International Entrepreneurship and Technology Transfer: The CDM's Reality in China

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Abstract:

The Clean Development Mechanism (CDM) is one of three flexible mechanisms emerging out of the Kyoto Protocol, which poses binding reduction targets for the emission of greenhouse gases (GHGs) by industrialised countries. The CDM allows governmental and business entities from these countries to invest in projects leading to the reduction of GHGs in the developing world. By doing so, they are expected to assist host countries in achieving sustainable development needs and contribute to the transfer of the so-called 'environmentally sound technologies'. This study aims to frame the CDM into a state-of-the-art of the literature streams on international entrepreneurship and technology transfer. We contend that the CDM is a public policy tool aimed at stimulating private sector investments in developing countries in the low-carbon sector, potentially contributing to the transfer of technologies across borders, with sustainable development benefits. Moreover, the CDM is posed as a potential mechanism for international technology transfer, and the CDM's reality in China is analyzed. For this purpose, a benchmarking scorecard is designed and applied to the Chinese experience with climate friendly technologies. On the basis of an empirical analysis, CDM projects are evaluated and the findings contrasted against a set of case studies outside the CDM framework. The analysis undertaken revealed that there is limited scope for the international transfer of technologies into China through the CDM, and that such transfers are more likely to occur outside the CDM framework. We concluded that this is due, to a large extent, on the Chinese internal regulations for CDM project development which, compounded by the minimum-local content requirements for domestic installations utilizing environmentally sound technologies, considerably hamper inward FDI by entrepreneurs engaged in the low-carbon sector and, consequently, the transfer of foreign technologies into China.

Key words: Benchmarking; Clean Development Mechanism; International Entrepreneurship; Technology Transfer.

1. Introduction

Set-up in the wake of the Kyoto Protocol in 1997, the Clean Development Mechanism (CDM) is a market-based tool aimed at reducing the emission of greenhouse gases (GHGs) in developing countries (Olsen, 2005). By providing financial and technological assistance to the developing world, the CDM not only contributes to the mitigation of climate change effects and sustainable development, but it also enables developed nations to achieve lower compliance costs on their GHG reduction commitments (Castro and Michaelowa, 2008).

The CDM is the focal topic of this dissertation, and we propose to examine it against the backdrop of two research areas: international entrepreneurship and technology transfer. In addition to this, we empirically analyze how does the CDM fare as a mechanism for the transfer of environmentally sound technologies. As such, we design a benchmarking framework to evaluate the performance of technology transfer mechanisms, which is then applied to the Chinese experience with climate change mitigation efforts, with an emphasis on the CDM.

The focus on China is due to three main reasons. Firstly, China is currently the world's largest emitter of greenhouse gases (IEA, 2007), making it imperative the deployment of low-carbon technologies. Secondly, Chinese policymakers are increasingly aware of the unsustainable path the country is undergoing, and have been directing their efforts in order to address this shortcoming. And thirdly, China is one of the countries with the highest number of CDM projects implemented so far, enabling a more comprehensive study of this phenomenon in comparison to other CDM host countries.

This paper is structured as follows: after this introduction, in section 2 we provide a literature review on the main streams of research on international entrepreneurship and international technology transfer. Section 3 has the CDM as a focal point and, in addition to the characterization of this 'Kyoto-mechanism', a background on the most relevant issues regarding the challenges of climate change is presented. Section 4 proposes a benchmarking methodology to analyze technology transfer mechanisms for environmentally sound technologies. Section 5 provides an illustration of how this benchmarking approach can be applied in practice in several case studies, with this framework being used to assess the CDM reality in China. Lastly, section 6 concludes and provides implications of this investigation and also presents the limitations of the current study and guidelines for future research.

2. Literature Review

2.1. International Entrepreneurship

Entrepreneurship is one of the driving forces of endogenous growth in modern economies. As a primary source of job creation, economic competitiveness and innovation, governments are increasingly aware of its importance, and have been shaping public policies to encourage entrepreneurial initiatives (Monitor Group, 2009; Leitão and Baptista, 2009a; Leitão and Baptista, 2009b).

