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Measuring the Risk of Investments in Climate Change Mitigation: A Composite Indicator

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1 Preface

This report presents the results of work package 1 of the project "Technology Transfer and Investment Risk in International Emissions Trading (TETRIS)". TETRIS has been financed by the European Commission under the Sixth Framework Programme. It explores the economic and industrial impacts as well as the prospects for achieving technology transfer associated with the implementation of the Kyoto flexible mechanisms.

The objective of work package 1 was to develop an indicator of the risks of investing in climate change mitigation projects. The cost side of investments in greenhouse gas mitigation is considered in work package 3 of the TETRIS project, which derives marginal abatement cost curves (MAC curves) on the basis of detailed energy and technology bottom-up models. The results of both studies will be incorporated into the analysis of emissions trading markets in work package 6 of the TETRIS project. All TETRIS reports can be downloaded from the project website (http://www.zew.de/TETRIS).

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2 Introduction

In the Kyoto Protocol, industrialised countries have agreed to a total cut in greenhouse gas (GHG) emissions of 5% from 1990 levels in the commitment period 2008-2012. In order to minimise the cost of compliance, three innovative **flexible mechanisms** have been defined: the Clean Development Mechanism (CDM), Joint Implementation (JI) and International Emission Trading (IET). The basic idea behind these flexible mechanisms is to reduce GHG emissions where this can be achieved at lowest cost: Industrialized nations with high abatement costs invest in mitigation activities in developing countries with low abatement costs, thereby reducing the economic cost of climate change mitigation to society.

One important field of research revolves around the question to what extent the flexibility mechanisms will be utilised and how great their potential to reduce the costs of achieving the commitments of the Kyoto Protocol is. A variety of models of the market for tradable greenhouse gas emission permits have been built in order to quantify these costs.[1] Bernstein et al. (1999), Böhringer (2000), Criqui and

[1] For a survey of the results and methods used see Springer (2003c).

Viguier (2000), Ellerman et al. (1998), Manne and Richels (1999), McKibbin et al. (1999), Nordhaus and Boyer (1999), and Sijm et al.(2000) analyse the cost efficiency and distributional implications of emissions trading at the global level under the Kyoto Protocol. They all find that emissions trading have the potential to substantially reduce the economic cost of meeting the targets of the Kyoto Protocol.

However, most existing studies ignore the **risks** associated with investments in climate change mitigation and emissions trading. Yet, these risks are likely to be substantial: Most climate change mitigation projects are located in developing countries, where regulatory certainty as well as economic and political stability is often weak. Using real data from pilot projects, Laurikka and Springer (2003) and Springer (2003a) show that the risks of investments in climate change mitigation are remarkably high. Taking investment risks into account reduces the likely benefits and scope of the flexible mechanisms considerably. Since investment risks differ across countries, incorporating investment risk also has an impact on the regional distribution of climate change mitigation (see Springer, 2003b).

In this paper, we develop a composite **indicator of the risks of investing in climate change mitigation projects**. Our contribution differs from previous work such as Jung (2006) and Fankhauser and Lavric (2003) in several respects. First, we focus on investment risks and do not incorporate the mitigation potential. Second, we produce a comprehensive risk indicator on the basis of a much broader pool of data from 143 countries.

Different classifications of risks associated with investments in climate change mitigation have been proposed in the literature.[2] Our composite indicator consists of three components:

- Institutional environment for JI and CDM activities
- Regulatory environment
- Economic environment

Information pertaining to each component has been gathered, weighted and aggregated. The resulting composite indicator ranks the countries according to the total risk of investing in GHG abatement projects.

The remainder of the paper is organised as follows: In section three, a short description of the flexible mechanisms of the Kyoto Protocol will be given, followed by a brief discussion of the causes and determinants of foreign direct investment and investments in climate change mitigation. In the fourth section, we describe each component of the risk indicator as well as our data sources. The values of the indicator for all countries are given in section five. Section six contains a summary and conclusions. Details about the compilation method and the data used are provided in Appendixes A and B.

[2] Janssen (1998) classifies the risks into three categories: technological, economic and political risks. Larson/Parks (1999) differentiate between private performance risk, price risk and sovereign or policy risk.

3 Investments in Climate Change Mitigation

3.1 The project-based mechanisms of the Kyoto Protocol

The Kyoto Protocol contains three so-called Kyoto Mechanisms which allow for spatial flexibility of emission reductions. These are:
- International Emission Trading (IET)
- Joint Implementation (JI)
- Clean Development Mechanism (CDM)

IET refers to the trade of emission rights between signatory states of the Kyoto Protocol. It can be considered an international cap-and-trade system, where emission allowances are exchanged between countries. JI and CDM, in contrast, are project-based mechanisms, where emission credits are produced by reducing GHG emissions below their business-as-usual path. Unlike IET, JI and the CDM necessarily involve investments in cleaner technology. For this reason, we focus only on the project-based mechanisms in the subsequent analysis.

3.1.1 Joint Implementation

Joint Implementation (JI) under the Kyoto Protocol involves a deal between two **countries with emission targets** under the Kyoto Protocol, in which emission credits resulting from a specific project are exchanged. In a JI project, GHG emissions are reduced by technical or organisational measures below the business-as-usual path commonly referred to as the **baseline**. Emission credits generated in the project equal the difference between baseline emissions and (actual) project emissions. JI projects can generate tradable credits called emission reduction units (ERUs) from the year 2008.

To be eligible for JI, a country must have a system for the estimation of emissions and a national registry in place. Moreover, it has to comply with reporting requirements under the United Nations Framework Convention on Climate Change (UNFCCC). If a country meets these requirements, it may approve JI projects in a simple procedure called **track 1**. In this case, the **project cycle** is quite short:

- Project developers describe the project in a project idea note (PIN)
- The national focal point pre-approves the PIN
- Project developers elaborate a project design document (PDD)
- The national focal point approves the PDD
- The JI project is implemented
- The host country verifies emissions and issues ERUs

If the host country does not meet all the eligibility requirements, **track 2** procedures apply. In this case, the project cycle is longer. The PDD must be approved

by an accredited independent entity as well as the JI supervisory committee. Furthermore, the operation and emission monitoring of the project must be validated by an accredited independent entity.

The JI supervisory committee has been established at the Meeting of the Parties in Montreal. It held its first meeting in February 2006, where it adopted draft rules of procedure.

Eastern European countries were considered to be the main host countries for JI projects. This is confirmed by recent data about the regional distribution of projects. Most of the 112 JI projects which have reached validation status are located in the Czech Republic, Bulgaria Russia and Ukraine (updated June 2006, see Table 21 in the Appendix). With the exception of New Zealand which hosts up to now 5 projects, all the other projects are located in Eastern Europe. However, recent policy developments have reduced the scope for JI in Eastern Europe significantly. This is due to the EU emissions trading scheme (EU ETS) which covers installations accounting for the bulk of CO_2 emissions. Installations falling under the EU ETS receive fewer allowances if they sell ERUs, which makes JI unattractive to them.[3]

Investors in JI projects face substantial **risks**: If the baseline of a (track 2) project changes, the total amount of emission credits may be reduced significantly. Even if the baseline remains constant, the number of ERUs is uncertain, as it depends on actual emissions. For both procedures there is also the risk of changes in the regulatory environment, which may affect both the cost and the revenue sides of JI projects.

3.1.2 The Clean Development Mechanism

The Clean Development Mechanism (CDM) involves a deal between an **industrialised country** with emission targets under the Kyoto Protocol and a **developing country** without a target. As in the case of JI, emissions are reduced by technical or organisational measures in specific projects. The main difference between JI and the CDM is that CDM host countries do not have any emissions targets and therefore incentives for overstating the emissions reductions are much larger for CDM than for JI host countries. To avoid excess issuance of emission credits, it is crucial that projects only receive credits for reductions which are additional to what would have been done anyway. To this end, project participants have to prove that they achieve real, measurable and **additional** emission reductions. The Executive Board of the CDM reviews the methodologies used to show additionality of projects. If a methodology is approved, it may be used in future projects under comparable circumstances. CDM projects can generate credits called Certified Emission Reductions (CERs) from the year 2000 on. The CDM **project cycle** involves the following steps:

– Project developers describe the project in a project idea note (PIN)

[3] See Blachowicz (2006), JI and Emissions Trading in Eastern Europe, TETRIS Deliverable 3.

- Designated national authority pre-approves the PIN
- Project developers elaborate a project design document (PDD)
- Designated national authority approves the PDD
- The project is implemented
- Designated operational entities validate the project
- The CDM Executive Board registers the project and issues CERs

As of June 2006, the CDM Executive Board has accepted 61 methodologies to determine the amount of emission reductions, which can be used in other projects. A total of **860 CDM projects** have reached at least validation status. The majority of them are located in Asia & Pacific (67%) and Latin America (26.9%). Africa and Europe host only very few CDM projects (see Table 1). 191 projects have been registered by the CDM Executive Board, and 25 projects have been issued CERs. Since the international transaction log has not been established, the transfer of these emission rights to the national accounts of their owners has not yet been possible.

Table 1: CDM Projects by Region (at Least Validation Status)

Region	**Number of projects**	**Total amount of credits (1'000 CERs until 2012)**
Latin America	325	279'015
Asia & Pacific	497	694'505
Europe (Armenia, Cyprus, Moldova)	10	3'000
Sub-Sahara Africa	15	40'474
North Africa and Middle East	13	18'858
Total	**860**	**1'035'851**

Source: Fenhann (2006), CDM pipeline overview (updated 20 June 2006).

Risks for investors in CDM projects depend on the nature and the stage of the project. Early in the project cycle, it is uncertain whether a project will deliver emission reductions at all. This risk is eliminated when a project is registered. However, the number of ERUs is still uncertain, as production and project emissions will vary over time. Since project owners in developing countries tend to be small companies without credit rating, there is also a substantial counterparty risk involved in investments in CDM projects. Finally, the regulatory framework on the national or international level may change, which constitutes a regulatory risk.

3.2 Theoretical background: International Trade and Investment

International trade is based on different resource endowments. Economies with abundant natural resources trade with economies which do not have such riches, countries with a high capital stock invest in countries lacking capital, et cetera. In principle, the benefits of trade could be exploited without **international investment**. Companies could purchase goods from other countries without having to acquire ownership of production factors abroad. However, multinational companies often find it profitable to operate subsidiaries in other countries. **Foreign direct investment** (FDI), as this is called, is driven by internalization strategies.[4] Owning facilities in other countries allows multinational enterprises to exploit the benefits of vertical integration without being exposed to delivery or price risks from its suppliers. Another reason for holding productive assets in foreign countries is technology transfer. Since technological knowledge is hard to value and control, it is more easily transferred and protected within a company.

Old and inefficient production facilities in developing and transition countries offer opportunities to reduce GHG emissions at low cost. Therefore, **international emissions trading** are also based on different resource endowments, just as any other international trade. As Arquit Niederberger and Saner (2005) note, "… low-cost greenhouse gas emission reduction and sink potentials will have to be added to the list of relevant initial endowments".[5]

Obviously, the availability of low-cost mitigation options is a necessary condition for undertaking investments in climate change mitigation in a developing country. However, many other factors also influence investment decisions of multinational companies. Fig. 1 shows **host country determinants of FDI**. The main categories are

- the policy framework,
- economic determinants, and
- the business environment

The policy framework includes general factors such as economic and social stability as well as specific policies regarding FDI. Economic determinants of FDI are related to the size and growth of the market, the availability of resources such as labour and raw materials, and the cost of assets and resources. The business environment includes all matters relevant to conducting business, such as investment promotion and incentives, hassle costs and social amenities.

