture with small projects accounting for 47% of the total and large scale projects, 53%.

Concerning investor countries, the United Kingdom, the Netherlands and Japan are the leading investor countries (Table 1). The United Kingdom represents 40%, with 333 projects. The Netherlands has 120 projects (15%) and Japan, 102 projects (12%). These three countries are the main investors and are followed by eleven European countries and two American countries, Canada and Brazil; the latter plays a double role (host and investor) in this scenario.

The attractiveness of host countries for CDM projects depends on several factors. Jung (2006) taked into account the next ones: mitigation potential, institutional CDM capacity and general investment climate. She conducted a cluster analysis according to these indicators and found that only a few potencial host countries will attract most of the CDM projects, being the most attractive countries China, India, Brazil, Argentina, Mexico, South Africa, Indonesia and Thailand. In fact, India is clearly the main receptor of CDM projects (316); this country by itself accounts for more than one third of all projects. China, Brazil and Mexico each host over a hundred projects. These four countries jointly account for 76% of the registered CDM projects. Perhaps this ranking can also be explained by the dynamism of their emerging economies, in the case of India and China, with a high growth potential. In the case of Brazil, institutional actors have clearly played an important role. As Lecoq and Ambrosi (2007) explain, the CDM is partly the result of the proposal made by the Brazilian delegation to the UNFCCC a few months before the Kyoto meeting[4] and Brazilian authorities have created a favourable framework to host CDM projects.

Figure 2 presents the expected CERs by host parties. China lies in first place (48%), followed by India (15%), Brazil (9%) and Korea (7%).The percentage of CDM projects by region is highest in Asia and the Pacific, which accounts for more than 60% of the total; Latin America and the Caribbean host about one third of the projects while Africa hosts only 25 projects (less than 3%). To a certain extent, this picture reflects foreign direct investment (FDI) flows. As Ellis *et al.*

[4] The Brazilian delegation proposed the creation of a Green Development Fund based on the "polluter pays" principle and financed by countries that do not meet their commitments, to be used to support mitigation projects in developing countries. For different reasons, developed and developing countries were opposed to this proposal. Eventually, the United States and Brazilian negotiators suggested that the Green Development Fund be turned into a positive scheme whereby countries listed in

(2007) point out, "the conditions for a strong presence of FDI may be similar to conditions that will support CDM investments as well as effective national CDM institutions". However, Arquit and Saner (2005) argue that close correlation between FDI flows and CDM financial flows may not occur, since countries without success in attracting classic equity FDI, such as India or Latin American countries, can be successful CDM host countries. CDM projects currently represent only a small share of the total ongoing FDI flows from developed to developing countries, but they have a high potential to stimulate additional investments following this pattern.

The host countries with the highest number of incoming projects are chiefly from the regions of India, China, Latin America and Middle Asia. Figure 2 provides a picture of the distribution of issued CERs among host countries and Table 2 presents the ratio between the average annual reductions and the number of CERs issued for a sample of 25 countries. A look at the data shows that a reduction in CO2e does not lead to an equivalent number of CERs; in fact the opposite is true: the last column of the table shows disparities among existing projects. The ratio of CO2 reductions to CERs shows figures higher than one for most countries, as *a priori* could be expected, ranging from 17 (Philippines) to 1.1 (Bhutan). However, five countries present figures below one; this means that GHG reductions are overcompensated with CERs issued; this is the case for Brazil, India, Republic of Korea, Sri Lanka, Jamaica and Vietnam.

