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The Clean Development Mechanism: too flexible to produce sustainable development benefits?

Charlene Watson and Samuel Fankhauser[*]

Abstract

The Clean Development Mechanism (CDM) of the Kyoto Protocol has a dual objective: to encourage low-cost emission reduction and to promote sustainable development in the host countries of CDM projects. The CDM has by and large delivered on the first objective but arguably not on the second. This paper assesses quantitatively the form and prevalence of co-benefits in CDM projects. Adopting a broad definition of sustainable development, the project design documents of 409 projects (10% of the October 2008 project pipeline) were searched for keyword indicators of contributions to economic growth, physical, social and natural capital. Economic growth co-benefits, in the form of employment, constitute the main project co-benefit, with 82% of projects claiming to contribute to employment. Under a stricter sustainable development definition, projects contribute principally to social capital, primarily training (67%), with physical and natural capital gains less prominent. End-of-pipe projects are found to have lower co-benefits than renewable energy or forestry projects in particular. Contrary to common belief, small-scale projects do not appear to provide higher co-benefits than large-scale projects.

Keywords: Clean Development Mechanism, sustainable development, GHG mitigation

1. Introduction

The Clean Development Mechanism (CDM) was set up with two objectives in mind. The first objective was cost effective mitigation. The CDM opened the door for low-cost mitigation in developing countries, thus involving all countries in the global mitigation effort and allowing annex I countries to meet their Kyoto targets more cost-effectively. The second objective was sustainable development. Article 12 of the Kyoto Protocol prescribes the need for tangible co-benefits to the countries hosting the projects.

On the first objective the CDM has broadly delivered, despite justifiable criticism about uncertainty in the regulatory framework, bottlenecks in the administrative process and the unproven additionality of some projects (see Streck and Lin, 2008). There are well over 4,000 projects in the CDM pipeline. They are expected to produce some 1.5 billion tonnes of certified emission reductions (CER) by 2012, even though only about 200 million CERs have so far been issued (Fenhann, 2008).

However, it would be imprudent to assume that the large number of CDM projects automatically results in high sustainable development (SD) benefits. There has been widespread criticism of the CDM contribution to SD (Boyd *et al.*, 2007; Olsen, 2007; Schneider, 2007; Sutter and Parreño, 2007;

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UNDP, 2006; Cosbey *et al*., 2005). Some authors have even argued that the two objectives of the CDM are largely incompatible (Pearson, 2007) with high SD benefits inherently too costly or too complex to attract the attention of CDM buyers. This may be an exaggeration. If the CDM fails to deliver on its SD objective, it is more likely due to shortcomings in procedures and not the inherent incompatibility of mitigation and SD objectives.

One such procedural problem is the lack of institutional guidance within the Kyoto Protocol, which does not define any specific requirements for SD. The Marrakech Accords give the Designated National Authorities (DNAs) of host countries the freedom to determine their own SD criteria (UNFCCC, 2002 Decision 17). For a CDM project to be validated, all the host country DNA has to do is confirm that the project activity contributes to SD. Information on DNA sustainability requirements is sparse, but it appears most host countries rely on qualitative and subjective checklists and some merely require no disagreement with in-country SD policy (Olsen and Fenhann, 2008; Sutter, 2003). Given that SD is such a broad concept this makes inconsistencies in SD policies across countries all but unavoidable.

In the competitive CDM market this flexibility and lack of reward may disincentivise the pursuit of SD benefits for host countries and project developers alike. SD potential being sacrificed in favour of investment potential. With no monitoring and verification (as there is on GHG reductions), and no reward for project developers in the compliance framework, the SD objective of the CDM is somewhat undermined. Continued absence of SD criteria may well exhaust the ‘low-hanging fruit’ of emission reductions in developing countries (Muller, 2007; Cosbey *et al*., 2005), making SD benefits through CDM project implementation necessary if non-annex I countries are to meet future emission abatement targets.

This paper seeks to quantify the extent to which the CDM has or has not contributed to SD. Defining short-term indicators of CDM co-benefits, we reviewed 409 project design documents (PDD) to gauge the real, small-scale, local impacts of pipeline CDM projects. At least initially, SD was defined fairly loosely to cover most types of local co-benefits, including contributions to economic growth (e.g., through job creation), the physical asset base (e.g. through capital investment), social capital (e.g., through training) and the environment (e.g., air quality benefits). Observable differences between sectors, regions, project size and over time was also investigated.

Reviewing project documents does not reveal how projects are implemented and what is happening on the ground. But it can tell us something about the mindset of project developers and the importance they assign to SD. Indeed, something that becomes apparent fairly soon is how little thought often goes into developing and articulating the SD aspects of a project, and how unfamiliar many project developers are with the notion of SD.

The paper starts, in section 2, with a review of earlier work on SD and the CDM and a definition of sustainable development. Section 3 then outlines the methodology applied in this study and section 4 discusses the main results. Section 5 concludes.

2. Sustainable Development in the Clean Development Mechanism

Previous attempts to analyse SD benefits of CDM have employed a variety of methodologies with often a narrow sector or location focus. Olsen (2007) provides the most comprehensive review to date confirming that although differing in approach, existing studies agree that the CDM is largely failing to be the win-win mechanism it was originally thought to be.

These studies often focus on particular sectors (for example forestry in Brown *et al*., 2004) and/or regions (for example energy in Brazil and China in Kolshus *et al*., 2001). They also rarely have extensive sample sizes. Sutter and Parreño (2007) sampling from all sectors and regions analysed 16 CDM projects. Using Multi-Attribute Utility Theory they conclude that less than 1% of CDM contribute significantly to SD. However, SD was narrowly defined and only employment, the distribution of CDM returns, and improvement of local air quality were considered. Nussbaumer (2008), also using multi-criteria evaluation, finds that labelled CDM projects including the Gold Standard and Community Development Carbon Fund only slightly outperform those that are not. However, this also has a small sample size, considering only 39 projects.