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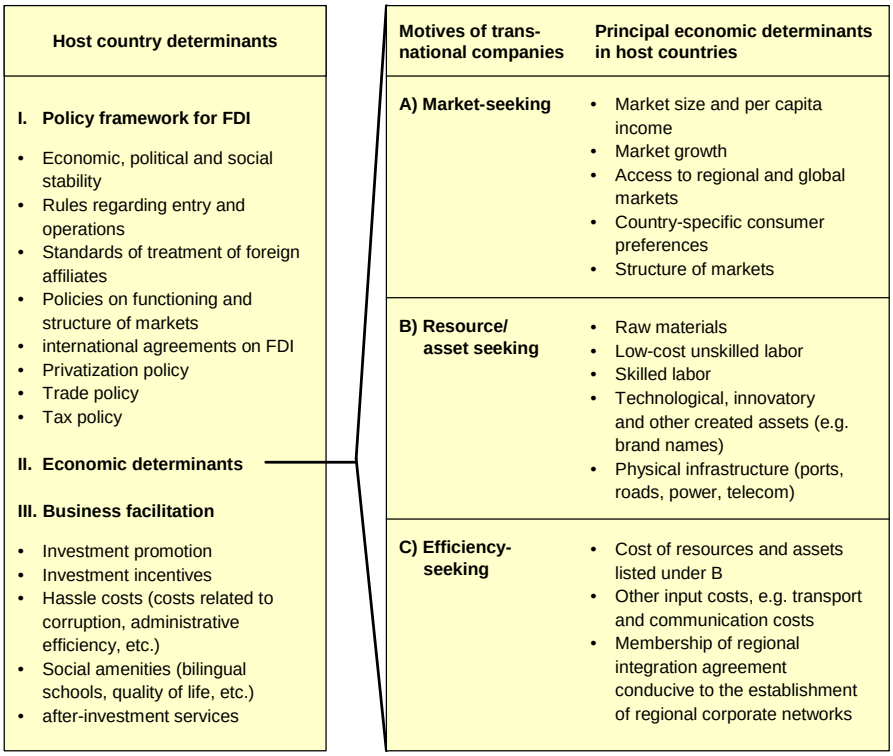
4 See Krugman and Obstfeld (1994), International Economics, p. 160.

5 Arquit Niederberger and Saner (2005), Exploring the relationship between FDI flows and CDM potential, p. 9.

Fig. 1. Host Country Determinants of FDI



Source: UNCTAD (1998), World Investment Report 1998, p. 91.

Like FDI, investments in climate change mitigation projects involve a long term commitment and the engagement of considerable assets.[6] Consequently, the host country determinants of FDI are also relevant for investors in JI and CDM projects. The policy framework in a specific country may favour or discourage investors from engaging in climate change mitigation projects in that country. China, for example, has introduced a CER tax which is differentiated according to project types.[7] Obviously, this tax influences the flow of inbound capital and reduces the attractiveness of CDM investments in China.

There are also significant **differences** between FDI and investments in climate change mitigation. For example, demand for CERs comes from both governments and the private sector, whereas governments do not engage in FDI. In addition, most FDI flows to the service sector, whereas CDM activities tend to focus on the

6 See UNCTAD (1998), World Investment Report 1998, p. 90.

7 The tax rate is 65% for HFC23, 30% for N2O and 2% for renewable energy projects. See Michaelowa and Michaelowa (2005).

energy and manufacturing sectors.[8] Nevertheless, we believe that the above framework represents a useful starting point for analysing the risks of investments in climate change mitigation projects.

In the following chapter, we describe the risks associated with investments in GHG mitigation projects, existing methods to measure them as well as our own approach and indicator.

4 Risks of Investing in Climate Change Mitigation Projects

4.1 Overview of Literature

Which factors may adversely affect the outcome of climate change mitigation projects? Which risks are the most relevant for investors in JI and CDM projects?

In one of the first papers on this topic, Janssen (2001, p. 78) distinguishes

- technological risks
- economic risks, and
- political risks

Technological risks emerge from the process of production. In JI and CDM projects, technological risks may relate to conventional technical problems such as failures of manufacturing equipment. A more specific source of risks are problems related to the avoidance of GHG emissions itself, such as modifications of a project's baseline or emission factors.

Economic risks are rooted in the uncertainty surrounding the market environment of economic activity. Prices of input and labour vary over time and change the cost of production. The demand for final products is influenced by many factors which are hard to predict. Since emission reductions are often a by-product of industrial activity, they are subject to quantity risk as well.

Uncertainty over property rights are referred to as **political risks**. They range from minor risks such as changes of the regulatory environment (permits, taxes, etc.) to serious threats like expropriation. For investments in climate change mitigation, political risks are highly relevant since the carbon markets are based on 'artificial scarcity' imposed by government regulation.

When we attempt to **measure** these risks, it is important to distinguish between project-level and country-level analysis. Technological risks are highly project-specific. Political risks, in contrast, mainly depend on government policy and are thus unlikely to vary within a country (apart from highly controversial projects such as large-scale hydro or nuclear power projects). Economic risks include pro-

[8] See Arquit Niederberger and Saner (2005), Exploring the Relationship between FDI Flows and CDM Potential, p. 30.

ject-specific factors such as the level of production or abatement costs as well as country-specific factors like input prices or interest rates. The risk indicator which we develop covers only risks at the **country-level**. Assessing risks which are relevant to specific projects or project types is beyond the scope of our analysis.

Several authors have used indicators of investment risks in their analysis of climate policy and emissions trading. Springer (2003b) examines the effect of investment risk on the composition of an optimal portfolio of global GHG mitigation activities. In his analysis, the volatility of the growth rate of regional CO_2 emissions is used as a proxy for investment risk. Böhringer and Löschel (2002) address the same question using the level and volatility of interest rate spreads as a proxy for investment risks. Jung (2006) assesses the attractiveness of CDM host countries based on cluster analysis. She draws on data from a broad number of sources to approximate the emission reduction potential, institutional CDM capacity, and the general investment climate in 114 countries. Fankhauser and Lavric (2003) use a similar approach for JI host countries in East and Central Europe. Point Carbon produces a rating of 25 major JI and CDM host countries. It is based on the analysis of the institutional environment for JI and CDM, the general investment climate, the potential for GHG reduction projects, and the number and status of JI or CDM projects.

4.2 A composite indicator of the risk of investing in GHG mitigation projects

We distinguish three broad categories of risks associated with investments in climate change mitigation projects (see Table 2): The institutional environment for JI and CDM, the regulatory environment in the host country, and the economic environment.

Table 2: Three Main Components of Investment Risk Indicator

Component	Description
Institutional environment	A country that has established local competence centres and has experience in dealing with GHG abatement projects boasts a better investment climate than a country where such institutions and experience are lacking.
Regulatory environment	Sound business-related regulation, enforcement of property rights and low levels of corruption favour the successful implementation of GHG mitigation projects.
Economic environment	Countries with high macroeconomic stability and good access to capital markets provide more certainty and predictability for investors.

These categories resemble the three main determinants of FDI shown in Fig. 1. Instead of the policy framework for FDI, we use the institutional environment for the Kyoto mechanisms. Our category “Regulatory environment” corresponds to

the category “Business facilitation” in the UNCTAD framework, and the category “Economic environment” has many elements in common with the economic determinants according to the UNCTAD report.

The indicator which we develop differs significantly from previous work. Unlike Jung (2006), Fankhauser and Lavric (2003) and Point Carbon, we focus solely on investment risks and do not take the mitigation potential into account. Our indicator thus reflects only **investment risks**, whereas those provided by Jung (2006), Fankhauser and Lavric (2003) and Point Carbon measure the **attractiveness** of host countries for JI and CDM projects. The second difference is the range of host countries. We do not focus on a specific region or on the major host countries only. We produce a risk indicator on a global scale, covering 143 industrialised and developing countries.

In the subsequent sections, we describe each of the three main components of our indicator, the variables they comprise and data sources.

4.3 Institutional Environment for JI and the CDM

4.3.1 Joint Implementation

As described in section 2.1.1, JI features two different project cycles. If a country meets the eligibility criteria, the project cycle under track 1 is quite short and consequently more attractive for investors. The JI project cycle under track 2 is longer and involves more parties. However, most of the countries will not meet the eligibility criteria in the near future. For investors, however, it is most important that JI policies and institutions are being set up with clear responsibilities in order to minimize bureaucratic hurdles, increase transparency and ensure independence from political interests (see OECD/IEA, 2002).

To determine the conditions of JI institutions of the host country, we take into consideration the following indicators (see Table 3):

- **Ratification of the Kyoto Protocol**
- **Establishment of a Designated National Authority (DNA)**[9]: DNAs play an important role in the JI project cycle. They pre-approve both PIN and PDDs. A functioning DNA therefore is a prerequisite for hosting JI in a country.
- **Establishment of a National Registry:** To be eligible for JI, a country must have a National Registry in place.
- **Participation in capacity building programs:** Several capacity building programs have been designed in order to help develop the national skill of host countries regarding the application of the flexible mechanisms to reduce GHG emissions. Countries which took part in such programmes took the opportunity

[9] In the context of JI, the Designated Focal Point (DFP) is the relevant institution. However, the UNFCCC has to date not published a list of DFP. It can be expected, that the current DNA will take over the work of the DFP. Under these circumstances, the DNA is a good proxy.

to enhance their institutions and signal their willingness to host JI. We have looked at programmes conducted by major multilateral or national organizations. The following programs have been examined: National Strategy Study launched by the World Bank and the Swiss Government[10], Carbon Finance-Assistance program providing technical assistance to implement CDM/JI projects[11], UNEPs "Capacity Development for the Clean Development Mechanism" program aimed at developing institutional and human capacity in 12 developing countries, UNIDO's CDM capacity building program for francophone African countries, Integrated Capacity Strengthening for CDM in South-East Asia.

- **Memoranda of Understanding (MoU)** with other countries: MoUs express political commitment and the intention for bilateral co-operation. However, the existence of a MoU is not a necessary condition for co-operation.
- Declaration of **JI policy** in the latest National Communication: National Communications have to be submitted to the UNFCCC according to decision 1/CP.9. Together with the annual greenhouse gas inventories, they are the main sources of information for reviewing the implementation of the Convention. Countries which explicitly state their policy toward a flexible mechanism – in this case JI – are more likely to develop good institutions than countries which do not.
- **Experience:** Institutions can further improve their institutional capacity while dealing with real projects. An increasing number of projects provide opportunities to gain experience, develop processes for approval and registration in the host country, and support the process of learning. We therefore include variables which indicate the level of experience an institution has made so far. This includes participation in the Activities Implemented Jointly (AIJ) program[12] as well as the number of JI projects at validation level.

The **track record** of host country approval would be an interesting indicator for the institutional environment as well. Unfortunately such information is not readily available for a vast set of countries. Therefore, this indicator cannot be considered.