The identification and exploitation of business opportunities lies at the core of entrepreneurship. While, for many years, opportunities available to entrepreneurs were confined to domestic borders, the globalization of markets has expanded the scope of opportunity exploitation to the global arena. This has enabled many companies to adopt a global focus from inception and pursue a rapid internationalization path (Oviatt and McDougall, 1994). Due to this, the study of international entrepreneurship has raised considerable interest among academics and practitioners in recent years, emerging as an independent field of academic studies.

According to several authors (e.g. Wennekers *et al.*, 2005; Stearns and Hills, 1996), no singular definition of entrepreneurship exists. Grilo and Thurik (2004) contend that entrepreneurship is a multidimensional concept, whose definition largely depends on the focus of the research undertaken. Concurrent with this view, the OECD (2008) considers that entrepreneurship manifests itself in many different ways, with the result that several definitions have been proposed and no single definition has been generally agreed upon.

There is some consensus in the literature that entrepreneurship revolves around the process of change (Audretsch, 2002) and innovation (Michael, 2007). Audretsch (2002, 2007) asserts that entrepreneurship is about change, since entrepreneurs are agents of change. However, such conceptualization poses considerable complexity, as the concept of change is relative to some reference, i.e. what may be perceived as change to an individual or organization may not imply any novelty to the related industry.

One of the most consensual and quoted definitions of international entrepreneurship was proposed by McDougall and Oviatt (2003:7), who assert that «international entrepreneurship is the discovery, enactment, evaluation, and exploitation of opportunities – across national borders – to create future goods and services». In a similar vein, Zahra and George (2005:6) consider international entrepreneurship as «the process of creatively discovering and exploiting opportunities that lie outside a firm's domestic markets in the pursuit of competitive advantage».

We can conclude that the opportunity concept is present in these definitions of international entrepreneurship, as well as the idea of crossing borders. This comes to no surprise, as opportunity exploitation lies at the core of entrepreneurship research, and international entrepreneurial firms should have the ability to identify and exploit opportunities in the international marketplace (Dimitratos and Plakoyiannaki, 2003).

In this dissertation, the study of international entrepreneurship is approached in the backdrop of international efforts to curb climate change. The engagement of the private sector is fundamental to climate change mitigation and will create innumerous business opportunities to individuals and companies directly or indirectly involved in the 'decarbonization' of our economies. According to Stern (2007), these markets could be worth hundreds of billions of dollars per year, and be an important source of employment generation.

Recognizing that the challenges posed by climate change can open a wide range of opportunities to entrepreneurs, policy makers worldwide are seeking to create the adequate environmental settings to encourage the exploitation of these opportunities. The CDM, one of the most innovative tools originating from the Kyoto Protocol, should be mentioned as having been specifically tailored to stimulate entrepreneurs in industrialized countries to cross national borders and invest in greenhouse gas reduction projects in developing countries. By doing so, they are also facilitating the transfer of technologies to these countries and contributing for the achievement of sustainable development goals.

2.2. International Technology Transfer

Technology transfer is a key element for economic development across all levels of industry, and it is a fundamental mechanism to foster economic growth and innovation intensity (Radosevic, 1999).

According to Maskus (2004), international technology transfer can be defined as a comprehensive term covering a set of mechanisms for shifting information across borders and its effective diffusion into the host economies. In short, and in line with Graham (1982), international technology transfer can be understood as the reception and utilization by one country of the technology developed in another.

The definitions of technology transfer found in the literature do not usually take into consideration specific modes of transfer (Radosevic, 1999). However, there are numerous dimensions that can be used to classify technology transfers modes. One of those, for example, is the maturity of the technology that is transferred. While the movement of an established technology from one entity to another is usually known as a horizontal transfer, vertical transfers are those technologies that are transferred directly from the R&D stage to the commercialisation phase (Andersen *et al.*, 2007; Ockwell *et al.*, 2008).

Another dimension pertains to the distinction between explicit and implicit technology. Whereas technology that can be codified into formulas, patent applications and the like can be deemed as explicit, non-codified technology – in the sense it requires some degree of implicit know-how from the personnel handling it – can be regarded as implicit technology (Maskus, 2004).