Olsen and Fenhann (2008) have performed the most comprehensive study so far, sampling 296 PDDs from the May 2006 UNEP-Riso pipeline of 744 CDM projects. Using text analysis software to find indicators of SD they report benefits within employment (68%), economic growth (46%), and air pollution (44%); thus contributions are predominantly social, followed by economic and then environmental. This paper presents an up-to-date assessment of SD benefits using the October 2008 UNEP-Riso pipeline of 4064 CDM projects. We sample from five times as many projects as were available to Olsen and Fenhann (2008) and incorporate the element of time into the analysis. We also take a much tighter capital asset definition of SD than most, distinguishing economic growth and development benefits from those that are more sustained. Furthermore, this paper does not utilise text analysis software that, by Olsen and Fenhann's admission, can result in 'deviant analytical results'.

There are many different approaches to defining and measuring SD, the discussion of which is beyond the scope of this paper (for an overview see Singh *et al*., 2009). SD is largely interpreted as a three dimensional concept, a triple-bottom-line, encompassing environmental, social, and economic components. This is commonly translated into protecting and managing the resource base, poverty eradication, and changing unsustainable patterns of production and consumption. However, the triple-bottom-line is better represented as a set of assets which, if declining in value, is considered an unsustainable development path where future well-being is less than current wellbeing. Following Hamilton *et al*. (2004)these assets can be divided broad capital categories: physical capital (economic assets inclusive of buildings, machines and infrastructure), social capital (people's abilities, institutions and relations shaping social interactions) and, natural capital (natural resources and environmental services providing life-support services).

To avoid entering into the theoretical debate about what SD means this paper takes a broad but pragmatic approach. From the outset, a distinction is made between economic growth and development and sustainable development which are commonly grouped together. Economic growth and development is used to refer to project benefits that are immediate, but not necessarily sustained; employment, further income opportunities for communities local to projects, and short-term livelihood improvements. This paper distinguishes between these important but impermanent benefits and more lasting benefits that are often not captured in conventional economic analysis. These sustainable development benefits are grouped here as contributions to physical, natural and social capital as defined by Hamilton *et al.* (2004) and we adhere to the prevailing weak sustainability concept whereby substitution possibilities exist between assets and thresholds and limits to substitutability are not considered (Pearce *et al*., 1989).

3. Our analytical approach

This analysis considers the claims of co-benefits made by CDM projects in their PDD. The PDD is the most widely-available[1] and comprehensive source of project-by-project information. Reviewed by the Designated Operating Entity (DOE; a body accredited by the UNFCCC) before submission to the EB, the PDD presents information on all aspects of the proposed activity following a standardised format including; a general description of the project activity, environmental impacts and stakeholder comments[2].

To assess economic growth and SD, eight consistent, understandable and practical indicators are established. Through this choice of indicators emerges a particular definition of SD that may or may not align with national definitions. Therefore, to encompass as many aspects of the numerous SD approaches as possible, PDD are also searched for a claim of 'sustainable development' *per se*, as well as indicators of economic growth. These keyword indicators, found in table 1, are selected to detect only improvements to the status quo. Indicators do not include the benefits that expected to occur in all projects, for example, GHG reductions, equipment, and CER revenues. Furthermore, negative impacts are not counted as they are unlikely to appear in project documents.

PDD are searched for both primary and secondary keywords associated with indicators and are scored 'yes' or 'no'. A result of this binary scoring they can only represent the type of co-benefits that CDM projects can bring rather than the size or scale of such benefits. As this method is subjective, requiring judgements to be made about the nature of the benefits, the sentence in which keywords reside will be carefully observed. Only true contributions will be scored positively, for example, there must be a clear mechanism by which livelihood benefits are delivered and not merely a statement to say that they will occur.

As the PDD presents the proposed co-benefits it is possible that after registration the project will fail on their delivery. This means only the potential benefits are observed by this methodology. With CDM projects too numerous to assess in-depth individually a limited web-based search of the project title is conducted to roughly gauge the reliability of project pledges. This constitutes a Google search of the project title, as in the PDD, with the first page of search results checked for negative press.

The scores generated from this methodology fall under a range of indicators that do not necessarily hold equal weighting. Thus, the aggregation of scores is meaningless. However, we can make some generalisations about sector and country level contributions to SD objectives as well as differences in project size.

TABLE 1. Keyword Indicators

Economic Growth and Development:

Primary Keyword	Secondary Keyword	Criteria for positive scoring
Employment	*Job/Labour/ Staff*	The project must create either temporary or permanent employment.
Livelihood	*Revenue/ Income/Poverty*	The project must generate revenue or income to local communities. This excludes CER sales or power sales arising from the project. This also includes claims of

[1] Project PDD available from: http://cdm.unfccc.int/Projects/Validation/index.html
[2] Standardised PDD forms available from: http://cdm.unfccc.int/Reference/PDDs_Forms/PDDs/index.html

		poverty alleviation, irrespective of baseline, and the generation of livelihoods and livelihood alternatives.

Sustainable Development:			
Form of Capital	**Primary Keyword**	**Secondary Keywords**	**Criteria for positive scoring**
Physical	Infrastructure	*Construction/ Roads*	The project must create man-made infrastructure such as roads that improve local travel, communication networks, or that involve construction beneficial to local communities in addition to the CDM activity.
	Techn. Transfer	-	A claim of technology transfer or of the use of new technology that is not widely available in the host-country in question.
Natural	Pollution	-	The project should generate air, water, or soil pollution improvements through project establishment. This excludes claims of no-change and air pollution from greenhouse gases.
	Environment	*Ecosystem/ Biodiversity*	The project will deliver positive environmental benefits, excluding pollution (see above). For example, increasing biodiversity benefits. This does not score replanting to compensate for environmental losses positively.
Social	Education	-	The project must contribute to the education of communities local to the project, beyond any training required for project implementation.
	Training	-	The project will provide training in operation of technologies, project management or in CDM protocols to any number of individuals.