10 Launched in summer 1997 and closed by the end of February 2004.

11 Launched in summer 2003 by The World Bank Carbon Finance Unit.

12 In order to build experience and "learn by doing", COP 1 (Berlin, March/April, 1995) launched a pilot phase called Activities Implemented Jointly (AIJ), under which Annex I Parties could implement projects in other countries that reduce emissions of greenhouse gases or enhance their removals through sinks. For a description and evaluation of the AIJ program, see Schwarze (2000) and Springer (2003a).

4.3.2 Clean Development Mechanism

In the case of the CDM, investors have to go through a complex project cycle in order to obtain CERs. The host country institution involved is the Designated National Authority (DNA), which needs to approve each project in the sense that it "assists in achieving sustainable development" (Paragraph 40a).

In order to determine the condition of a CDM institution in a host country, we consider the same variables as for JI:

- Ratification of the Kyoto Protocol
- Establishment of a DNA
- Participation in a capacity-building program
- Number of Memoranda of Understanding (MoU) signed with other countries
- Declaration of CDM policy in the latest National Communication.

CDM host countries as well had the opportunity to participate in AIJ which was aimed at improving their know-how. Further, the number of planned and existing CDM projects is an indicator of the quality of the CDM institutions of the host country. The CDM projects can be at different stages: at validation[13], validated[14] or registered[15] (see Table 3).

[13] At validation means that a Designated Operational Entity (DOE) is validating the CDM project proposal.

[14] Validated means that the UNFCCC secretariat has received a complete submission from a DOE including the payment of the registration fee. This category includes projects for which a review has been requested or carried out.

[15] Registered means that the EB has approved and registered the CDM project, which is then publicly available.

Table 3. Tracking Institutional Environment and Experience: List of Variables

Variable	Source	Dimension
Institutional Environment for JI (Host: Annex I Parties)		
JI Institutions		
Ratification of the Kyoto Protocol	UNFCC	Yes/No
DNA established	UNFCC	Yes/No
National Registry established	UNFCC	Yes/No
National Communication submitted	UNFCCC	Yes/No
Capacity-building programs	Different programs	Number
Memoranda of Understanding (MoU)	Homepage DNA	Number
JI policy expressed in NC	National Communication (NC)	Yes/No
Experience		
AIJ projects implemented	UNFCC (2002)	Number
JI projects	UNEP Risoe Centre	Number
- At validation		
Institutional Environment for CDM (Host: Non-Annex I Parties)		
CDM Institutions		
Ratification of the Kyoto Protocol	UNFCC	Yes/No
DNA established	UNFCC	Yes/No
National Communication submitted	UNFCCC	Yes/No
Capacity-building programs	Different programs	Number
Memoranda of Understanding (MoU)	Homepage DNA	Number
CDM policy expressed in NC	National Communication (NC)	Yes/ No
Experience		
AIJ projects implemented	UNFCC (2002)	Number
AIJ projects	UNEP Risoe Centre	Number
- At validation		
- Validated		
- Registered		

4.4 Regulatory Environment

In this context, the regulatory environment refers to the protection of property rights and conduct of business. Through this channel, potential actions of government affect expected returns on investment and therefore highly influence the allocation of foreign direct investments (FDI).[16] According to Arquit Niederberger and Saner (2005), CDM projects are comparable to FDI only to a certain extent. However, both are influenced by the regulatory environment in the respective host countries. The same holds true for JI projects.

The regulatory environment contains three subcomponents: enforcing contracts, starting a business and registering property (see Table 4). All three subcomponents are based on three variables each measuring the number of procedures, days and cost for doing one of the activity. Source is the World Bank (2005) Doing Business Report.

Table 4. Regulatory Environment: List of Variables

Variable	Source	Dimension
Enforcing contracts		
Procedures to enforce a contract	World Bank, Doing Business	Number
Days to enforce a contract	World Bank, Doing Business	Number
Cost to enforce a contract	World Bank, Doing Business	% of debt amount
Starting a Business		
Procedures to start a business	World Bank, Doing Business	Number
Days to start a business	World Bank, Doing Business	Number
Cost to start a business	World Bank, Doing Business	% of debt amount
Registering Property		
Procedures to register property	World Bank, Doing Business	Number
Days to register property	World Bank, Doing Business	Number
Cost to register property	World Bank, Doing Business	% of debt amount

4.5 Economic Environment

The category "Economic environment" refers to the uncertain future developments of the economy of the host country. In the context FDI, the most important determinant of economic risks is the stability of a country's currency (see Oetzel

[16] Bilson/Brailsford/Hooper (2002), The explanatory power of political risk in emerging markets, p. 2.

et. al., 2001). According to Janssen (1998), currency risks do not have a high significance in the context of JI and CDM projects, since "the pure gross return … consists of the additional emission reductions which are credited in the home country of the JI investor". Currency risks therefore do not represent an important factor in the context of climate change mitigation. However, the whole economic environment does play an important role, since most of the projects are not solely conducted in return for emission reduction units (ERUs) or certified emission reductions (CERs). Instead they are based on a variety of streams of revenues, the return for ERUs and CERs being one of them.

Our category "Economic environment" consists of three variables: the average level of inflation in the last ten years, the external debt in percent of the GDP, and the corruption level (see Table 5).

Interest rate spreads are considered to be a good measure of the country risk from the perspective of a foreign investor. This feature makes it a good indicator of the economic environment. Unfortunately, due to lack of data for a broad range of countries, this indicator could not be included in our analysis.[17]

Table 5. Economic Environment: List of Variables

Variable	Source	Dimension
Inflation	World Development Report 2005	%, av. 10 years
External Debt	World Development Report 2005	% of GDP
	Global Development Finance 2005	
Corruption	Transparency International, 2005	Corruption perception index, between 10 (highly clean) and 0 (highly corrupt).

[17] Interest rate spreads were only available for 53 of the 143 countries considered in our analysis.

5 Composite Indicators of Investment Risk for Climate Change Mitigation Projects

5.1 Approach

Investors in climate change mitigation projects face several risks at different levels. Some risks are country-related while others are highly project-specific (e.g. technological risk). Our approach is to develop a composite indicator for country-level risks which contains different aspects of risk. As shown in chapter 4 we distinguish three main aspects or components:

- Institutional environment for JI and CDM activities
- Regulatory environment
- Economic environment

Each of the three components is subdivided into sub-components, which in turn consist of three to seven variables (see Table 6). The variables are the fundamental building blocks of our composite indicator.

Each variable measures relevant aspects of risks an investor in climate change mitigation faces in a country. Due to data gaps not all relevant aspects could be covered. For example we were not able to include the track record of host country approval, which indicates how reliable and efficient the host country institutions work. In such a case we use proxy-variables which indicate the host countries institutional efficiency (in this case the number of planned and existing JI and CDM projects). Despite some remaining gaps, we think the variables we use provide a consistent picture of the risks of investing in climate change mitigation projects.

Before compiling the composite risk indicator, we divided the countries into two groups. One group are the so called Annex I countries, which can host JI projects. The other group are the remaining Non-Annex I countries which may host CDM projects.

The compilation of these two composite indicators has been done in five steps. After collecting the data we looked in the first step at the **data coverage** of each country. Our aim was to include as many countries as possible. From the initial 193 countries we had to exclude 50 since they did not contain enough data (see chapter 7.1.1).

In a second step we filled the **missing data** points for the remaining 143 countries. After checking different methods we finally settled for the unconditional mean imputation (see chapter 7.1.2).

In order to make the variables comparable to each other we **transformed and normalised** them in a third step. The transformation ensured that for each variable the principle “the more the better” is valid. The normalisation (or z-score) makes all variables comparable while converting them into a common scale and distribution (see chapter 7.1.3).

Table 6. List of all Components and Variables

Component	Sub-component	Variable Code	Variable
Institutional Environment	JI Institutions	KR	Ratification of Kyoto Protocol (Yes/No)
		DNA	DNA established (Yes/No)
		NR	National registry established (Yes/No)
		NCO	National communication submitted
		CBP	Number of capacity-building programs
		MOU	MoUs with number of countries
		POL	JI policy expressed in NC (Yes/No)
	CDM Institutions	KR	Kyoto ratification (Yes/No)
		DNA	DNA established (Yes/No)
		NCO	National communication submitted
		CBP	Number of capacity-building programs
		MOU	MoUs with number of countries
		POL	CDM policy expressed in NC (Yes/No)
	JI Experience	AIJ	Number of AIJ projects implemented
		AVAL	Number of JI projects at validation
	CDM Experience	AIJ	Number of AIJ projects implemented
		AVAL	Number of CDM projects at validation
		VAL	Number of CDM projects validated (request for registration or under review)
		REG	Number of CDM projects registered
Regulatory Environment	Enforcing Contracts	PROCC	Number of procedures to enforce a contract
		DAYC	Days to enforce a contract
		COSTC	Cost to enforce a contract (% of debt amount)
	Starting a Business	PROCB	Number of procedures to start a business
		DAYB	Days to start a business
		COSTB	Cost to start a business (% of income per capita)
	Registering Property	PROCP	Number of procedures to register property
		DAYP	Days to register property
		COSTP	Cost to register property (% of property value)
Economic Environment	Economic and Default Risk	INFL	Inflation (average last 10 years)
		DEBT	External debt (% of GDP)
		CORR	Corruption perception index (10=highly clean, 0=highly corrupt)

MoU: Memoranda of Understanding; NC: National Communication; AIJ: Activities Implemented Jointly; DNA: Designated National Authority.

In the fourth step we gave each variable a weight. The weight represents the importance of a variable. Each investor has a different notion of which risks are relevant. Some investors will consider the institutional environment the most im-

portant factor while for others, the regulatory environment plays a much important role. Given the diversity of risk perception, there will never be agreement on how to allocate weights to the variables. We settled on a weighting based on a statistical method called **principal component analysis** (PCA). The PCA allocates weights according to the correlation between variables. Variables with high correlation indicate overlapping information and receive low weights, whereas variables with low correlation contain information not covered by other variables and receive high weights. For further details on the weighting method see chapter 7.1.4. In the fifth and last step we **summarised** the weighted variable scores for Annex I and Non-Annex I countries. The result is a ranking of Annex I and Non-Annex I countries with respect to the risks of investments in climate change mitigation projects.

5.2 Composite Indicator: Annex I countries

Our composite indicator (CI) measures the risks involved in investments in climate change mitigation projects. In this chapter we look at countries that can host JI projects (i.e. Annex I countries). Recall that the CI reflects only risks and does not take the investment potential (amount or costs of mitigation options) into account.

At the **top** of the ranking are highly **developed countries** like New Zealand, Denmark, Sweden and Norway which boast a very good regulatory and economic environment (see Table 7). However, their score on Kyoto-related institutions is very often slightly above the average. This is because on the one hand they often fulfil all the institutional requirements (e.g. ratification of the Kyoto Protocol, submission of National Communication, etc.), on the other hand they lack experience in hosting JI projects. In contrast, both Eastern European countries – the Czech Republic and Slovakia – that made it to the top ten have above average scores in the field of institutional environment, but only average scores for the regulatory and economic environment. Estonia, Latvia, Romania and Hungary also have good scores for JI institutions, but inferior ones for the remaining two components.

