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Impacts of CDM projects on sustainable development: Improving living standards across Brazilian municipalities?

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ABSTRACT

The goal of the Clean Development Mechanism (CDM) is both emission reduction and sustainable development, but while emission reductions generate revenues for the project developer, no such benefit results from the achievement of sustainable development. The objective of this research is therefore to analyze to which extent CDM investments have led to sustainable development benefits, and whether there is a difference in these effects between renewable energy and waste handling and disposal projects. Complementary to existing studies, which are based on potential effects reported ex-ante by project developers, this paper aims at quantifying impacts of CDM projects on sustainable development based on empirical data. Using data for years 2000 (pre-CDM) and 2010 (post-CDM) for Brazilian municipalities, this paper combines difference-in-differences assessment with matching techniques to identify the effect of CDM investments on development and poverty indicators by distinguishing for four project's types: hydro, biomass energy, landfill gas and methane avoidance. Results show that CDM project types have stimulated local income and labor opportunities but only hydro projects have contributed to reduce poverty at the municipal level for the period analyzed.

1. Introduction

According to the twofold objective of the CDM instrument, this mechanism was designed not only "to help developed countries fulfill their commitments to reduce emissions", but also "to assist developing countries in achieving *sustainable development*". What sustainable development means or how this concept is or should be understood under this framework is (still) arguable or not clear (Banuri and Gupta, 2000; Schneider, 2007). Under the Marrakesh Accords (2001), each host country must decide what aspects of sustainable development should be accomplished when implementing CDM projects in its territory.

Concerns regarding the effective achievement of this objective have emerged and been discussed even before the official launch and implementation of the CDM instrument in host countries (See: Banuri and Gupta, 2000; Kolshus, Vevatne, Torvanger, & Aunan, 2001). Moreover, potential conflicts and trade-offs between the two CDM objectives may arise when trying to fulfill both targets through the implementation of CDM projects (Kolshus et al., 2001; Sutter, 2003). Since the CO_2 emission reductions is the only objective that is rewarded by the market through the generation of Certified Emission Reduction (CER) credits, the CDM instrument does not create by itself adequate incentives to fulfill the sustainable development objective (Ellis, Winkler, Corfee-Morlot, & Gagnon-Lebrun, 2007; Paulsson, 2009).

Moreover, the Designated National Authorities (DNAs), the entities in charge of approval of CDM projects in the host country, might have incentive to relax the stringency of the sustainable development requirements in order to attract more CDM investors (May, Boyd, Veiga, & Chang, 2004; Olsen, 2007; Muller, 2007), thus reinforcing the trade-off between the two objectives. Although very few developing countries have developed their own requirements for hosting CDM projects, these scarce efforts lose strength due to the lack of monitoring and verification of compliance of the sustainable development criteria (Wang, Zhang, Cai, & Xie, 2013; Crowe, 2013). In addition, the absence of international standards for sustainable development assessment of CDM projects as well as the missing obligation for the host countries to verify project's achievements in this aspect (in contrast to the existing strict monitoring of CO_2 emission reductions) might exacerbate the trade-off (Olsen and Fenhann, 2008).

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Although several definitions of sustainable development have been discussed in the literature, this concept can be generally understood as the intersection of three dimensions or pillars (WCED, 1987): social equality, economic growth and environmental protection. Under the framework of CDM projects, the sustainable development criteria should be based on country-specific development priorities with focus on these three dimensions (Olhoff, Markandya, Halsnaes, & Taylor, 2012).

Although several earlier studies have attempted to highlight the potential of CDM projects in contributing to sustainable development in host countries (Richards, 2003a; Troni et al., 2002; Smith and Scherr, 2002), other studies have also argued that this target was in reality more a hypothesis than a real causality effect (Markandya and Halsnaes, 2002; Kolshus et al., 2001). Since the CDM is a market instrument that targets least-cost mitigation projects rather than poorest communities, the sustainable development objective was expected to be overtaken by the reduction emission goal. Moreover, the assessment of any sustainable development impact due to CDM activities were left to host countries, so that very little in the Accord ensured that these benefits were effectively attained (Begg et al., 2003).

Those studies, that discussed the theoretical ability of CDM projects in generating synergies between environment and local livelihood improvements, have identified high potential in renewable energy projects and used the framework that links the provision of clean energy to local sustainable development to explain causal effects (Troni et al., 2002). Under this framework, the access to energy is a key vehicle that drives sustainable development through the provision of basic needs (e.g.: cooked food, piped water), realization of productive activities (e.g.: manufacturing, commerce) and protection of local environment; thus generating improvements in livelihood conditions (UNDP, 2000, 2005).