Figure 3 shows the distribution of the CDM projects arranged by scope. Energy industries account for more than half of all the projects (53%). The energy sector clearly has a high potential to obtain CERs by switching from fossil fuel-based technologies to other less polluting combustion processes. However, in relative terms, there has been little investment in alternative energy projects, perhaps as a consequence of the CER allocation system. As explained above,

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Annex B of the Kyoto Protocol would be allowed to exceed their emissions quotas by supporting emission reduction projects in developing countries.

credits are issued according to the "global warming potential" of the particular gas reduced. Rainer (2007) considers that this fact has strongly skewed the economics of the CDM towards reduction projects with low costs and high potential for obtaining CERs. Since renewable energy plants tend to be capital intensive, the overall profit from these installations is lower than other projects with reduced investment, small operating costs and a large number of CERs, such as recovery of methane from landfills, for instance. In fact, waste handling and disposal is the second largest sector to attract CDM projects (21%). Fugitive emissions from fuels, agriculture and manufacturing account for 8%, 7% and 6%, respectively. The remaining sectors account for a very small fraction, including the transport sector that is responsible for the most CO2 emissions.

Out of the 115 new projects that were added to the CDM pipeline in March 2008, 81 were renewable, 13 were energy efficiency (supply side), 7 were methane reduction, 5 were energy efficiency (demand side), 3 were fossil fuel switch, 2 were reforestation, 2 were N_2O reduction and 2 were coal bed methane. No HFC projects were submitted. Whereas the number of new CDM projects being added to the pipeline each month has stabilised at around 120, the number of resubmitted projects (40) was much larger than normal, and some of these were old projects first submitted for validation in 2006.

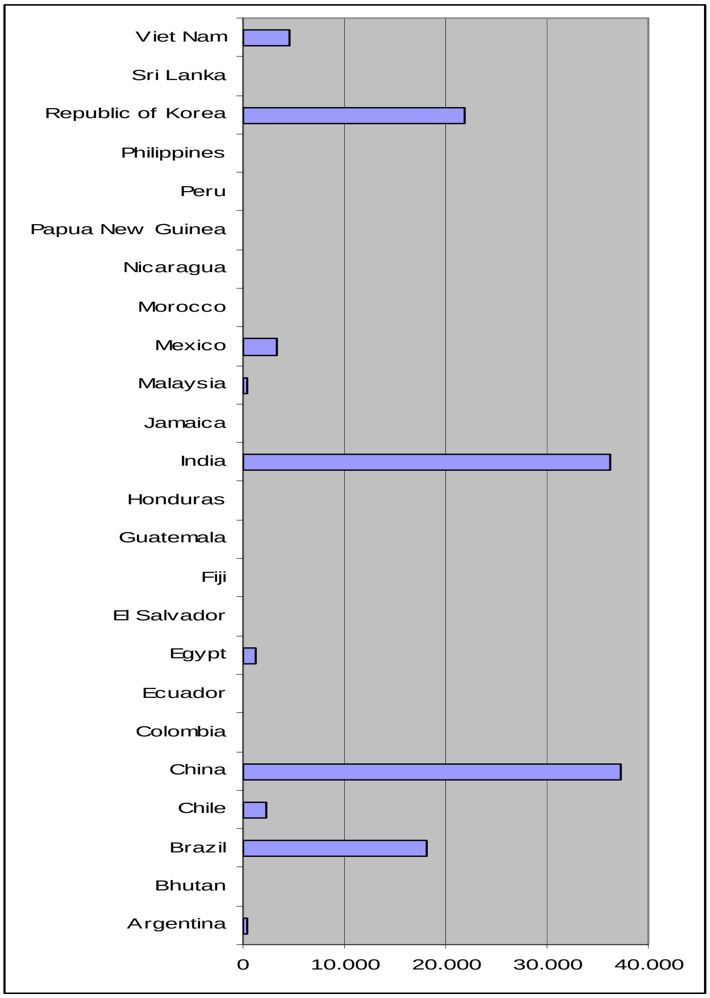
As of March 2008, the CDM pipeline contained 3,188 CDM projects (excluding the 63 rejected and the 14 withdrawn projects). Of these projects, 978 are now registered and a further 188 are in the process of registration. The number of projects requesting registration has increased again after low values in recent months. Finally, the number of CERs issued totalled 133 million. The average issuance success again increased slightly to 96.3%.