At the bottom **end** of the ranking are mostly Eastern and South Eastern European countries that not only lack institutional capacity but also have a poor regulatory and economic environment.

Countries in the **middle** of the ranking consist of different types. On one side there are for example Australia and USA which have a good regulatory and economic environment but did not join the Kyoto Protocol and therefore have poor scores on institutions. On the other side there are countries with average score for all three components (e.g. Austria or Italy).

Table 7. Composite Indicator for Annex I Countries: Ranking and Scores

Rank	Nation	CI	Score of Components		
			Institution	Regulation	Economy
1	N. Zealand	0.53			
2	Denmark	0.51			
3	Sweden	0.43			
4	Norway	0.40			
5	Finland	0.36			
6	Canada	0.35			
7	Switzerland	0.35			
8	Czech Rep.	0.34			
9	UK	0.29			
10	Slovakia	0.27			
11	Estonia	0.27			
12	Iceland	0.25			
13	Netherlands	0.25			
14	Latvia	0.25			
15	Germany	0.17			
16	Lithuania	0.16			
17	Japan	0.16			
18	Austria	0.12			
19	France	0.10			
20	Australia	0.01			
21	Romania	0.00			
22	Hungary	0.00			
23	Ireland	-0.06			
24	Italy	-0.09			
25	Belgium	-0.10			
26	USA	-0.11			
27	Spain	-0.14			
28	Russia	-0.16			
29	Poland	-0.19			
30	Slovenia	-0.27			
31	Bulgaria	-0.35			
32	Ukraine	-0.39			
33	Portugal	-0.42			
34	Greece	-0.44			
35	Turkey	-0.90			
36	Belarus	-0.96			
37	Croatia	-0.99			

Weights of the components: Institution 44%, Regulation 40%, Economy 16%.

5.3 Composite Indicator: Non-Annex I countries

In this chapter, we look at countries that can host CDM projects (Non-Annex I countries). Again we only consider risks associated with investments in climate change mitigation projects in those countries. The scope for investment possibilities has not been part of our assessment.

On the top of the list are India, China, Mexico, Brazil and Chile (see Table 8). All of them have a high overall score because of their excellent Kyoto-related institutions. The regulatory and economic environment is either average or slightly above. India's overall score is very high and mostly attributable to the high number of CDM projects at validation level which gives the institutions involved a great boost of experience and routine.

Below the top-scoring nations there are countries like Morocco, South Africa, Costa Rica, Argentina, Colombia and Bolivia which have put some effort into building up CDM institutions and/or have gained some experience with AIJ or

CDM projects. Still further down the ranking we find countries with above-average scores for the institutional environment (Uganda, El Salvador, Nicaragua, Viet Nam, Peru, Guatemala, Honduras and Ecuador). They can be described as countries with a relatively low investment climate but good institutions concerning CDM projects.

Table 8. Composite Indicator for Non-Annex I Countries: Ranking and Scores (Rank 1-52)

Rank	Nation	CI	Score of Components Institution	Regulation	Economy
1	India	1.87			
2	China	0.96			
3	Mexico	0.90			
4	Brazil	0.82			
5	Chile	0.73			
6	Morocco	0.60			
7	Singapore	0.55			
8	South Africa	0.47			
9	Costa Rica	0.45			
10	Tunisia	0.43			
11	Argentina	0.42			
12	Thailand	0.40			
13	S. Korea	0.37			
14	Colombia	0.32			
15	Malaysia	0.32			
16	Bolivia	0.29			
17	Nepal	0.28			
18	Uganda	0.27			
19	El Salvador	0.26			
20	Nicaragua	0.26			
21	Jamaica	0.24			
22	Viet Nam	0.22			
23	Sri Lanka	0.22			
24	Mongolia	0.22			
25	Armenia	0.22			
26	Peru	0.21			
27	Guatemala	0.21			
28	Israel	0.20			
29	Georgia	0.17			
30	Honduras	0.15			
31	Panama	0.15			
32	Mauritius	0.13			
33	Fiji	0.12			
34	Uruguay	0.11			
35	Egypt	0.10			
36	Philippines	0.10			
37	Ecuador	0.08			
38	Botswana	0.07			
39	Iran	0.07			
40	Moldova	0.07			
41	Guyana	0.06			
42	Jordan	0.06			
43	Kenya	0.05			
44	Albania	0.03			
45	Zambia	0.03			
46	Oman	0.03			
47	Ghana	0.02			
48	Samoa	0.02			
49	Mali	-0.01			
50	Saudi Arabia	-0.01			
51	Senegal	-0.01			
52	Taiwan	-0.01			

Weights of the components: Institution 47%, Regulation 40%, Economy 12%.

The **low-ranking** countries in Table 9 tend to have not only bad institutions, but also below-average regulatory and economic environments. They consist mainly of war-ridden countries or nations which have just emerged from a conflict.

The countries in the **middle** of the ranks are much more difficult to characterise. Most of them have scores around zero which indicates that they are average performers. Relatively few countries in the middle ranks have components showing strongly into different directions (e.g. Taiwan, Oman, Indonesia, Tonga). Taiwan for example does not have well developed CDM institutions, but good policies and a thriving economy.

Table 9. Composite Indicator for Non-Annex I Countries: Ranking and Scores (Rank 53+)

Rank	Nation	CI	Score of Components Institution	Regulation	Economy
53	Dom. Republic	-0.02			
54	Pakistan	-0.03			
55	Cambodia	-0.03			
56	Azerbaijan	-0.03			
57	Indonesia	-0.04			
58	Bhutan	-0.04			
59	Madagascar	-0.04			
60	Namibia	-0.05			
61	Mauritania	-0.06			
62	Benin	-0.06			
63	Macedonia	-0.06			
64	Solomon Islands	-0.06			
65	Ethiopia	-0.06			
66	Papua N. Guinea	-0.08			
67	Yemen	-0.08			
68	United Arab Emirates	-0.08			
69	Malawi	-0.09			
70	Rwanda	-0.10			
71	Tonga	-0.11			
72	Tanzania	-0.11			
73	Burkina Faso	-0.12			
74	Bangladesh	-0.12			
75	Kuwait	-0.13			
76	Niger	-0.15			
77	Guinea	-0.15			
78	Kazakhstan	-0.16			
79	Cameroon	-0.17			
80	Lesotho	-0.17			
81	Uzbekistan	-0.19			
82	Kyrgyzstan	-0.20			
83	Lebanon	-0.21			
84	Eritrea	-0.21			
85	Paraguay	-0.22			
86	Mozambique	-0.24			
87	Togo	-0.24			
88	Venezuela	-0.25			
89	Algeria	-0.28			
90	Afghanistan	-0.28			
91	Burundi	-0.29			
92	Zimbabwe	-0.29			
93	Serbia-Monten.	-0.33			
94	Côte d'Ivoire	-0.34			
95	Lao	-0.36			
96	Bosnia Herzegovina	-0.40			
97	Iraq	-0.44			
98	Centr. Afr. Rep.	-0.48			
99	Syrian Arab Republic	-0.49			
100	Nigeria	-0.52			
101	Haiti	-0.53			
102	Chad	-0.77			
103	Congo	-0.79			
104	Sierra Leone	-0.81			
105	Angola	-1.27			
106	Dem. Rep. Congo	-1.41			

Weights of the components: Institution 47%, Regulation 40%, Economy 12%.

5.4 Comparison to other rankings

How does our ranking compare to other rankings in this area? Since our approach to include a broad range of countries and to focus on investment risk is new, comparability to existing rankings is limited. Nevertheless, a comparison is meaning-

ful, since it highlights the effects of our alternative approach. We compare our rating to the CDM and JI host country rating of Point Carbon[18] as well as to the results of Jung (2006).

Point Carbon provides information for the power, gas and carbon emissions markets. One of the services it offers to its customers is a regularly updated rating of important CDM and JI host countries. The ranking is based on an assessment of the institutions for JI and the CDM, the general investment climate, the number of status of JI and CDM projects as well as the GHG mitigation potential. Point Carbon only considers countries with a certain potential for climate change mitigation. Countries below this threshold are not included in the ranking. This contrasts with our approach, which is to include as many countries as possible. Furthermore, the mitigation potential constitutes an important element of the Point Carbon rating, which we do not consider in our ranking.

For **Annex I** countries, there are **considerable differences** between the two rankings. Countries like Romania, Bulgaria, Poland, Hungary and Ukraine appear on the top of the Point Carbon ranking, whereas our ranking places them at the lower end of the country list. This can be explained by the great mitigation potentials of these countries, which we do not take into account in our ranking. Fankhauser and Lavric (2003) also consider most of these countries as having the highest scope for JI projects. On the other hand, top scoring countries like New Zealand, Slovakia or Czech Republic are at the bottom end of the Point Carbon list, but are among the best Eastern Europe countries when it comes to the regulatory environment and institutions for the Kyoto mechanisms.

Table 10. Annex I Countries: Point Carbon Rating and CI-Ranking

Country	Ranking Point Carbon [1)]	CI-Ranking	Difference [2)]
Romania	1	21	20
Bulgaria	2	31	29
Poland	3	29	26
Hungary	4	22	18
Ukraine	5	32	27
Estonia	6	11	5
Czech Rep.	7	8	1
New Zealand	8	1	-7
Russia	9	28	19
Slovakia	10	10	0

[1)] Source: Point Carbon, Rating 27 September 2006; [2)] A positive difference means, that a country has a lower CI-ranking.

[18] See http://www.pointcarbon.com.

For **Non-Annex I countries,** the Point Carbon rating and our ranking yield **similar results**. Both list India, China, Chile, Brazil and Mexico in the top 5. This is due to the fact, that these countries not only offer a relatively good investment climate, but also are considered to have a great mitigation potential. Only Indonesia and to a lesser extent Peru and Egypt are found in a significantly lower position in our ranking than in the Point Carbon ranking.

Table 11. Non-Annex I Countries: Point Carbon Rating and CI-Ranking

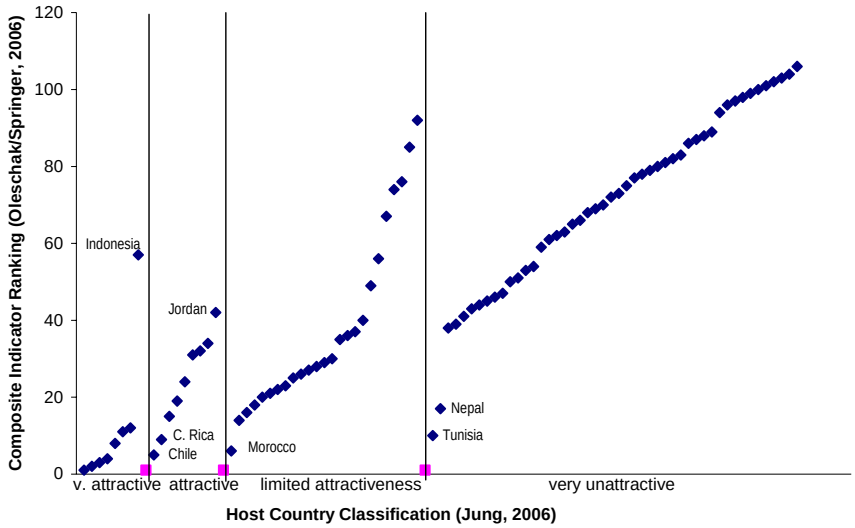
Country	Ranking Point Carbon [1)]	CI-Ranking	Difference [2)]
India	1	1	0
China	2	2	0
Chile	3	5	2
Brazil	4	4	0
Mexico	5	3	-2
Korea	6	13	7
Malaysia	7	15	8
South Africa	8	8	0
Argentina	9	11	2
Peru	10	26	16
Morocco	11	6	-5
Indonesia	12	57	45
Vietnam	13	22	9
Egypt	14	35	21
Thailand	15	12	-3

[1)] Source: Point Carbon, Rating 27 September 2006; [2)] A positive difference means, that a country has a lower CI-ranking.