In the context of CDM, the effects of small-scale rural renewable energy projects in local sustainable development have been translated into the opportunities generated by improved access to clean energy services by poor households through income diversification due to enterprise development and employment generation, improved health due to access to cleaner water as well as reduced fuel wood consumption, education due to lightning appliances as well as time available for studying at night, gender benefits due to less time collecting firewood and water by women, among other benefits (Troni et al., 2002, Brunt and Knechtel, 2005). In a similar way, effects in sustainable development have been analyzed in other sectors such as forestry (Smith and Scherr, 2002). Therefore, distinguishing impacts by project type is relevant to understand the nature and causality of effects at the local level.

In the particular case of Brazil, the third largest host country worldwide in terms of the number of CDM projects, its Designated National Authority (DNA) has explicit criteria to determine the contribution of CDM projects to sustainable development in the project area (ICGCC, 2003) as well as it has conducted very stringent evaluation processes (Hultman, Pulver, Guimarães, Deshmukh, & Kane, 2012); however, there are no indicators or specific measurement tools for monitoring and verifying compliance of the sustainable development goal established officially by the corresponding DNA (Americano, 2008).

The objective of this research is to determine to what extent CDM investments have provided Brazilian municipalities with sustainable development benefits by measuring the impact on development and poverty indicators. This research contributes to this strand of the literature in four ways: first, most assessments have applied qualitative methods and data based on expected effects; in contrast, we aim at quantifying the aggregated impact of CDM projects by combining difference-in-differences assessment with matching techniques using empirical data for the years 2000 (pre-CDM) and 2010 (post-CDM). Second, available studies on the impacts of CDM on poverty alleviation are still very limited (Crowe, 2013; Dirix, Peters, & Sterckx, 2016), so this research also aims at contributing to fill this gap in this specific niche. In addition, we also explore impacts on inequality and unemployment, variables barely analyzed in the empirical literature. Third, this study estimates impacts across Brazilian municipalities, or within-country analysis; since each country must define its own sustainable development criteria according to its national priorities, an analysis at the sub-national scale (in this case, at the municipal level) is more relevant and appropriate than cross-country comparisons. Finally, this paper investigates whether renewable energy projects (i.e.: hydro and biomass energy) have positive effects on sustainable development, by contrasting the effects triggered by this project type with waste handling and disposal projects (i.e.: landfill gas and methane avoidance).

This paper is organized as follows: Sections 2 presents a review of the literature on the impacts of CDM investments on sustainable development in host countries, Section 3 describes the situation of CDM projects in Brazil, while Section 4 describes the data and the methodological approach. Results of the regression analysis are presented in Section 5, while policy implications and conclusions are inferred in Section 6.

2. Empirical literature review

The empirical literature on the impacts of CDM projects can be divided into two main groups: the first group encompasses those studies that evaluate the effectiveness of CDM projects in reducing CO_2 emissions[1], while the second group assesses the impacts on sustainable development in host countries. In this section, the literature review focuses on this last group by presenting an overview of aspects/dimensions, proxy variables, main findings, methodologies and data used to determine the CDM achievements in sustainable development. As this study analyses the impacts on development and poverty indicators, we review empirical studies on poverty alleviation and discuss their main findings.

Research on the impacts of CDM on sustainable development has assessed effects using several group indicators that encompass the most relevant areas of any sustainable development strategy: social, economic and environmental. Some common indicators used to evaluate the economic aspects of sustainable development achievements of CDM projects are households' and/or per capita income (Subbarao and Lloyd, 2011; Bayer, Urpelainen, & Wallace, 2013) as well as generation of local employment (Sutter and Parreño, 2007; Olsen and Fenhann, 2008; Alexeew et al., 2010; Subbarao and Lloyd, 2011; Wang et al., 2013) and technology transfer (Schneider, Holzer, & Hoffmann, 2008; Dechezlepretre, Glachant, & Meniere, 2009; Seres, Haites, & Murphy, 2009, 2010; Alexeew et al., 2010; Costa-Junior, Pasini, & Andrade, 2013; Lema and Lema, 2013).

With respect to the social aspect of sustainable development, some studies have focused on analyzing impacts of CDM projects on health, education (Subbarao and Lloyd, 2011) and poverty alleviation (Sirohi, 2007; Subbarao and Lloyd, 2011; Crowe, 2013). Regarding this last group, studies available on this topic are still very limited (Crowe, 2013; Dirix et al., 2016). Although poverty alleviation is not explicitly part of the CDM mission, this aspect is integral of any sustainable development strategy; therefore,

[1] Findings from this first group of studies are not conclusive; while some studies do not support any contribution of CDM to reducing CO_2 (Schneider, 2007; Zhang and Wang, 2011), others have confirmed a significant decline associated with CDM projects (Huang and Barker, 2012).