4. Results and Discussion

4.1 Projects Evaluated

This analysis samples 10% of the 4064 projects in the October 2008 UNEP-RISO pipeline (Fenhann, 2008). Considering projects at all stages of validation except those rejected or withdrawn (97), this sample considers both early stage and recent CDM pipeline projects. Within each of the eight sectors CDM projects were allocated a number and random number generation used to select those for analysis (table 2).

Table 2. Sectors and Sample Size

	Sector	Type	Total Projects	At Validation	Request Registration	Registered	Sample
1	HFCs, PFCs and N2O	HFCs + PFCs + SF6, +N2O	95	37	4	54	11
2	Renewables	Biogas + biomass energy + geothermal + hydro +solar + tidal + wind	2465	1642	126	697	249
3	CH4 reduction and	Agriculture + cement + coal	641	368	24	249	66

	Cement and Coal mine/bed	bed/mine + fugitive + landfill gas +					
4	Supply-side EE	EE supply side+ EE own generation + Energy distribution	412	268	58	86	43
5	Fuel switch	Fossil fuel switch	132	89	12	31	14
6	Demand-side EE	EE households + EE industry+ EE service	188	130	8	50	20
7	Afforestation and Reforestation	Afforestation + reforestation	27	26	0	1	4
8	Transport	More efficient transport, biofuels are under biomass energy	7	5	0	2	2
	Rejected or Withdrawn		97	-	-	-	**0**
			4064	**2565**	**232**	**1170**	**409**

As well as adequate sector representation, the sample reflects the dominance of China (37%) and India (27%) in the CDM pipeline (see figure 1). Although only 91 of the 409 projects are registered, the combined emission reductions of the projects sampled could amount to 222,253 $KtCO_2$ by 2012 (8.0% of the total pipeline).

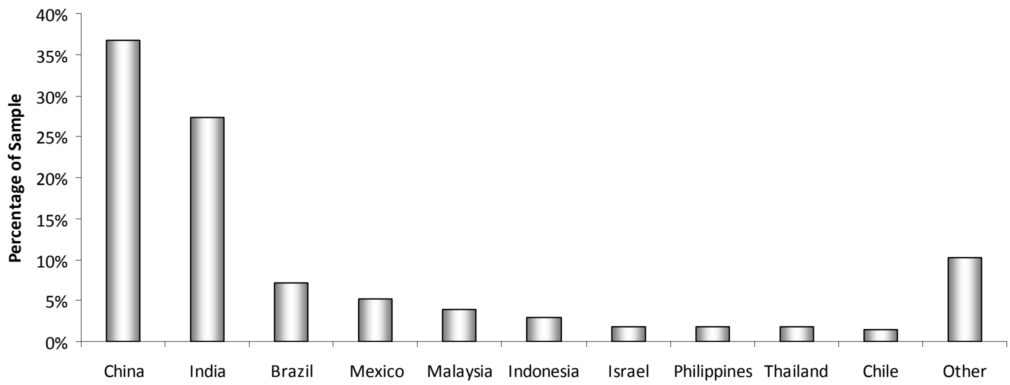

Figure 1. Global Distribution of Sample

4.2 Overall Project Contributions

Results show that the development benefits of CDM are predominantly employment (82%) and training (67%). Employment and training opportunities far exceed the contributions of the other indicators despite the fact that 96% of all projects claimed contribution to 'sustainable-development'. Technology transfer is claimed in 33% of projects, followed by livelihood benefits (23%), pollution benefits (21%), infrastructure building (21%), education (5%) and environmental benefits (4%) (figure 2).

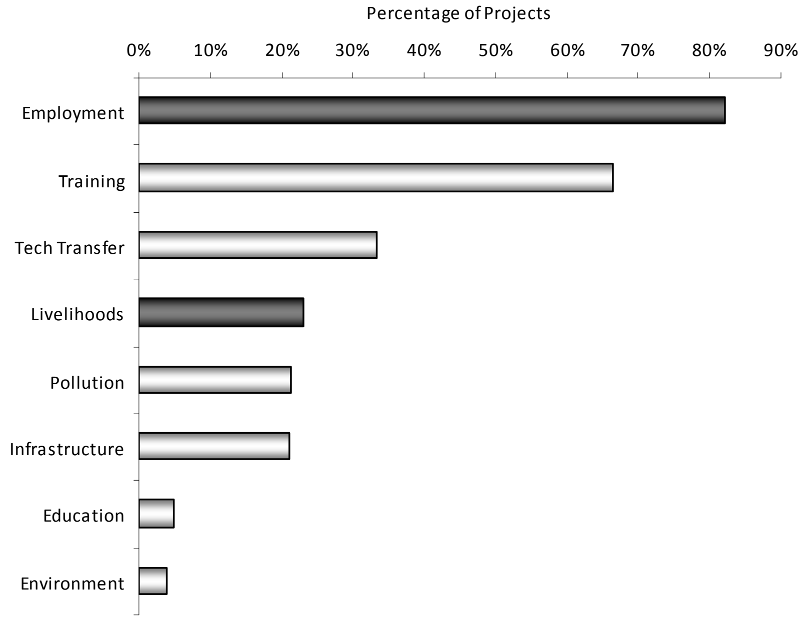

Figure 2. Presence of Indicators in Project Design Documents
(dark shading represents economic growth and development, light shading represents SD)

Any form of economic growth as defined here, is claimed by 84% of projects, with any form of SD co-benefit claimed by 83%. Considering only the sustainable development benefits, CDM projects contribute primarily to social capital (67%) and this is dominated by training for project activities. Both physical capital (50%) and natural capital (24%) are less widely claimed (figure 3).

