Additionality of Swiss-Chinese CDM Projects

Master's Thesis

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presented by

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ABSTRACT

The Clean Development Mechanism (CDM) is a market-based mechanism under the Kyoto Protocol. It allows developed countries to invest in emissions reduction projects in developing countries and generates certified emission reductions (CERs). The CDM has attracted considerable attention in China as a host country and Switzerland as an investing country.

Additionality is one of the core criteria that CDM projects must fulfill. This Master's thesis focuses on investment additionality, which is an element of the additionality tool used by project developers to demonstrate the additionality of a proposed project. Several authors suggest using the difference between the internal rate of return (IRR) with income from CERs and the IRR without income from CERs (Δ IRR) instead of comparing the internal rate of return (IRR) with a predefined benchmark. However, to date, no extensive analysis of this approach has been completed. For this reason, this thesis performs a multiple linear regression and a logistic regression to identify the determinants of the Δ IRR of Swiss-Chinese CDM projects. In addition, the characteristics of Swiss-Chinese CDM collaboration under CDM, which are not currently publicly available, are evaluated.

As expected, the results of the empirical analysis provide evidence that the annual revenue from power and gas generation has significant negative effects on the Δ IRR of Swiss-Chinese projects. However, annual revenue from CERs, investment and annual operation and maintenance costs are unlikely to significantly impact the Δ IRR. According to these findings, it can be argued that the annual revenue from CERs with respect to Swiss-Chinese CDM projects is only the 'icing on the cake'.

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LIST OF ABBREVIATIONS

AIJ	Activities Implemented Jointly
ANOVA	Analysis of variance
BAU	Business as usual
C	Costs
CDM	Clean Development Mechanism
CER	Certified emission reduction
CO_2	Carbon dioxide
CO_2eq	Carbon dioxide equivalent
COP	Conference of the Parties
DOE	Designated Operational Entity
EB	Executive Board
EE	Energy efficiency
EU ETS	European Emissions Trading System
GHG	Greenhouse gas
GJ	Gigajoule
HFC	Hydrofluorocarbon
HFC-23	Fluoroform
IET	International Emission Trading
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
JI	Joint Implementation
MWh	Megawatt hours
kt	Kiloton
kW	Kilowatt
m^3	Cubic meter
MATA	Multi-Attributive Assessment
MB	Marginal benefits
MC	Marginal costs
MOP	Meeting of the Parties to the Kyoto Protocol
MW	Megawatt
NDRC	National Development and Reform Commission
NGO	Non-governmental organization

N_2O	Nitrous oxide
NPV	Net present value
OLS	Ordinary least squares
PCF	Perfluorocarbon
PDD	Project Design Document
SO_2	Sulfur dioxide
t	Ton
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value added tax

1 INTRODUCTION AND MOTIVATION

The Clean Development Mechanism (CDM) is a market-based mechanism under the Kyoto Protocol that has grown considerably in recent years. This mechanism allows developed countries to invest in emissions reduction projects in developing countries, and therefore, enables cost-effective compliance with emissions reduction targets.

CDM projects have to fulfill several criteria. In addition to achieving technology transfer and sustainable development goals, additionality is one of the core criteria that CDM projects must meet, and, when implemented appropriately, this criterion ensures the environmental integrity of CDM projects. A project is considered to be additional if the reductions in greenhouse gases from the project would not have occurred in the absence of the CDM activity. The additionality test is premised on an ability to estimate a counterfactual, which is not possible. Several studies indicate that a considerable number of CDM projects are not likely to comply with the additionality requirement (Michaelowa and Purohit 2007; Sutter and Parreño 2007; Zhang and Wang 2011). Consequently, additionality and the methods used to prove additionality are controversial, and the topic is hotly debated in the scientific community.

The additionality tool was implemented by the Executive Board (EB) of the CDM and is used by project developers to demonstrate the additionality of the proposed project. It includes three steps: first, the identification of alternatives to the project, second, the investment analysis or, alternatively, the barrier analysis, and third, the common practice analysis. Of particular interest is the project specific internal rate of return (IRR), used in context of the investment analysis, since it is the only quantitative and objective measure among all steps. This indicator reflects the financial feasibility of a proposed project with and without the CDM. It uses a comparison to a pre-defined benchmark to allow for an assessment of whether the income from the CDM project is required for the project's implementation and its long-term operation. Questions have been raised regarding the reliability of the benchmarks since they are usually defined by governments. Hence, several authors suggest that the difference between the IRR with and without the CDM (Δ IRR) could serve as an appropriate indicator of investment additionality (Au Yong 2009; Sutter and Parreño 2007).

Most studies published in this field take a qualitative approach to evaluating additionality, in general and investment additionality, in particular. While moving to a Δ IRR approach, as is suggested by several authors, would ensure a quantitative approach is taken towards assessing additionality, there are no comprehensive evaluations of its determinants. Therefore, it can be argued, that this mechanism is not fully understood. To help close this knowledge gap, this Master's thesis uses an econometric approach to analyze the determinants of the Δ IRR.

The CDM has experienced considerable growth since its launch in 2005. By the end of September 2011, around 3400 CDM projects had been registered. A more detailed analysis shows that China hosts the majority of CDM projects, housing around 45% of all CDM projects (UNFCCC 2011e). Also of interest is the make-up of the developed countries that invest in these project activities. The United Kingdom and Northern Ireland are the largest investors in CDM projects, accounting for 30% of projects followed by Switzerland, which is involved in over 20% of CDM projects (UNFCCC 2011d). Switzerland's prominent role in investing in CDM projects can be explained by the fact that Zurich has the second largest concentration of companies across Europe operating in the international carbon market (nachhaltigkeit.org 2010). This pattern indicates that both Switzerland and China are important players in the development of CDM projects. To date, no studies that evaluate the characteristics of Swiss-Chinese CDM projects have been completed. This fact, combined with the questions that remain regarding investment additionality and, in particular, the application of the Δ IRR approach, indicates that there is considerable room to further the understanding of the factors that influence the Δ IRR. For these reasons, this Master's thesis focuses on the underlying research question - **What are the determinants of the Δ IRR of Swiss-Chinese CDM projects?**

Finding solutions to the issues surrounding the additionality tool is necessary to ensure the long-term success of the CDM (Michaelowa 2009). The results of this analysis may contribute to improving methods used to prove additionality in general and investment additionality in particular. Moreover, focusing on Swiss-Chinese CDM projects has a welcome side-effect: it allows the patterns of this collaboration, which are not currently publicly available, to be analyzed.

In accordance with the investment analysis and the findings of various studies, a standard econometric model is defined where Δ IRR is the dependent variable. The independent variables included in the model are the following project specific indicators: investments, annual emission reductions, annual revenues, annual operation and maintenance costs, investments per unit of capacity installed, investments per ton reduction of CO_2eq, project type and province of implementation. Based on this model, five different sub-models are identified which estimate of the effects of the independent variables on the dependent variable Δ IRR by employing both OLS regression and logistic regression techniques. The results show that, unexpectedly, three out of four of the central financial indicators used to demonstrate investment additionality are unlikely to significantly impact the Δ IRR. When the analysis is limited to Swiss-Chinese CDM projects, the results suggest that in the hypothetical situation where the Δ IRR approach is implemented as an alternative to normal investment additionality criteria, determinants beyond those that have been used so far for the calculation of the IRR with and without the CDM, must be considered.

This Master’s thesis is divided into two parts – the first part (sections 2 and 3) includes a theoretical discussion which provides the essential inputs for the second part (section 4). Section 2 gives an overview of the Kyoto-Protocol and its market-based mechanisms. This section provides the basis for the detailed discussion of the CDM, including, in addition to conceptual aspects, information about the characteristics of the projects implemented. In section 3 the theoretical background of additionality is explained. Special attention is paid to investment additionality and the IRR since these are the focus of the empirical analysis. Moreover, current studies and publications that discuss additionality are reviewed. Section 4 presents the econometric models and corresponding hypotheses and provides some insight into Swiss-Chinese collaboration under the CDM. The second part of this section presents the empirical analysis, followed by a discussion of the results. Finally, the horizon is widened in section 5 and the findings and key aspects of this Master’s thesis are discussed in a broader context.

2 CLIMATE CHANGE, THE KYOTO-PROTOCOL AND MARKET-BASED MECHANISMS

In order to understand the CDM and the concept of additionality it is important to introduce some basic information on the Kyoto Protocol and market-based mechanisms.

Since the industrial revolution, atmospheric greenhouse gas (GHG)[1] concentrations have increased dramatically due to anthropogenic impacts including fuel combustion, land use change, and agricultural activities (IPCC 2007a). The result is an increase in global average temperature. As the Intergovernmental Panel on Climate Change (IPCC 2007a: 10) states: "Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations." Based on climate model simulations, it is expected that, in the future, the frequency and severity of extreme weather events such as storms, heavy rainfall, or drought will increase. This in turn has inestimable consequences for water supply and management, food security, energy security, industrial production, and human health (IPCC 2007b).

In order to avoid of the most drastic impacts of climate change, global GHG emissions must be reduced. From an economic point of view, carbon taxes and emission trading may serve as instruments to increase emission abatement activities. Therefore, negative externalities play an important role since they reflect the activities of agent A that have unintended consequences for other agents, future generations and ecosystems for which no compensation is given (Stephan and Ahlheim 1996; Rogall 2008). The concept of carbon taxes originates from Pigou (1920) who suggested a tax to address environmental issues that is equal to the externalities caused by the pollution. Later, Coase (1960) suggested that externalities should be internalized by defining property rights. Coase showed that in the absence of any transactions costs and when information is distributed symmetrically, the trade in externalities leads to efficient outcomes, independently of the allocation of the property rights. In the particular case of climate change, entities are allotted emission permits that can be traded on the international carbon market. When appropriately implemented, the relative prices would reflect the damage to the climate. Depending on the marginal costs of emission abatement, this may encourage the development of more efficient technologies or climate-friendly substitutes (Common and Stagl 2005). Figure 1 illustrates the effect of different actor-specific marginal costs of emission abatement in the context of emissions trading.

Assume there are two firms, A and B, operating under a national GHG emission target E which reduces emissions E* by 50% and is based on internationally negotiated emission targets.

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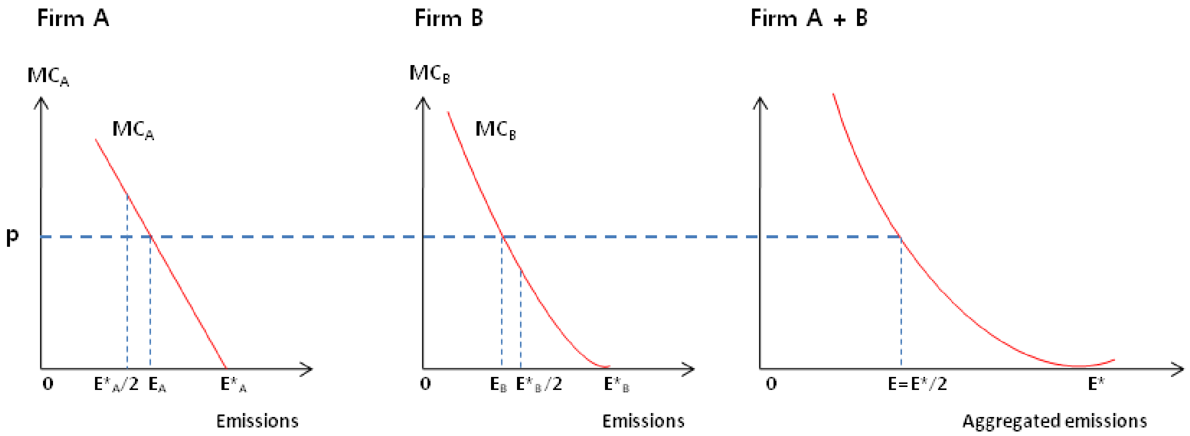
[1] Besides water vapor, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are the most important green house gases IPCC (2007a: 2).

Firm A has higher marginal abatement costs (MC_A) than firm B (MC_B) (red lines). Hence, for firm B it is cheaper to reduce emissions. Now assume that firms A and B are endowed with the same amount of emission rights ($E^*_1/2$ and $E^*_2/2$), which can be bought and sold on the carbon market at price p. Firm A prefers to buy emission rights instead of reducing emissions since the price of emission rights (p) is below its marginal abatement costs. By contrast, firm B prefers to reduce emissions because the price of emission rights (p) is above its marginal abatement costs. The emission rights that are freed up by the abatement activities of firm B are sold to firm A. By doing so, firm A can compensate for its additional emissions. As a result, firm A's emissions are above its allocated amount of emission rights ($E^*_1/2$), while firm B's emissions are below its allocated amount of emission rights ($E^*_2/2$). Nevertheless, the overall emission reduction target E is met.

Figure 1: Marginal costs of abatement



Source: adopted and modified from Stephan and Ahlheim (1996)

In addition to carbon taxes and emissions trading, legal regulations such as technology standards or requirements to monitor production processes may be implemented (Stephan and Ahlheim 1996). These three instruments differ in the degree of their market conformity[2]. In the context of climate change, emissions trading and carbon taxes have the advantage that the marginal abatement costs of the actors are considered. The result is a system where actors with low marginal abatement costs reduce emissions while actors with high marginal abatement costs pay the carbon price. Hence, economic efficiency is ensured since abatement measures are implemented where marginal abatement costs are lowest (Brohé *et al.* 2009; Stephan and Ahlheim 1996; Rogall 2008).

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[2] Market conformity indicates that individuals have sovereign rights to their decisions, prices are the sole basis of all decisions made, and pricing occurs in accordance to supply and demand, i.e. a free market (Stephan and Ahlheim 1996).

The concept of emission trading is not new. One of the first examples was the Clean Air Act, implemented to control air pollutants in the United States in the 1970s. It enabled enterprises under the emissions cap to offset higher emissions by making payments to entities willing to reduce their emissions by a corresponding quantity. Other examples where the same approach is applied include water pollution and biodiversity programs (Gillenwater 2011).

2.1 KYOTO PROTOCOL AND MARKET-BASED MECHANISMS

The scientific community first began to draw attention to the problem of climate change in the 1980s, and politicians have now begun to acknowledge that a global solution is necessary. One of the critical barriers to implementing such a solution is the fact that greenhouse gas abatement is a public good which, evidence suggests, is susceptible to 'free-riding'. As a result, countries have an incentive to profit from the abatement activities of other countries while they themselves do not act to address the issue (Goodstein 2005). Therefore, it was reasonable to implement a global climate regime that requires countries to undertake emission reduction measures. In 1997, the Kyoto Protocol was signed by 167 states, the treaty came into force in 2005. This global climate regime requires developed countries to reduce their GHG emissions between 2008 and 2012[3] by 5.2% below 1990 levels on average (BAFU 2009). An important element of the agreement is Article 3.1 of the 1992 Rio Climate Convention which declares that (UNFCCC 1992: 4):

> *The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities.*

Article 3.1 has a significant impact on the Kyoto mechanisms discussed below as it emphasizes the differentiated responsibilities and respective capabilities of developed and developing countries. From a historic perspective developed countries are those that are primarily responsible for the increase in GHG concentrations in the atmosphere (differentiated responsibility). In general their net emissions and per capita emissions are higher than those of most developing countries[4]. Therefore, developed countries are required to play a lead role within the global climate regime. Moreover, they are able to do so because of their considerable financial and institutional resources (respective capabilities). Consequently, developed countries that sign on to the Kyoto Pro-

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[3] Referred to as 'first commitment period' (BAFU 2009).

[4] According to the latest OECD Environment Outlook it is projected that global GHG emissions will be more than double to 2050 (compared to 1990 levels). It is expected that net GHG emissions in OECD countries grow at a slower pace than those of emerging and developing countries which would drop contribution of OECD countries to 23%. However, their emissions per capita remain the highest (OECD 2012).

tocol must reduce their GHG emissions as defined through international negotiations (Brohé *et al.* 2009; UNFCCC 1998).

Annex I countries[5], i.e. developed countries, must ensure that emission reductions under the Kyoto Protocol are primarily accomplished using domestic measures. In addition, the Kyoto Protocol allows market-based mechanisms, also known as the Kyoto mechanisms, to be used to meet their obligations. Each of these mechanisms, International Emissions Trading (IET), Joint Implementation (JI), and the Clean Development Mechanism (CDM), are characterized by different properties. The IET, defined in Article 17 of the Kyoto Protocol, authorizes trade in carbon credits among Annex I countries on the carbon market, which is a key tool for all three market-based mechanisms. JI, as set out in Article 6 of the Kyoto Protocol, allows investments by an Annex I party in emission reduction projects in another Annex I country. The CDM is similar to the JI, but by contrast, it enables Annex I countries to invest in emission reduction projects in non-Annex I countries[6], i.e. developing countries, which usually have lower marginal abatement costs. The CDM and the JI are both project-based instruments (BAFU 2009; UNFCCC 2011g).

The main goals of the Kyoto mechanisms are to:

- Increase sustainable development in non-Annex I countries through investment and technology transfer,
- Help countries under the Kyoto Protocol to comply with their targets in a cost-effective way, and
- Encourage developing countries and the private sector to assist in emission reduction efforts (UNFCCC 2011g).

These goals reflect the international consensus which attempted to bundle the heterogeneous interests of the countries involved in the decision making process. However, according to economic theory one instrument, i.e. CDM or JI, may not be appropriate to accomplish various markedly different objectives. Given that there is an unambiguous cause-and-effect relationship between an instrument and its objective, economic theory suggests that at least *n* (policy) instruments are needed to accomplish *n* objectives. In addition, policy instruments may have further, unintended effects (Petit 1990). The following sections will outline several drawbacks to the CDM that reflect and support these theoretical considerations.

The Kyoto mechanisms take two approaches. First, a cap-and-trade scheme, where national emission caps are negotiated. This is the basis for the allowances distributed to actors (e.g. firms)

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[5] Annex I countries refer to the OECD countries and economies in transition, listed in Annex I of the UNFCCC (1992).

[6] Non-Annex I countries are mainly developing countries that are not listed in Annex I of the UNFCCC (1992).

participating in the scheme. Allowances can then be traded on the carbon market. An example of this system is the European Emission Trading Scheme (EU ETS). The second approach is a baseline-and-credit scheme such as the CDM. Based on a project-specific baseline, this system allows actors to generate carbon credits through emission reduction projects (Brohé *et al.* 2009)

2.2 CDM PROJECTS

While the CDM has faced criticism in recent years, it is has also attracted a lot of attention, making it an interesting field of research. Defined under Article 12 of the Kyoto Protocol, the CDM should be beneficial for both developed and developing countries (UNFCCC 1998). The core elements of this mechanism are on the one hand, enabling cost-effective compliance with Kyoto targets, and on the other hand, ensuring sustainable development in developing countries and the transfer of technology and knowledge. This in turn, may increase the ability of societies in developing countries to adapt to and mitigate the impacts of climate change (UNFCCC 2011g). The variety of CDM projects is large – from the installation of solar, wind or hydro power stations instead of low cost coal-fired power plants to methane recovery in waste water treatment plants to demand-side energy efficiency programs. According to Paragraph 5 of Article 12 of the Kyoto Protocol, emission reductions resulting from CDM projects shall (a) be based on the voluntary participation of the parties involved, (b) result in real, measurable, and long-term emissions reductions, and (c) be additional to any emissions that would have occurred in the absence of the project activity (UNFCCC 1998).

Market-based mechanisms, such as the CDM, were initially heavily promoted by the United States and were approved at the first COP[7] in Berlin in 1995. The predecessor to the CDM and JI was the Activities Implemented Jointly (AIJ)[8] mechanism, a pilot project whose goal was to gain experience with a global offset mechanism. During this period the first discussions concerning additionality occurred (Gillenwater 2011; Grubb *et al.* 2011). This specific issue is discussed in further detail in section 3.