Table 1. Current CDM projects by receiving regions and investor countries

Host Region	Number of projects
Asia and the Pacific	586
Latin America and the Caribbean	330
Africa	25
Other	8
Total	949
Investor Country	**Number of Projects**
United Kingdom	333
Netherlands	120
Japan	102
Switzerland	50
Germany	39
Sweden	39
Spain	34
Italy	27
Canada	19
Austria	18
Denmark	14
France	14
Finland	13
Norway	3
Belgium	1
Brazil	1
Luxembourg	1

Source: UNFCCC, own elaboration

Figure 2. Thousands of CERs issued by host party



Source: Own elaboration based on UNFCCC

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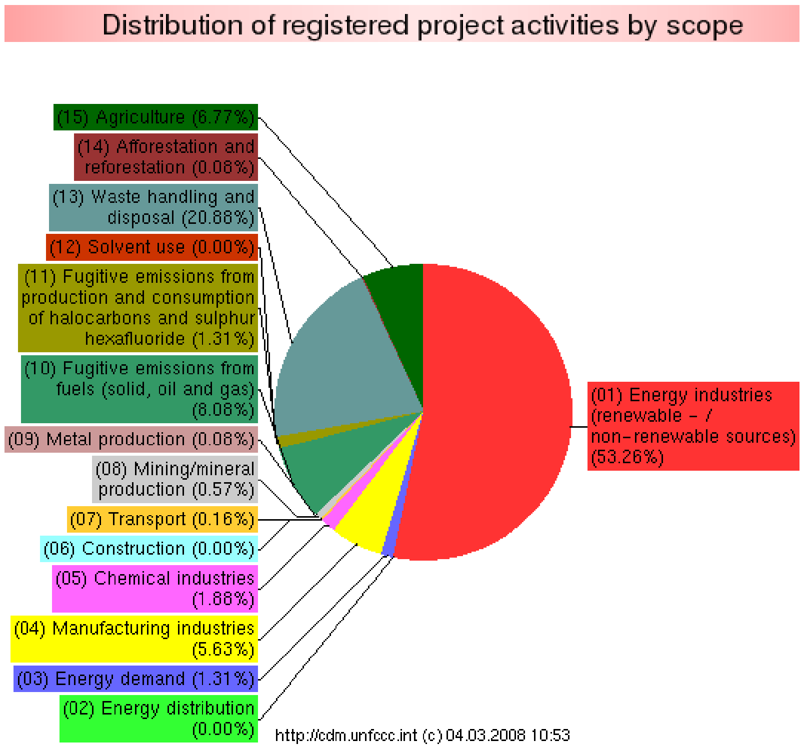
Table 2. Amount of CO2e reduction corresponding to one CER

Host Country	Average annual reductions	CER issued	Reductions/CERs
Philippines	481,863	27,807	17.21
Argentina	3,851,143	330,919	11.63
Morocco	255,794	26,213	9.85
Peru	909,195	104,693	8.66
Colombia	958,166	152,949	6.26
Malaysia	2,242,132	504,827	4.44
Honduras	229,032	63,877	3.58
El Salvador	475,444	134,955	3.52
China	92,902,049	37,215,547	2.50
Mexico	7,006,185	3,396,342	2.06
Nicaragua	456,57	262,645	1.74
Chile	3,973,232	2,334,853	1.70
Ecuador	465,451	275,444	1.69
Guatemala	279,694	197,928	1.41
Fiji	24,928	18,176	1.39
Egypt	1,685,393	1,223,921	1.38
Bhutan	524	474	1.11
Brazil	17,675,004	18,079,892	0.98
India	28,995,416	36,351,680	0.80
Korea	14,356,217	21,830,155	0.66
Sri Lanka	109,619	173,107	0.64
Jamaica	52,54	127,58	0.41
Vietnam	681,306	4,486,500	0.15

Source: Own elaboration based on UNFCCC data.