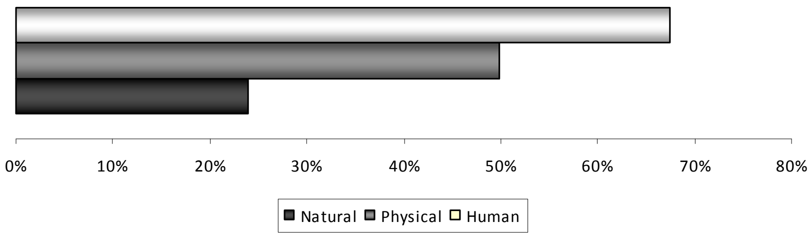

Figure 3. Forms of Capital Co-Benefits Claimed by Projects

Web search of the project titles revealed only five of the sampled projects had received either negative press associated with lack of SD benefits. This was inclusive of projects exemplified in publications exploring SD in the CDM. Only two had received positive press articles with the remaining searches merely linking to project details and documents on the UNFCCC website.

4.3. Sector Level Contribution

CDM projects are divergent in type and each sector will inherently have differing impacts on the resource and environment system as well as differing infrastructure requirements. Analysis by sector finds very low employment benefits from HFC, PFC, and N_20 reduction (18%) followed by fossil fuel switch (43%) projects, in comparison to all other sectors where employment benefits are over 65%. The industrial gas projects did, however, all claim technology transfer (table 3).

Although some sector sample sizes are small, the full complement of SD benefits is found in the Renewables, CH_4 Reduction and Cement and Coal Mine Bed, and Supply Side Energy Efficiency sectors.

Renewables also showed the highest contribution to infrastructure (31%) as opposed to other sectors that ranged from 0% to 7% as well as livelihoods (35%) as opposed to other sectors that ranged from 0% to 5% (both exclusive of Afforestation/Reforestation and Transport sectors due to small sample sizes, n=4 and n=2 respectively). This finding largely supports the general consensus that end-of-pipe adjustments have meagre SD benefits (Schneider, 2007) and that Renewable projects have greater capacity to contribute to SD (Schroeder, 2009; Liu, 2008; Ellis 2004).

Table 3. Sector level Benefits %

Sector	n	'Sustainable Development'	Economic Growth		Physical Capital		Social Capital		Natural Capital	
			Employment	Livelihoods	Infrastructure	Tech Transfer	Education	Training	Pollution	Environment
HFCs, PFCs & N2O reduction	11	91	18	0	0	100	18	100	0	0
Renewables	249	96	89	35	31	23	6	61	19	3
CH4 reduction & Cement & Coal mine/bed	66	99	74	3	5	62	1.5	76	46	6
Supply-side EE	43	100	88	2	5	33	4.7	67	14	2
Fuel switch	14	79	43	0	7	36	0	71	7	0
Demand-side EE	20	95	65	5	0	40	0	75	5	0
Afforestation & Reforestation	4	75	100	75	75	0	0	75	25	75
Transport	2	100	100	0	50	50	0	100	100	0
Total	409	96	82	23	21	33	5	67	21	4

Although only four Afforestation and Reforestation projects have been sampled, the sector is notable for high contributions to both environment and livelihoods as well as scant contribution in technology transfer. Environmental benefits are pledged in three of the four projects surveyed, in comparison with only four of the 66 CH_4 Reduction and Cement and Coal Mine Bed with the second highest contribution to environment at 6%. This finding is supportive of the belief that forestry carbon projects are better able to contribute to sustainable development (Smith and Scherr, 2003; Brown, 2002; Asquith *et al*., 2002) although involve no technology transfer (IPCC, 1999).

4.4. Country Level Differences

At the country level DNA have differing approaches to measuring SD. Taking China, India and Brazil, which together comprise 75% of CDM projects by location (71% of the sample), it appears that Chinese and Indian projects contribute more to economic growth than Brazilian projects, but these are comparable in terms of sustainable development co-benefits (figure 4).

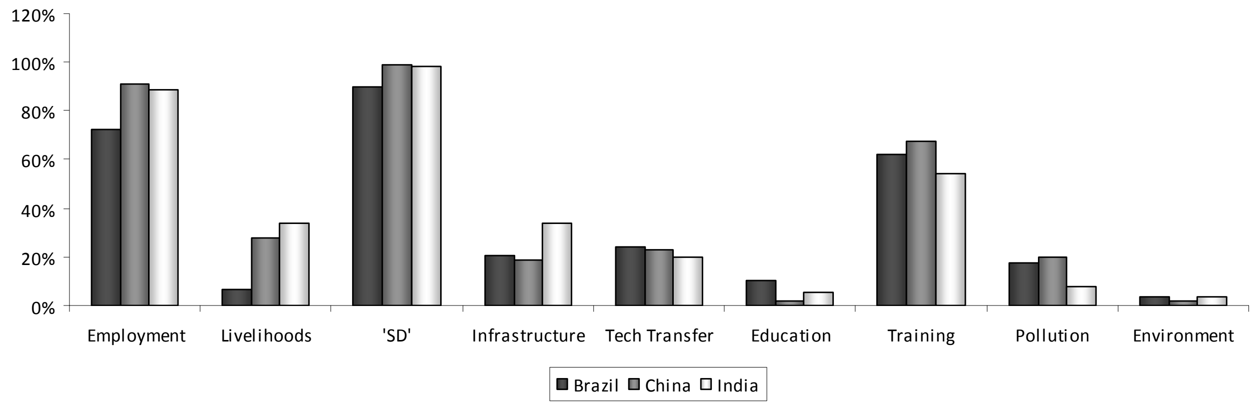

Figure 4. Sustainable Development Contribution in China, India and Brazil

Indian projects contribute more to infrastructural development than either Chinese or Brazilian projects, but with less technology transfer which is indicative of the increase in unilateral Indian projects. Chinese projects appear to contribute more to natural capital in the form of reduced pollution, although it is unclear whether this is a result of China's DNA's prioritisation of Energy Efficiency and Renewables that reflects energy development policy towards self-sufficiency and additional electricity generating capacity (NCCCC, 2005). It does appear though, that the high level of taxation that the Chinese government has imposed on CER revenues (2% from Afforestation and Reforestation and those generating electricity, 30% from N_20, and 65% from other industrial gas projects), has not impacted the SD benefits pledged by the project activities relative to other host countries.