The CDM, the world's largest GHG emissions offset scheme, is open to all legal and natural entities from governments to financial institutions to private sector companies. Participants of the CDM have to fulfill various requirements. For countries, the most important criterion is the ratification of the Kyoto Protocol. In addition, countries must set up a national inventory system for emissions and sinks, and a national registry to track emission allowances. In addition, non-Annex I-

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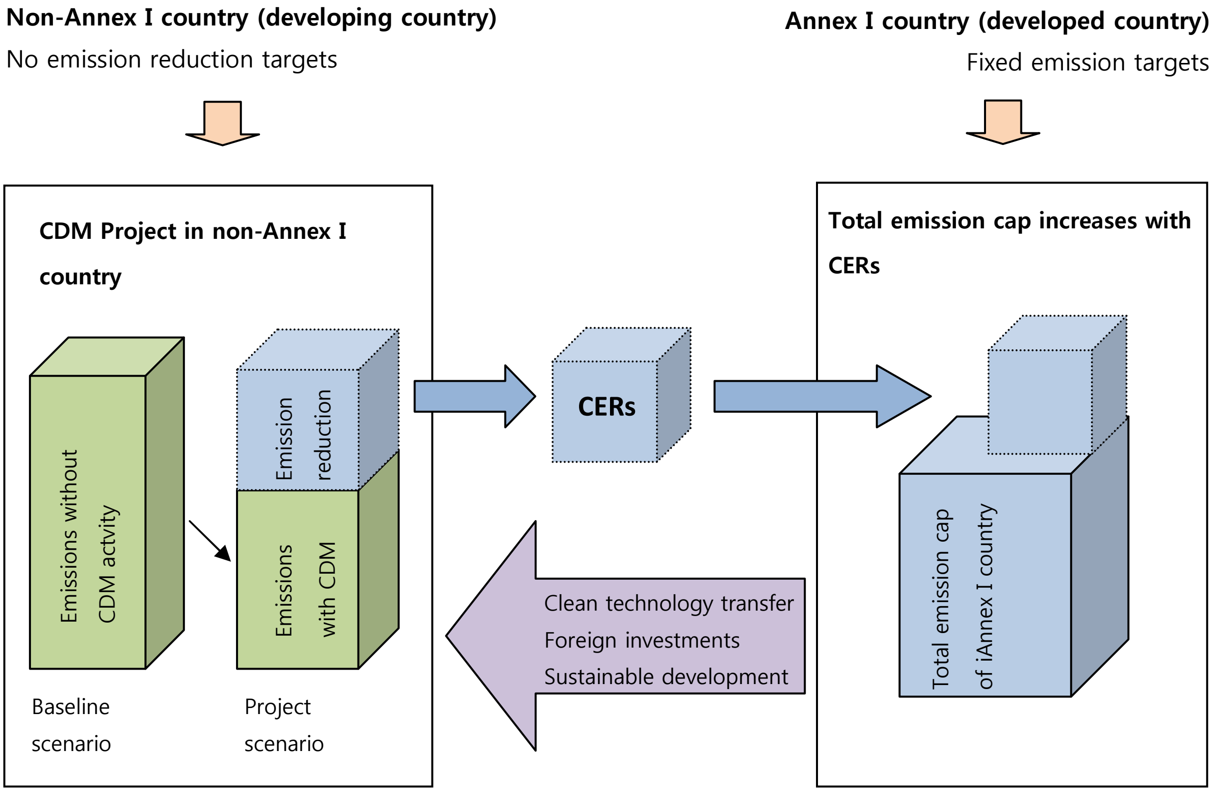
[7] The COP is the Conference of the Party and refers to the meetings of the parties of the UNFCCC.

[8] Decision 5/ CP.1 (UNFCCC 1995).

countries must define their requirements related to sustainable development (FOEN 2011; Gillenwater 2011).

CDM projects generate certified emission reduction certificates (CERs)[9]. CERs are traded on the international carbon market and can be used by industrialized countries to comply with their Kyoto targets. Therefore, the CDM can also be defined as an offset-scheme because emission reductions in non-Annex I countries are offset by a corresponding increase in emissions in Annex I countries (Brohé *et al.* 2009; Yamin 2005). Certificates are based on the difference between the actual emissions within a certain time period and the emissions baseline that reflects a 'business-as-usual' (BAU) scenario. Figure 2 illustrates the collaboration between an Annex I country and a non-Annex I country under the CDM.

Figure 2: Concept of CDM projects



Source: adopted and modified from JQA Japan Quality Assurance Organization (2007) and Brohé *et al.* (2009)

So called 'carbon-leakage' is another important but controversial issue. Carbon leakage can occur when countries take on differing emissions reduction targets as is the case under the Kyoto Proto-

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[9] 1 CER = abatement of 1 ton of CO_2 equivalent.

col. According to economic theory 'carbon-leakage' describes the outsourcing of emission intensive production processes from countries with emission targets to countries without binding targets since the former is not willing to invest in emissions reductions. The result is a situation where the climate regime triggers an increase in net global emissions, and hence, the environmental integrity of the climate regime is seriously threatened (Kallbekken 2007). Kallbekken (2007) demonstrates that the CDM is an appropriate instrument to significantly reduce 'carbon-leakage' using market forces. According to Kallbekken, the CDM reduces compliance costs because CERs generated by CDM projects increase the supply of emission permits on the market, which leads to a decrease in permit prices. This in turn increases the incentive for actors to buy emission permits instead of out-sourcing production processes. However, an opposing view is presented by Vasa and Neuhoff (2011). They claim that the CDM is suitable for a transitional scheme but in the long-run, they argue that it is not an appropriate instrument for an international climate regime. The authors mainly criticize the lack of incentives for developing countries to implement domestic climate policies and for developed countries to invest in low-carbon technologies.

2.2.1 PROJECT CYCLE OF A CDM PROJECT AND INSTITUTIONS INVOLVED

A number of institutions are involved in the CDM project cycle. Even though the CDM is defined under Article 12 of the Kyoto Protocol, detailed operational guidelines are not specified in the Protocol itself. Therefore, during COP 7 in Marrakesh in 2001, the project cycle, including different steps, was defined more precisely[10] (Yamin 2005). In the meantime, progress has been made and the project cycle now basically contains the following six steps (FOEN 2011; UNFCCC 2010; UNFCCC 2012a; Yamin 2005):

Step 1: Project Design

The project participants must prepare a Project Design Document (PDD) which includes detailed information on the project purpose, a description of the baseline and monitoring plan, an assessment of environmental impacts, an outline of stakeholder views on the project and information on any additional benefits the project will bring. The project must be approved by the Designated National Authority (DNA) of the countries involved. In addition, the host country[11] must evaluate the project's compliance with the defined requirements for sustainable development.

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[10] Decision 17/ CP.7 (UNFCCC 2002b).

[11] In the context of the CDM the non-Annex I country may be referred to as the host country.

Step 2: Validation

The Designated Operational Entity (DOE) is selected by the project developer. The DOE independently evaluates the project activity based on the PDD and ensures that the planned activities are consistent with CDM modalities.

DOEs[12] need to be accredited by the Executive Board (EB). The project developer is free to choose its DOE and pays the DOE for services rendered (UNFCCC 2011a). The financial flows from the project developer to the DOE have raised concerns. Even if DOEs follow the review guidelines, their objectivity can be called into question. Therefore, Schneider (2009: 251) argues that the rules should be adapted so that the EB is responsible for making payments to the DOE. This may enhance the credibility of the validation process.

Step 3: Registration

The DOE submits the validated PDD to the EB. The EB consists of 10 members and 10 alternate members; it operates under the COP/MOP[13] and supervises activities under the CDM. The formal acceptance of a project by the EB includes the evaluation of the PDD and the registration of the project, provided that requirements are fulfilled. PDDs are then published on the website of the UNFCCC[14] and can be accessed by the public.

In addition to accrediting DOEs, managing the registration process, and issuing of CERs (see below), the EB is also authorized to develop technical rules and procedures for the CDM and approve new methodologies (Michaelowa 2009).

Step 4: Monitoring

Once a project is operating, the project developer regularly monitors the emissions according to the approved methodology described in the PDD and prepares a monitoring report. The report also includes an estimate of the CERs generated and is submitted to the DOE.

5. Verification and certification

The DOE is responsible for the periodic independent review and verification of the emission reductions according to the monitoring reports. As a next step the DOE certifies that the project activity achieved the emission reductions as demonstrated in the verification process. This certification report legitimizes the CERs and is submitted to the EB.

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[12] A list of accredited DOEs is accessible on the website of the UNFCCC http://cdm.unfccc.int/DOE/list /index.html.

[13] MOP is the Meeting of the Parties and refers to the parties to the Kyoto Protocol.

[14] http://cdm.unfccc.int/Projects/projsearch.html

6. Issuance of CERs

Once the EB has verified the certification report, the EB issues the requested CERs. 2% of the value of the CERs generated is transferred to the Adaptation Fund, a fund designed to help particularly vulnerable developing countries adapt to climate change.

It should be noted that the project cycle described above is only applicable to large-scale projects. Small-scale projects can use a simplified version in order to reduce transaction costs (Yamin 2005).

One of the challenges facing the CDM is finding an accurate balance between transaction costs and environmental credibility (Yamin 2005). On the one hand, institutions to control and verify projects are necessary to guarantee the environmental integrity of the system. This is a crucial issue since using fictitious CERs increases net global emissions (Michaelowa 2009). On the other hand, the fact that it takes 3 years on average between project submission and the issuance of the first CERs increases transaction costs and reinforces uncertainty (The World Bank 2010: 2).

There is one further important issue that impacts environmental integrity that must be considered. The CDM involves various stakeholders; project developers, investing countries[15], host countries, CER buyers and sellers, consultants, non-governmental organizations (NGOs) and regulators. Most of these actors have an incentive to generate as many CERs as possible (Michaelowa 2009). This behavior pattern may enhance the risk that CDM projects will not accomplish the necessary environmental goals. At this point asymmetric information presents a significant challenge to regulators (Gillenwater 2011). While the project developer is accurately informed regarding the related project parameters, the regulator is less well informed and relies on information published in the PDD in order to assess a project's compliance with the necessary requirements.

Given the limitations of the Kyoto Protocol, the CDM seems to be an appropriate solution to increase efficiency. Developed countries under the Kyoto Protocol can meet their emission targets in a cost effective way while developing countries benefit from technology transfer and income generation from CERs that enhances their capacity to adapt to climate change. However, the CDM has been criticized heavily in recent years. First, there is uncertainty as to whether a project would have been implemented anyway as a result of, for example, increased demand for energy in the host country. Since it is attractive to generate income from CERs, project developers may have an incentive to 'push' their projects through the CDM cycle even though they would have been implemented anyway. Second, domestic climate policies in the host country may be delayed in favor of financially attractive CDM projects. This is reinforced by the fact that host countries do not have any emission reduction targets (FitzRoy and Papyrakis 2009). The question of whether a project

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[15] In the context of the CDM, an Annex I country that invests in an emissions reduction project may be referred to as an investing country.

would have been implemented anyway is at the heart of the additionality problem which will be discussed in section 3.

There are internal impacts such as decisions made by the EB that determine how CDM projects are implemented, however, it is important to see the CDM in a broader context. As a part of the global climate regime, it is heavily influenced by decisions made on the international political stage. While 38 countries agreed to a 2nd commitment period under the Kyoto Protocol at COP 17 in Durban[16], some uncertainty regarding the future of the CDM after 2012 remains. Therefore, Martin Hession, the head of the CDM EB, urged countries to provide a clear signal on the future of the CDM at the COP in Qatar (IISD 2011).

2.2.2 HOST COUNTRIES AND THE DISTRIBUTION OF CDM PROJECTS

Following on the discussion of the theoretical aspects of the CDM, the paper now focuses on the implementation of projects and the development of the CDM over the years.

As of September 2011, there were over 3400 registered CDM projects. These projects generate over 516 million CERs annually. Over 2 billion CERs are expected to be in the pipeline by the end of the first commitment period in 2012. Over 80% of CDM projects are implemented in Asia and China is the most common host country for CDM projects, accounting for around 1590 projects, or roughly 45%, of all projects registered. China is followed by India (20.8%) and Brazil (5.6%). All in all, over 95% of all projects are implemented in Asia and the Pacific, and Latin America (UNFCCC 2011e). Figure 3 shows the distribution of projects among host countries.

The distribution of expected annual CERs shows a similar pattern. China's share is 64%, India's 11% and Brazil's 10% (UNFCCC 2011c). The distribution of CDM projects as well as the corresponding distribution of CERs is biased towards a few host countries. Hence, it is uncertain whether the CDM will be able to meet its requirement to support sustainable development and technology transfer to developing countries. These concerns are not new - the experience of the AIJ pilot program had already raised concerns regarding the unequal distribution of projects given that, of the 125 AIJ projects, only 5 took place in Africa (UNFCCC 2002a).

The distribution of investing parties shows that the United Kingdom and Northern Ireland are the most active participants with 1185 projects (September 2011), equivalent to 29.6% of all projects. Switzerland is involved in 20.6% (810 projects) and Japan in 11.2% (446 projects) of CDM

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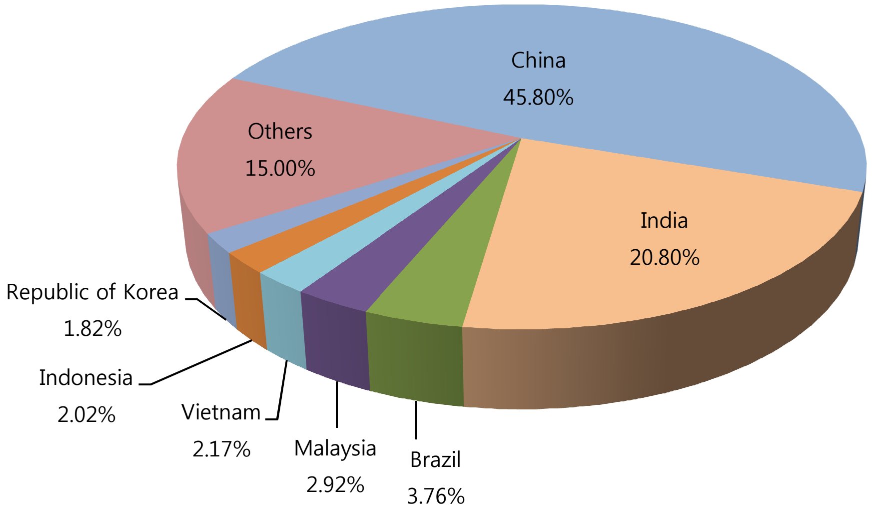
[16] Decision 1/ CMP.7 and Decision 3/ CMP.3

projects (UNFCCC 2011d). These figures indicate that Switzerland, or to be more precise Swiss actors, play an important role in the CDM. The collaboration between Swiss and Chinese actors under the umbrella of the CDM will be discussed in further detail in section 4.

Figure 3: Registered CDM projects by host party (September 2011)



Source: UNFCCC 2011e

The paper now focuses on project categories because they provide a useful indication of how abatement capacity varies with project type. The CDM includes 15 different project categories[17] (UNFCCC 2011b). According to UNEP's Risoe Centre, 64% of projects can be classified as 'Renewables', i.e. energy industries (Figure 4) (UNEP Risoe Centre 2011). The distribution with respect to the CERs expected to be put in place between 2005 and the end of the first commitment period shows a different pattern. While HFC (hydrofluorocarbon), PFC (perfluorocarbon), and N_2O (nitrous oxide) projects account for only 2% of projects, they are expected to make up 27% of all CERs

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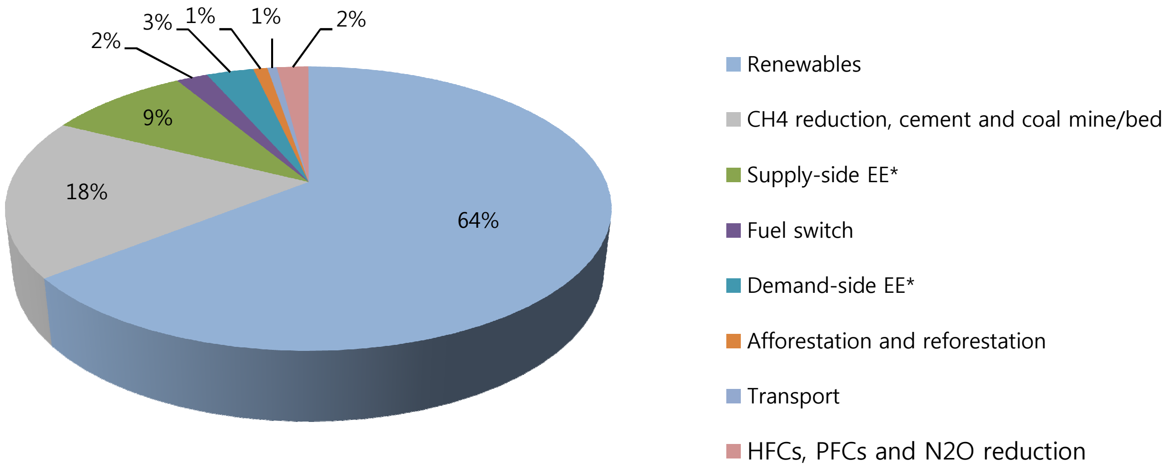
[17] Energy industries (renewable- /non-renewable resources), energy distribution, energy demand, manufacturing industries, chemical industries, construction, transport, mining/mineral production, metal production, fugitive emissions from fuels, fugitive emissions from production and consumption of halocarbons and sulfur hexafluoride, solvent use, waste handling and disposal, afforestation and reforestation, agriculture UNFCCC (2011b).

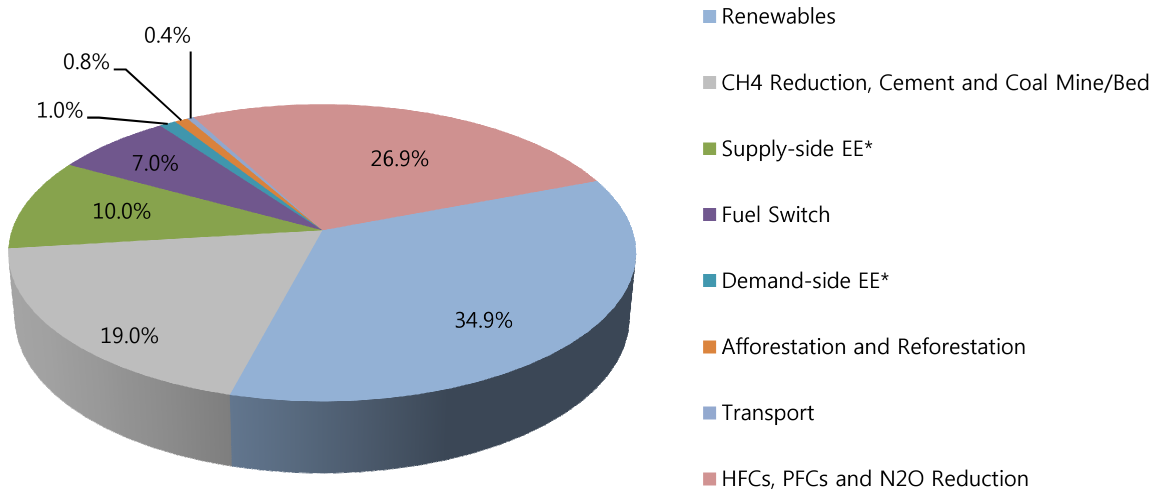
issued by the end of 2012 as illustrated by Figure 5 (UNEP Risoe Centre 2011). This trend arises due to the high global warming potential of GHGs such as HFCs, PFCs or N_2O[18] (IPCC 2007a: 25).

Figure 4: Distribution of CDM projects in % among project types



* EE = energy efficiency
Source: UNFCCC 2011b

Figure 5: Expected CERs in % until 2012 by project type



* EE = energy efficiency

Source: UNEP Risoe Centre 2011c

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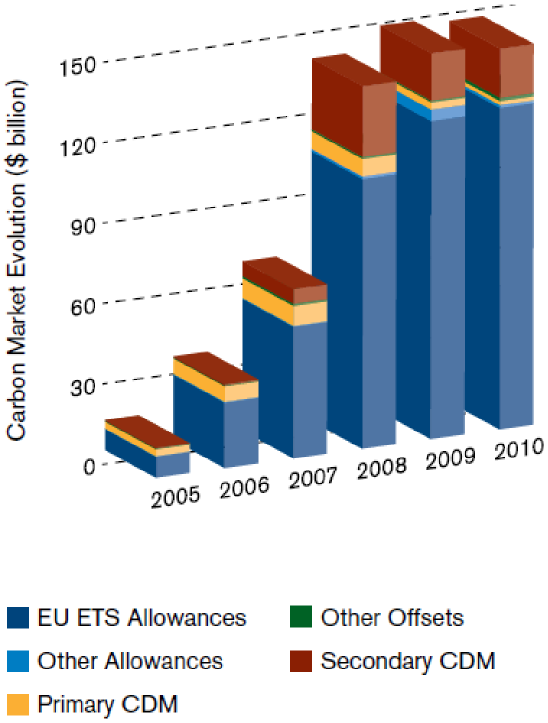
[18] The global warming potential is defined as: "… the combined effect of the differing times theses gases [GHGs] remain in the atmosphere and their relative effectiveness in absorbing outgoing thermal infrared radiation." IPCC (2007: 134).

2.2.3 THE CDM AND THE CARBON MARKET

The carbon market is not the focus of this master thesis. Nevertheless, it is worth discussing it briefly, in order to provide a comprehensive understanding of the CDM.

As shown in Figure 6, various types of allowances and credits are traded on the carbon market. The total market value of carbon credits increased exorbitantly between 2005 and 2008. It then leveled off in 2010 at a total carbon market value of US$ 142 billion. At this time, the share of CDM projects was around 14%, a market value of around US$ 20 billion. After peaking in 2008, both the primary and secondary[19] CDM markets experienced drops in their market values. At the same time, the EU ETS Allowances became more dominant, accounting for 84% of the total carbon market value in 2010 (The World Bank 2011: 9).

Figure 6: Carbon market values 2005-2010



Source: The World Bank (2011: 9)

In 2011, 320 million CERs were generated, a significant increase over the 132 million CERs that were generated in 2010. The increase in the supply of CERs is reflected by falling market prices. Prices peaked in July 2008 when certificates were traded at a price of around 33 US$ in some

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[19] The CDM market is divided in two segments. The primary market refers to direct transactions of CERs from the project developer to the investor. The secondary market includes all subsequent transactions.

stock exchanges. Since then prices have fallen steadily. In December 2011, the price dropped to 6.60 US$ per CER. The reason for the falling prices is, in addition to the impact of the financial crisis, an oversupply on the carbon market triggered by uncertainty regarding post-2012 regulations. In addition, the exclusion of carbon credits generated by HFC-23 and N_2O projects by the European Union from 2013 onwards has caused companies to dump their credits on the market. While the growth rate of supply is currently leveling out, supply is expected to continue to exceed demand until 2020 (The World Bank 2011: 10; Bloomberg 2011a,2011b).