As we can observe from the two examples above, several dimensions can be used to characterize technology transfer modes, which emphasize different aspects of the transfer process. In spite of this, most researchers and practitioners have placed their attention on the examination of the mechanisms – i.e. the channels – that lead to technology transfers (Radosevic, 1999).

A possible categorization of technology transfer mechanisms stems on the market vs. non-market dichotomy. In terms of the most relevant market-based technology transfer mechanisms found in the literature, they include the trade of goods and services across borders, Foreign Direct Investment (FDI), Joint Ventures (JVs), licensing, franchising, and other commercial agreements that potentially lead to the international transfer of technologies, such as assignments, consultancy arrangements, and turn-key projects (WIPO, 2004). Non-market based technology transfer mechanisms include spin-offs, imitation, and the study of public available information about, for example, patented technologies.

In the reference literature other important international technology transfer mechanisms can be identified that do not necessarily fall into the market vs. non-market dichotomy. Examples include the so-called “Cooperative Research and Development Agreements”, which are an example of cooperative arrangements established between an R&D organization and a receptor organization for the transfer of technology, and the movement of people between organizations (Rogers, 2002).

3. Climate Change and the role of the CDM

Climate change is one of the most important challenges the humanity currently faces. The warming of the planet due to the emission of anthropogenic greenhouse gases is now considered unequivocal (IPCC, 2007), and international collective action is required to address this challenge (Stern, 2007; World Bank, 2008).

One of the most important milestones in the fight against climate change has been the Kyoto Protocol, which determines that industrialized countries (also known as Annex-I countries) reduce their combined greenhouse gas emissions (excluding those controlled by the Montreal Protocol) by an average of 5.2% below 1990 levels between 2008 and 2012. The Protocol does not stipulate how these reductions should be achieved, but it proposes three flexible market-based mechanisms to allow industrialized countries meeting their commitments: (i) Emissions Trading Schemes (ETS); (ii) Joint Implementation (JI); and (iii) Clean Development Mechanism (CDM).

The CDM has two main purposes: (i) to allow Annex-I countries to invest in projects that reduce emissions in developing countries to offset a part of their domestic obligations; and (ii) to assist non-Annex-I countries in achieving sustainable development needs. Certified Emission Reductions (CERs) are the CDM's currency, and they are the measure of the quantity of greenhouse gas emissions that have been avoided by CDM projects.

There are three main approaches to develop a CDM project: bilateral; unilateral; and multilateral. A bilateral approach is observed when an Annex-I country or one of its legal entities invests in projects in partnership with a non-Annex-I country (Yamin, 2005). Unilateral projects are those where there is no foreign investment and the project is developed entirely in the host economy (Wilder, 2005). A multilateral approach is where an international financial institution or intermediary puts together a portfolio of CDM activities on behalf of others (Yamin, 2005).

One key aspect related to the CDM is that it is intended to stimulate private sector investments in climate-friendly projects, because at its core is the generation of carbon credits that have market value and can be sold for a profit (Yamin, 2005; Stern, 2007). In this sense, if we exclude unilateral project types from our analysis, CDM projects can be considered as a form of international entrepreneurship. In fact, the CDM laid out an institutional framework that enables and stimulates firms that own some type of 'climate-friendly technology' to proactively seek new markets for their technologies and, in complement, to benefit from the extra revenues provided by the sale of CERs. By installing in a certain country a technological solution that leads to the reduction of greenhouse gases, entrepreneurs are moving innovations across borders, bringing change to where it is needed, and being expected to contribute to local sustainable development goals.

Notwithstanding the fact that the CDM does not have an explicit technology transfer mandate, one of the sustainable development benefits that CDM projects are expected to deliver is the use of technologies and know-how that are not available in host countries (de Conick *et al.*, 2008; Doranova *et al.*, 2009; Seres, 2007).