Jung (2006) analyses host country attractiveness for CDM non-sink projects. She did not produce country rankings, but clusters of countries with similar features. Jung (2006) considers three dimensions: the emission reduction potential, the institutional CDM capacity and the general investment climate. A comparison of her results with our ranking also shows a high similarity (see Fig. 2). Countries like India, China, and Brazil not only have comparably low investment risks, but apparently also a high mitigation potential. This result corresponds to the findings above. Still there are some outliers to be observed. One of them is Indonesia, which Jung – as well as Point Carbon – considers to be a very attractive CDM host country. Our ranking, in contrast, places Indonesia fairly low. Again, the difference can be attributed to the high mitigation potential of Indonesia (which we do not take into account). Besides that, our ranking places countries like Morocco and Tunisia high, whereas Jung classifies them as limited attractive and very unattrac-

tive, respectively. Again, this is due to the (low) mitigation potential in these countries.

Fig. 2. Composite Indicator vs. Host Country Attractiveness (Jung, 2006)



Comparing our ranking to the flows of **FDI**, we find that there is **little correlation** between the attractiveness for FDI and for investments in climate change mitigation. Table 12 shows the countries which received the highest amounts of FDI in 2005. In the top 15 of this list, there are only five countries which appear in the top 10 of our investment risk ratings. The United Kingdom received the highest amount of FDI, but occupies only position 9 in our ranking of JI host countries. Interestingly, China is equally attractive for FDI and CDM investments. India, on the other hand, has the highest score in our ranking, but does not attract sizeable amounts of FDI.

This finding is in line with the literature on this subject. Arquit Niederberger and Saner (2005, p. 34), for example, write: "…the simplistic assumption that CDM financial flows will be correlated closely with FDI flows may not hold".

Table 12. Ranking of FDI Inflows vs. Ranking Based on Composite Indicator

Country	FDI inflows (2005)	Composite Indicator JI	Composite Indicator CDM
United Kingdom	1	9	-
United States	2	26	-
China	3	-	2
France	4	19	-
Netherlands	5	13	-
Hong Kong, China	6	-	-
Canada	7	6	-
Germany	8	15	-
Belgium	9	25	-
Spain	10	27	-
Singapore	11	-	7
Italy	12	24	-
Mexico	13	-	3
Brazil	14	-	4
Russian Federation	15	28	-

Source: UNCTAD (2006), World Investment Report 2006.

6 Summary and conclusions

We have built a **composite indicator** for the risks of investing in climate change mitigation projects. The indicator contains a broad range of variables which measure

- the institutional environment for the Kyoto mechanisms
- the regulatory environment, and
- the economic environment.

Data sources include official statistics, other rankings and indices, UNFCCC publications and other sources. The indicator has been computed for **143 countries**, which we have divided into industrialized countries (JI host countries) and developing and transition countries (CDM host countries). Based on the scores of the composite indicator, we have produced two separate **rankings** for JI and CDM host countries.

We find that the risks of investing in **JI** projects are lowest in New Zealand, Denmark and Sweden. These countries offer very stable regulatory and economic environments. Among the “classic” JI host countries in Eastern Europe, the Czech

Republic (position 8) and Slovakia (position 10) appear to be the least risky places to invest. In the top 5 of the **CDM** ranking we find India, China, Mexico, Brazil, and Chile. The first four of them already host a large number of CDM projects, which has brought them a lot of experience and, consequently, high scores related to the institutional environment for the CDM. In Chile, there are not many CDM projects, but the regulatory and economic environment is better than in the other high-ranking countries.

Our results for **CDM** host countries are quite **similar** to other rankings. For **JI** host countries, however, our ranking exhibits significant **differences** from other rankings. This is due to the fact that we only consider risk factors and do not take the mitigation potential into account. Furthermore, our work has confirmed the view held by other researchers that investments in climate change mitigation do not follow the same patterns as foreign direct investment.

The composite indicator described in this report may be used for several purposes. First, it can be used to make models of international emissions trading more realistic by incorporating investment risks (we attempt to do this in another work package within the TETRIS project). Second, the indicator may be helpful for investors in the carbon market in the processes of **investment allocation and portfolio diversification**. In fact, we believe that for the latter, our indicator is better suited than other existing indicators. Investors assessing a GHG mitigation project or a portfolio of projects are only interested in the risks associated with such an investment, but not in the total mitigation potential of a specific country.

7 Appendix A: Methodology

7.1 Constructing the composite indicator

7.1.1 Step 1: Selection of countries

The initial number of countries considered for our analysis is 193. They consist of the 191 members of the United Nations plus Taiwan and Puerto Rico.

However, not all countries could be considered for our risk indicator. The decision to include a country in the index was based on variable and component coverage. Finally, a total of **143 countries** met the criteria for the risk indicator.

Table 13. Composite Indicator: Number of Countries Covered

Total number of countries	193
Variable Coverage: We exclude countries that have fewer observations than half of the variables (for CDM host countries, there are 24 variables and for JI-Countries 23 variables)	- 29
Component coverage: We also exclude countries that have no observations for one or more variables in at least one component of the indicator	- 21
Number of countries included	**143**

7.1.2 Step 2: Imputation of missing data

Most of the variables have no missing data. Most of the remaining countries have a low prevalence of missing data with less than 5% of the observations missing. The missing data problem is again limited to a small amount of variables, namely the variables for external debt (% of GDP), inflation (average last 10 years), and corruption. Of those three variables only one reaches beyond the 10% missing-rate (see Table 14).

In order to build a composite indicator we need to fill in these gaps. An analysis of the distribution of the missing values could not disclose a pattern, since most of the cases respectively countries concerned have only one missing value each. Countries with two or more missing values are rare and randomly distributed. We therefore assume that the values are **missing at random**. This is an important characteristic, since most of the methods for imputing missing values require a missing at random mechanism (OECD, 2005).

Table 14. Variables with Missing Values: Proportion of Missing Values

Proportion	**Variable Code**	**Variables**
Less than 5% missing	COSTB	Cost to start a business
	PROCC	Number of procedures to enforce a contract
	DAYC	Days to enforce a contract
Between 5% and 10% missing	CORR	Corruption perception index
	INFL	Inflation (average last 10 years)
More than 10% missing	DEBT	External debt (% of GDP)

There are different approaches to fill in the gaps caused by missing values. OECD (2005) provides an overview of several commonly used methods. The most often used methods are the **regression imputation** and the **hot deck imputation**. In case of the latter the blank cells are filled with values from countries with similar characteristics (e.g. region, debt, inflation etc). The regression imputation fills missing data with the predicted values obtained from a regression.

In a first step we applied both methods. We found, that in our case, the hot deck imputation does not deliver reasonable results. Countries in the same region and

with similar debt-levels, for example, do not necessarily have the same inflation. The regression imputation faces the same basic problems. Due to low interdependence the predicted values were close to the mean of the sample.

Therefore, we decided to employ the **unconditional median imputation** method. The missing values are therefore replaced by the sample median of the valid values.

7.1.3 Step 3: Transformation and normalisation

A prerequisite for a composite indicator are variables which can be compared. Data sets often have different measurement units and have to be interpreted differently. Prior to any data aggregation, we therefore have to make the variable sets comparable. To this end, we transform and normalise the data.

Transformation: For each variable the principle "the more the better" must be valid. The variable "Days to enforce a contract", for example, has to be transformed since the more days it takes to enforce a contract, the worse the country will be ranked. In such circumstances we put a negative algebraic sign.[19]

Normalisation: There is a wide range of normalisation methods available (for an overview, see e.g. Freudenberg (2003) or Jacobs et. al. (2004)). We apply the standardisation (or z-scores) method (see box below for the formula), because it has good properties when it comes to aggregation: it converts all variables into a common scale as well as distribution and so makes them comparable. The mean of each standardised variable is zero which avoids distortions arising from different means of the variables.

Standardisation:

For each variable x_{qc}, the mean of all countries $x_{qc=\bar{c}}$ and the standard deviation of countries $\sigma_{qc=\bar{c}}$ are calculated. The normalisation formula is: $I_{qc} = \frac{x_{qc} - x_{qc=\bar{c}}}{\sigma_{qc=\bar{c}}}$.

It is important to note that the result of the standardisation depends not only on the score of each country, but also on the distribution of the scores of all the countries together. To illustrate this point, we provide an example in Table 15. In the original set (i.e. before standardisation), country A, which has set up a National Registry (NR), but has not participated in a capacity-building program, would get 1 point. Country B, which has it the other way around (no NR, but participation in a capacity-building program), gets the same overall score as country A. After the standardisation, this would not be true any more: Country B is now ahead of Country A. The reason is that most of the Annex I countries have set up a National Registry, but fewer took part in capacity-building programs. The standardisation therefore tends to reward countries which excel in areas where few countries do.

[19] The same approach has been suggested by Jacobs, Smith and Goddard (2004), p. 87.

Being on the top in fields where you find yourself in company with other many countries reduces the score.

Table 15. The Effect of Standardisation

Variable	Country A		Country B	
	Original Score	Standardised Score	Original Score	Standardised Score
National Registry	1	0.68	0	-1.42
Capacity-Building	0	-0.34	1	2.83
Total Score	**1**	**0.34**	**1**	**1.41**

7.1.4 Step 4: Weighting

There exists a wide range of weighting methods which can alter the value of the composite indicator and therefore the ranking of a country considerably.[20] A correct weighting method does not exist. Regardless of the method, choosing weights always involves **subjective judgement**.

In order to explore the effect of the weighting on the country-ranking we will compute the weights based on two methods. In the first method, weights are based on statistical models. This method is being used for the ranking presented in section 5 of this paper. The second method consists of equal weighting and will be applied in the sensitivity analysis in order to explore the effects of different weighting methods (section 7.2.2).

Weights based on statistical models

In this case, the weighting is based on the **correlation** between the variables. Variables with high correlation are allocated low weights in order to correct for the overlapping information. Variables with low correlation are given high weighs since they contain information which is not covered by other variables. However, a basic level of correlation is required. If no or very low level of correlation exists, weights can not be obtained with this method. This method is being applied in the construction of several composite indicators.[21]. The statistical analysis leading to the results (Principal Component Analysis, PCA) is explained in section 7.2.1.

[20] For an overview of the existing techniques and their influence on country rating, see OECD (2005), p.64 ff.

[21] See for example Boylaud et al. (2000).

Equal weighting

Most composite indicators use equal weighting, where all variables are given the same weight.22 In order to avoid the situation where sub-components have a higher weight just because they group more variables together, the method is being applied top-down: the three main components get an equal weight of each 1/3. Within each component this share is equally divided between the sub-components. Further the remaining share of the sub-components is again equally divided between the variables.