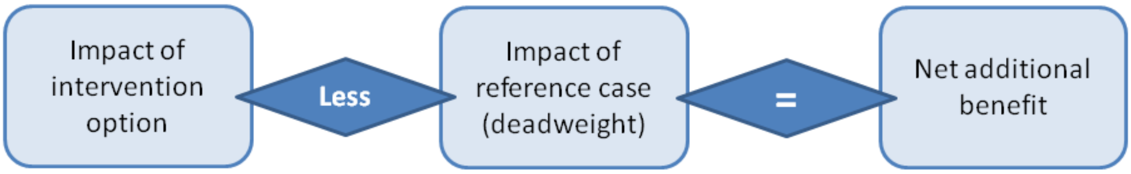
3 ADDITIONALITY

3.1 DEFINITION AND FRAMEWORK OF ADDITIONALITY

Additionality[20] is a core aspect of CDM rules and implies that emission reductions must be real. It is a purely technical concept originating in the evaluation of government intervention. Figure 7 outlines the framework of additionality, which can be described as follows:

> *The additional benefit of an intervention is the difference between the reference case position (what would happen anyway) and the position if / when the intervention (intervention option) is implemented … (Scottish Enterprise 2008: 2).*

Figure 7: Framework of additionality



Source: Scottish Enterprise (2008: 28)

Additonality in the context of the CDM is defined in paragraph 43 of Decision 3/ CMP.1 (UNFCCC 2005: 16) as follows:

> *A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity.*

So far, this vague definition of additionality has not been specified further by the COP/MOP even though its members have acknowledged the importance of additionality. One reason a definition has not been agreed to yet is the fact that the parties involved have fairly different views regarding additionality. Furthermore, a lack of understanding of this technical concept has complicated the process of finding a common definition. Hence, the decision making process within the COP/MOP has resulted in decisions that represent the least common dominator (Michaelowa

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[20] Paragraph 5 of Article 12 of the Kyoto Protocol (UNFCCC 1998).

2009). Since additionality has not been specified, researchers working in this field use different definitions. Michaelowa (2009: 249), for instance, defines addtionality as follows:

> *The essential idea underlying the concept of additionality is that the emissions reductions of a CDM project would not have happened under 'business-as-usual'.*

A further example is Schneider (2009: 242) who states that additionality is "… the demonstration that the emission reduction would not occur without registration as a CDM project."

3.2 DEMONSTRATING AND ASSESSING THE ADDITIONALITY OF CDM PROJECTS

These different definitions have one common core point: only projects that can demonstrate that - they need the (financial) support of the CDM can enter the project cycle.
Figure 8 illustrates this concept. Assume a power plant uses coal for power generation. This results in baseline emissions, i.e. the 'business-as-usual' scenario that is indicated by the dashed line. At time *t* the CDM project activity starts. An example is a project that switches from producing coal power to hydro power. This leads to project emissions that are below the baseline emissions (solid line). The outcome is the emission reduction illustrated by the blue triangle. Since the baseline emissions become hypothetical as soon as the project activity starts, the reduction has to be proven based on the baseline calculated according to a methodology approved by the EB[21]. This methodology in turn has to be consistent with the guidelines defined in the Marrakesh Accord[22]. Even if methodologies exist, calculating baselines is inherently difficult since they are subject to uncertainty because the counterfactual can never be measured (Lee and Shrestha 2005). Once the baseline is defined, the project developer has to demonstrate in the PDD that these emission reductions are real, i.e. additional.

Devising the appropriate tools to demonstrate additionality is extremely challenging because any effort to define additionality creates both false positives and false negatives. False negatives arise when a proposed project does not pass the additionality assessment but does in fact meet the additionality requirements. By contrast false negatives, i.e. non-additional projects, may enter the CDM cycle which is a pitfall for the environmental integrity of the CDM (Trexler *et al.* 2006). That is, registering a project that would have been implemented anyway increases net global GHG emissions because these CERs are used in developed countries to meet emission targets. Both, false negatives and false positives, negatively affect economic efficiency. While false

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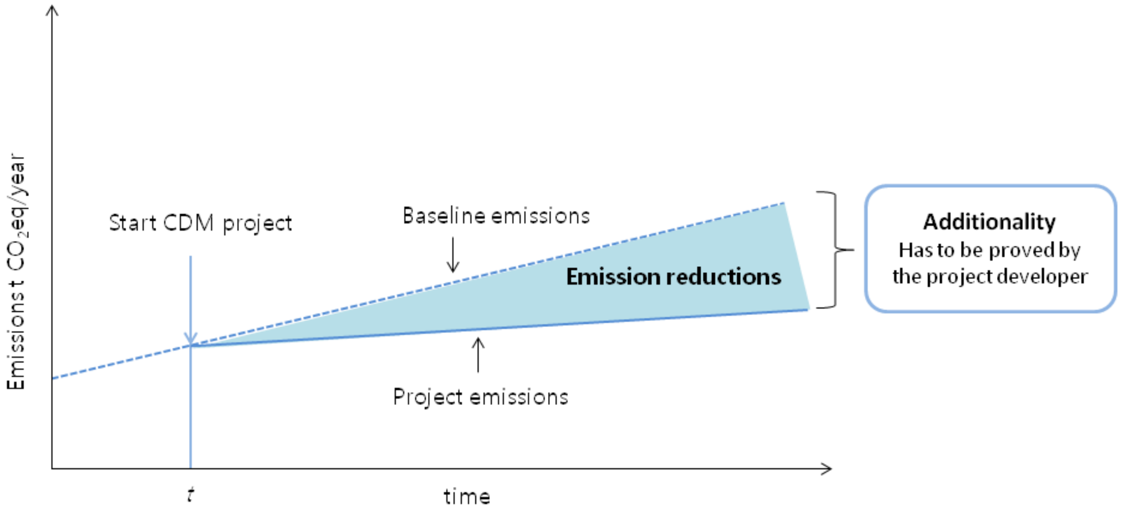
[21] So far, there have been over 100 methodologies accepted (UNFCCC 2012b).

[22] Decision 17/CP.7 (UNFCCC 2002b).

positives reflect inefficient investments due to the over-allocation of resources, false negatives can be interpreted as the worthwhile investment opportunities that are lost as a result of the under-allocation of resources (Michaelowa and Purohit 2007). In order for the system to have environmental integrity and be economically efficient, the additionality tools must be set up in such a way as to avoid both a high number of false negatives, and a high number of false positives (Schneider 2009; Trexler *et al.* 2006). Greiner and Michaelowa (2003: 1009) describe the challenge of defining an accurate additionality tool as an optimization problem. On the one hand, the tool should not be too exclusive because its purpose is to also encourage financially profitable projectson the other hand, requirements should not be too inclusive as they should deter the participation of projects that would have been implemented anyway.

Figure 8: Concept of additionality under the CDM

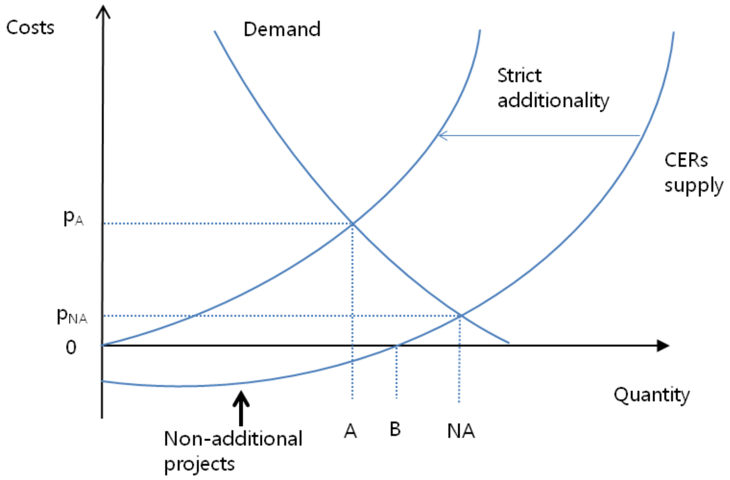


Source: adopted and modified from Climate Control Strategies (2011)

The definition of additionality requirements directly impacts the supply of CERs. As illustrated in Figure 9, stricter requirements create scarcity and shift the supply curve to the left. While supply decreases from 0-NA to 0-A, the equilibrium price increases from pNA to pA and the number of additional projects increases from B-NA to 0-A. Higher prices on the carbon market may increase emission reductions in countries under the Kyoto Protocol and raise revenues for project developers, in cases where the elasticity of the demand is greater than 1 (Michaelowa 2010: 216).

The procedures for demonstrating and assessing additionality have undergone a steady transition in recent years. The results of the pilot projects implemented under the AJI were rather sobering because they were unlikely to contribute to the guidelines and the assessment of additionality (Gillenwater 2011). Since it was expected that the COP/MOP would not develop detailed rules for the additionality proof within reasonable time, the EB was entrusted with this task. After creating an initial tool, the EB decided to modify it. The result is the consolidated additionality tool as illustrated in Figure 10. This tool does not remove the requirement to establish a baseline and a baseline scenario[23]. So far, the COP/MOP has not agreed on the additionality tool proposed by the EB. Nevertheless, it has become the standard procedure (Michaelowa 2009).

Figure 9: Impact of additionality requirement on CER supply



Source: Michaelowa (2010: 217)

The first step includes identifying and defining realistic and credible alternatives to the proposed project. The outputs of these alternatives must be comparable to the output of the proposed CDM project. In addition, the alternatives must abide by all legal and regulatory requirements. In order to prove that the proposed project is not preferred to the alternatives an investment analysis or, alternatively, a barrier analysis must be performed (Lee and Shrestha 2005).

As the term indicates, a barrier analysis identifies barriers that hinder the implementation of the proposed project. These may include investment barriers such as a lack of funding for innovative projects or technological barriers like a lack of skilled and properly trained labor (Lee and Shrestha 2005). A project developer can prove additionality by demonstrating that the CDM is necessary to overcome the barriers identified. In the past, some project developers gave vague and qualitatively insufficient explanations of the particular barriers the project faced. This raised concerns regarding the credibility of this test for additionality. As a result, the EB rejected several

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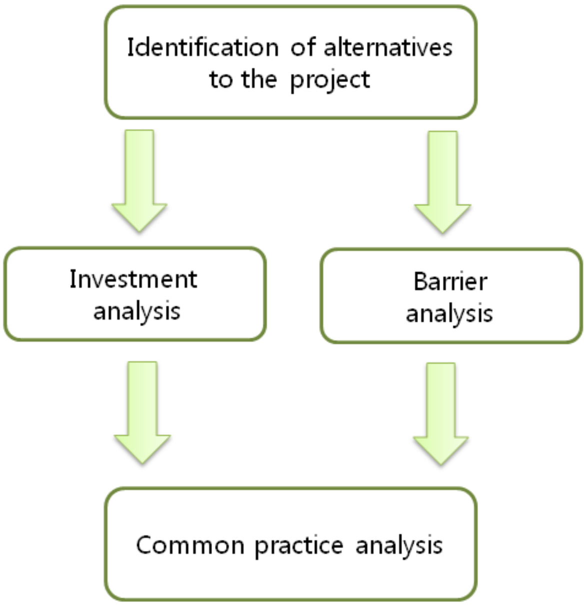
[23] EB 39, Annex 10, Paragraph 7.

projects which in turn led to a decrease in the number of projects submitted using the barrier analysis (Michaelowa 2009).

Figure 10: Consolidated additionality tool



Source: adopted and modified from Michaelowa (2009: 253)

The investment analysis is a procedure that demonstrates that, without the income from the CERs, a proposed project is either, not the most financially and economically attractive project when compared to alternative projects, or not financially and economically feasible at all. The investment analysis can follow one of three different approaches. The simple cost analysis applies to projects that do not generate any income in addition to the revenue from CERs. Project developers only need to demonstrate that the implementation and maintenance of the proposed project will have higher costs when compared to the alternatives. Projects that generate additional income, including revenue from power or gas generation, must use either an investment comparison analysis or a benchmark analysis. While the investment comparison analysis compares the economic attractiveness of the project with a plausible alternative, the benchmark analysis evaluates the project based on financial indicators and a defined benchmark for the economic attractiveness of the proposed project (Schneider 2009). Examples of financial indicators that can be used in the benchmark analysis include the internal rate of return (IRR) and the net present value (NPV). The project developer proves additionality by showing that the income generated through the CDM is substantive for the implementation of the project.

Finally, a common practice analysis assesses the technology or practice of the project type proposed. The goal is to show whether the technology or practice is already deployed in the corresponding sector or region. In order to prove additionality, the project developer must demonstrate that the idea of the project is 'unique' and the CDM is needed because the technology or practice proposed is not common. A problem with the common practice analysis is a lack of clearly defined common rules that would enable an objective evaluation of whether a proposed project is common practice or not. There are examples where a threshold of 5% is set. That is, a project activity is considered to be common practice if projects with similar characteristics are deployed in more than 5% of all projects implemented in the sector or region (Schneider 2009; Michaelowa 2009). In these cases, the probability is relatively high that this project would have been implemented anyway.

Generally, each project developer must prove that a proposed project is additional. However, some exceptions do exist. However, some exceptions do exist. First, the 'positive list' that lists project types considered to be additional anyways. To date, only HFC-23 projects have been included in this list. Second, the EB agreed on a simple barrier test for small-scale projects. This test is less resource intensive than the normal process and is expected to increase the participation of small-scale projects (Schneider 2009).

At the heart of the CDM, additionality is controversially debated in international climate negotiations and in the literature. The main challenge is that the concept of additionality is hypothetical. That is, it can never be proven with absolute certainty whether or not a project would be implemented without the CDM (Schneider 2009). Within academic discussions, two opposing opinions are prevalent. On the one hand, the 'additionality skeptics' deny the necessity of additionality. They argue that any project below the baseline should receive CERs. Wara and Victor (2008), for instance, do not deny the benefits of a carbon offset scheme as a concept. However, they state that the performance of the additionality test is very poor because the complexity of some CDM projects can hardly be reflected in the test. Hence, they propose that additionality tests should focus on project types for which assessing additionality is less difficult. On the other hand, there are stakeholders who state that no profitable project should get any CERs (Michaelowa 2009). According to this view, projects generating income from electricity generation would automatically be excluded from the CDM.

The role of national governments in host countries is another issue regarding additionality that must be addressed. For example, controversy arose recently concerning China's National Development and Reform Commission (NDRC), the commission that controls Chinese power tariffs for wind generated electricity. The EB observed decreasing power tariffs in 2009 which artificially reduced the economic feasibility of wind power projects. This raised the concern that the falling power tariffs were the result of an intentional intervention by the Chinese governments to increase the number of CDM projects that could make valid additionality claims. This in turn implies that CDM revenues are replacing government subsidies for renewable energy, which is not the intention of the CDM. This example indicates that incorporating domestic energy policy (e.g. subsidies for low-carbon technologies) is important for the credibility of additionality tests and should be considered. However, this is likely to be challenging (He and Morse 2010). He and Morse (2010: 7) call this crucial decision making point the 'Offsetters' Paradox', described as follows:

> *On the one hand, ignoring domestic subsidies for lesser-emitting investments results in CDM crediting for BAU domestic activity. On the other hand, incorporating emissions-reducing domestic policies into the baseline against which CDM projects are compared might create a perverse incentive against implementing such policies, as they would jeopardize CDM revenues.*

Summing up, additionality under the CDM is not a mature concept yet. Being aware of the limitations of additionality, Gillenwater (2009) advocates a rather pragmatic view regarding both offset schemes in general and additionality in particular. He proposes that the tools in place should be considered accurate, as long as they are at least as good, or better than, the competing policy alternative.

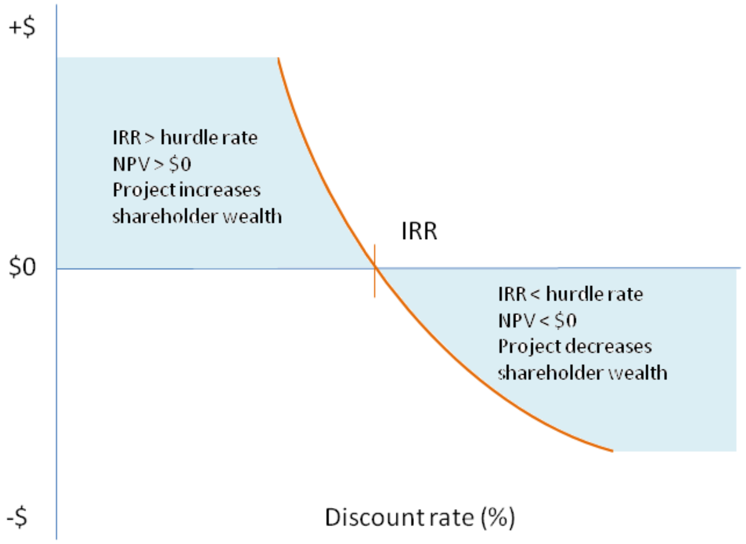
3.3 INVESTMENT ADDITIONALITY AND THE INTERNAL RATE OF RETURN

In section 3.2 the concept of investment additionality was introduced. Since it is the underlying basis of the empirical analysis it will be discussed in further depth in this sub-section. Before going into more detail, it is important to note that investment additionality must be distinguished from financial additionality. For the conditions for financial additionality to be met, CDM projects must be implemented independently from existing foreign aid programs. By contrast, investment additionality refers to the expected rational behavior of an actor under a program that allows revenue to be generated from emissions credits (Gillenwater 2011).

In order to assess the investment additionality of a CDM project, financial parameters are required that will enable the financial feasibility of a project to be evaluated. The IRR, a financial parameter and investment decision criterion that is applied globally, is the parameter that is normally used. It is defined as: "… the compound annual rate of return on the project given its up-front costs and subsequent cash flows" (Megginson and Smart 2009: 340). Specifically, the IRR is the discount rate that makes the NPV of project specific cash flow equal to zero. This relationship is illustrated by Figure 11.

In order to calculate the IRR, first, the project's expected future cash flows must be estimated. Second, the discount rate must be evaluated for the case where the NPV of cash flow is zero. Finally, the IRR obtained in the previous step is compared to the hurdle rate, the rate that reflects the market return rate for similar investments, and therefore, defines the minimum acceptable return on the project. A project is implemented if the IRR exceeds the hurdle rate. It follows that, the higher the project's IRR, the more desirable it is to undertake the project (Megginson and Smart 2009).

Figure 11: General concept of the IRR and the NPV

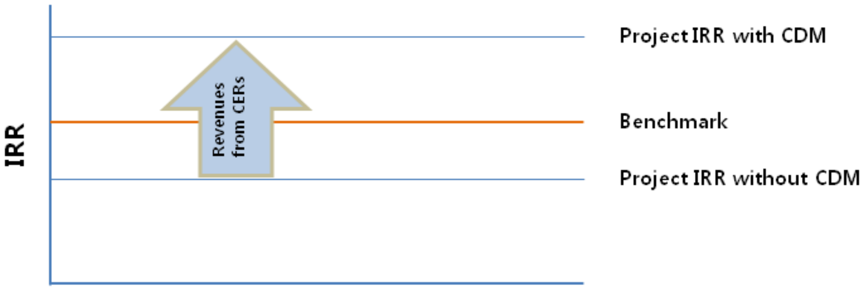


Source: Megginson and Smart (2009: 341)

In the context of the CDM, evaluating the IRR follows roughly the same procedure as described above. Nevertheless, there are slight differences. As a first step, the project specific future inputs and outputs of cash flow must be specified. Unlike the manner in which non-CDM projects are treated, this methodology requires two types of IRR. The first is the IRR excluding revenues from CERs, which is calculated based on input cash flows including the revenue from power or gas generation (depending on the project type) but excluding the revenue from CERs. Output cash flows usually include income taxes, and operation and maintenance costs, such as expenditures for salaries. The second parameter is the IRR including revenue from CERs. It includes not only the cash input from power or gas generation but also the revenue from CERs. It follows that the IRR without CER revenues is lower than the IRR with CER revenues. Because the IRR is based on assumptions regarding future cash inputs and outputs, it is necessary to perform a sensitivity analysis that confirms the credibility of the calculation.

The benchmark[24] applied to CDM projects must "… present standard returns in the market, considering the specific risk of the project type, but not linked to the subjective profitable expectation …"[25]. It is usually based on government bond rates adjusted based on a risk premium (Lee and Shrestha 2005). Depending on the project type, benchmarks are between 8% and 18%. In order to demonstrate investment additionality, the project developer must show that the IRR without CER revenue is below the benchmark, while the IRR including CER revenue is above the benchmark. This demonstrates that the proposed project is not financially and economically feasible, and hence, investment additionality is fulfilled. The interrelationship between the IRR, revenue from CERs, and the benchmark is shown in Figure 12.

Figure 12: Interrelationship between the IRR, revenue from CERs, and the benchmark



Source: adopted and modified from He and Morse (2010)

There are several advantages to the IRR method. First, it is a financial indicator that is used globally and can be interpreted intuitively. Second, it serves as a basis for comparing different projects and explaining or justifying investment decisions (Megginson and Smart 2009).