According to van der Gaast *et al.* (2009), it remains to be seen how important is CDM's contribution in transferring environmentally sound technologies to developing countries. Nevertheless, we can find in the literature some studies that have analyzed technology transfer issues within the CDM. Haites *et al.* (2006) concluded that technology transfers occur in one third of the projects analyzed (860), accounting for two-thirds of the CERs generated. Seres (2007), making an analysis out of the 2293 projects existent in the CDM pipeline, found technology transfers to be very heterogeneous across project types, varying in terms of reliance on imported technology, knowledge and equipment flows, and the countries where the technology came from.

Albeit recognizing improvement opportunities in the CDM as a mechanism to the transfer of environmentally sound technologies, most studies in the reference literature have been moderately positive to the results so far achieved. However, the analysis of alternative mechanisms to the transfer of these technologies has barely received any attention in the literature. That is the main motivation for presenting, in the next section, an alternative approach for identifying and analysing technology transfer mechanisms.

4. Methodology: a Benchmarking Proposal

The main goal of the benchmarking approach proposed is to assess how does the CDM fare in comparison with other international technology transfer mechanisms. The process of setting-up this benchmarking approach encompassed four steps. The two final steps of this process, which consisted on the definition of the; (i) focus areas; and the (ii) key performance indicators; deserve a brief explanation.

From the insights provided from the literature review undertaken we came up with the definition of four focus areas which, in our view, are quintessential in the scope of international transfers of environmentally sound technologies. They are the following: (i) capacity building; (ii) investment and operational costs; (iii) enabling environment; and (iv) sustainable development.

The first area, capacity building, consists on the strengthening of the host economy’s technological infrastructure, including its human and institutional capabilities (IEA, 2001). According to many authors and studies (e.g. Wei, 1995; Radosevic, 1999), the capacity to master the received technology and innovate on that knowledge is a critical aspect of the transfer process.

The second area of analysis concerns the financial flows associated with the mechanism under evaluation. That is, it has the goal of evaluating the propensity of the mechanism to financially contribute to the implementation of environmentally friendly technologies in the host country.

The third area pertains to the enabling environment of the host economy. This aspect has to do with the policies, regulations and institutions that exist in the country and which strongly influence the effectiveness of the technology transfer process.

The fourth area is related to the extent the technology transfer mechanism contributes to sustainable development needs in the host economy, an aspect that is very important in the case of environmentally friendly technologies. Indeed, one of the reasons for criticisms on the CDM projects related to the reduction of hydrofluorocarbons (HFCs) has been due to their limited contribution to local communities’ sustainable development needs.

The final step consisted on defining the key performance indicators (KPIs) for each of the referred areas. Both the evaluation areas and the respective KPIs are presented in Table 1 below. Based on these indicators we were able to build a benchmarking scorecard, which could then be used by practitioners to evaluate technology transfer mechanisms on a case-to-case basis.

Table 1 – Focus areas and KPIs for the benchmarking analysis

Focus areas	Key performance indicators (KPIs)
1. Capacity Building	1.1 Type of technology transferred
	1.2 Maturity of the technology transferred
	1.3 Transfer of complementary non-technological capabilities
	1.4 Knowledge spillovers into the host economy
2. Investment and operational costs	2.1 Total annual investment
	2.2 International technology transfer costs
3. Enabling Environment	3.1 Stakeholders involved
	3.2 Intellectual Property Rights (IPR) protection
4. Sustainable Development	4.1 Economic benefits to local communities
	4.2 Social benefits to local communities
	4.3 Environmental benefits to local communities

Source: Own elaboration

5. Case Studies: Benchmarking approach applied to the Chinese reality

China was a relatively latecomer in regard to its CDM policy, defining a first draft in 2004 and adopting a final version of it as late as November 2005 (Lütken and Michaelowa, 2008). The Chinese CDM set-up has some noteworthy features, some of them without parallel in many other CDM host countries. In this regard, two essential aspects should be underscored. First, the obligation of all Chinese CDM projects to have a minimum of 51% Chinese ownership stake. And second, the existence of a minimum purchase price for the CERs generated by the project activity (IGES, 2009). This is for protecting project owners from price dictations imposed by foreign buyers of CERs (Schroeder, 2009).

Given this framework, we applied our benchmarking framework to the Chinese experience on climate friendly projects and, for this purpose, we have selected eight case studies – four CDM projects and four non-CDM cases – which are described in Table 2 below.

