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Diffusion of Kyoto's clean development mechanism

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ABSTRACT

To date, developed countries can only tap mitigation opportunities in developing countries by investing in projects under the Clean Development Mechanism (CDM). Yet CDM investments have so far failed to reach all of the high-potential sectors identified in IPCC reports. This raises doubts about whether the CDM will be able to generate an adequate supply of credits from the limited areas where it has proved successful. Our paper examines the current trajectory of potential mitigation entering the CDM pipeline and projects it forward under the assumption that the diffusion of the CDM will follow a path similar to other kinds of innovations. Projections are then compared to pre-CDM predictions of the mechanism's potential market size used to assess Kyoto's cost, in order to discern whether limits on the types of project entering the pipeline will also limit the eventual supply of certified emission reductions (CERs). The main finding of the paper is that the mechanism is on track to deliver an average annual flow of roughly 700 million CERs by the close of 2012 and nearly to 1100 million tons by 2020. Parameter tests suggest that currently identified CDM investments will exceed early model predictions of the potential market for CDM projects.

1. Introduction

The Kyoto Protocol, the convention that regulates the climate change combating activities agreed upon by the international community, has two project-based investment mechanisms that are designed to encourage low-carbon growth and to help industrialized countries reduce the cost of meeting their emission reduction targets in the first commitment period, which runs from 2008 to 2012. The first program, Joint Implementation (JI), allows these countries to claim credit for emission reductions that arise from new low-carbon investments in other industrialized countries. The second program, the Clean Development Mechanism (CDM), allows emission–reduction projects in developing countries that generate "certified emission reductions" (CERs) for use by the investor country and foster sustainable development in the host country. Under both programs, participants include both the public and private sector. However, in terms of the scale of current investments under the program and in terms of its mitigation potential, the CDM is by far the larger of the two.[3]

Under the Kyoto Protocol, the CDM is the only formal way for the industrialized Annex B countries that have pledged to reduce greenhouse gas emissions to tap potential sources of mitigation in countries that have not pledged reductions[4]. For the most part, developing countries comprise the second group and are known, in Protocol parlance, as non-Annex B countries.

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[3] Offsets from JI projects are called Emission Reduction Units (ERUs). Both ERUs and CERs are tradable. Another source of flexibility in the Protocol is a provision that allows Annex B countries (named for the UNFCCC annex that lists them) to trade assigned amount units (AAUs), national units that correspond to emission levels permitted under pledged caps.

[4] Annex B countries are named for the section of the Kyoto Protocol in which they are listed. Currently 38 countries including the European Community are listed in Annex B.

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In most instances, a CDM project is a direct investment by an Annex B government or firm hosted by a non-Annex B country.[5] Projects are designed with the objective of reducing greenhouse gas emissions or speeding the removal of greenhouse gases from the atmosphere relative to a business-as-usual baseline, and must be approved by the governments of both investor and host.[6] In addition, they are reviewed individually by a CDM Board prior to implementation and are subject to continuous monitoring and a verification process. If successful, the projects generate offsets (CERs) that Annex B countries can use to meet their Kyoto obligations. Overall, the CDM is expected to lower the cost of meeting the environmental goals of the Kyoto Protocol by encouraging investments in low-cost abatement efforts wherever they can be found. Another stated objective of the CDM is to assist host developing countries achieve sustainable development through the mobilization of direct private foreign investment and technology transfer.[7]

With its dual objectives, the CDM attracts both Annex B and non-Annex B parties to the convention. Since its inception in 2003, Greenhouse Gases (GHG) abatement activity under the CDM has increased rapidly. By August 2009, a total of 5316 CDM projects have been submitted to the United Nations Framework Convention on Climate Change (UNFCCC), the institution created by the initial 1994 international treaty to handle global climate change affairs, for validation [4]. 1792 of the submitted projects are already validated and registered by the CDM board, 234 are in the process of registration, 2605 are in the process of validation, and 685 projects were either withdrawn or rejected [4]. The 4631 projects in the pipeline are expected to generate approximately 2.79 billion CERs during 2008–2012, the first commitment period of the Kyoto Protocol [4]. Moreover, many investors expect the CDM or some similar mechanism to continue beyond the first commitment period and many CDM projects currently underway will generate emission reductions well beyond 2012.

Nevertheless, the scope for additional CDM projects is limited by the fundamental components of demand and supply, which are in turn, determined by the rate and composition of global economic growth, current Kyoto targets, and expectations about future regulations, as well as domestic and JI mitigation efforts in Annex B countries.

Another line of analysis could be to examine the determinants (including time and country-specific attributes) that explain differences in the probability and level of CDM adoption over time and across countries, with distinction between developing (host) and developed (investor) countries. The adoption and diffusion functions complement each other in that individual-level explanation is provided in the adoption analysis and an economy-wide explanation is provided in the diffusion analysis, which further help to analyze policy interventions that may affect the trend of CDM adoption.

As is discussed later, there are a variety of predictions about the size of the eventual CDM market that take these fundamentals into account. In this paper, we look at CDM as a new technology that diffuses over time across adopters. We verify whether or not our predictions of CDM diffusion are consistent with the historic pattern of growth in CDM projects and behave according to conceptual models of technology diffusion. We fit a sigmoid expansion path model to historic CDM expansion data and test whether the predicted size of the CDM market will be exceeded during the first commitment period of the Kyoto Protocol and beyond. Estimates of the future size of the CDM market are of paramount importance to investors and policy makers as both groups are concerned with the attractiveness of the CDM mechanism. One of the questions discussed in the UNFCCC Conference of the Parties (COP) in Copenhagen in December 2009 is whether or not CDM should remain one of the major mechanisms to allow countries to reduce the cost of meeting their emission reduction targets. The answer to such question may rely heavily on the trends of the CDM market, as predicted in our analysis.

The remainder of the paper is organized as follows. The next section presents a brief review of relevant literature on diffusion of technologies. Section 3 examines the mitigation potential of the CDM and presents the available estimates of the size of the CDM market. Section 4 describes the CDM pipeline data and presents the empirical results for the CDM diffusion pattern along with projections of CDM activity during and beyond the first commitment period of the Kyoto Protocol. The last section discusses the policy implications, indicates areas of future research, and concludes.

2. Technology diffusion literature

Various models of diffusion have been developed to explain changing populations, technology diffusion, and adoption of new consumer products. All of those models are founded on theories concerning the spread of information either through interactions between adopters and non-adopters or through exogenous sources [5]. Aggregate models on technology diffusion are founded upon the epidemic or logistic model [e.g., 6–12]. The logistic model views the diffusion process to be similar to the spread of an infectious disease, with the analogy that contact with other adopters (i.e., learning from the experience of others) and exposure to information on the innovation (i.e., demonstration effect) lead to adoption. The model is based on the assumption that members of a homogeneous population have an equal probability of coming into contact with each other and that the flow of new adopters of the technology in a given point in time is a function of the stock of existing adopters. When the stock of existing adopters is small, there is little risk of "contagion." The risk of "contagion" increases as the stock of existing adopters increases (potential adopters decreases), and the flow of new adopters rises exponentially. However, as the stock comes closer to the total number of potential adopters, the flow of new adopters gradually decreases and eventually becomes zero. The diffusion of the innovation thus follows a

[5] In some "unilateral" projects, the eventual credit buyer is determined late in the project cycle.
[6] For a discussion of pilot programs preceding the CDM, see [1].
[7] A detailed description of the CDM and analysis of the issues related to this provision can be found in [2] and [3].