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Who uses the Clean Development Mechanism? An empirical analysis of projects in Chinese provinces☆

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ABSTRACT

China is by far the largest host of projects implemented under the Kyoto Protocol's Clean Development Mechanism (CDM). However, earlier studies shed little light on the determinants of the distribution of CDM projects across Chinese provinces. Given China's large size and political-economic diversity, this dearth of research is troubling. We provide an empirical analysis of 2097 CDM projects in 30 Chinese provinces, 2004–2009. We find that high electricity consumption, low per capita income, and a lack of foreign direct investment are all associated with CDM project implementation. The findings are particularly strong for electricity and foreign direct investment. These findings are consistent with the economic theory of CDM project implementation. Project developers focus on minimizing the cost of carbon abatement. Moreover, they suggest that the CDM can, despite its limitations, contribute to reducing economic inequality and uneven development in China.

1. Introduction

To reduce the Kyoto Protocol's compliance cost, the Clean Development Mechanism (CDM) allows industrialized countries to substitute carbon credits, which are acquired from climate mitigation projects implemented by investors from developing countries, for domestic emissions reductions (CDM Pipeline, 2011). An important criterion for CDM carbon credits is "additionality," which states that eligible carbon abatement projects must not be economically feasible without the carbon credits. China is by far the most important host of carbon abatement projects implemented under the CDM. On December 1, 2011, China held 3564 of the 8836 projects that were available from the CDM/JI Pipeline Database (CDM Pipeline, 2011). This accounts for 40% of all CDM projects since 2003 that were registered, waiting for registration, or at validation stage under the regulations of the CDM. These projects allowed China to reduce its rapidly growing greenhouse gas emissions in various ways, ranging from hydroelectricity to wind power and avoiding methane from agriculture. This concentration of the CDM in China is understandable given that China is the world's largest developing economy and consumes enormous amounts of energy. Moreover, the Chinese government has actively promoted the CDM to increase investment in the energy sector and to induce technology transfer from industrialized countries (World Bank, 2004).

While China's dominance in the CDM is unsurprising, it is important to remember that China itself is a large and diverse economy. In this article, we conduct a statistical analysis of the distribution of CDM projects across Chinese provinces and over time. This analysis is useful because it helps scholars and practitioners understand exactly why China has proven such a lucrative CDM host. Additionally, the analysis allows us to test the applicability of standard economic theories, which emphasize the importance of carbon abatement costs for CDM project implementation, within one national legislative context. Finally, the analysis can offer lessons for other developing countries interested in increasing the use of the CDM. By analyzing the determinants of CDM project implementation in China, we can shed light on those regional characteristics that are conducive to CDM projects. This allows both governments in developing countries and foreign investors to plan their investments in the CDM more carefully.

The empirical analysis provides three key insights into the determinants of CDM project allocation. First, Chinese CDM projects are heavily concentrated in poorer provinces in China's interior, such as Yunnan or Sichuan, rather than in Guangdong and other rich coastal provinces that have become the world's factory.

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This finding is consistent with the logic of marginal abatement costs: poor provinces have less access to advanced technology than rich provinces, so opportunities for profitable carbon abatement are more abundant in poor than wealthy provinces. An industrial or energy development project in Yunnan absent CDM might use heavily polluting technology a generation or more behind the times, whereas the industrial economies of China's Yangtze and Pearl river delta regions are among the world's most sophisticated.

While consistent with previous research (Han and Han, 2011), the negative association between economic development and CDM implementation contrasts with findings from the empirical literature on the global distribution of CDM projects. In general, CDM projects are heavily concentrated in large and rapidly industrializing countries with institutional capacity for project implementation, including China (Jung, 2006; Michaelowa, 2007; Castro and Michaelowa, 2011). In our view, the internal logic in China is different because there is institutional capacity for project implementation even among the poorer Chinese provinces. This capacity explains why economic development reduces CDM implementation in China, even as it increases CDM implementation in the global setting. While many least developed countries in Sub-Saharan Africa have ample potential for carbon abatement, their institutional weaknesses inhibit CDM project implementation. This constraint is not present for poor Chinese provinces.

Second, Chinese CDM projects are more common in provinces that consume a lot of electricity. Again, this is consistent with standard economic theories, as electricity use creates opportunities for climate mitigation. Of the two effects, the effect of electricity consumption appears larger than that of GDP per capita, suggesting that the increased use of electricity is more important for the creation of CDM opportunities than the inefficiencies associates with low income levels.