Table 1 provides an example of the results published in the PDD. In this case, the project is not financially feasible since the IRR excluding income from CERs (6.95%) is below the benchmark of 8%. By contrast, the IRR including CER revenues is 10.09% and exceeds the benchmark.

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[24] Usually, the expression ‚benchmark' is used in context of the CDM. This is equivalent to hurdle rate.

[25] EB 16 Report Annex I (UNFCCC 2004).

Therefore, the revenue from CERs is necessary for the project to be financially and economically feasible, and hence, for investment additionality to be fulfilled.

Table 1: Example of the IRR (project number 3107)

Project IRR without CER income	Project IRR with CER income	Benchmark
6.95%	10.09%	8%

Source: UNFCCC (2011f)

At first glance, assessing investment additionality seems fairly straight forward. However, economic activities also involve non-monetary parameters that are difficult to observe and quantify. For instance, the investments additionality tool does not have the capacity to consider many of the risks and challenges project developers face. Depending on the specific situation and the risk taking behavior of the project developer, the level of risk aversion differs among project developers. Even if, in theory, risk aversion can be quantified by probabilistic evaluation, in reality, this quantification is constrained by time and financial resources (Greiner and Michaelowa 2003).

There are also additional drawbacks. Businesses criticize this methodology because it requires the disclosure of highly confidential business data. This highlights the tensions that can arise between the need for transparency[26] and industry concerns regarding confidential information In addition, academia points out the underlying paradox of the investment additionality – the tradeoff within the CDM between environmental integrity and cost-effective emission reductions (Greiner and Michaelowa 2003). Grubb *et al.* (2011: 558) describe this paradox as: "... the more cost-effective the project, the more uncertain the additionality". That is, if a project only requires a small additional benefit in the form of CER revenues in order to become financially feasible, a slight change in economic conditions such as higher electricity prices would have the same effect as the CERs. But since the project is now feasibile as a result of economic conditions, the project would not be considered additional.

A critical element in determining investment additionality is setting the benchmark. The level of influence exerted by decision makers on the benchmark setting process cannot be ignored. For fully-market oriented sectors, benchmarks are based on profitability considerations. However, in China, for instance, many sectors and consequently market power within those sectors, are influenced by central government policy. According to He and Morse (2010) a benchmark of 8% for

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[26] All documents including PDDs and monitoring reports are available on the website of the UNFCCC.

wind power projects, set by the State Power Company in 2002, is both arbitrary and antiquated. They claim that the benchmark of 8% does not reflect current market conditions and, since the power sector in China is dominated by state owned enterprises, the benchmark may not be reliable. Therefore, whether assessing investment additionality based on the IRR-benchmark comparison is appropriate tool questionable.

In summary, investment additionality and its components reveal several drawbacks. Nevertheless, it is the most objective and the only quantitative test available to assess additionality (Au Yong 2009). Therefore, there is good reason to analyze it in more detail in the empirical part of this thesis.

3.4 LITERATURE AND STUDIES ON ADDITIONALITY

This section of the Master's thesis provides an overview of the current literature and studies that analyze additionality in the context of the CDM. By focusing on studies related to investment additionality, the aim of this section is to present different findings and approaches that provides additional context to the empirical section of this thesis.

Studies have been completed by Michaelowa and Purohit (2007), Sutter and Parreño (2007), Zhang and Wang (2011) and Au Yong (2009), to name a few. Michaelowa and Purohit use a qualitative approach and analyze 19 PDDs from Indian CDM projects registered in 2006. The criteria used for the evaluation include the use of independent resources in the barrier analysis, types of barriers listed, accuracy of the common practice analyses, completeness of the information provided and assessment of additionality tests on behalf of the DOE (Michaelowa and Purohit 2007). The results show that around one-fifth of the projects are not considered to be additional. The primary reason for this result is that project developers do not provide sufficient or consistent information and argumentation Therefore, additionality cannot be proven. In addition, it was frequently the case that the DOE did not properly check the additionality argumentation given by project developers. In these cases the DOEs failed to do their job (Michaelowa and Purohit 2007). In addition, experiences in the past have shown that some investment additionality tests exhibit a lack of transparency in their calculations. In particular, investment costs, revenues and discount rates had not been clearly specified. To avoid this pitfall, the EB defined more detailed rules for investment analysis in 2008 (Michaelowa 2009).

The study by Michaelowa and Purohit (2007) indicate that the additionality proof reveals drawbacks. Nevertheless, it is worth noting that the projects evaluated in this study were registered in 2006. Since then, a lot of progress has been made. There are stricter guidelines regarding additionality and the DOEs have professionalized their work.

Although there do exist guidelines for demonstrating additionality, certain authors argue that the assessment and review process is still rather subjective. Vasa and Neuhoff (2011) compare various studies addressing this issue. They conclude that between one-fifth (Michaelowa and Purohit 2007) and two-thirds (Wara and Victor 2008) of CDM projects are not likely to be additional. Assuming these results are credible, they calculate that the use of CERs in the EU ETS between 2008 and 2009 led to an increase in net global GHG emissions (in CO_2eq) of 30-106 million tons (Vasa and Neuhoff 2011: 3). In addition they point out that CERs generated by false positives lead to falling carbon prices, and hence, diminish the incentive for domestic emission reduction measures in countries with emission targets.

Ellis *et al.* (2007) assess, among other things, the investment costs and revenue from CDM projects. They calculate the number of CERs generated annually per unit of investment in US$ for various projects. While N_2O- or HFC23 projects generate 0.5 - 0.99 CERs per US$ invested annually, renewable electricity generation has a much lower share of 0.002-0.004 CERs per US$ invested. This indicates that investments vary considerably between project types. They conclude that for many projects the revenue from CERs are 'the icing on the cake', and hence, the CDM plays a minor role in determining financial and economic feasibility. This argument has limitations, because the authors do not consider that project developers may also face other challenges such as technological or political barriers.

An additional study was completed by Zhang and Wang (2011). They evaluate additionality and co-benefits, i.e. sulfur dioxide emission reduction (SO_2), of Chinese CDM projects simultaneously. This is one of the rare examples where an econometric approach is used. Since GHG emissions are not reported at the Chinese sub-national level, they use SO_2 emissions as an indicator of GHG emissions. The logic underlying this methodology is, if renewable energy projects under the CDM replace fossil-fuel power generation, both GHG and SO_2 emissions will decrease. Therefore, additionality can be evaluated indirectly. According to the results, the CDM does not have a statistically significant effect on SO_2 emissions. Therefore, the authors conclude, that the additionality of CDM projects is questionable.

Sutter and Parreño (2007) evaluate the relationship between additionality and the sustainable development of CDM projects. They analyze 16 registered CDM projects covering different host countries[27]. Sutter and Parreño use the ΔIRR (= IRR including CER revenues – IRR excluding CER

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[27] Included host countries: Brazil, Republic of Honduras, India, China, Republic of Korea, Kingdom of Bhutan, Bolivia and South Africa Sutter and Parreño (2007: 82 f).

revenues) for evaluating the additionality of the projects. They state that, if CER revenues make a significant contribution to economic feasibility, the ΔIRR should give a relatively high value, and therefore, it is very likely that the project is additional.

The project specific ΔIRRs are rated according to three scales defined by the authors and then included in the MATA-CDM model[28]. They conclude that 11 out of 16 projects are very unlikely to be additional. This result is in consistent with the findings of the studies discussed above.

The investment analysis is considered to be the most objective and the only quantitative test among the different steps of the additionality assessment. Au Yong (2009) provides an analysis of the IRR based on a sample of 222 registered CDM projects in Brazil, China, India, Mexico and Malaysia including several project types. Similar to Sutter and Parreño (2007), Au Yong uses the ΔIRR as an indicator for investment additionality. The study assumes that the higher the difference is, the more additional a project is. This assumption is supported by Sutter and Parreño who have the same interpretation of the ΔIRR. Furthermore, Au Yong defines a threshold of 2% for the ΔIRR. The study concludes that projects with a ΔIRR below 2% are unlikely to be additional since CER revenues do not make a substantial contribution to financial and economic feasibility.

Au Yong uses the One-way Analysis of Variance (ANOVA) for the analysis. The results show that landfill gas projects exhibit the highest median ΔIRR of 19.4. There are two explanations for this result. First, methane has a high global warming potential, hence, a large amount of CERs can be generated. Second, landfill gas projects do not generate any revenues except from CERs. Therefore, it is reasonable that the CDM is the decisive factor for participating in the mechanism. By contrast, hydro (2.2%) and wind (2.2%) projects have the lowest ΔIRR. Based on the arguments made by Au Yong, landfill gas projects are more additional than hydro- and wind projects. Overall, 26% of the projects feature a ΔIRR below 2%.

After discussing the theoretical background to the concept of additionality and the current literature on the subject, the implications for the empirical part of this master thesis are extracted. The literature review has shown that the additionality tool needs to be improved. This is particularly true for the investment additionality test. This was also acknowledged at COP 17 in Durban in 2011, where it was emphasized that additionality guidance and standardized baselines need further refinement (IISD 2011). Modification and improvements may enhance the credibility of the additionality test which in turn can support the CDM in its uncertain future.

The review of current literature shows that the proof of additionality presented by project developers can be evaluated in two different ways, by using a qualitative approach as Michaelowa and Purohit (2007) do, or, by using a quantitative approach as Zhang and Wang (2011), and Au

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[28] The Multi-Attributive Assessment of CDM, introduced by Sutter, is a model to evaluate sustainable development contribution of CDM projects Sutter and Parreño (2007).

Yong (2009) do. The qualitative approach has the advantage that project specific challenges and problems can be taken into consideration. This includes determinants such as technological or political barriers which cannot be measured in quantitative terms. The drawback is that this method requires considerable knowledge of the technological, political and economic conditions in the particular region. Furthermore, assessments of 'soft' factors may be influenced by subjective opinion.

The quantitative approach has the advantage that objective determinants, i.e. financial indicators, can be used. One approach is to use the ΔIRR as Au Yong, and Sutter and Parreño do. A second approach is to use SO_2 as a proxy variable for GHG emissions. However, it is difficult to gather this data since access to reliable Chinese databases is restricted. By contrast, information about project specific IRRs are easily accessible on the website of the UNFCCC where the PDDs are published. This is one reason why the empirical part of this thesis follows this approach. More importantly, using the ΔIRR could contribute substantially to the improvement of the investment additionality test since it can be applied independently from the benchmark. However, currently, knowledge about the ΔIRR and its determinants is lacking. Therefore, an econometric analysis of the determinants of the ΔIRR can substantially contribute to the understanding of this financial indicator.

4 EMPIRICAL ANALYSIS OF THE Δ IRR OF SWISS-CHINESE CDM PROJECTS

This section is divided into three parts: sub-section 4.1 describes the data used, provides descriptive statistics and analyses the features of Swiss-Chinese CDM projects. The second subsection includes the econometric model and the hypotheses, and the third subsection presents the results of the analysis.

4.1 DATA

Based on the previous discussion, the determinants of Δ IRR *(delta_irr)* are identified. The following parameters of input and output cash flows are included as independent variables; annual revenue from CERs *(annual_reduction)*, annual revenue from gas/power generation *(annual_revenues)*, investment *(investment)* and annual operation and maintenance costs *(annual_o_m),* all values are given in millions of US dollars. Results presented by Au Yong (2009) show considerable project-related differences with respect to the Δ IRR. Therefore, the project type *(type)* is included as an independent variable. Project types are highly dependent on regional characteristics such as topography, political circumstances and the availability of technology. In order to control for these impacts, the province *(province)* that the project is implemented in is included as a control variable. Obviously, the province variable is not likely to control for each aspect mentioned. Nevertheless, it is assumed to reflect at least the province specific political circumstances.

Ellis *et al.* (2007) show that the efficiency of investment with respect to annual GHG reductions and capacity (kW) installed varies significantly between CDM projects. However, there is little experience with how these parameters affect Δ IRR. Therefore, investments per tCO_2eq reduction *(investment_co2)* and investment per kW installed in US$ *(investment_kw)* are considered, both values are given in US dollars.

There are two main sources for the data. First, the PDDs published on the website of the UNFCCC[29], second, the 'CDM/JI Pipeline Analysis and Database' published by the UNEP Risoe Centre[30]. According to the UNFCCC, 310 Swiss-Chinese projects were registered between December 2005 and July 2011. The majority of the variables originate from the UNEP Risoe Centre (2011). These are, investment in millions of US dollars[31], annual operation and maintenance costs in mil-

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[29] http://cdm.unfccc.int/Projects/projsearch.html

[30] http://cdmpipeline.org/index.htm unfccc.int/Projects/projsearch

[31] In PDDs the parameters are usually expressed in Chinese Yuan. Nevertheless, the UNEP Risoe pipeline provides all data converted into US$.

lions of US dollars, investment in $US per tCO_2eq abatement, investment in $US per kW, project type, and province of implementation. The annual reductions in $ktCO_2eq$ are also taken from the UNEP Risoe Centre. This variable will be used as a proxy for annual revenues from CERs. This method is defensible because annual revenues from CERs are proportional to annual emission reductions. The CER price can be ignored because project developers calculate input cash flows of CERs by using carbon prices that vary only slightly between 8-10 $US per CER.

Both the Δ IRR and annual revenues from power gas/generation are not directly available and must be calculated using key figures published in the PDDs. Δ IRR is calculated by taking the IRR including the income from CERs minus the IRR not including the income of CERs. Some PDDs contain inconsistent information regarding the IRR. This is especially true for projects in the early stages of development. In order to get the essential information, the Excel files containing detailed calculations attached to the PDDs were analyzed. 47 projects were excluded from the analysis because the Δ IRRs could not be determined for these projects. There are two main reasons for this. First, some project types, such as HFC23 projects, are not required to calculate their IRRs. They are considered to be additional in terms of investment anyway since they do not generate any revenue apart from the income from the CERs. Second, some project developers perform a barrier analysis instead of an investment analysis. Finally, there are a few projects for which comprehensive information is not available, neither in the PDD nor in the attached Excel file. Consequently, these projects are not considered in the empirical analysis.

The final step is to calculate annual revenues from production. The most common income source is the generation of power which is then delivered to the grid. Some projects also produce gas or heat. The PDDs contain the expected annual production from power[32], gas[33] or heat[34] and corresponding expected prices. Particular attention is required, since project developers make calculations using different prices[35]. In addition, the value added tax (VAT) is not included in a consistent manner.. Some project developers list the expected price including VAT, while others list it excluding VAT. For the purpose of this thesis, the prices excluding VAT are considered. As for the IRR, some PDDs do not provide comprehensive and reliable information on the annual production of power, gas, and heat and corresponding prices. These projects are excluded from the empirical analysis.

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[32] Expressed in MWh

[33] Expressed in m3

[34] Expressed in GJ

[35] Prices on the electricity market considerably vary depending on the source (wind, hydro, landfill, etc) and the grid provider (purchaser).

Table 2 defines the variables and presents the descriptive statistics. It shows the minimum and maximum values, which demonstrate considerable differences. Therefore, the data set is validated regarding potential outliers that could trigger a bias. The results show that these values are correct and, hence, are not excluded from the analysis. The data set includes one project with zero revenue. This is a landfill gas project that does not generate any revenue from power/gas production. The results show that all variables have a high standard deviation, indicating that values are not likely to follow a normal distribution. Comparing the mean values with the minimum and maximum values show that all variables are right-skewed. There are differences regarding the number of observations due to either missing values in the data provided by the UNEP Risoe Centre or ambiguous and inconsistent information in the PDD which are treated as missing values.

Table 2: Definition of the independent variables and descriptive statistics

	Definition	**Mean**	**Standard deviation**	**Min**	**Max**	**N**
annual_reduction	Annual reduction in $ktCO_2eq$; proxy for CER revenue	169.9	255.76	10	2136	263
annual_revenue	Annual revenue from power/gas production in million US$	9.64	16.15	0	135.73	261
investment	Project investment in million US$	57.13	67.67	1.70	408.70	259
annual_o_m	Annual operation and maintenance costs in million US$	3.37	8.56	0.40	107.02	228
investments_co2	Investment per tCO_2 emission reduction in US$	381.10	222.97	14.20	1424.70	259
investment_kw	Investment per kW installed in US$	1188.25	484.37	208.80	5787.30	256

The project type *(types)* and the province where the project is implemented *(province)* are expressed as dummy variables. The dataset includes 12 different project types[36] and 28 different provinces[37]. Building on this, 12 dummy variables are generated for *types* and 28 for *province.*

As mentioned above the descriptive statistics indicate that the variables are right-skewed. Several tests performed with STATA confirm these findings. In order to get a less skewed distribution

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[36] Wind, hydro, biomass, coal bed/mine methane, EE own generation, fossil fuel switch, HFC23, landfill gas, methane avoidance, N_2O, solar, and transport.

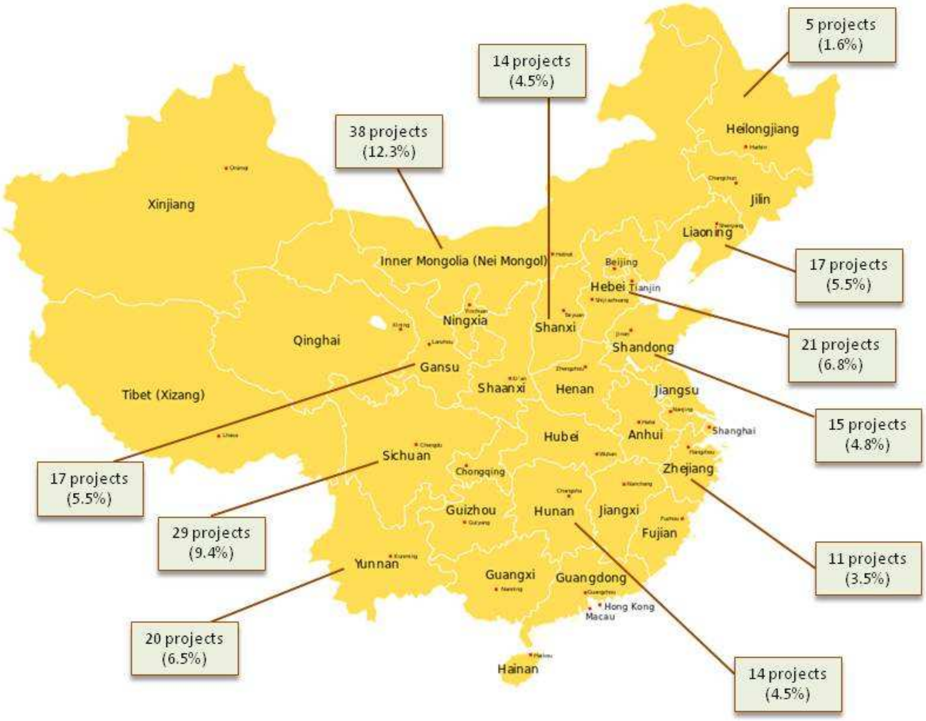
[37] Inner Mongolia, Sichuan, Hebei, Yunnan, Gansu, Liaoning, Shandong, Hunan, Shanxi, Zhejiang, Guangdong, Henan, Jilin, Anhui, Jiangsu, Ningxia, Hubei, Xinjiang, Guizhou, Chongqing, Fujian, Heilongjiang, Jianxi, Shaanxi, Beijing, Qinghai, Guangxi, and Hainan.

and to avoid biased results caused by very small or high values, logarithmic values can be employed (Kohler and Kreuter 2008). Therefore, the logarithmic functions are calculated for each continuous variable.

4.1.2 SWISS-CHINESE CDM PROJECTS

The analysis now considers the features of Swiss-Chinese collaboration under the CDM. Figure 13 shows the regional distribution of the 310 Swiss-Chinese CDM projects. For the sake of readability only the 10 most common provinces for CDM projects are listed[38]. The map below shows that the most common province for Swiss-Chinese project activities is Inner Mongolia, with 38 projects, equal to a share of around 12% of all projects. Inner Mongolia is followed by Sichuan with 29 projects (9.4%), Hebei with 21 projects (6.8%) and Yunnan with 20 projects (6.5%). The remaining provinces have a share that is equal or lower than 5.5%. It is not unusual for investors from different Annex I countries to jointly participate in a CDM project. Therefore, the expression 'Swiss-Chinese' is used to indicate that at least one Swiss actor is involved in the project activity.

Figure 13: Regional distribution of Swiss-Chinese CDM projects



Source: Map: (Wikipedia 2011); Numbers: calculation according to dataset.