Table 2 – Selected case studies for benchmarking assessment

Title	Category	Description
Changling Wind Power Project	CDM	Installation and operation of a wind farm in the Jilin Province, China. The total installed capacity is 9.35 MW.
China Shangbao Small Hydropower Project	CDM	Located in the Hunan Province, China, the project is a run-of-river power production facility with a capacity of 14.1 MW.
Hubei Eco-Farming Biogas Project Phase I	CDM	The project proposes to build and put into operation a set of biogas digesters utilizing pig manure as raw materials in the Chinese province of Hubei

Federal Pengyang Solar Cooker Project	CDM	Located in the dry region of Ningxia in Northwestern China, the project proposes to install 17.000 solar cookers for poor rural households.
Passive Solar Heating for Rural Health Clinics in China	Non-CDM	Jointly implemented by the Global Environmental Facility (GEF) and the World Bank, the project aims to demonstrate and promote energy efficient passive solar health clinic designs.
Vestas Foreign Direct Investment in China	Non-CDM	The case study analyzes Vestas' contribution to international technology transfer in the scope of its investments in China.
Licensing agreement for technology transfer	Non-CDM	This case is about an agreement established between an Australian and a Chinese company for the licensing of an environmentally sound technology.
Novozymes Foreign Direct Investment in China	Non-CDM	The case study analyzes Novozymes' contribution to international technology transfer in the scope of its investments in China.

Source: Own elaboration.

From the four CDM case studies analyzed, in only one did we report the occurrence of international technology transfers. In this project, which proposes the installation of a small-scale wind farm in the Chinese province of Jilin, we can 'indirectly' expect the transfer of environmentally sound technologies through the purchase of a foreign-owned technology which is locally manufactured.

In regard to the non-CDM case studies, we obtained different results across the four benchmarking assessment areas. However, three main insights should be highlighted. The first is that FDI can be an effective mechanism for the transfer of environmentally sound technologies (namely in terms of capacity building), as the Novozymes and Vestas' experiences confirm. The second, this one drawn from the GEF/World Bank case study, is that the involvement of governmental and municipal stakeholders in the host country is likely to improve the country's technological capacity and the enhancement of the enabling environment. And the third conclusion is that private sector technology transfers are less likely to bring sustainable development benefits to local populations in host countries, an aspect which is more salient if we compare such finding with our CDM case studies. This can be explained by the fact the latter are small-scale project activities which, in many respects, are more suitable to fit the needs of local populations than larger projects. Integrated in a community, such projects are more likely to improve the living conditions of these communities without generating negative externalities

6. Concluding Remarks and Implications

In this study we concluded on the limited benefits delivered by a set of CDM projects in China in terms of their contribution to technology transfer.

In regard to the implications of this study, it should be noted the inadequacy of the Chinese legal framework to stimulate the investment of small international entrepreneurs into China through the CDM. Most in particular, these players are likely to feel deterred with the obligation of relying on a Chinese partner for venture control, and may also feel discouraged with the prospects of having to pay a minimum purchase price for the CERs generated by the project. As such, if Chinese policymakers are willing to attract foreign investment into China through the CDM and, indirectly, stimulate the transfer of environmentally sound technologies, they should consider reforming the internal CDM framework on these aspects. At a different level, the 70% requirement for locally produced renewable energy equipment in domestic installations is bound to aggravate the limited extent to which technology transfers might occur.

Two limitations can be pointed out to this investigation. One aspect pertains to the difficulties in determining the benchmark targets or the best practices for the KPIs in order to evaluate selected case studies. Another potential limitation stems on having the PDD as the major source of data for the benchmarking analysis, because it pertains to information prior to the project implementation.

For future research, three guidelines are suggested. Firstly, to study the incidence of unilateral CDM in large-scale projects in China, and the extent they hinder international technology transfers. Secondly, to contrast the findings of this study with the CDM reality of other countries, namely Brazil, India and Mexico, which are those with a higher share of CDM projects after China. And thirdly, to investigate the future of the CDM in China and the constitution of an internal domestic carbon market in the outlook of a post-Kyoto architecture.

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