By geographical region, figure 5 reveals that Latin America receives more technology transfer (52%) than either South Asia (20%) or East Asia and the Pacific (43%). This may represent the increasing use of in-country technologies that have become '*common practice*' in India and China as project numbers continue to rise. Remaining regions sample sizes that are too small to analyse; resulting from either lack of CDM activity, such as in Sub-Saharan Africa, or eligibility of countries within these regions, such as in Europe and Central Asia where countries are more engaged in other flexible mechanisms of the Kyoto Protocol.

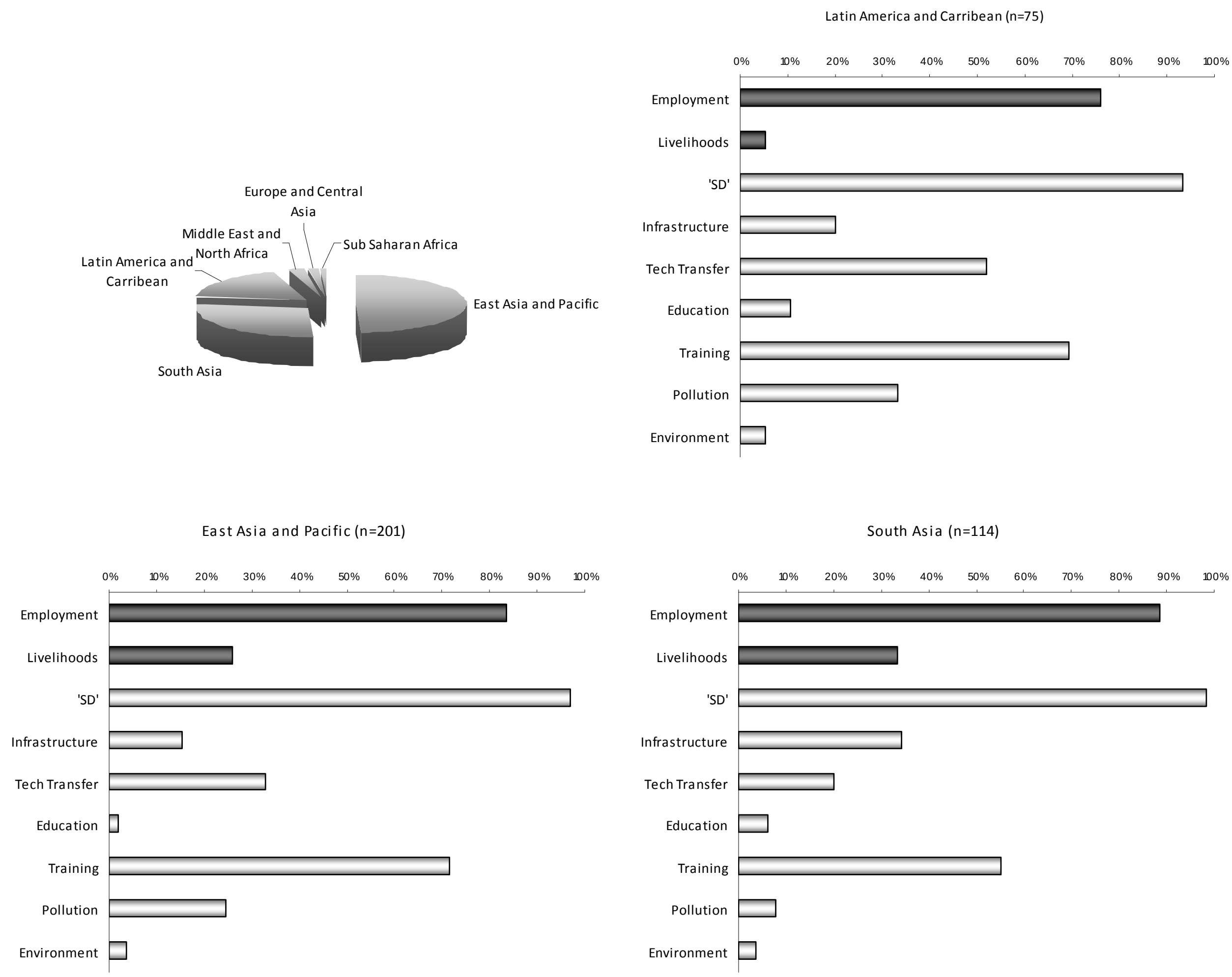

Figure 5. Sustainable Development Benefits by Geographical Region

In terms of development stage, the sample is predominantly composed of host countries in the lower-middle income category (76%, n=309), with upper-middle income and low income comprising 19% (n=77) and 2% (n=7) respectively. With small sample sizes for low income countries it is not possible to assess co-benefits relative to other income categories. Considering only middle-income economies, the lower-middle income group appear to accrue more benefits through economic growth. Furthermore, a higher incidence of technology transfer but a lower incidence of infrastructural gains is made by upper-middle income economies (figure 6).