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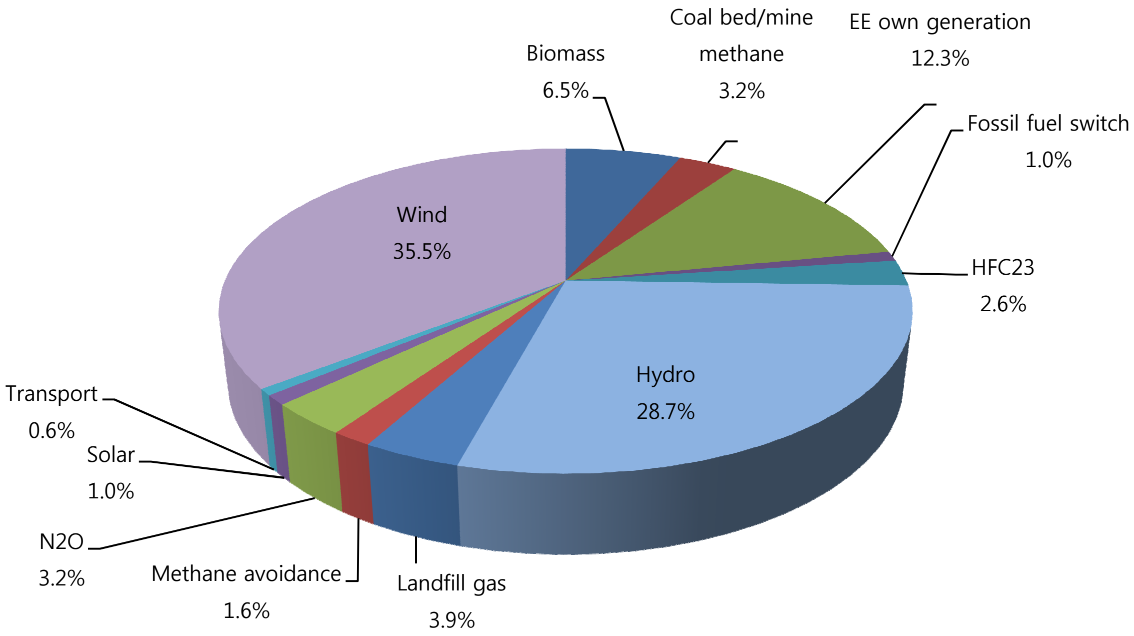
[38] The complete list is attached in the appendix.

The next element considered is the project type. This is of interest since studies have shown that the Δ IRR is affected by project type (Au Yong 2009). Figure 14 illustrates the distribution of project types[39]. The two most common project types, which are wind and hydro power projects, make up the majority of projects, over 60%. A significant number of projects presented in Figure 14 can be assigned to activities in the energy sector. In other words, Swiss actors predominantly invest in projects where emission intensive power production is replaced by wind or hydro power production.

Figure 14: Share of project types among Swiss-Chinese CDM projects



Source: calculation according to dataset.

Table 3 provides an overview of project types and corresponding values of the mean Δ IRR. The figures show that wind projects have a mean Δ IRR of 2.78% and hydro projects of 3.69%, which are relatively small differences. This is consistent with the findings of Au Yong (2009) who also concludes that wind and water projects have the lowest values. However, results from this study show a smaller Δ IRR of 2.2% for both types. This suggests that CER revenues make a relatively small contribution to the financial and economic feasibility of these projects. Hence, it's possible

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[39] Note that a detailed description of the different project types is provided on the website of the UNEP Risoe: http://cdmpipeline.org/index.htm

that wind and hydro projects should not be included in the CDM program since slight changes in economic conditions can make such projects profitable.

Table 3: Project type and mean ΔIRR

Project Type	Mean ΔIRR	Project Type	Mean ΔIRR
Coal bed/mine methane	30.48	Hydro	3.69
Landfill gas	27.15	Wind	2.78
Methane avoidance	13.61	Solar	not available
Biomass energy	6.80	Transport	not available
EE own generation	5.74	HFC23	not available
Fossil fuel switch	3.86	Nitric Acid	not available

Source: calculation according to dataset.

The highest mean values come from coal bed and coal mine methane projects and landfill gas projects. There are several reasons for the high ΔIRRs of these project types. While the cost of generating power from coal mine /coal bed methane is relatively low, China lacks technical knowledge in this particular field. Hence, maintenance costs are relatively high and performance relatively low (IEA 2009: 20). Therefore, it is reasonable that CER revenues make a significant contribution to the profitability of coal mine/ coal bed methane projects. A similar explanation may be given for landfill gas projects. Since the revenue from power generation is insufficient to cover the project investment and operating costs, there is no incentive for the operator of a landfill to capture emissions. The revenue from CERs is likely to make such a project profitable and therefore increase the ΔIRR (UNFCCC 2011f)[40].

Since the dataset includes relatively few coal mine/ coal bed methane (10 projects) and landfill gas projects (12 projects) the figures listed in the table below must be treated with caution. Nevertheless, the mean ΔIRRs give an indication of which projects are more likely to be additional. The calculation of Δ IRRs shows that there are two projects that reveal relatively high values. First, project number 1664 (Δ IRR = 82.80%), and second, project number 3219 (Δ IRR = 74.5%). After checking the calculations in the PDDs, it is assumed that these values are correct, and therefore, are not treated as outliers.

Figure 15 enumerates the Swiss actors that are involved in CDM activities in China[41.] The most relevant seven actors are companies that operate globally, with branches in Switzerland. These

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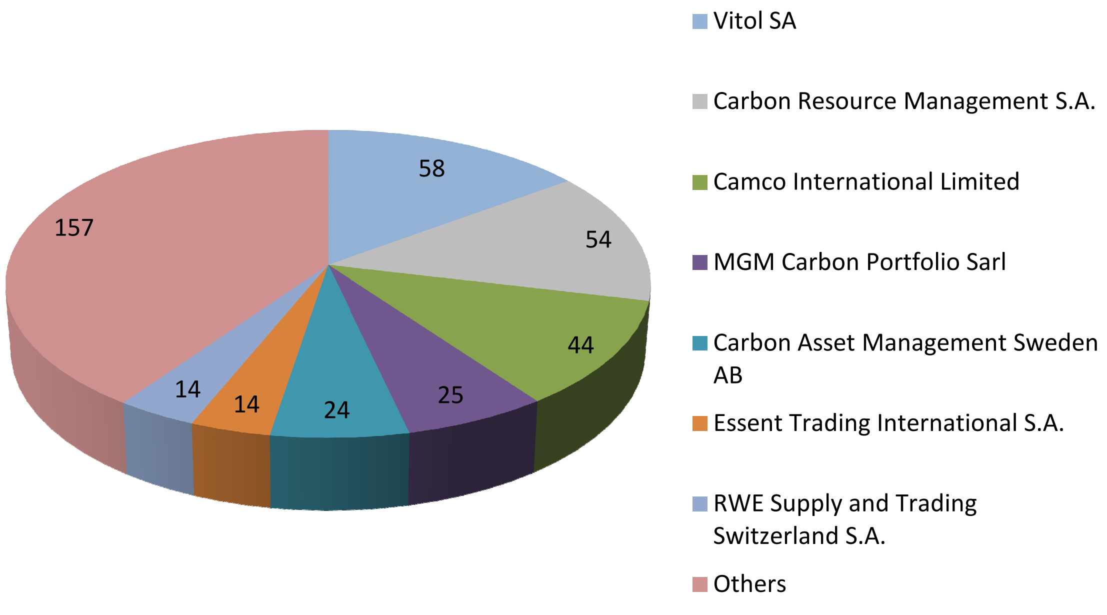
[40] See PDDs of the following projects published on the UNFCCC website: 2892, 1906, 4668, and 4610.

[41] A complete list of Swiss actors is attached in the appendix.

companies are involved in over 150 CDM projects, which have led to a reduction of around 48,000 $ktCO_2eq$ annually. Vitol S.A. is involved in 58 projects, which reduce 10,850 $ktCO_2eq$ annually. The majority of these projects are hydropower projects, specifically, run of river projects. As a worldwide energy trading company, Vitol has one of the largest carbon project portfolios and is a leader in the carbon market. Resource Management S.A. participates in 54 projects (reduction of 7,486 $ktCO_2eq$ annually). After being taken over by Vitol S.A. in January 2011, it is now a division of Vitol S.A.. Carbon Resource Management S.A. is a leader in carbon asset development and monetization and helps companies looking to partner up in this field (Vitol 2011). Camco International Ltd. is involved in 44 CDM projects which contribute 16,800 $ktCO_2eq$ annually to global reductions in GHGs. The company provides clients with expertise regarding the development of greenhouse gas emission reduction projects (Camco 2011). Camco International Ltd. is followed by MGM Carbon Portfolio (25 projects/annual reduction of 2,116 $ktCO_2eq$), Carbon Asset Management Sweden AB (24 projects/annual reduction of 4,482 $ktCO_2eq$), Essent Trading International S.A. (14 projects/annual reduction 4,828 $ktCO_2eq$), and RWE Supply and Trading Switzerland S.A. (14 projects/annual reduction 1,439 $ktCO_2eq$). Summing up, the majority of Swiss actors are active international energy traders with a branch of their business specializing in carbon trading and developing GHG emission reduction projects.

Figure 15: Swiss actors and number of CDM projects



Source: calculation according to dataset.

The category 'Others' includes all remaining Swiss actors participating in less than 10 projects. The most well known actor in this category is the Climate Cent Foundation. Established by Swiss industry, it is part of a voluntary initiative whose goal is to reduce greenhouse gas emissions. It is funded by a charge of 1.5 Swiss cents levied on all imports of diesel and petrol into Switzerland. The foundation is required to reduce 17 million tones of CO_2 between 2008 and 2012, 15 million tons of which should take place in foreign countries (Climate Cent Foundation 2011). According to the data, the Climate Cent Foundation supports three CDM projects in China, including two hydropower projects and one biomass energy project, that reduce 117 $ktCO_2eq$ annually.

As mentioned above there exist many projects where more than one investor party is involved. The CER share held by the corresponding party may change over time because new investment partners enter while others withdraw from the project. In this context it would be interesting to learn more about the shares of CERs each party owns. However, according to the Swiss Emissions Trading Registry[42], there exist no such statistics. The accumulated annual transactions to and from Switzerland are the only information available from the Swiss Emissions Trading Registry (Table 4).

Table 4: National and international transfers of CERs

Year	Domestic transfers	International transfers (outgoing)	International transfers (incoming)
2008	50,624,737	98,014,551	114,876,319
2009	123,955,018	128,708,146	124,202,707
2010	43,483,900	91,150,815	89,478,872
2011	21,158,490	78,903,838	87,858,470

Source: Emission Trading Registry (2012)

'Domestic transfers' represent the transfers of CERs within the Swiss Emission Trading Registry. 'International transfers outgoing' are the CERs transferred from the Swiss Emission Trading Registry to accounts in foreign countries while 'international transfers incoming' are the CERs that are transferred to the Swiss Registry. This also includes entries from the primary market, hence, direct transfers between project developers and investors. The large amount of incoming and outgoing transfers reflects the fact that Swiss-Chinese collaboration is dominated by carbon trading companies.

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[42] Information via email from National Registry October 10, 2011. -

4.2 ECONOMETRIC MODEL AND HYPOTHESES

The econometric analysis is used to estimate the effects of the variables introduced in section 4.1 on the Δ IRR. There are two underlying methods that are applied in this master's thesis, a multiple linear regression, and, a logistic regression analysis. The multiple regression model can be expressed as (Wooldridge 2003)

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_k x_k + u \tag{1}$$

where y is the dependent variable. There are k independent variables x with coefficient β_k, and error term u. Accordingly, Model I is defined as

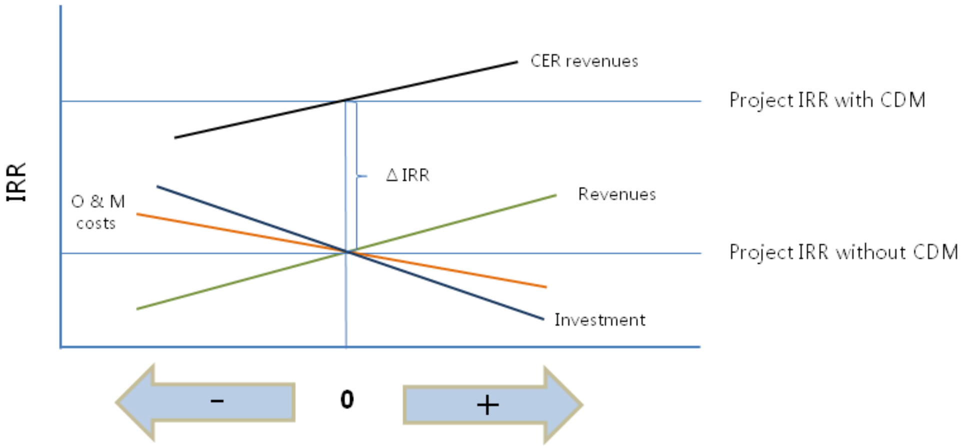
$$\begin{aligned} logdelta\_irr = {} & \beta_0 + \beta_1 logannual\_reduction + \beta_2 logannual\_revenue + \beta_3 loginvestment + \\ & \beta_4 logannual\_o\_m + \beta_5 loginvestment\_co2 + \beta_6 loginvestment\_kw + \beta_j type_j + \\ & \beta_k province_k + u \end{aligned}$$

where β_j is the coefficient of the dummy variable of project type *j* and β_k is the coefficient of the dummy variable of *province k.*

Figure 16 illustrates the expected effects of *logannual_reduction, logannual_revenue, loginvestment* and *logannual_o_m* on *logdelta_irr*. According to the logic of the IRR calculation, an increase in emission reductions is expected to lead to higher CER revenues which in turn leads to increases in the Δ IRR. Hence, it is assumed that *logannual_reduction* (the proxy for income from CER revenue) has a significant positive impact on *logdelta_irr* (H1). By contrast, annual revenue generated by power, heat, and gas production (*logannual_revenue*) are likely to have a significant negative impact on *logdelta_irr* (H2), since cash inflow increases, which enhances the probability that projects will be financial feasible. The variables that reflects cash outflows, i.e. the project's investment (*loginvestment*) and the annual operation and maintenance costs (*logannual_o_m*), are both assumed to have a significant, positive impact on *logdelta_irr* (H3 and H4).

The determinants *investment_co2* and *investment_kw*, which are not included in the investment analysis, are expected to positively affect *logdelta_irr* (H5 and H6). The rationale behind this assumption is that projects that have low investment efficiency (high investment-CO2 or investment-kW ratios) have relatively high cash out flows compared to projects with higher efficiency.

Figure 16: Illustration of expected effects on *logdelta_irr*



Source: author's graphic based on sensitivity analysis as presented in the PDDs (UNFCCC 2011f)

Project types (*type*) are included as dummy variables. Depending on the project type there may be significant positive as well as significant negative effects. According to Au Yong (2009) and the authors own calculations, wind and hydro projects are likely to have a negative impact on the Δ IRR because of their relatively low mean Δ IRR. By contrast, landfill and coal bed /coal mine methane projects usually have a high mean Δ IRR. Therefore, these project types are expected to positively affect Δ IRR. The expected impacts are summarized in Table 5.

Table 5: Expected impacts on Δ IRR and hypotheses

Independent variable	Expected impact on Δ IRR *(logdelta_irr)*	
logannual_reduction	+	(H1)
logannual_revenue	-	(H2)
loginvestment	+	(H3)
logannual_o_m	+	(H4)
loginvestment_co2	+	(H5)
loginvestment_kw	+	(H6)

In order to estimate Model I, introduced above, an OLS regression is performed in section 4.3. As mentioned above, there are two questions that are the focus of this Master's thesis. On the one hand, there is considerable interest in evaluating whether the determinants used to perform the investment additionality test are appropriate to calculate the Δ IRR of Swiss-Chinese CDM projects.

The information gathered through this analysis may serve as a basis for developing an alternative tool under the umbrella of the investment analysis. On the other hand, it is of interest to delve further into the pattern of Swiss-Chinese CDM activities.

In addition to Model I, a logistic model, containing four sub-models is introduced. The aim of this model is to demonstrate that the findings of Model I are robust enough to hold for a variety of thresholds defined for the Δ IRR. This consideration is based on the study by Au Yong (2009) who suggests that a threshold for the Δ IRR to be defined – i.e. CDM projects demonstrating a Δ IRR above this threshold are expected to be additional in terms of investments and vice versa. The equation is expressed as (Kohler and Kreuter 2008)

$$P(Y=1)=\frac{e^{L}}{1+e^{L}} \tag{2}$$

where $e \approx$ 2,718. and

$$L=\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots+\beta_k x_k+u \tag{3}$$

For the logistic regression the equation is defined as

$$P(\log delta\_irr=1)=\frac{e^{L}}{1+e^{L}}$$

with

$$\begin{aligned}L=\beta_0+\beta_1 logannual\_reduction+\beta_2 logannual\_revenues+\beta_3 loginvestment+\\ \beta_4 logannual\_o\_m+\beta_5 loginvestment\_co2+\beta_6 loginvestment\_kw\ +\beta_j type_j+\\ \beta_k province_k+u\end{aligned}$$

There are no details on the manner in which the thresholds for *logdelta_irr* are selected in order to divide the sample into additional and non-additional projects in the literature or in economic theory. Au Yong (2009), for instance, suggests a threshold of 2% for the Δ IRR. However, this choice is not justified by the author and not proven by theory. Due to a lack of information, those thresholds that reflect the critical values as closely as possible are chosen. The selected thresholds for *logdelta_irr* are: 2%, 2.5%, 3% and 5%. The models are defined and summarized in Table 6.

Table 6: Models for the logistic regression

	$logdelta\_irr_i$ = 0 if	$logdelta\_irr_i$ = 1 if
Model II	$L_i \geq 2\%$	$L_i < 2\%$
Model III	$L_i \geq 2.5\%$	$L_i < 2.5\%$
Model IV	$L_i \geq 3\%$	$L_i < 3\%$
Model V	$L_i \geq 5\%$	$L_i < 5\%$

According to Table 6 *logdelta_irr* is encoded with 1 if the Δ IRR is below 2% and 0 otherwise. This is done for the benchmarks of 2.5%, 3% and 5%.

4.3 RESULTS

This sub-section presents the results of the empirical analysis. The first part presents the results of the multiple regression (Model I), and the second part the results of the logistic regressions (Models II-V). The analyses are performed with STATA.

The first column in Table 7 presents the results of Model I. The reference variables are *wind* for the project type and *inner mongolia* for the province the project was implemented in. The command *stepwise* at p-level 0.2 is included for clarity. Therefore, STATA automatically omits all variables having a p-value higher than 0.2. The Breusch-Pagan/Cook-Weisberg test and the residual-versus-fitted-plot both control for homoskedasticity, they indicate that the pattern of the residual differs slightly from the assumption of homoskedasticity. This pattern does not invalidate the regression analysis, however, it may weaken the validity of the results. Therefore, the analysis is performed with robust variance estimators (Kohler and Kreuter 2008; Wooldridge 2003).

The number of observations N is 222. The results show that three out of four variables relevant to the investment analysis do not have a significant effect on the Δ IRR of Swiss-Chinese CDM projects. These variables are: investment (*loginvestment)*, annual operation and maintenance costs *(logannual_o_m)* and revenues from CERs *(logannual_reduction).* By contrast, annual revenues of power/gas generation *(logannual_revenues)* have a significant negative effect on *logdelta_irr* ($\alpha = 5\%$). Hence, a 1% increase in annual revenues decreases *logdelta_irr* by 0.18%. Furthermore, the results show that both *loginvestment_kw* and *loginvestment_co2* have a significant impact at level $\alpha = 1\%$. As expected *loginvestment_kw* has a significant positive impact on *logdelta_irr.* If this determinant increases by 1%, *logdelta_irr* increases by 0.28%. The coefficient of *loginvestment_co2* has a minus sign and is therefore inconsistent with expectations. The cause of this result could be the curvilinear relationship between the independent and dependent variables. In order to verify this assumption, a slightly adopted Model I, including square functions of *loginvestment_co2* and *loginvestment_kw,* is estimated. The results provide evidence for the curvilinear relationship. While *loginvestment_kw* reveals a concave curve, *loginvestment_co2* has a convex curve.

Table 7: Results of Models I – V

logdelta_irr	(1) Model_I	(2) Model_II	(3) Model_III	(4) Model_IV	(5) Model_V
logannual_revenues	-0.180*	3.657*	4.644***	4.662***	6.824*
	(0.035)	(0.011)	(0.000)	(0.000)	(0.023)
loginvestment	0.115	-4.695**	-5.637***		1.891**
	(0.153)	(0.003)	(0.000)		(0.004)
logannual_reduction		1.742*	1.378	-4.889***	-9.254**
		(0.042)	(0.055)	(0.000)	(0.005)
logannual_o_m				0.811	1.033*
				(0.063)	(0.018)
loginvestment_co2	-0.654***	4.647**	5.361***		-3.354
	(0.000)	(0.002)	(0.000)		(0.091)
loginvestment_kw	0.284**				2.925
	(0.003)				(0.073)
fossil_fuel	0.771***				
	(0.000)				
biomass	0.651***				
	(0.000)				
EE				-3.490***	-19.95***
				(0.000)	(0.000)
coalmine	0.221				
	(0.153)				
landfill	0.386				
	(0.083)				
hydro	-0.320***	1.936*	2.324**	1.962*	-11.22***
	(0.000)	(0.032)	(0.002)	(0.013)	(0.000)
anhui	-0.145*				
	(0.044)				
beijing	-0.331				
	(0.102)				
gansu	0.135				
	(0.053)				
ningxia	-0.175*				
	(0.045)				
guizhou	0.133				
	(0.176)				
hainan	-0.300***				
	(0.000)				
shaanxi	0.329*				
	(0.022)				
shanxi	0.518**				
	(0.002)				
yunnan	0.130				
	(0.099)				
sichuan	0.177				
	(0.055)				
constant	3.038***	-28.18***	-92.43***	13.75***	40.93**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
N	222	188	189	188	188
r2	0.821				

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

The results for the dummy variables indicate that fossil fuel and biomass projects have a significant positive impact on *logdelta_irr* compared to the reference category *wind*. As expected, hydro projects have a significant negative impact. These findings are similar to those listed in Table 3. Since a higher Δ IRR implies a higher probability that the project will be additional, fossil fuel and biomass projects are more likely to be additional than hydro projects. In order to demonstrate the quality of the model specification, a Ramsey RESET test is performed. According to the p-value (0.2117) the null hypothesis cannot be rejected, and therefore, the model is assumed to have no omitted variables.