Finally, we find that inflows of foreign direct investment (FDI) deter CDM project implementation. This finding may appear surprising because large FDI inflows mean that foreign investors have experience with, and information about a province. Despite much folklore about the paramount importance of connections (*guanxi*) in Chinese economic and political life, we find that other factors can trump such relationships. Project developers invest in CDM projects, not where FDI is directed, but in other locations. Large FDI inflows mean that the province already has access to foreign technology; moreover, production may already be relatively clean because foreign investors from industrialized countries have incentives to "green" their image by reducing their carbon dioxide emissions.

Our findings suggest that the distribution of CDM projects in China is economically efficient. The CDM has allowed China to reduce greenhouse gas emissions in provinces where the cost of doing so is low. For the future, the findings also suggest that unless the CDM system collapses due to the deadlock in multilateral climate negotiations, China will continue to benefit from the CDM. Large parts of China remain poor, consume rapidly growing amounts of electricity, and draw little FDI. Given this, China's bet on the benefits of the CDM seems warranted. Moreover, the Chinese government should pay particular attention to improving the quality of CDM projects, ensuring that they promote economic growth in a sustainable manner.

We begin with a brief discussion of our three hypotheses. Next, we provide an overview of the CDM in Chinese provinces. The remainder of the article consists of the presentation of our research design and our main results as well as a concluding section. A supplementary appendix contains additional data description and robustness tests.

2. Using the CDM: hypotheses

The CDM is a Kyoto Protocol "flexibility mechanism" (Article 12) that allows industrialized countries to reduce the cost of complying with their emissions obligations by funding climate mitigation projects in the developing world (UNFCCC, 2012). While developing countries are not obliged to reduce their emissions under the Kyoto Protocol, many developing countries could reduce their emissions at a low cost due to inefficient energy technology. The CDM allows industrialized countries to substitute carbon credits from developing country projects for domestic emissions reductions. In practice, the projects are usually implemented by project developers from the host country; therefore, the CDM is itself not a form of FDI (Lütken and Michaelowa, 2008).

According to economic theory, the use of the CDM should depend on the marginal cost of reducing greenhouse gas emissions. The global demand for carbon credits depends on carbon abatement costs in industrialized countries. Given the expected demand, project developers can be expected to implement potential CDM projects whenever the total project cost falls below the benefit. Building on this insight, we examine some determinants of CDM project allocation in the largest CDM host, China. In our empirical analysis, the unit of analysis is a province-year, so we examine province characteristics.

To begin with, we consider the role of electricity consumption. A large number of CDM projects are intended to reduce the otherwise large carbon footprint of the electricity sector. All else constant, then, we expect increased electricity consumption to increase the number of opportunities for profitable CDM projects. Provinces that consume a lot of electricity should host more CDM projects than provinces that consume little electricity, and if electricity consumption within a province grows over time, then the number of CDM projects hosted should increase.

Hypothesis 1 (Electricity consumption and project implementation).
The higher a province's electricity consumption at a given time, the higher is the number of CDM projects implemented in that province at that time.

Alternatively, one could focus on total energy consumption or greenhouse gas emissions. Total energy consumption is somewhat problematic for a CDM analysis because there is considerable variation in the suitability of different energy types for carbon abatement. For greenhouse gas emissions, accurate measurements at the province-year level are unfortunately not available.

Another determinant of CDM project allocation is wealth. Within a given country, some areas are wealthier than other areas. According to economic theory, productivity is an important determinant of wealth (Grossman and Helpman, 1991; Keller, 1996). Since sustained economic growth requires productivity improvements, technological advances are important for economic growth. In a country like China, energy technologies play a particularly important role, as much of the economy's growth occurs in energy-intensive sectors such as manufactured exports.

Moreover, high levels of economic wealth are associated with a large service sector, with financial centers such as Shanghai playing an increasingly important role in China. Since the service sector often has a low energy intensity, it is not ideal for CDM projects. To illustrate, the data we use below shows that GDP per capita is, for province-years in the 2003–2011 period, positively correlated with the size of the service sector ($r = 0.601$, statistically significant at $p < 0.001$).

Consequently, it is reasonable to assume that, on average, wealthier provinces rely on more advanced energy technologies