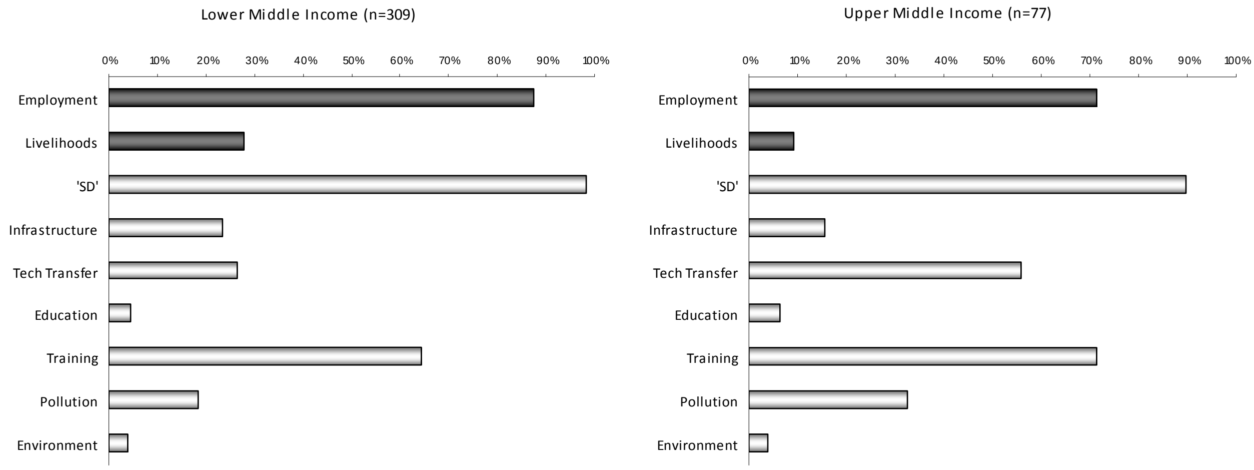

Figure 6. Sustainable Development Benefits by Income Category

4.5. Differences in Project Size

Fifty nine projects, or 14% of the sample, are classified as small-scale CDM activities. Small-scale projects produce less than 15,000 tCO2e annually and benefit from streamlined procedures. They require simplified methodologies, project design documents, and lower registration fees, all based on the assumption that these projects better deliver the 'development-dividend' (Cosbey *et al.*, 2005). Our analysis does not support this consensus, and we only find minimal differences in the incidence and range of indicators observed for the different project sizes (figure 7).

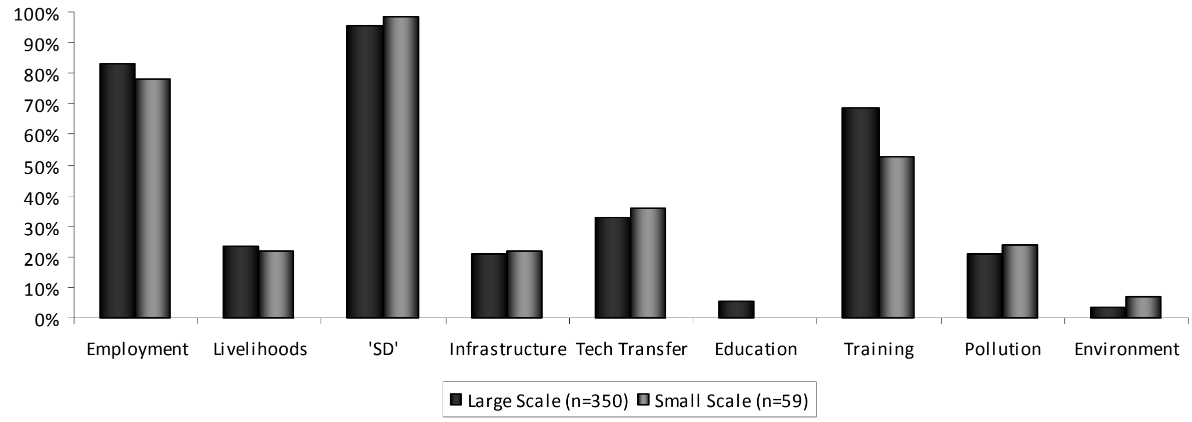

Figure 7. Sustainable Development Benefits by project size

4.6. Differences over Time

Entry into the pipeline occurs when project documents available for public comment under validation. The number of projects entering the CDM pipeline has been increasing steadily since the fourth quarter of 2003 (coded here 034 with the 03 representing 2003 and the 4 the fourth quarter) and the analysis contains both early stage and recent CDM pipeline projects. Figure 8 shows the percentage of projects claiming economic growth and development benefits have been variable over time, but without major trend in either direction.

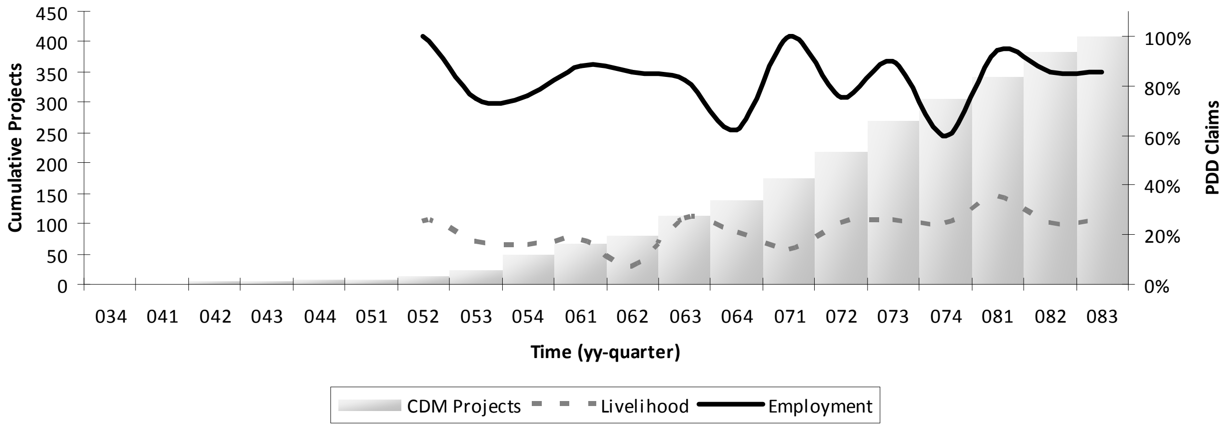

Figure 8. Projects Claiming Economic Growth by Pipeline Entry Date
(projects prior to the second quarter of 2005 excluded due to small sample size)

Figure 9 illustrates the percentage of projects claiming SD through physical, social or natural capital according to the date of entry into the pipeline. No evidence is found of decline in proposed SD benefits, a so-called 'race-to-the-bottom' (Sutter, 2003) and again, no strong trends over time are observed.