Table 16 shows the weights based on the statistical method (PCA) and equal weighting (EW). One can observe that the PCA gives the institutional and the regulatory environments more weight than an equal weighting of the components does. As a result, PCA weighs the economic environment by nearly half as much compared to equal weighting. This holds for Annex I as well as for Non-Annex I countries.

Therefore, the PCA is better suited for our purpose, because it takes the correlation between the variables into account.

22 See for example the Esty et al. (2005).

Table 16. Weights Using PCA or EW, for Annex I and Non-Annex I Countries

Annex I Countries	PCA	Weights			PCA	Weights	
Variables	EW	PCA	EW	Components	EW	PCA	EW
Kyoto Ratification		5%	2%				
DNA established		5%	2%				
National registry established		5%	2%				
National communication submitted		5%	2%				
Number of capacity-building programs		3%	2%	Institutional Environment		44%	33%
MoUs with number of countries		6%	2%				
Policy expressed in National Communication		5%	2%				
Number of AIJ-projects implemented		5%	8%				
Number of JI-projects implemented		5%	8%				
Number of procedures to enforce a contract		4%	4%				
Days to enforce a contract		5%	4%				
Cost to enforce a contract (% of debt amount)		3%	4%				
Number of procedures to start a business		5%	4%				
Days to start a business		5%	4%	Regulatory Environment		40%	33%
Cost to start a business (% of income per capita)		4%	4%				
Number of procedures to register property		3%	4%				
Days to register property		5%	4%				
Cost register property (% of property value)		6%	4%				
Inflation (average last 10 years)		5%	11%				
External debt (% of GDP)		5%	11%	Economic Environment		16%	33%
Corruption perception index		6%	11%				
Non Annex I Countries	PCA	Weights			PCA	Weights	
Variables	EW	PCA	EW	Components	EW	PCA	EW
Kyoto Ratification		4%	2%				
DNA established		4%	2%				
National communication submitted		3%	2%				
Number of capacity-building programs		4%	2%				
MoUs with number of countries		5%	2%	Institutional Environment		48%	33%
Policy expressed in National Communication		3%	2%				
Number of AIJ-projects implemented		4%	2%				
Number of CDM-projects implemented		7%	6%				
Number of CDM-projects validated		7%	6%				
Number of CDM-projects registered		7%	6%				
Number of procedures to enforce a contract		5%	4%				
Days to enforce a contract		4%	4%				
Cost to enforce a contract (% of debt amount)		5%	4%				
Number of procedures to start a business		5%	4%				
Days to start a business		4%	4%	Regulatory Environment		39%	33%
Cost to start a business (% of income per capita)		4%	4%				
Number of procedures to register property		5%	4%				
Days to register property		3%	4%				
Cost register property (% of property value)		4%	4%				
Inflation (average last 10 years)		5%	11%				
External debt (% of GDP)		5%	11%	Economic Environment		13%	33%
Corruption perception index		4%	11%				

7.1.5 Step 5: Aggregation

A composite indicator contains aggregated information from the variables it is built with. At this stage again, there is a variety of aggregation methods available. They range from simple adding up the country-ranking for each variable to the complex so called non-compensatory multi-criteria approach[23]. The most widespread aggregation method however, is the summation of weighted and normalised variables (OECD, 2005). We will focus on this method since it is widely used and congruent with both weighting methods we discussed in the previous chapter. The geometric aggregation, where variables scores are raised to the power of their weight and multiplied, cannot be applied since our variable scores are not strictly positive.

Summation of weighted and normalised variables
The formula below yields the composite indicator (CI):

$CI_c = \sum_{q=1}^{Q} w_q I_{qc}$, with $\sum_q w_q = 1$

w_q stands for the weights of each variable (v) and I_{qc} stands from the normalised variable scores.

7.2 Statistical Analysis

7.2.1 Principal Components Analysis

The aim of the Principal Components Analysis (PCA) is to investigate the **interrelations** between variables of a model and to **reduce** the original set of variables to a few so called principal components which represent the key drivers behind the data. It is a useful tool to help understand the relationships between the variables our composite risk indicator consists of. Besides this, PCA can as well be employed to derive the weights used for aggregating our variables into one composite indicator.

In mathematical terms, the PCA is computing p linear combinations of q variables. The linear combinations are also called principal components. The number p of principal components can range from none to all q variables ($0 \leq p \leq q$). But the aim of the PCA is to keep the number of principal components as small as possible and at the same time retain as much information as possible (e.g. maximizing the explained variance of the data). The p principal components are constructed such that they are independent of each other. Each new principal component, ex-

[23] For further details, see Munda and Nardo (2003).

plains a smaller share of the variance in the original data set. In other words Z_1 explains the highest variance of the variance and Z_p the smallest.[24]

$$Z_1 = a_{11}x_1 + a_{12}x_2 + ... + a_{1q}x_q$$
$$Z_2 = a_{21}x_1 + a_{22}x_2 + ... + a_{2q}x_q$$
...
$$Z_p = a_{p1}x_1 + a_{p2}x_2 + ... + a_{pq}x_q$$

Note: Z stands for the principal components; a stands for the weights; x for the variables

The first step in a PCA is to select as few principal components as possible which explain the highest possible share of variance of the original data set. For this purpose we have a look at the Eigenvalue of the components. An Eigenvalue of a component below 1 signalises that the additional component explains less variance than is contained in the original dataset and therefore there is no gain from adding this principal components to our set. We will therefore cut off principal components with Eigenvalues below one. Table 17 shows the resulting set of principal components. In the case of Annex I countries we can explain up to 75% of the variance of 21 variables with only 6 principal components. In the case of Non-Annex I countries 7 principal components can explain roughly 66% of the variance of the original data set of 22 variables. We therefore keep **6 and 7 principal components, respectively** for the subsequent analysis.

[24] For a mathematical illustration, see http://149.170.199.144/multivar/pca.htm

Table 17. Cumulative Variance Explained by Chosen Principal Components

Annex I

Principal Component [1)]	Initial Eigenvalues		
	Eigenvalue [2)]	% of Variance	Cumulative %
1	6.15	29.29	29.29
2	2.70	12.87	42.16
3	2.25	10.73	52.89
4	1.87	8.91	61.80
5	1.60	7.62	69.42
6	1.16	5.52	74.94

Non-Annex I

Principal Component [1)]	Initial Eigenvalues		
	Eigenvalue [2)]	% of Variance	Cumulative %
1	3.95	17.93	17.93
2	3.14	14.25	32.19
3	2.00	9.09	41.27
4	1.53	6.96	48.23
5	1.47	6.67	54.90
6	1.33	6.04	60.95
7	1.11	5.03	65.98

[1)] Cut off point for principal components: Eigenvalue < 1. [2)] The score of the Eigenvalues indicates how much of the variance of the original data set a principal component explains.

The second step involves the rotation of the matrix (Varimax-Rotation) in order to reallocate the component loadings. Component loadings are the correlation coefficients between the principal components and the variables. The results are shown in Table 18 for Annex I and Table 19 for Non-Annex I countries.

For the Annex I as well as Non-Annex I countries, it can be seen that each principal component loads on a different set of variables. This underlines the multidimensionality of risks in the context of investments in climate change mitigation.

In the case of Annex I countries the following relations can be observed:

- The first principal component is highly correlated with variables related to the regulatory environment like measures to enforce a contract or days to start a business. So are the fourth and fifth principal components. The first component, though, is also correlated with variables from different areas like “JI or CDM policy expressed in national communication” or “Inflation”, whereas the fourth and fifth principals are not.
- The second and sixth principal components are highly correlated to experience-related variables like number of capacity building programs.
- The third principal component rather consists of institution-related variables like “national registry established” or “Kyoto ratification”.

Table 18. Annex I: Rotated Components Loading Matrix and Constructed Weights

	Principal Components						
Variables	1	2	3	4	5	6	**Weights**
Kyoto Ratification	-0.12	0.28	**0.83**	0.15	0.09	-0.13	0.05
DNA established	0.25	-0.42	0.46	-0.02	0.47	-0.26	0.05
National registry established	0.07	-0.25	**0.83**	-0.10	-0.12	0.19	0.05
National communication submitted	0.41	0.01	**0.71**	0.29	0.06	0.03	0.05
Number of capacity-building programs	-0.17	**0.62**	0.02	0.10	0.10	-0.16	0.03
MoUs with number of countries	0.02	**0.85**	-0.02	-0.27	-0.03	0.32	0.06
Policy expressed in National Communication	**0.71**	-0.12	0.32	-0.22	-0.14	-0.21	0.05
Number of AIJ-projects implemented	-0.12	0.31	0.13	0.10	0.11	**0.84**	0.05
Number of JI/CDM-projects implemented	-0.03	**0.90**	-0.01	-0.03	-0.06	0.07	0.05
Number of procedures to enforce a contract	0.17	-0.66	-0.02	0.45	-0.05	0.07	0.04
Days to enforce a contract	0.07	-0.31	-0.04	**0.78**	-0.07	0.03	0.05
Cost to enforce a contract (% of debt amount)	**0.73**	0.03	0.01	0.01	0.04	0.11	0.03
Number of procedures to start a business	**0.74**	-0.17	-0.02	0.29	0.30	0.10	0.05
Days to start a business	**0.68**	-0.08	-0.22	0.45	0.20	0.08	0.05
Cost to start a business (% of income per capita)	**0.52**	-0.01	0.06	0.33	**0.57**	0.04	0.04
Number of procedures to register property	0.34	-0.25	0.20	0.02	**0.56**	-0.10	0.03
Days to register property	0.10	0.06	0.30	**0.78**	0.10	-0.01	0.05
Cost register property (% of property value)	-0.10	0.25	-0.17	-0.05	**0.87**	0.10	0.06
Inflation (average last 10 years)	**0.71**	-0.40	0.37	0.02	-0.06	0.17	0.05
External debt (% of GDP)	-0.33	0.20	0.07	0.04	0.09	-0.80	0.05
Corruption perception index	**0.58**	-0.57	0.25	0.31	0.26	-0.16	0.06
Values between 0.5 and 0.75							
Values above 0.75							

Extraction method: Principal Components Analysis; Rotation method: Varimax Kaiser-normalised rotation.

In the case of the Non-Annex I countries the loadings show a different picture:

- The first and the fourth component show a high correlation to variables measuring the experience in the field of climate change mitigation projects of a country.
- The second principal component is strongly correlated to variables depicting the condition of climate change related institutions.
- The third component is dominated by variables measuring the economic environment.
- Component five to seven correlate most significantly with variables related to the regulatory environment.

Based on the loadings we constructed the weight of each variable (see right column in Table 18 and Table 19). We follow the approach of Boylaud et al. (2000). In their paper they "weigh each variable according to the proportion of its variance that is explained by the principal component it is associated to (i.e. the normalised squared loading), while each principal component was weighted according to its contribution to the portion of the explained variance in the dataset (i.e. the normalised sum of squared loadings)."