Figure 3



4. THE EFFECTS OF CDM PROJECTS ON HOST AND INVESTOR COUNTRIES

The Kyoto mechanisms were initially designed to help developed countries to achieve the emissions targets established by the Kyoto protocol at minimum cost. In theory, the project-based Kyoto mechanisms should allow for classic win-win situations in which both the project developer/investor and the receiving country can benefit economically. On the one hand, CDM projects may assist Annex I countries in achieving their emissions reduction goals in a cost-efficient mammer; project developers have a new source of revenue stemming from the sale of

CERs, which make the projects more attractive. On the other hand, host countries can benefit from the technology transfer embodied in the investment projects, and from contributions the project makes in generating employment and promoting sustainable development.

4.1 The Effects of CDM Projects on Host Countries

The CDM projects should foster several goals simultaneously: GHG emission reduction, technology transfer and sustainable development. In fact, it is worthing to note that for a CDM project to be considered for registration, project participants must first the approval from the host country, stating that the project assists him in achieving its sustainable development targets. However, some authors argue that the CDM may not achieve these goals, like Muller (2007) and Olsen (2007).

The main problem concerning sustainable development benefits is that this aspect is not incorporated into the market benefits of the mechanism. The CDM only provides monetary incentives linked to one of the purposes of the CDM projects, namely GHG reduction. According to Ellis *et al.* (2007), projects producing large amounts of emissions reduction usually generate small benefits for local development, whereas smaller projects that deliver fewer CERs have direct benefits for local communities (e.g. increases in household energy efficiency). In that sesnse, Olsen and Fenhann (2008) suggest to improve the sustainability assessment in the approval process carried out by the designated national authorities (DNA) in host countries in order to select the most suitable projects to achieve sustainable development.

Concerning technology transfer, researchers agree on the fact that CDM projects may encourage technological change in developing countries. Technology transfer is very heterogeneous across product types and it is more common in large projects, as shown in studies by Haites *et al*. (2006) and Dechezleprête *et al.* (2007). According to de Coninck *et al.* (2007), a significant proportion of the projects use technology from outside the host country, mainly in large-scale non-CO_2 greenhouse gas projects and in wind energy. These technology transfers would most likely induce capital accumulation and economic growth.

In March 2008, the UNFCCC secretariat published a study, prepared by a team of consultants[1], analysing information on technology transfer used in CDM. The main results indicate that 39% of the projects claim to involve technology transfer. In addition, 56% of the projects that involve technology transfer include both equipment and knowledge transfers; 32% of the projects claim transfer of equipment only. The main sources of equipment and knowledge transfer are Japan, Germany, the USA, France, and the United Kingdom. The potential for these transfers has not been exhausted and will continue to be a source of potential benefits for developing countries hosting CDM projects. The trends published in the above mentioned UNFCCC report are thus likely to continue during the period 2008-2012.

One way to analyse the potential economic effect of CDM projects on host countries is to compare these investments with other sources of foreign transfers/investment flowing from developed to developing countries. These flows include foreign direct investment (FDI) and official development aid (ODA). While FDI flows became a dominant element in the 1990s, ODA remained relatively stable over the period in absolute terms. However, at the beginning of the 2000s FDI flows decreased for many receiving countries, whereas aid transfers increased according to UNCTAD and OECD statistics.

Table 3 shows ODA and FDI in million current US$ for some countries in 2006 and the number of CDM projects registered in some selected countries. Several important differences can be observed. The number of CDM projects is higher in India, where FDI flows are less important than in other developing countries (India ranked 21st in terms of inward FDI in 2006, according to UNCTAD FDI statistics, whereas it ranked first in terms of number of CDM projects). In terms of ODA, the amount received by Vietnam, Indonesia and China is more than twice the amount received by India and is much higher than that received by other recipient countries, such Brazil, Chile and Peru.