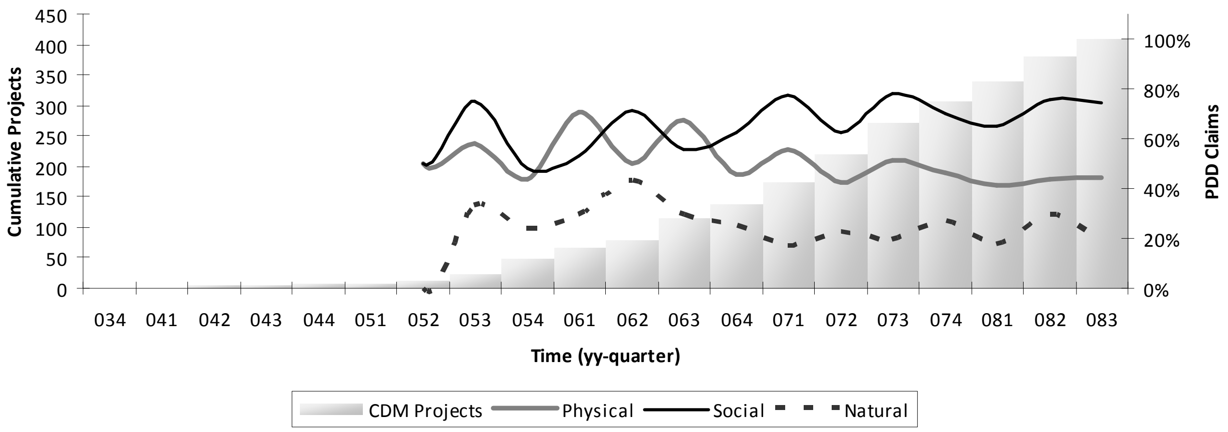

Figure 9. Projects Claiming Sustainable Development Benefits by Pipeline Entry Date
(projects prior to the second quarter of 2005 excluded due to small sample size)

4.7. Regression Analysis

To further investigate the determinants of the primary co-benefits offered by CDM projects we undertook some basic regression analysis, using a standard logit model where the probability of observing a particular co-benefit, p_i, is a function of a series of independent variables, X_i:

$$\text{logit}(p_i) = \log(\frac{p_i}{1-p_i}) = \alpha + X_i * \beta$$

Although the dataset is large in number of projects some sectors contain only a small number of observations. To reduce perfect prediction of co-benefit presence or absence, sector 7: afforestation and reforestation (n=4) and sector 8: transport (n=2) were dropped from the regression analysis. Two regression models were run to analyse employment and training co-benefits, the explanatory variables and the regression results for which are found in table 4.

Table 4. Logit Regression Variables and Coefficients (with standard errors)

Explanatory Variables		Dependent Variables			
		Employment		Training	
Variable	Description	Model 1	Model 2	Model 1	Model 2
Sector_1	Dummy: Sector 1 (HFCs, PFCs and N20 reduction) 1=Yes, 0=No	a	a	a	a
Sector_2	Dummy: Sector 2 (Renewables)	4.626***	4.675***	-18.769***	-18.330***
	1=Yes, 0=No	1.153	1.057	0.681	0.661
Sector_3	Dummy: Sector 3 (CH4 reduction, Cement and Coal mine/bed methane)	3.712**	3.963***	-18.211***	-17.949***
	1=Yes, 0=No	1.153	1.068	0.712	0.708
Sector_4	Dummy: Sector 4 (Supply-side energy efficiency)	4.327***	3.954***	-18.522***	-18.012***
	1=Yes, 0=No	1.232	1.133	0.741	0.725
Sector_5	Dummy: Sector 5 (Fuel switch)	1.686	1.684	-18.296	-18.182
	1=Yes, 0=No	1.188	1.129	.	.
Sector_6	Dummy: Sector 6 (Demand-side energy efficiency)	2.635*	2.563*	-17.680***	-17.253***
	1=Yes, 0=No	1.250	1.176	0.856	0.847
Region_1	Dummy: Region 1 (East Asia and Pacific) 1=Yes, 0=No	a		a	
Region_2	Dummy: Region 2 (Europe and Central Asia)	-0.316		-0.536	
	1=Yes, 0=No	1.037		0.965	
Region_3	Dummy: Region 3 (Latin America and Caribbean)	-0.237		0.119	
	1=Yes, 0=No	0.407		0.346	
Region_4	Dummy: Region 4 (Middle East and North Africa)	0.026		-0.580	
	1=Yes, 0=No	0.892		0.803	
Region_5	Dummy: Region 5 (South Asia)	1.000*		-0.615*	
	1=Yes, 0=No	0.443		0.272	
Region_6	Dummy: Region 6 (Sub Saharan Africa)	0.678		-0.762	
	1=Yes, 0=No	2.221		1.425	
Other Country	Dummy: Not China, India, Mexico or Brazil 1=Yes, 0=No		a		a
China	Dummy: China		2.016***		-0.832*
	1=Yes, 0=No		0.447		0.337
India	Dummy: India		1.589*		-0.440
	1=Yes, 0=No		0.467		0.578
Mexico	Dummy: Mexico		1.965***		-1.195***
	1=Yes, 0=No		0.467		0.339
Brazil	Dummy: Brazil		0.350		-0.641
	1=Yes, 0=No		0.505		0.474
Time	Entry into the project pipeline	0.040	0.027	0.056	0.060
	Continuous: year and quarter	0.042	0.041	0.032	0.031
Size	Project size in first commitment period	0.001*	0.001	0.000	0.001
	Continuous: ktCO2e/year	0.001	0.001	0.001	0.001
	Constant	-3.353*	-4.089**	18.555***	18.591***
		1.408	1.263	0.881	0.840

pseudo r^2	0.165	0.233	0.057	0.069

[†] classified developing countries according to World Bank
[a] reference scenario
Significance levels: *5%, **1%, ***0.1%

In model one, all sectors other than fossil-fuel switching were found to have significantly more employment and significantly fewer training benefits than the industrial gas projects at the 5% level or below. It was also found that larger projects predict significantly more employment gains than smaller ones at the 5% level as might be expected where project implementation demands are higher.