The analysis now turns to the logistic regressions of Models II – V. The goal of these analyses is to evaluate whether the results of Model I hold up under different thresholds for the Δ IRR. The analysis focuses specifically on the variable *annual_reduction* since it is a critical element in the investment analysis. For the purposes of the logistic regression analysis the dummy variables for *province* are excluded since the results of the first regressions have shown that including dummies does not lead to efficient estimations. The first logistic regression performed is Model II. This model has a threshold of 2%, i.e. *logdelta_irr* = 1 if L_i < 2%. A numerical example demonstrates the implications of this threshold. According to the data set 23 Swiss-Chinese CDM projects belong to this group of projects which feature a Δ IRR below 2%. They represent annual emission reductions of around 3800 ktCO_2eq which is around 9% of the total emission reductions achieved annually by all Swiss-Chinese CDM activities.

The results of the logistic regression of Model II (benchmark 2%) are presented in Table 7. Again, the reference variable is *wind.* The number of observations is 188 – this is lower than for Model I. The lower number of observations results from the inclusion of less dummy variables because estimability excludes the corresponding observations. As in Model I, both *loginvestment_co2* and *loginvestment* are highly significant at α-level of 1%. While increasing investments decrease the probability that a project has a *logdelta_irr* below 2%, increasing annual reductions has the opposite effect. Unlike the results of Model I, *logannual_reduction* and *logannual_revenues* show significant positive impacts (α = 5%). Therefore, an increase in annual revenues and annual reductions increases the probability that *logdetla_irr* is below 2%. Regarding annual revenues, the findings are consistent with the outcome of Model I. Note that the negative coefficient in Model I and positive coefficient in Model II do, in fact, have the same effect. The logistic regression indicates that a project with increasing annual revenues reveals an increasing probability that it will be assigned to the project-cluster with the lower Δ IRR which is < 2% than to the project-cluster with Δ IRR ≥ 2%. This is comparable to the negative impact on continuous *logdelta_irr* in Model I.

The marginal effects of *logannual_reduction* show that a marginal change from the mean of 4.6 increases the probability that a project has a *Δ IRR* below 2% by 0.8%. The positive relationship between annual emission reductions and the group of projects with Δ IRRs below 2% contradicts the theoretical assumptions, since it is expected that higher annual emission reductions lead to higher Δ IRRs. Another significant variable is *hydro.* The coefficient is positive, therefore *logdelta_irr* of hydro projects is more likely to be below 2% compared to other project types. This is consistent with the mean values of the Δ IRR presented Table 3 which implies that hydro power projects are likely to have a relatively low Δ IRR.

The results of Model III (benchmark 2.5%) presented in Table 7 show a slightly different pattern. *logannual_revenues, loginvestment* and *loginvestment_co2* have a significant impact on *logdelta_irr*. However, *logannual_reduction* does not have a significant effect on *logdelta_irr*. The marginal effects increase for all significant variables, indicating a stronger impact compared to the previous model. Again, there is a significant positive correlation between *hydro* and projects below the benchmark of 2.5%.

The trend that *logannual_revenue* is likely to have a significant impact on *logdelta_irr* is confirmed by the results of Model IV (benchmark 3%). The coefficient of *logannual_reduction* is now significant at α-level of 1% and has a positive sign. Therefore, the threshold where the coefficient changes from positive to negative must lie somewhere between the values of 2% and 3%. The marginal effect of *logannual_reduction* indicates that a marginal increase above the mean decreases the probability by 1.1% that *logdelta_irr* is below 3%. The results of the logistic regression also indicate that energy efficiency projects *(EE)* have a significant negative impact on the probability that the *Δ IRR* is below 3%.

The last logistic regression that is performed is the one for Model V. A numeric example demonstrates the effect of adapting the 5%-benchmark to Swiss-Chinese projects. According to the data, 194 projects have a Δ IRR below 5%. This is equal to an annual emissions reduction of 30400 ktCO2eq. As presented in Table 7, all crucial variables of the investment test have a significant effect at α-levels of 5% or lower. *loginvestment, logannual_o_m* and *logannual_revenues* are positively related to the probability that *logdelta_irr* is below 5%. As was the case in Model III, *logannual_reduction* has a negative impact on this probability. Regarding the project types, the results indicate that hydro and energy efficiency projects are less likely to have a *Δ IRR* below 5%. The marginal effect of the continuous variables considerably decreases in Model V. This can be explained by the strong effect of *EE*. Therefore, the interpretation of the marginal effects should be treated with caution.

In the next sub-section the extent to which these results help to understand the determinants of the Δ IRR of Swiss-Chinese CDM projects is discussed. In addition, the potential implications for the application of the Δ IRR within the investment analysis are identified.

4.4 DISCUSSION OF THE RESULTS

A comparison of the outcomes of all five models provides evidence that only one variable used in the investment analysis has a significant impact on the Δ IRR - the annual revenues from power/gas production. The significant negative impacts found in Model I are confirmed by the results of the logistic regressions, where increasing annual revenues lead to a higher probability that the project is assigned to the project-cluster with a lower Δ IRR. Based on this, H_2 cannot be rejected.

The annual reductions, which are a proxy for annual revenues from CERs, do not show the same pattern. While the findings of Models II, IV and V reveal a significant impact, this result was not confirmed by Models I and III. Therefore, no final conclusion can be drawn on H_1.This result is unexpected because according to the calculation of the Δ IRR (IRR *with revenues* from CERs minus IRR *without revenues* from CERs), it is obvious that the annual revenue from CERs (annual reductions) must make a difference. This raises some concerns. First, the conditions for investment additionality may not be fulfilled since for two models the annual reductions are not likely to substantially contribute to the explanation of the Δ IRR. Second, the Δ IRR can be criticized as an inappropriate reference to evaluate additionality. These considerations can be drawn on to analyze the determinants of the annual reductions in more detail. Therefore *logannual_reduction* is analyzed based on the independent variables defined in Model I. The reference variables are again *wind* and *inner mongolia.* As presented in Table 8, *loginvestment* has a significant impact (α = 1%) on *logannual_reduction*. Specifically, a 1% increase in investment increases annual reduction by 0.96%. In addition, the efficiency of investment with respect to CO_2 abatement (*loginvestment_co2*) is also significant (α = 1%). This result provides evidence that higher investment efficiency (ratio becomes lower) has a positive impact on annual emission reductions. Project types in the context of annual emission reductions do not seem to have a significant impact.

Running the same regression for the second income variable, which is annual revenues from gas/power generation, shows a different pattern. Several project types have a significant positive impact (α = 5) with respect to the reference type *wind*. The variables *hydro* and *coalmine* are exceptions as they are associated with a significant negative (α = 1%) effect. These occurrences reflect the relatively low income generated by hydro, and coal bed and coal mine methane projects, which receive lower feed-in tariffs compared to power from gas and other sources.

As for *logannual_reduction*, *loginvestment* has a significant positive impact on *logannual_revenues*. The value of the coefficient is only slightly lower. A 1% increase in investment leads to an increase in annual revenues of 0.94 %. In addition, the investment efficiency with respect to GHG abatement and capacity installed also has a significant positive effect. In summary, investments and investment efficiency positively affect the annual revenue from power/gas generation and annual reductions, i.e. revenue from CERs.

Table 8: Results of multiple linear regressions for annual reduction (*logannual_reduction)* and annual revenues *(logannual_revenues)*

	(1) logannual_reduction	(2) logannual_revenues
loginvestment	0.958***	0.993***
	(0.000)	(0.000)
loginvestment_kw	0.0420	-0.444***
	(0.165)	(0.000)
loginvestment_co2	-0.984***	-0.336***
	(0.000)	(0.000)
methane	-0.0803	
	(0.145)	
fossil_fuel	0.131	0.549***
	(0.130)	(0.000)
landfill		-0.405*
		(0.043)
coalmine		-0.319*
		(0.031)
hydro		-0.293***
		(0.000)
EE		0.330***
		(0.000)
hainan	-0.0571	0.265***
	(0.072)	(0.000)
anhui		0.297***
		(0.000)
shanxi		-0.179*
		(0.032)
fujian		0.189*
		(0.037)
guangdong		0.262***
		(0.000)
shandong		0.168*
		(0.018)
henan		0.207*
		(0.034)
hubei		0.194***
		(0.000)
hunan		0.190***
		(0.000)
jiangsu		0.203**
		(0.002)
jiangxi		0.145*
		(0.012)
zhejiang		0.213**
		(0.002)
liaoning		0.169***
		(0.000)
ningxia		0.110
		(0.064)
yunnan		-0.255
		(0.102)
biomass		0.676***
		(0.000)
constant	6.651***	3.200***
	(0.000)	(0.000)
N	223	222
F	.	.

p-values in parentheses
* p<0.05, ** p<0.01, *** p<0.001

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The last parameter used in the investment analysis is annual operation and maintenance costs. There is little statistical evidence that this variable is a critical determinant of Δ IRR since the results imply significant effects for Model V only. Therefore, no conclusion can be drawn on H_4.

The investment efficiency ratios with respect to CO_2eq emission reductions and kWs installed have a significant impact in Model I. However, Models II – V do not reflect this pattern for *loginvestment_kw.* By contrast, the *loginvestment_co2* has a significant positive effect (α = 5%) in Models II and III. These ambiguous results imply that H_5 and H_6 can neither be rejected nor confirmed.

Hydro projects are the only types of projects that have a significant impact on Δ IRR throughout. With the exception of the results in Model V, the outcomes are in accordance with the expectation that hydro projects are likely to have a negative impact on Δ IRR. However, these findings must be treated with caution since the hydro projects are overrepresented in the data set. Therefore, it may be that in reality other project types would also have a crucial impact, but due to the low number of observations, these impacts are not reflected in the analysis.

In summary, the results of the empirical analysis imply three key results. First, there is considerable evidence that annual revenues from gas/power generation are a crucial determinant of the Δ IRR of Swiss-Chinese CDM projects. Second, the outcome of annual reductions, investments and the investment/CO_2 ratio provides partial evidence for their impact. And third, it is unlikely that annual operation and maintenance costs and the investment/kW ratio do matter with respect to the Δ IRR of Swiss-Chinese CDM projects.

These findings also have implications for the further development of the investment additionality test. Several authors argue that the Δ IRR would be a more objective measure for investment additionality since it has the capacity to reflect the impacts of the revenues from CERs. However, the outcome of the empirical analysis suggests that this may not be the case. This in turn, raises concerns regarding compliance with additionality requirements. Of course, this analysis is limited to Swiss-Chinese projects only and in order to provide more comprehensive insights into the aspects of Δ IRR, it would be important to include more countries in the analysis. Moreover, it is not necessary to limit the evaluation to one specific investing country. There are also other determinants which have not been discussed in the framework of this master thesis. Therefore, further studies on this specific issue may incorporate additional factors in their econometric models. While chosen arbitrarily, the application of different benchmarks to the Δ IRR has revealed a crucial result; it is likely that determinants are highly sensitive to the application of different benchmarks. This has to be kept in mind in the case where the ΔIRR is considered as an alternative option to the contemporary investment analysis.

An aspect that cannot be ignored when using the Δ IRR is the fact that project developers calculate IRRs based on project specific financial indicators. This may result in an information bias. Taking into consideration that revenue from CERs may attract some project developers, even if their projects are non-additional, manipulation may not be far off. Consequently it is rather difficult to prove with certainty whether the IRRs published in the PDDs are true and reliable. Even if the accuracy of investment additionality is evaluated by DOEs, there remains an information bias. This may be a fairly pessimistic view and it is unlikely that a significant number of project developers have the intentions described above. Nevertheless, information bias and its consequences suggest that results, including financial indicators, must be treated with caution.

Furthermore, it is important to highlight that the findings of the empirical analysis are restricted to Swiss-Chinese CDM activities. This has the overwhelming advantage that the research question can be narrowed down to a specific issue. In addition, an analysis in this particular field is of great importance and interest since there are no comprehensive studies of Swiss-Chinese collaboration under the CDM. While the results have useful implications for the development of the investment analysis there exists the need for further development - not least because of the relatively low number of cases examined in this study (N=222).

5 CONCLUSION AND OUTLOOK

In this Master's thesis the importance of additionality under the umbrella of the CDM is elaborated. Of particular interest are Swiss-Chinese CDM projects, and the use of the Δ IRR as an alternative option to prove investment additionality. There exists no extensive literature on either Swiss-Chinese CDM projects or the Δ IRR. Therefore, this Master's thesis provides considerable further insight into these two topics.

It is hypothesized that the Δ IRR is more likely to represent additionality than the benchmark analysis currently in use since it isolates the impacts of annual CER revenue. This study uses a linear and a logistic regression model to evaluate the determinants of the Δ IRR for Swiss-Chinese CDM projects registered between 2005 and September 2011. The analysis is based on the determinants that are normally used to calculate the IRR with and without CER revenues. The results show that annual revenues from gas and power generation are a crucial factor effecting the Δ IRR. There is less evidence of a significant impact of annual revenues from CERs, investments and annual operation and maintenance costs. In addition, different benchmarks for the Δ IRR give considerably different results. Even if the findings are limited to Swiss-Chinese CDM projects, they have important implications for the implementation of the Δ IRR as a substitute or additional instrument to assess investment additionality. First, annual revenue should be included as an element. Second, further work is needed in order to analyze the impacts of annual reductions, investments and annual operation and maintenance costs in more detail. Any further analysis should focus on annual revenues from CERs in particular, since they are a crucial element of the IRR calculation process. If the results show that their impact is negligible this would call into question whether the Δ IRR is an appropriate indicator for the effect of CER revenues.

This study does not discuss how the benchmark for the Δ IRR is determined nor does it discuss the decision-making criterion used to for prove additionality. In this regard, academia could develop and provide proposals for decision makers. In this context, the many challenges faced in implementing a new tool and the need for decision makers to be convinced of the advantages of the Δ IRR, must be taken into consideration.

Drawing on the assumption that the Δ IRR is an appropriate tool for proving investment additionality, there are further implications for new market mechanisms. In the debate in the scientific community, these new mechanisms are similar to the CDM but in this case a sector or subsector approach is applied. This implies that only approved project types are allowed to participate in the scheme. The results of this study show that hydro projects are less likely to belong to the approved group of project types since they reveal a negative impact on Δ IRR. Further studies, which are based on extended data, are necessary in order to identify additional project types.

Finally, the discussion of additionality should not be limited to financial aspects. There is a broad variety of CDM projects and in addition to the challenge of financial feasibility, project developers may face challenges that cannot be quantified, for example, unfavorable political circumstances, or a lack of technological or managerial knowhow, to name a few. Therefore, assessing the additionality of CDM projects requires a comprehensive approach.

Besides the discussion regarding Δ IRR, this study has also shown the pattern of Swiss-Chinese collaboration under the CDM. Swiss project activities can be found in almost all Chinese provinces. The majority of the projects are realized in Inner Mongolia, Sichuan and Hebei. And the most common project types are wind and hydro projects. Furthermore, the analysis of the data has shown that most Swiss actors involved in CDM activities are international companies that operate globally the field of energy trade and project development.

There is no doubt that, the CDM in general and additionality in particular, will remain hotly debated issues. In order to enhance the credibility of the CDM and to ensure its environmental integrity the international community should do everything in its power to improve and adapt the additionality tool.

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APPENDICES

APPENDIX I: LIST OF PROJECTS INCLUDED IN THE DATA SET

Register Number	Title	Province State	Investment Country Partner	Type	Reductions per Year ktCO2e
11	Project for GHG Emission Reduction by Thermal	Jiangsu	Trading Emissions PLC, Intertrust	HFCs	8'411
71	Nanjing Tianjingwa Landfill Gas to Electricity Pr	Jiangsu	Ecosecurities Ltd.	Landfill gas	246
232	Shandong Dongyue HFC23 Decomposition Proje	Shandong	Shangdong Dongyue Chemical C	HFCs	10'110
233	Zhangbei Manjing Windfarm Project	Hebei	Vitol SA	Wind	94
306	Project for HFC23 Decomposition at Changshu 3	Jiangsu	Trading Emissions PLC, Intertrust	HFCs	10'437
366	Taishan Cement Works Waste Heat Recovery ar	Shandong	Intertrust (NL) B.V.	EE own gene	106
388	Fujian Zhangpu Liuao 30.6 MW Windpower Proj	Fujian	EDF Trading Limited	Wind	52
483	Jilin Changling Wind Farm Phase I Project	Jilin	European Carbon Fund	Wind	100
537	Liaoning Kangping 24.65MW Wind Farm Project	Liaoning	Carbon Asset Management Swed	Wind	42
539	Liaoning Zhangwu 24.65MW Wind Farm Project	Liaoning	Carbon Asset Management Swed	Wind	35
549	Project for HFC23 Decomposition at Zhejiang Dc	Zhejiang	Enel Trade S.p.A.	HFCs	3'657
550	Project for HFC23 Decomposition at Limin Chem	Zhejiang	Enel Trade S.p.A.	HFCs	4'784
561	Saihanba East 45.05 MW Windfarm Project	Inner Mongolia	Essent Trading International S.A.	Wind	112
576	Saihanba North 45.05 MW Windfarm Project	Inner Mongolia	RWE Supply and Trading Switzerl	Wind	112
594	5MW Renewable Energy Project for grid, Gansu	Gansu	MGM Carbon Portfolio Sarl	Hydro	19
600	9.6 MW Xiaohe Small Hydropower Project	Gansu	MGM Carbon Portfolio Sarl	Hydro	42
695	Yanling Shendu Hydropower Project	Hunan	J.P. Morgan Ventures Energy Cor	Hydro	20
767	HFC23 Decomposition Project at Zhonghao Che	Sichuan	Enel Trade S.p.A.	HFCs	2'066
771	Changling Wind Power Project	Jilin	Climate Change Capital Carbon N	Wind	20
778	Hebei Jinzhou 24MW Straw-Fired Power Projec	Hebei	European Carbon Fund	Biomass ene	179
819	Zhongjieneng Suqian 2*12MW Biomass Direct B	Jiangsu	Vitol SA	Biomass ene	123
840	Pansan Coal Mine Methane Utilisation and Dest	Anhui	Vitol SA	Coal bed/mi	126
842	Hebei Shangyi Manjing East Wind Farm Project	Hebei	RWE Supply and Trading Switzerl	Wind	120
868	No.2 HFC-23 Decomposition Project of Zhejiang	Zhejiang	Climate Change Capital Carbon F	HFCs	4'810
869	Datang Jilin Shuangliao Wind Farm Project	Jilin	Climate Change Capital Carbon F	Wind	104
877	Hebei Chengde Songshan Wind Farm Project	Hebei	Essent Trading International S.A.	Wind	106
878	Hebei Kangbao Wolongtushan 30 MW Wind Far	Hebei	ICECAP Carbon Portfolio Ltd.	Wind	59
883	Liaoning Changtu Wind Farm Project	Liaoning	Carbon Resource Management S	Wind	101
886	Anguoer Hydropower	Gansu	MGM Carbon Portfolio Sarl	Hydro	72
887	Shenzhen Xiaping Landfill Gas Collection and Ut	Guangdong	Climate Change Capital Carbon F	Landfill gas	472
892	Yangquan Coal Mine Methane (CMM) Utilizatio	Shanxi	Intertrust (NL), European Carbon	Coal bed/mi	2'136
898	Ningguo Cement Plant 9100KW Waste Heat Rec	Anhui	Cargill International; Camco Inte	EE own gene	55
902	Yangquan Coal Mine Methane Advanced Indust	Shanxi	Intertrust (NL) B.V.; European Ca	Coal bed/mi	965
904	Guangrun Hydropower Project in Hubei Provinc	Hubei	SwissRe	Hydro	76
939	Yutan Hydroelectric Project	Chongqing	Ecosecurities Ltd.	Hydro	36
993	Hainan Province Diaoluohe Hydropower Projec	Hainan	Vitol SA; Carbon Resource Mana	Hydro	21
994	Inner Mongolia Chifeng Saihanba West 30.6 MW	Inner Mongolia	Vitol SA; Carbon Resource Mana	Wind	83
996	Zhoubai Hydroelectric Project	Chongqing	Ecosecurities Ltd.	Hydro	58
1019	Qixia Tangshanpeng Windfarm Project	Shandong	Vitol SA; Carbon Resource Mana	Wind	38
1038	6.5MW WHR Project in Huasheng Tianya Cemer	Hainan	Carbon Asset Management Swed	EE own gene	38
1083	N2O decomposition project of Henan Shenma N	Henan	Intertrust (NL)	N2O	4'047
1120	Jiaozishan Landfill Gas Recovery and Utilisation	Jiangsu	Camco International Ltd.	Landfill gas	153
1155	Waste heat power generation project at Hunan	Hunan	Vitol SA	EE own gene	51
1190	Pingwu Renjiaba 12.6 MW Small Hydropower Pr	Sichuan	Carbon Asset Management Swed	Hydro	73
1194	China Fluoro HFC23 abatement project in China	Shandong	Bear Sterns International Ltd., Cl	HFCs	4'248
1209	Wuerguli 30 MW Wind Power Project	Heilongjiang	ICECAP Carbon Portfolio Ltd.	Wind	75
1222	Xiangziyan Hydroelectric Project	Sichuan	Ecosecurities Group PLC	Hydro	82
1223	Wahei Hydroelectric Project	Sichuan	Ecosecurities Ltd.	Hydro	178
1225	30 MW WHR Project of Hongshi Group	Zhejiang	MGM Carbon Portfolio Sarl	EE own gene	160
1226	Youshuishiti Hydroelectric Project	Sichuan	Ecosecurities Group PLC	Hydro	309
1228	Waste Gas based Captive Power Plant in Liangai	Hunan	Marubeni Corporation	EE own gene	332
1230	Shanxi Liulin Coal Mine Methane Utilization Prc	Shanxi	ICECAP Carbon Portfolio Ltd.	Coal bed/mi	318
1231	Shanmugou Small Hydropower Project	Sichuan	Ecosecurities Group PLC	Hydro	46
1238	N2O decomposition project of PetroChina Com	Liaoning	Intertrust (NL)	N2O	10'017
1261	Guohua Inner Mongolia Huitengliang Wind Farn	Inner Mongolia	Carbon Resource Management S	Wind	127
1262	Waste gases utilisation for Combined Cycle Pov	Hebei	Carbon Asset Management Swed	EE own gene	666
1269	Ningxia Yinyi 49.50MW Wind-farm Project	Ningxia	Carbon Asset Management Swed	Wind	98
1284	Ningxia Shapotou Hydropower Project of Yellov	Ningxia	Carbon Asset Management Swed	Hydro	487
1318	Fujian Zhangpu Liuao 45MW Wind Power Projec	Fujian	RWE Supply and Trading Netherl	Wind	84
1319	Shanxi Coal Transport Market Co., Ltd. Yangquai	Shanxi	ICECAP Carbon Portfolio Ltd.	Coal bed/mi	590