Figure 4 shows the evolution of CDM projects registered over time for the countries with a higher number of projects (India, China, Brazil, Mexico, Chile and Malaysia). The number of registered projects has been growing steadily in China and India, whereas in Brazil, Mexico and Chile fewer projects were registered in 2007 than in 2006. A lot of projects are currently in the pipeline (more than 3,000 in total) awaiting registration. When considering only data on registered CDM projects, we find that the expected value of these projects is highly correlated with FDI; the single correlation coefficient is almost 0.60, as shown in Table 4.

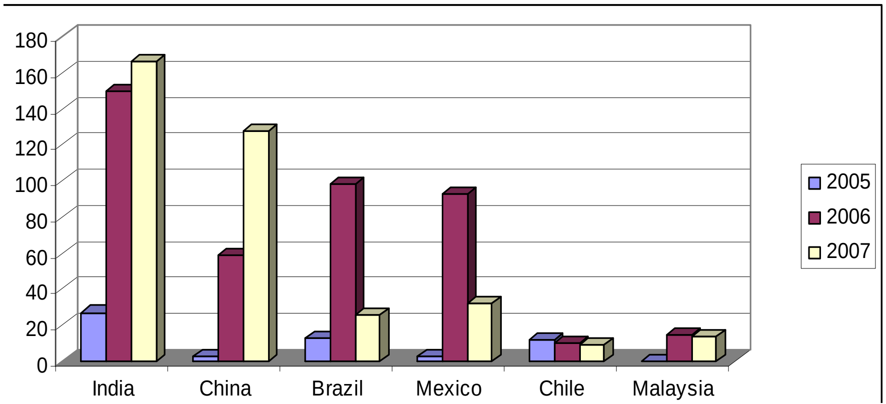
Table 3. ODA, FDI and number of CDMs to selected countries in 2006

	ODA	**FDI**	**CDM**
India	378.92	50 680	316
China	1245.48	292 559	161
Brazil	82.42	221 914	125
Chile	83.01	80 732	22
Indonesia	1404.50	19 056	13
Colombia	98.02	44 773	10
Peru	46.86	19 356	10
Vietnam	1846.39	33 451	2

Source: ODA data are from OECD statistics and FDI data from UNCTAD.
(In current millions US $).

[1] Seres, S.; Haites, E.; Murphy, K. (2007): Analysis of Technology Transfer in CDM Projects. Report prepared for the UNFCCC.

Figure 4. Yearly evolution of registered CDM per host parties



Source: Own elaboration based on UNFCCC.

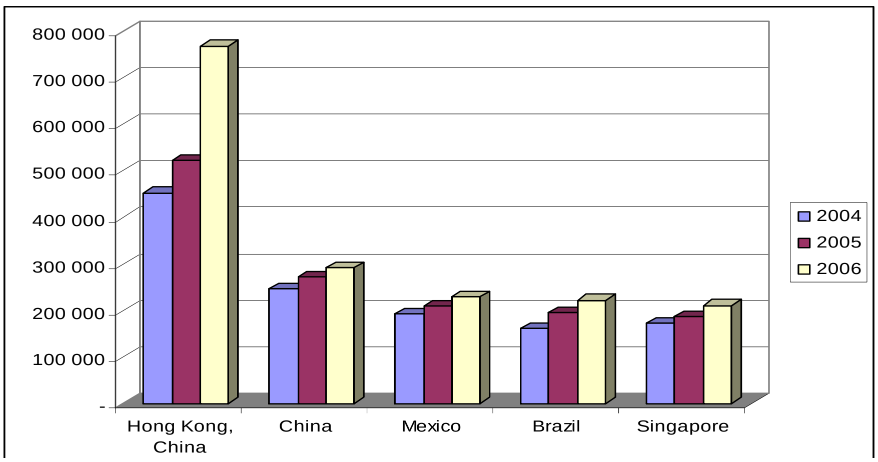
Figure 5 shows the evolution of FDI flows in the last three years for the most important receiving countries: Hong Kong, China, Mexico, Brazil and Singapore. Three of these countries (China, Mexico and Brazil) are also among the most important CDM project host countries. Only India, the host country with the greatest number of CDM projects, is not an important receiver of FDI flows. This evidence indicates that countries that have not been very successful in attracting FDI have the chance to become important receivers of CDM projects as long as they are able to establish the required institutional framework and to offer a low-risk environment in terms of the potential generation of CERs by CDM projects. *A priori* CDM projects could also complement ODA projects in developing countries; however the correlation coefficient between ODA and CDM is negative, as shown in Table 4.