Table 19. Non-Annex I: Rotated Components Loading Matrix and Constructed Weights

	Principal Components							
Variables	1	2	3	4	5	6	7	**Weights**
Kyoto Ratification	0.01	**0.68**	0.12	0.17	-0.25	0.21	-0.01	0.04
DNA established	0.11	**0.63**	-0.04	0.22	0.08	-0.08	0.23	0.04
National communication submitted	0.03	**0.67**	-0.01	0.22	-0.01	0.00	-0.12	0.03
Number of capacity-building programs	0.23	0.30	0.04	0.35	-0.29	-0.53	0.09	0.04
MoUs with number of countries	0.24	0.18	0.05	**0.71**	-0.10	0.24	0.03	0.05
Policy expressed in National Communication	0.00	0.22	0.07	**0.50**	0.31	-0.17	-0.26	0.03
Number of AIJ-projects implemented	0.06	0.14	0.04	**0.74**	-0.15	0.02	0.11	0.04
Number of JI/CDM-projects implemented	**0.98**	0.05	0.03	0.06	-0.04	-0.04	0.00	0.07
Number of CDM-projects validated	**0.98**	0.05	0.01	0.07	-0.08	0.00	-0.03	0.07
Number of CDM-projects registered	**0.97**	0.06	0.01	0.13	-0.04	0.05	-0.04	0.07
Number of procedures to enforce a contract	0.04	**0.66**	0.14	-0.21	0.36	0.16	-0.07	0.05
Days to enforce a contract	-0.02	0.28	0.49	-0.32	0.03	0.24	0.26	0.04
Cost to enforce a contract (% of debt amount)	0.03	-0.25	**0.75**	0.06	0.06	0.20	-0.07	0.05
Number of procedures to start a business	-0.07	-0.01	-0.05	-0.15	**0.82**	0.17	0.02	0.05
Days to start a business	-0.13	0.06	0.35	0.07	**0.62**	-0.13	0.30	0.04
Cost to start a business (% of income per capita)	0.07	0.26	0.39	0.21	0.31	**0.51**	-0.09	0.04
Number of procedures to register property	-0.07	-0.01	0.03	-0.05	0.01	0.03	**0.81**	0.05
Days to register property	0.03	0.01	0.01	0.42	0.12	0.15	0.49	0.03
Cost register property (% of property value)	0.03	0.20	0.08	0.12	-0.16	**0.74**	0.11	0.04
Inflation (average last 10 years)	-0.03	0.08	**0.76**	0.13	0.22	-0.14	0.09	0.05
External debt (% of GDP)	0.11	0.26	**0.66**	-0.02	-0.33	0.21	0.01	0.05
Corruption perception index	0.05	-0.01	0.21	0.09	0.22	**0.51**	0.40	0.04

Values between 0.5 and 0.75
Values above 0.75

Extraction method: Principal Components Analysis; Rotation method: Varimax Kaiser-normalised rotation.

7.2.2 Sensitivity analysis

The development of the composite indicator involves making choices between different methods at several stages (see chapter 7.1). One crucial question is which choices are most likely to alter the country raking. A first assessment of the choices made, leads to the following result:

– **Country Selection:** Deleting countries from the sample has several effects. It affects the imputation of missing values as well as the weights derived from the PCA. The standardized values may also change as a result of excluding countries. The consequences are most severe when the deleted countries have similarities (developing countries, countries from one region, etc). In our case we mostly had to exclude microstates (most often small islands) and some least developed countries. Since most of the excluded countries would be most probably ranked low, this step might have altered the ranking of the included low ranking countries. We think, however, that it has no or very little effect on the order of the high ranking countries.

- **Imputation of missing data:** As a result of deleting countries with a prevalence of missing values, most variables had a complete set of values. The proportion of missing data points of the remaining variables was in most of the cases below 10%. The variables with missing values above 10% are contrived to the component of economic environment, which has a low weight in our composite indicator. The effects of different imputation methods can be considered low.
- **Weighting:** The impact of different weighting methods is shown below.
- **Aggregation:** The choice of an aggregation method can affect the country-ranking as well. We have aggregated the variables by summing up the weighted values. There are as well other methods available. For example the geometric aggregation or the non-compensatory multi-criteria approach. In our case the geometric aggregation cannot be applied due to negative values in our data set. The non-compensatory multi-criteria approach is most suitable for composite indicators with a small number of variables. Greater number of variables mostly lead to unambiguous results. Composite indicators consisting of 21 or more variables are difficult to approach with this method.

As a result of the discussion above we study the impact of using two different weighting as well as normalization methods. Specifically, we compute four different rankings based on the following alternatives (see Table 20):
- Two different standardisation methods: Re-scaling and z-score method.
- Two different weighting methods: equal weighting vis-à-vis to weights derived from a PCA.

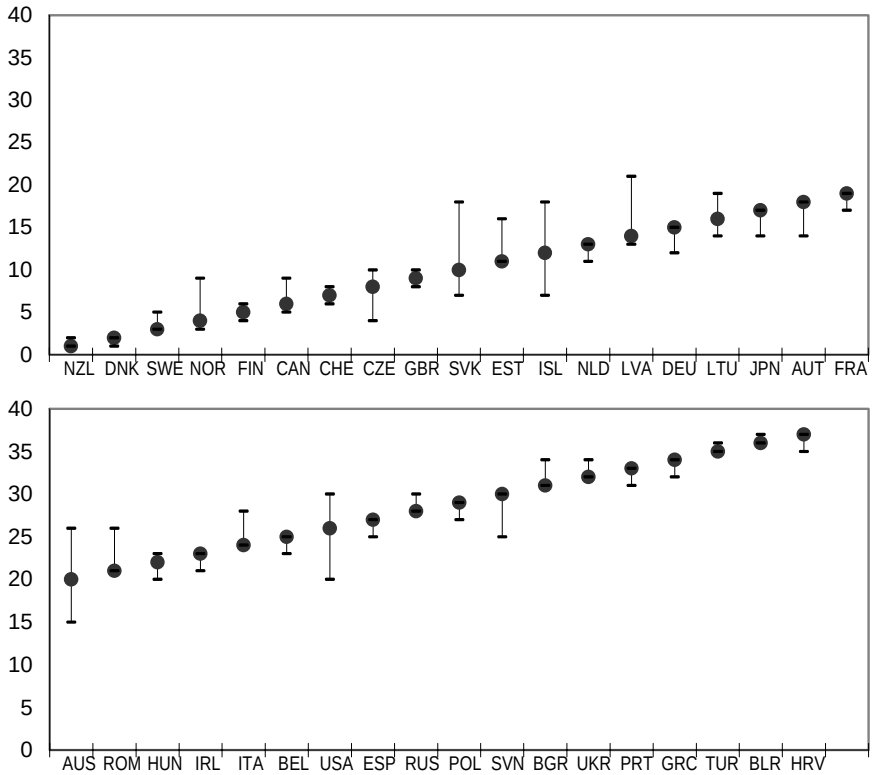
Table 20. Sensitivity Analysis: Comparison of four Different Methods

		Standardisation methods	
		Re-scaling	*z-score*
Weighting methods	*Weights from PCA*	Method applied for composite indicator	Alternative Method 1
	Equal weighting	Alternative Method 2	Alternative Method 3

The results are displayed in Fig. 3 and Fig. 4. For Annex I countries the sensitivity analysis shows, that the ranking remains stable for most of the countries. The ranking is very robust at the top and bottom end of the ranking. In between the bandwidth picks up. A remarkable high bandwidth can be observed for Slovakia, Iceland, Latvia, Australia and USA. It is interesting to note, that all these countries have components with scores showing into different directions (e.g. Iceland having a positive score for policy but a negative one for institutions). But not all countries with different scores for their components must have an unstable ranking (e.g. Poland which has a very robust ranking but is found to be above average in the area of Kyoto-Institutions but performs poorly on policy).

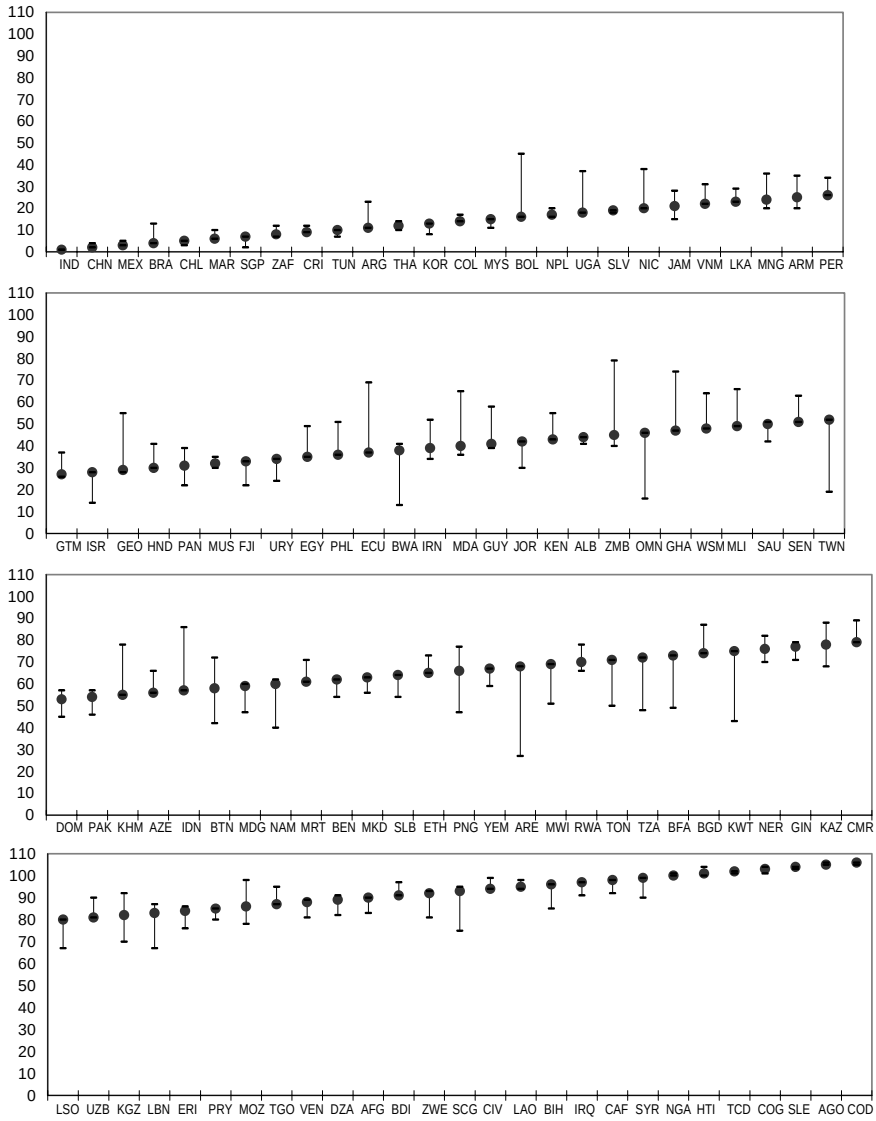
For the Non-Annex I countries the picture is analogue: one finds a robust ranking at the top and bottom of the list. Countries in the middle are at close range and small changes in the way the scores are calculated have a great effect on their relative position.

Fig. 3. Effects of Different Weighting and Normalisation Methods (Annex I)



Bullets represent the actual ranking (weights based on PCA and z-score). Upper and lower beams depict the maximum and minimum rank of one of the three remaining combinations.