1320	Beijing Taiyanggong CCGT Trigeneration Project	Beijing	Camco International Ltd.	Fossil fuel sv	1'516
1340	Yichang Yihua Waste Heat Recovery and Utilizat	Hubei	Carbon Asset Management Swec	EE own gene	195
1353	Hebei Quzhai Cement 9000kW Waste Heat Recc	Hebei	Carbon Asset Management Swec	EE own gene	53
1365	China Guanmenyan Hydropower Project	Hunan	Carbon Asset Management Swec	Hydro	91
1366	Biomass generation project, in Sheyang county,	Jiangsu	Climate Change Capital Carbon N	Biomass ene	109
1367	China Changniping Hydropower Project	Hunan	Carbon Asset Management Swec	Hydro	78
1376	China Shangbao Small Hydropower Project	Hunan	Carbon Asset Management Swec	Hydro	58
1390	Power Generation (20MW) by utilizing Coke Ov	Shanxi	Carbon Asset Management Swec	EE own gene	68
1391	Yuliangwan Small Hydroelectric Project, Hunan	Hunan	Carbon Asset Management Swec	Hydro	32
1402	BBMG Cement WHR for 10.5 MW power generat	Beijing	Ecosecurities Group PLC	EE own gene	74
1416	Baotou Iron & Steel Blast Furnace Gas Combine	Inner Mongolia	Camco International Ltd.	EE own gene	1'871
1423	Dongbaliang 49.5 MW Winpower Project	Hebei	Vitol SA	Wind	118
1432	Ganluo Kaijianqiao Hydropower Project, P.R.Ch	Sichuan	Carbon Asset Management Swec	Hydro	242
1436	Tianji Group Line 1 N2O Abatement Project	Shanxi	Vitol SA, Ecosecurities Group PL(	N2O	502
1437	Tianji Group Line 2 N2O Abatement Project	Shanxi	Vitol SA	N2O	659
1441	Tianji Group Line 3 N2O Abatement Project	Shanxi	Vitol SA	N2O	524
1455	Jinxiang – Golden Elephant Line 1 N2O Abateme	Sichuan	Ecosecurities Group PLC	N2O	188
1457	Jinxiang – Golden Elephant Line 2 N2O Abateme	Sichuan	Ecosecurities Group PLC	N2O	39
1464	Yueliangshan 49.5 MW Wind Power Project	Hebei	Vitol SA	Wind	118
1467	Qinghai Jinshaxia 70MW Hydropower Project	Qinghai	Carbon Asset Management Swec	Hydro	211
1468	Jilin Liaoyuan Meihe coal mine methane power	Jilin	Camco International Ltd.	Coal bed/mi	41
1474	Qinghai Qinggangxia 43.8MW Hydropower Proj	Qinghai	Carbon Asset Management Swec	Hydro	149
1480	Xinjiang Xiaocaohu Wind Power Project	Xinjiang	European Carbon Fund	Wind	109
1498	Baji River Stage I 10MW Run-of-river Hydropow	Sichuan	MGM Carbon Portfolio Sarl	Hydro	46
1523	Daguan Linguanyan 9.6 MW Small Hydropower I	Yunnan	Vitol SA	Hydro	40
1533	Daguan Linguanyan Small Hydropower Project i	Yunnan	Vitol SA	Hydro	39
1546	Straw generation project in Wei county Hebei p	Hebei	Climate Change Capital Carbon N	Biomass ene	131
1577	CGN Inner Mongolia Zhurihe Phase I Wind Farm	Inner Mongolia	Carbon Resource Management S	Wind	128
1592	Huadian Ningxia Ningdong Yangjiayao 45MW W	Ningxia	Carbon Asset Management Swec	Wind	94
1608	Anshan Iron and Steel Group Corporation (Yingk	Liaoning	Camco International Ltd.; Standa	EE own gene	871
1609	Anshan Iron and Steel Group Corporation (Ansh	Liaoning	Camco International Ltd.; Standa	EE own gene	1'740
1664	Mianyang Landfill Gas Utilsation Project	Sichuan	Sindicatum Carbon Capital Ltd.	Landfill gas	94
1670	Anshan Iron and Steel Group Corporation (Ansh	Liaoning	Camco International Ltd.	EE own gene	138
1671	Anshan Iron and Steel Group Corporation (Yingk	Liaoning	Camco International Ltd.	EE own gene	132
1672	Waste Heat Recovery and Utilisation for Power	Anhui	Cargill International SA; Camco I	EE own gene	119
1673	Waste Heat Recovery and Utilisation for Power	Anhui	Cargill International SA; Camco I	EE own gene	116
1674	Waste Heat Recovery and Utilisation for Power	Zhejiang	Cargill International SA; Camco I	EE own gene	55
1675	Waste Heat Recovery and Utilisation for Power	Anhui	Cargill International SA; Camco I	EE own gene	302
1676	Waste Heat Recovery and Utilisation for Power	Anhui	Cargill International SA; Camco I	EE own gene	216
1686	Waste Heat based Captive Power Project in Hur	Hunan	Marubeni Corporation	EE own gene	134
1688	Shanxi Xiaoyi Waste Gas Combined Cycle Powe	Shanxi	Camco International Ltd.	EE own gene	877
1705	Shanxi Taigang Stainless Steel Co., Ltd. Sinter M	Shanxi	Camco International Ltd.	EE own gene	195
1709	Angang Sinter Machine Waste Heat Recovery ar	Henan	Camco International Ltd.	EE own gene	115
1711	Shanxi Taigang Stainless Steel Co., Ltd. Waste S	Shanxi	Camco International Ltd.	EE own gene	103
1714	Baofeng Country Waste Heat Recovery for Powe	Henan	First Climate AG	EE own gene	44
1715	Hebei Chengde Fengze Wind Farm Project	Hebei	Carbon Resource Management S	Wind	128
1721	2*6MW Coke Oven Gas Power Generation Proje	Henan	First Climate AG	EE own gene	65
1723	Henan Xichuan Waste Heat Recovery for Power	Henan	First Climate AG	EE own gene	53
1742	Zhuhai Hengqin Island Wind Farm Project	Guangdong	Carbon Resource Management S	Wind	33
1743	Yunnan Yuanjiang Lutong Hydropower Station	Yunnan	South Pole Carbon Asset Manage	Hydro	46
1768	Gansu Luqu Dazhuang Hydropower Station Proj	Gansu	Cargill International SA	Hydro	38
1769	Yunnan Weixi Jicha Hydropower Project	Yunnan	MGM Carbon Portfolio Sarl	Hydro	47
1775	Yunnan Weixi Gedeng Hydropower Project	Yunnan	MGM Carbon Portfolio Sarl	Hydro	46
1789	Shandong Tuoji Island Windfarm Project	Shandong	Carbon Resource Management S	Wind	25
1808	Danian 14MW Hydropower Project in Gansu Pro	Gansu	MGM Carbon Portfolio Sarl	Hydro	64
1823	Inner Mongolia Bayin'aobao 49.5MW Wind Farn	Inner Mongolia	MGM Carbon Portfolio Sarl	Wind	119
1837	Zhejiang Cixi Wind Farm Project	Zhejiang	Carbon Resource Management S	Wind	99
1854	Hebei Shangyi Qijiashan Wind Farm Project	Hebei	Carbon Resource Management S	Wind	418
1855	CECIC Zhangbei Dayangzhuang Wind Farm Proje	Hebei	Vitol SA	Wind	104
1862	Yunnan Lushui Country Laowohe 25MW Hydrop	Yunnan	First Climate AG	Hydro	99
1873	Hebei Chengde Huifeng Windfarm Project	Hebei	Carbon Resource Management S	Wind	115
1875	Sanchawan 32MW Hydro Power Project in Guizh	Guizhou	MGM Carbon Portfolio Sarl	Hydro	118
1891	Animal Manure Management System (AMMS) G	Shandong	SwissRe	Methane avc	66

1906	Shenyang Laohuchong LFG Power Generation P	Liaoning	International Clean Fund LLC	Landfill gas	137
1909	Kunming Dongjiao Baishuitang LFG Treatment a	Yunnan	International Clean Fund LLC	Landfill gas	62
1926	Fuxin CMM/CBM Utilization Project in Liaoning	Liaoning	Camco International Ltd.; Natsou	Coal bed/mi	615
1946	Ningxia Yinyi Hongsipu 49.50MW Wind-farm Pro	Ningxia	MGM Carbon Portfolio Sarl	Wind	112
1990	Inner Mongolia North Longyuan Zhurihe WindF	Inner Mongolia	Carbon Resource Management S	Wind	126
2003	Yunnan Guangnan Duimen River Hydropower St	Yunnan	South Pole Carbon Asset Manage	Hydro	79
2013	Beijing 48 MW Guanting Wind Power Project	Beijing	Shell Trading International Limit	Wind	101
2040	Hebei Shangyi Manjing West Wind Farm Project	Hebei	Carbon Resource Management S	Wind	109
2041	Huangtuwan Hydropower Project in Gansu Prov	Gansu	MGM Carbon Portfolio Sarl	Hydro	69
2043	Zhejiang Qushan Wind Farm Project	Zhejiang	Vitol SA; Carbon Resource Mana	Wind	82
2047	Guohua Inner Mongolia Huitengliang West Win	Inner Mongolia	Carbon Resource Management S	Wind	129
2051	Goldwind Damao Wind Farm Project	Inner Mongolia	Carbon Resource Management S	Wind	127
2078	Inner Mongolia North Longyuan Huitengxile Wi	Inner Mongolia	Carbon Asset Management Swec	Wind	112
2086	Yunnan Gangquhe No.1 Hydropower Project	Yunnan	MGM Carbon Portfolio Sarl	Hydro	216
2087	25.5MW Xinnali Hydropower Project	Guangxi	MGM Carbon Portfolio Sarl	Hydro	71
2089	Ayishan Small Hydropower Project in Gansu Pro	Gansu	MGM Carbon Portfolio Sarl	Hydro	19
2123	Liaoning Faku Baijiagou Wind Power Project	Liaoning	RWE Supply and Trading Switzerl	Wind	124
2131	25MW Liangwan Hydropower Development Pro	Guangxi	MGM Carbon Portfolio Sarl	Hydro	70
2133	Nansha Hydro Power Project in Yunnan Provinc	Yunnan	Carbon Asset Management Swec	Hydro	520
2136	Tongren Tianshengqiao Hydropower Project	Guizhou	Vitol SA	Hydro	58
2158	Inner Mongolia North Longyuan Huitengliang W	Inner Mongolia	Carbon Resource Management S	Wind	127
2159	Erbaqu Small Hydropower Project in Gansu Prov	Gansu	MGM Carbon Portfolio Sarl	Hydro	34
2170	CECIC HKC Danjinghe Wind Farm Project	Hebei	Vitol SA	Wind	349
2184	Shuangqiao, Banqiao and Longtoushan Bundled	Heilongjiang	MGM Carbon Portfolio Sarl	Hydro	46
2199	48 MW Duduluo River Hydroelectric Power Plan	Yunnan	First Climate AG	Hydro	166
2206	Sichuan Jiulong Shaping Hydropower Project	Sichuan	Vitol SA	Hydro	639
2214	Zuo XI Hydropower Plant	Zhejiang	First Climate AG	Hydro	88
2221	Hubei Eco-Farming Biogas Project Phase I	Hubei	SwissRe	Methane avo	58
2307	Federal Intertrade Pengyang Solar Cooker Proje	Ningxia	Post 2012 Carbon Credit Fund C.V	Solar	36
2311	Federal Intertrade Hong-Ru River Solar Cooker I	Ningxia	Post 2012 Carbon Credit Fund C.V	Solar	36
2320	Jinan Chemical Fertilizer Plant Co., Ltd. N20 Aba	Shandong	Vitol SA	N2O	242
2324	Jinan Chemical Fertilizer Plant	Shandong	Vitol SA	N2O	312
2344	Zhumadian Zhongyuan Gas-Steam Combined Cy	Henan	Carbon Asset Management Swec	Fossil fuel sw	858
2397	Shandong Penglai Pingdingshan Wind Farm	Shandong	Vitol SA	Wind	107
2406	CGN Inner Mongolia Duerbote Wind farm Proje	Inner Mongolia	Carbon Resource Management S	Wind	120
2413	Xinjiang Huadian Xiaocaohu the 2nd phase of N	Xinjiang	Carbon Asset Management Swec	Wind	105
2448	Qingxi 28MW Hydropower Project in Guizhou P	Guizhou	MGM Carbon Portfolio Sarl	Hydro	71
2451	Taiyuan Xingou Landfill Gas Recovery and Utliza	Shanxi	ASJA Environment International	Landfill gas	43
2452	Taiyuan Shanzhuangtou Landfill Gas Recovery a	Shanxi	ASJA Environment International	Landfill gas	39
2483	Inner Mongolia Wuliji Wind Farm Project	Shandong	Carbon Resource Management S	Wind	124
2586	Jilin Da'an Dagangzi Wind Power Project Phase	Jilin	Carbon Resource Management S	Wind	246
2598	Huaneng Jilin Tongyu Phase II Wind Farm Projec	Jilin	Carbon Resource Management S	Wind	263
2599	Huaneng Tongliao Baolongshan Phase II Wind F	Inner Mongolia	Carbon Resource Management S	Wind	137
2608	Yunnan Shangri-La Shiwang River Hydropower S	Yunnan	South Pole Carbon Asset Manage	Hydro	49
2693	Gansu Luqu Duosongduo Hydropower Station P	Gansu	Cargill International SA	Hydro	75
2703	Angang Coke Dry Quenching Project	Henan	Camco International Ltd.	EE own gene	191
2737	Sichuan Shimian County Ximagu Hydropower P	Sichuan	Vitol SA	Hydro	61
2738	Ping An Yiji 6 MW Hydropower Project	Chongqing	Vitol SA	Hydro	21
2739	Gansu Min County Qingshui Hydropower Statio	Gansu	Cargill International SA	Hydro	72
2771	Guangdong Chaonan Chengtian Wind Power Pro	Guangdong	Vitol SA	Wind	90
2777	Heilongjiang Shaobaishan Wind Power Project	Heilongjiang	Essent Trading International S.A.	Wind	128
2808	Sichuan Heishui Changde 20MW Hydropower P	Sichuan	Vitol SA	Hydro	81
2814	Shandong Rushan Luneng Wind Farm	Shandong	RWE Supply and Trading Switzerl	Wind	73
2817	Liaoning Changtu Shihu Wind Power Project	Liaoning	RWE Supply and Trading Switzerl	Wind	116
2841	Dangshun 15.1 MW Hydropower Project	Qinghai	Vitol SA	Hydro	52
2850	Sichuan Muli River Dashawan Hydroelectric Dev	Sichuan	Vitol SA	Hydro	1'134
2862	Sichuan Luding Moxi 20MW Hydropower Projec	Sichuan	Vitol SA	Hydro	90
2873	Tianxin Waste Heat Recovery Project	Inner Mongolia	Camco International Ltd.	EE own gene	146
2875	Saiwuduo Hydropower Project in Gansu Provinc	Gansu	MGM Carbon Portfolio Sarl	Hydro	70
2892	Xiangtan Shuangma Landfill Gas Recovery and U	Hunan	Essent Trading International S.A.	Landfill gas	20
2911	Huaneng Damao Maoming Phase I Wind Farm P	Inner Mongolia	Carbon Resource Management S	Wind	129
2918	Huaneng Liaoning Fuxin Phase II Wind Farm Pro	Gansu	Carbon Resource Management S	Wind	660
2929	SDIC Xiyang Huangyanhui CMM to Power Gener	Shaanxi	Camco International Ltd.	Coal bed/mi	281
2945	Sichuan Baoxing Dongfeng Hydropower Project	Sichuan	Vitol SA	Hydro	184
2946	Guangzhou Zhujiang Beer Methane Recovery Pr	Guangdong	South Pole Carbon Asset Manage	Methane avo	36