Table 4. Single correlation coefficients

Nobs=37	CDM annual average	FDI 2006	ODA 2006
CDM annual average	1		
FDI 2006	0.5869	1	
ODA 2006	-0.2194	-0.1159	1

Source: Own elaboration.

Figure 5. Inward FDI in Million US$ for most important receiving countries



Source: UNCTAD statistics.

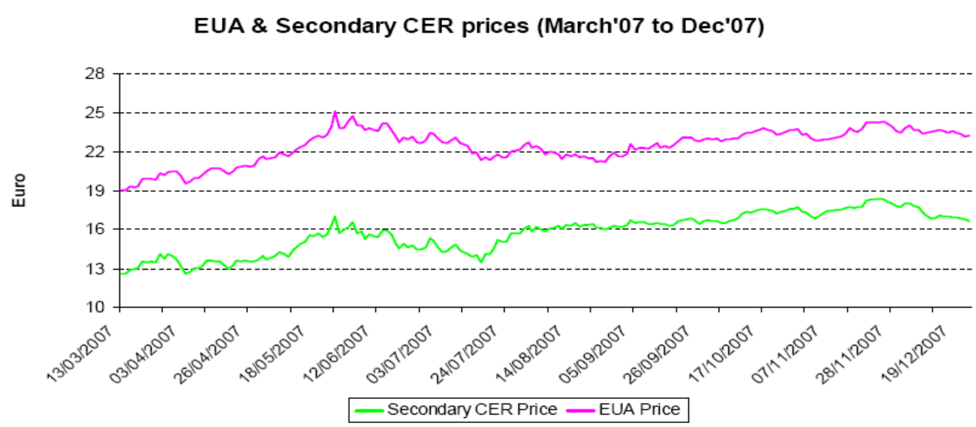
4.2 The Effects of CDM Projects on Investor Countries

As mentioned above, investors in CDM projects have a new source of revenue stemming from the sale of CERs. To analyse these potential revenues we focus on the demand and supply of CERs and the benchmark market price since the value of CERs in the carbon market has a direct impact on the project's profitability, as demonstrated by Diakoulaki *et al.* (2007). EU legislation allows for CERs and EUAs (European Union Allowances) to be used in the European Union

Emission Trading Scheme (EU ETS) under the "Linking Directive"[2]. Therefore, JI and CDM projects may reduce the costs of compliance for European industry. In fact, the Intergovernmental Panel on Climate Change (IPCC) has projected lower costs for EU countries using CDM and JI mechanisms fully than those that only take domestic action[3]. However, it is worth noting that inaction has an even higher cost, as pointed out by Stern (2006) and the European Environmental Agency (2007).

In 2006, CERs from CDM projects were traded on a forward basis between €5 and €20 per tonne CO_2 equivalent. Figure 6 compares the evolution over time of the prices for EUAs and secondary CERs.

Figure 6



Source: ECX, Nord Pool. Benchmark prices.

CER prices have usually traded lower than EUA prices (in the range of 65% to 85% of EUAs). There are substantial differences between CERs and EUAs that help explain this difference: whereas EUAs are government permits that can be delivered once they are issued, CERs are only

[2] This Directive was adopted by the EU parliament in April 2004 and allows emissions units generated by the project-based Kyoto

issued when generated and there are no guarantees they will be generated at all. In addition, delivery usually takes place within a few months and there are no delivery time guaranties. Another difference is that every CER issued will be traded, unlike the issuance of EUAs, many of which are never traded but are held by emitters to meet carbon compliance requirements.