Regression model 2, where country dummy variables were added for China, India, Brazil and Mexico (countries with greater than 20 sampled projects), largely reaffirms the results of model 1. However, size is no longer a significant determinant of employment under model 2. Mexican, Chinese and Indian CDM projects are found to be significantly more likely to result in employment benefits than 'Other' countries, although China and Mexico are less likely to see training benefits. It should be noted that the pseudo r^2, an indicator of the explanatory power of the equation, was low in the training models in particular.

Focussing on SD benefits, a further logit regression was undertaken to explore the determinants of the various forms of capital (table 5). The industrial gas reduction projects were on the whole, significantly more likely to build physical and social capital than all sectors except fossil-fuel switch projects. This is due to *all* of the sampled industrial gas projects claiming both technology transfer and training. However, as predicted by the descriptive statistics above these industrial gas projects are less likely to provide natural capital than other project sectors.

South Asian CDM projects are found to be significantly less likely to result in natural and social capital gains than in East Asia and the Pacific, most likely representing differences between Indian and Chinese CDM projects: both countries carry the majority of CDM market share in these regions. Although, the pseudo r^2 in these models is low and the model suffers from small sample sizes and high standard errors the regression results largely support the observations of the descriptive statistics.

Table 5. Logit Regression Coefficients (with standard errors)

Explanatory Variable	**Dependent Variables**		
	Physical	**Natural**	**Social**
Sector_1	a	a	a
Sector_2	-19.081***	17.347***	-18.762***

	0.515	1.097	0.556
Sector_3	-18.671***	18.472***	-18.248***
	0.585	1.110	0.635
Sector_4	-19.449***	17.185***	-18.595***
	0.607	1.167	0.633
Sector_5	-19.301	16.021	-18.336***
	0.849	.	0.855
Sector_6	-19.301***	17.387***	-17.771
	0.693	1.515	.
Region_1	a	a	a
Region_2	-0.138	-0.318	-0.578
	0.954	1.204	0.963
Region_3	0.568	-0.108	0.059
	0.323	0.356	0.347
Region_4	-0.833	0.478	-0.621
	0.873	0.889	0.802
Region_5	0.126	-1.167**	-0.589*
	0.265	0.388	0.274
Region_6	0.263	b	-.0831
	1.428		1.425
Time	-0.037	-0.038	0.055
	0.030	0.379	0.032
Size[†]	0.001	-0.398	0.000
	0.001	0.379	0.001
Constant	19.273***	-17.522***	18.637
	.	1,285	0.750***
pseudo r^2	0.067	0.111	0.052

Significance levels: *5%, **1%, ***0.1%
[a] variable dropped due to co-linearity
[b] dropped as perfectly predicts failure
[†] In contrast to table 4, size refers to a dummy variable for large-scale projects (1 =yes, 0 = no)

5. Conclusions

The CDM has been growing rapidly, even if falling carbon prices and the approaching 2012 threshold have slowed its expansion in recent months. In the seven months between October 2008 and May 2009 pipeline, over 800 projects opened for public comments. The carbon benefits and capital flows generated through these projects are clear, if not undisputed. The CDM has contributed to the objectives of the UN framework convention on climate change and in doing so has engaged a number of developing countries in climate change mitigation. The SD benefits though, are slim and narrowly focussed. It remains uncertain to what extent the CDM contributes towards the SD of the host country. The approach taken in this paper, although subjective and not absolute, presents a way to consistently demonstrate how CDM projects provide co-benefits.

At face value, the 409 CDM projects in our sample promise SD benefits in 96% of cases. However, it is clear that most developers have taken a very broad approach to SD with significant benefits falling under economic growth, primarily through local employment gains. Under a stricter definition of SD, 67% of projects build social capital, with physical and natural capital less prominent. Sector differences coincide with popular opinion that industrial gas projects have meagre co-benefits and renewable and forestry projects have greater capacity to contribute to SD. The results also reflect the increasing incidence of unilateral projects, through relatively low technology transfer, in South Asia and East Asia and the Pacific; more specifically in India and China, which comprise 75% and 98% of projects in these regions respectively. It is notable that both large and small-scale projects have similar co-benefit profiles. Going against general consensus that small-scale projects have greater SD benefits, finer analysis would be required to identify if small scale projects do provide greater co-benefits relative to their size.

Whilst this paper highlights that a number co-benefits are delivered under CDM, it is acknowledged that our methodology has its limitations. The indicators create a narrow definition of SD and do not allow for differences in host-country definition. However, the indicators do represent SD broadly defined and findings align well with common thinking. The inability of the method to determine the scale of co-benefits, for example the number of people employed or the duration of employment, is partly due to lack of such information in the majority of PDDs. From a longer-term viewpoint, quantifying the co-benefits of projects in the PDD would involve a significant investment of time. Lastly, the method quantifies the potential, not actual, SD benefits received in a host country. With no need to measure or monitor co-benefits in the current CDM architecture, there is a deficit of data in this respect so any analysis would require on-the-ground assessment at project sites.

A method that is able to identify if the co-benefits are both long-term, as well as additional, would be preferable. However, an over complicated process for measuring SD may make alternative flexible mechanisms more favourable. The valuation of proposed SD benefits of CDM activities, for example, would be costly and add to already high transaction costs of project development.

Although the exact measurement of SD impacts under CDM is likely to remain impracticable, the delivery of SD benefits must be ensured for the mechanism to offset host country's opportunity costs. If meeting SD criteria was a pre-requisite for CDM projects, with registration dependent on a positive contribution to each form of capital, it would be important to address inherent sector differences as well as differences in country level SD policy. To create a universal measure without taking away sovereignty is problematic. If it is agreed that no measurement process for SD is likely to be found, there should be an investment of efforts into alternative mechanisms for host countries to realise development benefits through CDM. This could include widening the geographical spread of CDM projects to focus not only on host-countries with strong economies; for example, building institutional capacity to receive investment. Other approaches to address SD failings include; programmatic approaches, sector-based approaches, bundling projects, and expanding the role of forestry in the CDM. With additionality and procedural efficiency also to be addressed (Hamilton *et al*., 2008) reform will be a lengthy process.

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