2953	Guangdong Taishan Shangchuandao Island Phas	Guangdong	Carbon Resource Management S	Wind	86
2954	Guangdong Taishan Shangchuandao Island Phas	Guangdong	Carbon Resource Management S	Wind	63
2964	Shenmu County Jieneng Multipurpose Use Pow	Shaanxi	Post 2012 Carbon Credit Fund C.	EE own gene	430
3031	Liaoning Changtu Taiyangshan Phase One 49.5M	Liaoning	Camco International Ltd.	Wind	110
3044	Jianli Kaidi Biomass Power Project	Hubei	Camco International Ltd.	Biomass ene	117
3055	Jingshan Kaidi Biomass Power Project	Hubei	Camco International Ltd.	Biomass ene	114
3056	Poyang Kaidi Biomass Power Project	Jiangxi	Camco International Ltd.	Biomass ene	165
3057	Qichun Kaidi Biomass Power Project	Hubei	Camco International Ltd.	Biomass ene	117
3061	Tongcheng Kaidi Biomass Power Project	Anhui	Camco International Ltd.	Biomass ene	107
3064	Wuhe Kaidi Biomass Power Project	Anhui	Camco International Ltd.	Biomass ene	107
3065	Hunan Yueyang Kaidi Biomass Power Project	Hunan	Camco International Ltd.	Biomass ene	191
3066	Hunan Qidong Kaidi Biomass Power Project	Hunan	Camco International Ltd.	Biomass ene	190
3068	Suqian Kaidi Biomass Co-generation Project	Jiangsu	Camco International Ltd.	Biomass ene	101
3069	Wangjiang Kaidi Biomass Power Project	Anhui	Camco International Ltd.	Biomass ene	105
3070	Fujian Fuqing Gaoshan Phase I Wind Project	Fujian	Essent Trading International S.A.	Wind	53
3071	Wanzai Kaidi Biomass Power Project	Jiangxi	Camco International Ltd.	Biomass ene	116
3072	Hunan Yiyang Kaidi Biomass Power Project	Hunan	Camco International Ltd.	Biomass ene	198
3078	Huaneng Jilin Taobei Phase II Wind Farm Projec	Jilin	Carbon Resource Management S	Wind	111
3079	Hebei Chengde Peifeng Wind Farm Project	Hebei	Carbon Resource Management S	Wind	122
3080	Huaneng Inner Mongolia Keyouzhongqi Gaolib	Inner Mongolia	Carbon Resource Management S	Wind	131
3084	Huaneng Tongliao Baolongshan Phase III Wind	Inner Mongolia	Carbon Resource Management S	Wind	124
3091	Huadian Tongliao Beiqinghe 300 MW Wind Far	Inner Mongolia	Camco International Ltd.	Wind	730
3095	Gansu Tanchang County Shawan Hydropower St	Gansu	Vitol SA	Hydro	160
3104	Huadian Kailu Yihetala Phase one 49.5 MW Win	Inner Mongolia	Camco International Ltd.	Wind	127
3107	Xinjiang Dabancheng Sanchang Phase IV Wind	Xinjiang	Essent Trading International S.A.	Wind	133
3121	Yunlong 8MW Hydropower Project	Yunnan	Vitol SA	Hydro	35
3122	Jilin Longyuan Changling Shuanglong Phase I Wi	Jilin	Essent Trading International S.A.	Wind	118
3124	Huaneng Tongliao Zhurihe Phase I Wind Farm P	Inner Mongolia	Carbon Resource Management S	Wind	115
3135	24 MW Waste Heat Recovery for Power Generat	Ningxia	MGM Carbon Portfolio Sarl	EE own gene	100
3153	Tongliao Naiman Banner Baxiantong Haritang W	Inner Mongolia	Essent Trading International S.A.	Wind	119
3196	Lubanshan North and South Coal Mine Methane	Sichuan	MGM Carbon Portfolio Sarl	Coal bed/mi	323
3211	Funing County Baida Hydropower Station	Yunnan	South Pole Carbon Asset Manag	Hydro	45
3212	Funing County Gula Township Nalin Hydropowe	Yunnan	South Pole Carbon Asset Manag	Hydro	43
3219	SDIC Xiyang Baiyangling CMM to power generat	Shanxi	Camco International Ltd.	Coal bed/mi	450
3228	Huadian Xinjiang Xiaocaohu Second Wind Farm	Xinjiang	Carbon Resource Management S	Wind	99
3241	Huadian Gansu Guazhou Ganhekou No. 7 Wind	Gansu	Camco International Ltd.; Standa	Wind	425
3258	Tongliao Kezuozhong Banner Dailiji Aorimu Wir	Inner Mongolia	Essent Trading International S.A.	Wind	112
3274	Huaneng Hailar Xiaoliang Phase I Wind Farm Pr	Guizhou	Carbon Resource Management S	Wind	141
3277	Zhejiang Cangnan Xiaguan Wind Power Project	Zhejiang	Carbon Resource Management S	Wind	24
3278	Zhejiang Dongtou 13.5MW Wind Power Project	Zhejiang	Carbon Resource Management S	Wind	16
3280	Yunnan Wenshan Yanlashan Hydropower Proje	Yunnan	Vitol SA	Hydro	52
3292	Majing'ao and Matou 15 MW Bundled Small Hy	Guizhou	Carbon Asset Management Swe	Hydro	43
3299	LinCang Yun County, Xin TangFang Hydropower	Yunnan	International Clean Fund LLC	Hydro	69
3303	CGN Inner Mongolia Huitengliang Phase I Wind	Inner Mongolia	Carbon Resource Management S	Wind	134
3315	Ebian Yi Autonomous County Shugujiao Hydrop	Sichuan	Climate Cent Foundation	Hydro	34
3340	Wanzhou Kehua Cement WHR to 13.5MW Electr	Chongqing	Luso Carbon Fund	EE own gene	80
3342	Inner Mongolia Siziwangqi Wulanhua Wind Far	Inner Mongolia	Carbon Resource Management S	Wind	112
3353	Huaneng Changyi Phase I Wind Farm Project	Shandong	Carbon Resource Management S	Wind	118
3394	Waste Heat Recovery and Utilisation for Power	Guangdong	Camco International Ltd.	EE own gene	186
3436	Guangdong Chaonan Shalong Wind Power Proje	Guangdong	Vitol SA	Wind	92
3453	CGN Inner Mongolia Zhurihe Phase II Wind Farn	Inner Mongolia	Carbon Resource Management S	Wind	119
3470	Liaoning Faku Ciensi Wind Power Project	Liaoning	Essent Trading International S.A.	Wind	113
3500	Waste gas for power generation in Shenmu Cou	Shaanxi	Carbon Asset Management Swe	EE own gene	133
3520	Federal Intertrade Haiyuan Solar Cooker Projec	Ningxia	Post 2012 Carbon Credit Fund C.	Solar	33
3537	Ninger Mengxian River Second Cascade Hydrop	Yunnan	Bunge Emissions Holding Sarl	Hydro	56
3543	Fujian Datian Jianshe Hydropower Project	Fujian	Vitol SA	Hydro	23
3551	Xinjiang Bazhou Haermodun 15MW Hydropowe	Xinjiang	MGM Carbon Portfolio Sarl	Hydro	66
3579	Huaneng Xinjiang Hami Santanghu Phase I Win	Xinjiang	Carbon Resource Management S	Wind	102

3582	Zhuhai Hongwan Natural Gas Power Generation	Guangdong	Carbon Resource Management S	Fossil fuel sv	275
3596	Huaneng Wuchuan Lihanliang Phase I Wind Farr	Inner Mongolia	Carbon Resource Management S	Wind	122
3603	Huaneng Binhai Wind Farm Project	Shandong	Carbon Resource Management S	Wind	108
3613	Waste Heat Recovery and Utilisation for Power	Hunan	Camco International Ltd.	EE own gene	59
3681	Sichuan Heishui County Reshuitang 2nd Cascade	Sichuan	Vitol SA	Hydro	53
3691	Waste Heat Recovery and Utilisation for Power	Jiangsu	Camco International Ltd.	EE own gene	154
3704	Hebei Shangyi Longyuan Wind Power Project	Hebei	Essent Trading International S.A.	Wind	331
3718	Shandong Huaneng Hekou Phase I Wind Farm P	Shandong	Carbon Resource Management S	Wind	95
3736	Jiangsu Rudong (II) Expansion Wind Power Proj	Jiangsu	Essent Trading International S.A.	Wind	193
3741	Sichuan Dechang Xinma Hydropower Project	Sichuan	Vitol SA	Hydro	464
3750	Huadian Kailu Yihetala Phase Two 49.5 MW Win	Inner Mongolia	Standard Bank Plc	Wind	113
3760	BRT Chongqing Lines 1-4, China	Chongqing	Grütter Consulting	Transport	218
3767	Xinjiang Uygur Autonomous Region Kashgar Tar	Xinjiang	Vitol SA	Hydro	358
3769	Jiangxi Jinjia Biomass Generation Project	Jiangxi	Climate Cent Foundation	Biomass Ene	54
3778	Sichuan Pingwu County Sancha Hydropower Sta	Sichuan	Vitol SA	Hydro	152
3798	Jilin Longyuan Tongyu Phase III Wind Power Prc	Jilin	Essent Trading International S.A.	Wind	115
3842	Inner Mongolia Bayinxile Wind Power Project	Inner Mongolia	Vitol SA	Wind	130
3847	Guangdong Hejiang 7.2MW Hydropower Project	Guangdong	Vitol SA	Hydro	18
3851	Beixu Group Methane to Energy Project	Henan	South Pole Carbon Asset Manage	Methane avc	60
3867	Huaneng Fuxin Phase III Wind Farm Project	Liaoning	Carbon Resource Management S	Wind	219
3889	Caishenliang 49.5MW Wind Power Generation I	Inner Mongolia	Carbon Resource Management S	Wind	108
3893	Tongliao Changxing Molimiao Wind Farm Chang	Inner Mongolia	Vitol SA	Wind	124
3976	N2O Abatment Project of Nitric Acid Plant	Henan	Vitol SA	N2O	85
4004	Inner Mongolia Tongliao Naiman Banner Baxian	Inner Mongolia	Essent Trading International S.A.	Wind	120
4053	Heilongjiang Qianjin Biomass Power Generatio	Heilongjiang	Mercuria Energy Trading	Biomass Ene	142
4055	Heilongjiang Youyi Biomass Power Generation I	Heilongjiang	Mercuria Energy Trading	Biomass Ene	142
4095	CECIC Zhangbei Gaojialiang Wind farm Project	Hebei	Carbon Resource Management S	Wind	89
4111	24MW Yunnan Deze Hydropower Project	Yunnan	Vitol SA	Hydro	100
4113	Chongqing Shizhu County 48MW Yangdong Rive	Chongqing	Vitol SA	Hydro	178
4141	Hubei Xuan'en Jintan Hydropower Station	Hubei	RWE Supply and Trading Switzerl	Hydro	22
4142	Hubei Wufeng Shuijinsi, Zhuqiao and Zhifangto	Hubei	RWE Supply and Trading Switzerl	Hydro	88
4149	Ningxia Dalisi 40.5MW Wind-farm Project	Ningxia	MGM Carbon Portfolio Sarl	Wind	76
4150	Inner Mongolia Wulanchabu Hongji Wind Farm	Inner Mongolia	Carbon Resource Management S	Wind	657
4154	Gansu Shuigouping Small Hydropower Project	Gansu	MGM Carbon Portfolio Sarl	Hydro	41
4172	Inner Mongolia Wengniute Wudaogou Xigouli V	Inner Mongolia	RWE Supply and Trading Switzerl	Wind	123
4178	Inner Mongolia Chifeng Songshan Laoshuiquan	Inner Mongolia	RWE Supply and Trading Switzerl	Wind	127
4180	Inner Mongolia Wengniute Sunjiaying Shangcha	Inner Mongolia	RWE Supply and Trading Switzerl	Wind	123
4204	Huaneng Weichang Yudaokou Phase I Wind Farı	Hebei	Carbon Resource Management S	Wind	103
4241	Huaneng Tongliao Zhurihe Phase II Wind Farm F	Inner Mongolia	Carbon Resource Management S	Wind	109
4253	Gansu Guazhou Qiaowan Wind Farm Project	Gansu	Vitol SA	Wind	405
4320	Huaneng Fuxin Zhangbei Wind Farm Project	Liaoning	Carbon Resource Management S	Wind	55
4395	Yanbian County Yanshuihe Hydropower Station	Sichuan	Climate Cent Foundation	Hydro	29
4425	Hunan Shuangpai Wulipai 45MW Hydropower P	Hunan	Vitol SA	Hydro	141
4439	Pingju 4MW Hydropower Project in Guizhou Prc	Guizhou	Vitol SA	Hydro	10
4503	Landfill Gas Recovery and Utilization Project in I	Shandong	BKW FMB Energie AG	Landfill gas	26
4570	Sichuan Yanyuan Woluoqiao Hydropower Statio	Sichuan	Vitol SA	Hydro	366
4573	Xinjiang Alahhankou Phase II Wind Power Proje	Xinjiang	RWE Supply and Trading Switzerl	Wind	97
4609	Sichuan Shimian Songlinhe Hongyi Hydropower	Sichuan	Vitol SA	Hydro	337
4610	Boading Landfill Gas Recovery and Utilization Pı	Hebei	BKW FMB Energie AG	Landfill gas	53
4623	Ji'an Kaidi Biomass Power Project	Jiangxi	Vitol SA	Biomass Ene	144
4628	Shanxi Pinglu Kaidi Wind Power Project Co., Ltd	Shaanxi	Vitol SA	Wind	92
4658	Hongkou 200 MW Hydropower Project	Fujian	Vitol SA	Hydro	328
4668	Changchun City Landfill Gas Power Generation I	Jilin	Vitol SA	Landfill gas	94
4671	Sichuan Kangding County Lajiaogou Second Sta	Sichuan	Vitol SA	Hydro	73
4686	Sichuan Zhaojue Subagu 52MW Hydropower Prc	Sichuan	Vitol SA	Hydro	170
4729	Sichuan Ganzi Jiulong Wuyiqiao Hydropower Pr	Sichuan	Vitol SA	Hydro	447
4733	Sichuan Heishui Zumu 21MW Hydropower Proje	Sichuan	Vitol SA	Hydro	75
4744	BRT Zhengzhou, China	Henan	Grütter Consulting	Transport	205
4784	Liaoning Kangping Aoliyingzi Wind Power Proje	Liaoning	RWE Supply and Trading Switzerl	Wind	115
4849	Yunnan Dali Zhemoshan Wind Farm Phase II Prc	Yunnan	Mercuria Energy Trading	Wind	29
4854	Inner Mongolia Keyouqianqi Chaersen Wind Po	Inner Mongolia	RWE Supply and Trading Switzerl	Wind	114
4865	Guizhou Louxiahe Small Hydropower Project	Guizhou	Climate Protection Invest AG; Q.	Hydro	23
4893	Lintao County Ruilong Hydropower Project	Gansu	Arcadia Energy (Suisse) S.A.	Hydro	50
5042	Biogas Utilization Project in Zhejiang Jingxing P	Zhejiang	Swiss Carbon Asset Ltd.	Methane avc	61

APPENDIX II: LIST OF REGIONAL DISTRIBUTION OF CDM PROJECTS

Province	Amount of Projects	Share in %
Inner Mongolia	38	12.3
Sichuan	29	9.4
Hebei	21	6.8
Yunnan	20	6.5
Gansu	17	5.5
Liaoning	17	5.5
Shandong	15	4.8
Hunan	14	4.5
Shanxi	14	4.5
Zhejiang	11	3.5
Guangdong	10	3.2
Henan	10	3.2
Jilin	10	3.2
Anhui	9	2.9
Jiangsu	9	2.9
Ningxia	9	2.9
Hubei	8	2.6
Xinjiang	8	2.6
Guizhou	7	2.3
Chongqing	6	1.9
Fujian	5	1.6
Heilongjiang	5	1.6
Jiangxi	4	1.3
Shaanxi	4	1.3
Beijing	3	1.0
Qinghai	3	1.0
Guangxi	2	0.6
Hainan	2	0.6
Total	**310**	**100**

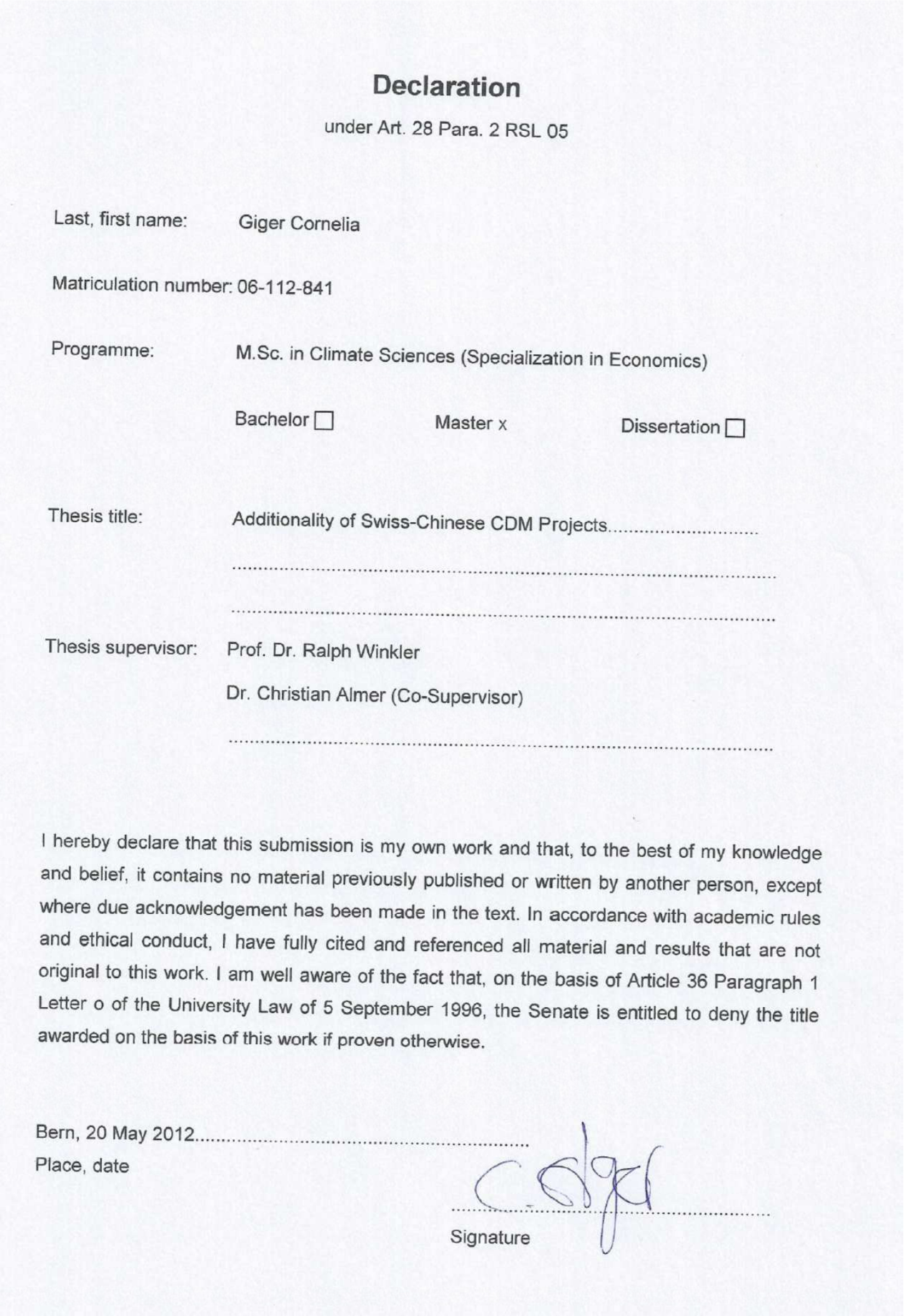
APPENDIX III: LIST OF DISTRIBUTION OF PROJECT TYPES

Project Type	Number of Projects	Share
Wind	110	35.48%
Hydro	89	28.71%
EE own generation	38	12.26%
Biomass	20	6.45%
Landfill gas	12	3.87%
Coal bed/mine methane	10	3.23%
N_2O	10	3.23%
HFC23	8	2.58%
Methane avoidance	5	1.61%
Fossil fuel switch	3	0.97%
Solar	3	0.97%
Transport	2	0.65%
Total	**310**	**100.00%**

APPENDIX IV: LIST OF INVESTMENT COUNTRY PARTNER

Investment Country Partner	Freq.	Share in %	Cum.
ASJA Environment International B.V.	2	0.65	0.65
Arcadia Energy (Suisse) S.A.	1	0.32	0.97
BKW FMB Energie AG	2	0.65	1.61
Bear Sterns International Ltd., Climate	1	0.32	1.94
Bunge Emissions Holding Sarl	1	0.32	2.26
Camco International Ltd.	32	10.32	12.58
Camco International Ltd.; Natsource Aeo	1	0.32	12.90
Camco International Ltd.; Standard Bank	1	0.32	13.23
Camco International Ltd.; Standard Bank	2	0.65	13.87
Carbon Asset Management Sweden AB	24	7.74	21.61
Carbon Resource Management SA	48	15.48	37.10
Cargill International SA	3	0.97	38.06
Cargill International SA; Camco Interna	5	1.61	39.68
Cargill International; Camco Internatio	1	0.32	40.00
Climate Cent Foundation	3	0.97	40.97

Climate Change Capital Carbon Fund II S	1	0.32	41.29
Climate Change Capital Carbon Fund Sarl	2	0.65	41.94
Climate Change Capital Carbon Managed	3	0.97	42.90
Climate Protection Invest AG; Q.C.A. AG	1	0.32	43.23
EDF Trading Limited	1	0.32	43.55
Ecosecurities Group PLC	6	1.94	45.48
Ecosecurities Ltd.	4	1.29	46.77
Enel Trade S.p.A.	3	0.97	47.74
Essent Trading International S.A.	14	4.52	52.26
European Carbon Fund	3	0.97	53.23
First Climate AG	6	1.94	55.16
Grütter Consulting	2	0.65	55.81
ICECAP Carbon Portfolio Ltd.	4	1.29	57.10
International Clean Fund LLC	3	0.97	58.06
Intertrust (NL)	2	0.65	58.71
Intertrust (NL) B.V.	1	0.32	59.03
Intertrust (NL) B.V.; European Carbon F	1	0.32	59.35
Intertrust (NL), European Carbon Fund,	1	0.32	59.68
J.P. Morgan Ventures Energy Corporation	1	0.32	60.00
Luso Carbon Fund	1	0.32	60.32
MGM Carbon Portfolio Sarl	25	8.06	68.39
Marubeni Corporation	2	0.65	69.03
Mercuria Energy Trading	3	0.97	70.00
Post 2012 Carbon Credit Fund C.V.	4	1.29	71.29
RWE Supply and Trading Netherlands S.A.	1	0.32	71.61
RWE Supply and Trading Switzerland S.A.	11	3.55	75.16
RWE Supply and Trading Switzerland S.A.	2	0.65	75.81
Shangdong Dongyue Chemical Co Ltd.	1	0.32	76.13
Shell Trading International Limited	1	0.32	76.45
Sindicatum Carbon Capital Ltd.	1	0.32	76.77
South Pole Carbon Asset Management Ltd.	7	2.26	79.03
Standard Bank Plc	1	0.32	79.35
Swiss Carbon Asset Ltd.	1	0.32	79.68
SwissRe	3	0.97	80.65
Trading Emissions PLC, Intertrust (NL)	2	0.65	81.29
Vitol SA	53	17.10	98.39
Vitol SA, Ecosecurities Group PLC	1	0.32	98.71
Vitol SA; Carbon Resource Management	4	1.29	100.00
Total	**310**	**100.00**	



Declaration

under Art. 28 Para. 2 RSL 05

Last, first name: Giger Cornelia

Matriculation number: 06-112-841

Programme: M.Sc. in Climate Sciences (Specialization in Economics)

Bachelor ☐ Master x Dissertation ☐

Thesis title: Additionality of Swiss-Chinese CDM Projects............................

Thesis supervisor: Prof. Dr. Ralph Winkler

Dr. Christian Almer (Co-Supervisor)

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person, except where due acknowledgement has been made in the text. In accordance with academic rules and ethical conduct, I have fully cited and referenced all material and results that are not original to this work. I am well aware of the fact that, on the basis of Article 36 Paragraph 1 Letter o of the University Law of 5 September 1996, the Senate is entitled to deny the title awarded on the basis of this work if proven otherwise.

Bern, 20 May 2012..
Place, date

....
Signature