As a result, there is wide price dispersion in the CDM market[4], since the CDM price depends on the distribution of risk between seller and buyer. The seller could obtain a very good price if it agrees to bear the risk. The degree of risk depends on several factors: the project's baseline, the monitoring methodology, the probability to reject the project by the host country or by the CDM Executive Board and the possibility that the project, for some reason, will produce fewer credits than foreseen.

With regard to demand and supply, a study from the analyst New Carbon Finance[5] (NCF) reveals that the market for CERs could double or treble in the period 2012-2020, compared with the levels expected in 2008–2012. If an international agreement on future emissions reduction targets is reached, demand for CERs may rise to as high as 2.3 billion tonnes a year by 2020. NCF based its forecast on the assumption that proposed legislation from the EU, US, Canada, Japan and Australia will come into force and that demand from voluntary markets will increase. Nevertheless, if no international agreement is reached, the demand for CERs in 2020 could be as low as 410 million a year, leading to a 60% reduction in the level of investment on current levels. The global carbon market is therefore highly sensitive to decisions taken by the major developed countries, notably the US and Japan. The study indicates that there is significant inertia in the CER supply system and it could take several years to respond to a shortage of credits in the

mechanisms to be used for compliance by companies operating under the EU ETS.

[3] Climate Change 2001 - Synthesis report. Figure SPM-8 IPCC, 2001.

[4] It can vary from US$8 to US$16 depending on the risk for the buyer/seller.

[5] http://www.newcarbonfinance.com/

market. At the end of March 2008 more than 3,000 projects were in the pipeline, the CERs for which are forecast at 2.7 billion tonnes until the end of 2012 (UNFCCC statistics).

5. ECONOMETRIC ANALYSIS

In the previous sections we have presented descriptive statistics of the inter-country differences in the number of CDM projects, the number of CERs issued and the the expected reductions in emissions. In order to understand what drives these differences, we have conducted a simple econometric analysis to investigate the specific effect of ~~a number of~~two variables on the ~~likelihood that~~number of ~~a~~ CDM projects that are~~is~~ approved and developed. We are especially interested in explaining the relationship between FDI, ODA and the distribution of CDM projects across host countries. To examine this relationship, the following equation is estimated

$$n_j = \alpha + \beta_j FDI + \gamma_j ODA + \mu_j \qquad (1)$$

w~~W~~here n denotes the number of CDM projects registred in country *j* until January 2007, FDI denotes foreign direct investement in current US$ in 2006, ODA denotes official development aid also in current US $ in 2006 and μ_j denotes the error term that is assumed to be white noise. The model is estimated with the variables in levels to be able to include ~~also~~ the zero values of the observations and also with the variables in logs. Equation 1 is estimated using the traditional OLS estimator and a Poisson model which is especially suitable for count data. The Poisson model is estimated using pseudomaximum likelihood. In order to facilitate the interpretation of the estimated coefficient and to be able to compare them with the OLS estimates, we consider two specifications for the Poisson model. In the first one all the variables are in levels and in the second the dependent variable is in levels and the independent variables are in logs. In this way the coefficient can be interpreted as semi-elasticities and are comparable with the ones obtained using the log-log model estimated using OLS. ~~We also present additional results considering alternative estimation techniques.~~

The first two columns of Table 5 present~~s~~ the results~~.~~ of estimating equation 1 in levels and in logs respectively using OLS. Models 3 and 4 present the results when estimating a Poisson model with the variables in levels (model 3) and with the dependent variable in levels and the explanatory variable in logs (model 4).

Table 5. Explaining the number of CDM projects

	Model 1	Model 2	Model 3	Model 4
	OLS	OLS	Poisson	Poisson
Dep. Var.	n	ln	n	n
Oda_mill	-0.02		-0.002	
	-1.026		-1.01	
fdi_mill	0.001		0	
	14.772		4.114	
Loda		0.04		-0.147
		0.299		-1.163
Lfdi		0.459		0.844
		5.371		9.308
C~~–c~~onstant	7.387	-2.733	2.528	-5.218
	0.751	-3.073	3.251	-5.073
Pseudo_R^2			0.424	0.738
R^2 ~~r2~~	0.~~3588628~~359	0.~~5608944~~561		
N	49	34	49	34
Log-lik	-252.917	-42.79049	-871.7567	-134.307

The results indicate that higher levels of FDI in host countries influence positively the number of CDM projects registered. This result is robust to different specifications and estimation techniques. Since model 4 presents the higher explanatory power in terms of the Pseudo R^2, we can interprete the coeffient obtained for lfdi in column 4 as follows: a 10 percent increase in FDI is associated to an 8.4 percent increase in the number of CDM projects in a given host country. We find therefore some preliminary evidence showing that CDM projects are driven by FDI. We do not find a robust relationship between ODA and the number of CDM projects. It could be due to the small number of observations used. However, in models 1, 3 and 4, the ODA coefficient is negative signed showing a potential negative effect of ODA on the number of CDM projects.

As an alternative specification we used as dependent variable the number of CER issued by host country. The results are presented in Table 6. We find a stronger relationship between FDI and CERs and a negative and significant relationship between ODA and numbers of CER issued.

Table 67. Explaining the number of CER issued

	model1	model2	model3	model4
	OLS	OLS	Poisson	Poisson
Dep. Var.	cer	lcer	cer	cer
Oda_mill	-4847.231		-0.007	
	-1.908		-2.305	
fdi_mill	84.952		0	
	3.312		4.804	
Loda		-0.143		-0.79
		-0.53		-2.413

Lfdi		0.898		1.521
		8.295		7.557
C~~c~~onstant	9.69E+05	4.655	14.561	1.219
	0.753	3.421	20.471	0.564
Pseudo_R^2			0.552	0.883
R~~r~~^{2}	0.444~~39506~~	0.785~~4667~~		
N	49	19	49	34
Log-lik~~l~~	-834.6344	-27.04117	-1.22E+08	-7138696

5. CONCLUSIONS

In this research we have analysed the project-based Kyoto mechanisms, focusing on the CDM projects. They involve investment flows and technology transfers between countries. By March 2008, more than 3,000 CDM projects were in the pipeline awaiting registration. This implies that in the next few years, foreign direct investment could be redirected towards emission reducing projects in countries where specific reduction costs are lower.

The economic effects of CDM projects in both investor and host countries should allow for classic win-win situations in which both the project developer and the host country can benefit economically. On the one hand, the project developers have a new source of revenue stemming from the sale of CERs, which make the project more attractive. On the other hand, the host countries can benefit from the technology transfer embodied in investment projects and from contributions the project makes in generating employment and promoting sustainable development.

Almost forty per cent of all CDM projects in the pipeline seem to involve technology transfer, being a source of potential benefits for developing countries hosting CDM projects. Technology transfer is more common in larger than in smaller projects. However, large projects producing large amounts of emission reductions usually generate lesser benefits for local development than smaller projects with few CERs. In order to keep a balance, we can conclude that host countries could combine small and large CDM projects, enabling developing countries to benefit from both technology transfer and economic development.

In order to understand what drives the inter-country differences in the number of CDM projects, we have conducted an econometric analysis to investigate the relationship between FDI, ODA and the distribution of CDM projects across host countries. The results indicate that higher levels of FDI in host countries influence positively the number of CDM projects registered. However, we do not find a robust relationship between ODA and CDM projects. Therefore, we may complete the study conducted by Ellis *et al.* (2007) showing that CDM investments follow the FDI flows.

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