Fig. 4. Effects of Different Weighting and Normalisation Methods (Non-Annex I)



Bullets represent the actual ranking (weights based on PCA and z-score). Upper and lower beams depict the maximum and minimum rank of one of the three remaining combinations.

8 Appendix B: Input Data

Table 21. JI Projects by Country

Region	Number of projects	Total amount of credits (1'000 ERUs)
Czech Republic	19	3'845
Bulgaria	16	13'762
Russia	12	15'522
Ukraine	12	8'971
Hungary	10	6'478
Poland	10	3'052
Romania	10	4'328
Estonia	9	2'297
New Zealand	5	2'553
Germany	3	1'119
Lithuania	3	673
Slovakia	3	1'425
Total	112	65'025

Source: Fenhann (2006), CDM pipeline overview (updated 20 June 2006).

Table 22. Data Sources

Variable	Source	Date available
Kyoto ratification	http://unfccc.int/files/essential_background/kyoto_protocol/application/pdf/kpstats.pdf	2006-06-10
DNA established	http://cdm.unfccc.int/DNA	2006-08-07
NR established	http://europa.eu.int/comm/environment/ets/registrySearch.do	2006-08-07
National communication, Non-Annex I	http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php	2006-08-07
National communication, Annex I	http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/1395.php and http://unfccc.int/national_reports/annex_i_natcom/submitted_natcom/items/3625.php	2006-08-07
CDM / JI policy expressed in national communication	From National Communication. Link: see above.	2006-08-07

Variable	Source	Date available
Number of AIJ projects implemented	http://unfccc.int/kyoto_mechanisms/aij/activities_implemented_jointly/items/2094.php	2002-02-12
Number of JI projects at different levels	http://cd4cdm.org/Publications/CDMpipeline.xls	2006, June
Number of AIJ projects at different levels	http://cd4cdm.org/Publications/CDMpipeline.xls	2006, June
All variables in the regulatory environment component	http://www.doingbusiness.org/CustomQuery/	2005
Inflation	http://siteresources.worldbank.org/INTWDR2005/Resources/wdr2005_selected_indicators.pdf	1990-2003
External debt	http://siteresources.worldbank.org/INTWDR2005/Resources/wdr2005_selected_indicators.pdf	2002
Corruption perception index	http://www.transparency.org/policy_and_research/surveys_indices/cpi/2005	2005

Table 23. Capacity Building Programs

Program	Source
National Strategy Study (NSS)	http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTCC/0,,contentMDK:20484413~pagePK:148956~piPK:216618~theSitePK:407864,00.html
CF-Assist program	http://carbonfinance.org/Router.cfm?Page=CFAssist&ItemID=3874&cp=1
cd4cdm	http://cd4cdm.org/
UNIDO - Francophone	http://www.unido.org/doc/45989
Integrated Capacity Strengthening	http://www.iges.or.jp/en/cdm/activity.html

Table 24. Memoranda of Understanding

Annex I Country	Source
Austria	http://www.ji-cdm-austria.at/en/portal/sterreichischesjicdmprogramm/ rechtlicherahmenbedingungen/
Belgium	http://www.pembina.org/pdf/publications/ Review_of_Current_Status_of_CDM_and_LAC_Implications_para_web.pdf
Canada	http://www.ec.gc.ca/press/2005/051207_n_e.htm http://www.ec.gc.ca/press/2005/051208_n_e.htm http://www.ec.gc.ca/press/2005/051208-1_n_e.htm http://www.ec.gc.ca/press/2005/051208-2_n_e.htm http://www.ec.gc.ca/press/2004/041214_m_e.htm http://can-chil.gc.ca/English/Resource/mou.cfm
Denmark	http://www.mst.dk/transportuk/01070201.htm
Finland	http://global.finland.fi/english/projects/cdm/lessonslearned_301105.pdf
France	http://www.effet-de-serre.gouv.fr/fr/actions/nordsud.htm
Germany	http://www.bmu.de/reden/bundesumweltminister_sigmar_gabriel/doc/36391.php
Greece	http://www2.mfa.gr/www.mfa.gr/en-US/Policy/Priorities/Environment/Greek+Policy/
Iceland	No Information
Irleland	No Information
Italy	http://cd4cdm.org/countries%20and%20regions/North%20Africa%20and%20Middle%20East/ Region/Jerba%20Investment%20Forum/19-ItalianPolicy&Plan_Groce.ppt
Japan	http://www.unido.org/file-storage/download/?file_id=43277
Luxembourg	No Information
Netherland	http://www.ez.nl/content.jsp?objectid=17232#nl_joint_impl
Norway	http://www.odin.no/md/norsk/dok/regelverk/avtaler/nn.html
Portugal	No Information
Spain	http://www.pointcarbon.com/Home/News/Archive/2004/article5796-429.html; http://ec.europa.eu/environment/climat/pdf/eu_mechanisms_kyoto.pdf#search= %22belgium%20%22memorandum%20of%20understanding%22%20%2BCDM%22;
Sweden	http://www.internat.naturvardsverket.se/
Switzerland	http://adminsrv.admin.ch/swissaij/index.htm
UK	No Information

Last search was conducted in August 2006.

References

Arquit Niederberger, Anne and Raymond Saner (2005), Exploring the Relationship Between FDI Flows and CDM Potential, *Transnational Corporations*, Vol. 14, No. 1, p.1-40.

Bernstein, Paul M., W. David Montgomery, and Thomas F. Rutherford (1999), Global Impacts of the Kyoto Agreement: Results from the MS-MRT Model, *Resource and Energy Economics*, Vol. 21, Issues 3-4, p. 375-413.

Bilson, Christopher M., Timothy J. Brailsford and Vincent C. Hooper (2002), The explanatory power of political risk in emerging markets, *International Review of Financial Analysis*, Vol. 11, No. 1, p.1-27.

Böhringer, Christoph and Andreas Löschel (2002), Climate Policy induced Investments: The Implications of Investment Risks. ZEW Discussion Paper No. 02-68, Mannheim.

Böhringer, Christoph (2000), Cooling Down Hot Air: A Global CGE Analysis of Post-Kyoto Carbon Abatement Strategies, *Energy Policy*, Vol. 28, Issue 11, p. 779-789.

Boylaud, Olivier, Guiseppe Nicoletti and Stefano Scarpetta (2000), Summary Indicators of Product Market Regulation with an Extension to Employment Protection Legislation, OECD Economics Departement Working Papers, No. 226.

Criqui, Patrick, and Laurent Viguier (2000), "Kyoto and Technology at World Level: Costs of CO_2 Reduction under Flexibility Mechanisms and Technical Progress", *International Journal of Global Energy Issues*, Vol. 14, No. 1-4, p. 155-168.

Ellerman, A. Denny., Henry D. Jacoby and Annelene Decaux (1998), The Effects on Developing Countries of the Kyoto Protocol and CO_2 Emissions Trading, Policy Research Working Paper 2019, The World Bank, Washington, DC.

Esty, Daniel C., Marc A. Levy, Tanja Srebotnjak and Alexander de Sherbinin (2005), Environmental Sustainability Index: Benchmarking National Environmental Stewardship.

Evans, Meredydd, Susan Legro and Ilya Popov (2000), The Climate for Joint Implementation: Case Studies from Russia, Ukraine, and Poland. *Mitigation and Adaptation Strategies for Global Change*, Vol. 5, No. 4, p. 319-336.

Fankhauser, Samuel and Lucia Lavric (2003), The Investment Climate for Climate Investment: Joint Implementation in Transition Countries, *Climate Policy*, Vol. 3, No. 4, p. 417-434.

Fenhann, Jørgen (2006), CDM pipeline overview (updated 20 June 2006). UNEP Risø Centre, available online at: www.cd4cdm.org/Publications/CDMpipeline.xls.

Freudenberg, Michael (2003), Composite Indicators of Country Performance: A Critical Assessment, OECD Science, Technology and Industry Working Papers, 2003/16.

Jacobs, Rowena, Smith Peter and Goddard Maria (2004), Measuring performance: An examination of composite performance indicators, Center for Health Economics Technical Paper Series 29.

Jahn, Michael, Axel Michaelowa, Stefan Raubenheimer and Holger Liptow (2004), Measuring the Potential of Unilateral CDM – A Pilot Study, HWWA Discussion Paper No. 263.

Janssen, Josef (1998), Strategies for Risk Management of Joint Implementation Investments, in: Riemer, P., A. Smith and K. Thambimuthu (eds.), *Greenhouse Gas Mitigation: Technologies for Activities Implemented Jointly*, Elsevier, p. 357-365.

Janssen, Josef (2001), Risk Management of Investments in Joint Implementation and Clean Development Mechanism Projects, Ph.D. Thesis, University of St. Gallen.

Jung, Martina (2006), Host country attractiveness for CDM non-sink projects, *Energy Policy*, Vol. 34, Issue 15, p. 2173-2184.

Kaufmann, Daniel, Aart Kraay and Massimo Mastruzzi (2005), Governance Matters IV: Governance Indicators for 1996-2004, World Bank Policy Research Working Paper No. 3630.

Kaufmann, Daniel, Aart Kraay and Pablo Zoido-Lobatón (1999), Aggregating Governance Indicators, Policy Research Working Paper No. 2195.

Krugman, Paul R. and Maurice Obstfeld (1994), *International Economics, Theory and Policy*, third edition. Harper Collins, New York.

Larson, Donald F. and Paul Parks (1999), Risks, Lessons Learned, and Secondary Markets for Greenhouse Gas Reductions, Policy Research Working Paper 2090, The World Bank, Washington, DC.

Laurikka, Harri and Urs Springer (2003), Risk and Return of Project-Based Climate Change Mitigation: a Portfolio Approach, *Global Environmental Change* 13, p. 207-217.

Manne, Alan S. and Richard G. Richels (1999), The Kyoto Protocol: A Cost-Effective Strategy for Meeting Environmental Objectives? in: Weyant, J. (ed.) (1999), The Costs of the Kyoto Protocol: A Multi-Model Evaluation, *Energy Journal*, Special Issue, 1-23.

McKibbin, Warwick J., Martin T. Ross, Robert Shackleton, and Peter J. Wilcoxen (1999), Emissions Trading, Capital Flows and the Kyoto Protocol, in: Weyant, John (ed.) (1999), The Costs of the Kyoto Protocol: A Multi-Model Evaluation, *Energy Journal*, Special Issue, 287-333.

Michaelowa, Axel and Katharina Michaelowa, Sustainable Development: The forgotten aspect of the CDM. JIN discussion platform, December 2005.

Munda, Giuseppe and Michela Nardo (2003), On the methodological foundations of composite indicators used for ranking countries. Paper presented at the OECD/JRC Workshop on composite indicators of country performance. Ispra, Italy, 12 May 2003 (Version November 2003).

Nordhaus, William D. and Joseph G. Boyer (1999), Requiem for Kyoto: An Economic Analysis of the Kyoto Protocol, in: Weyant, J. (ed.) (1999), The Costs of the Kyoto Protocol: A Multi-Model Evaluation, *Energy Journal*, Special Issue, 93-130.

OECD Organisation for Economic Co-operation and Development (2005), Handbook on Constructing Composite Indicators: Methodology and User Guide. OECD Statistics Working Paper. Paris.

OECD Organisation for Economic Co-operation and Development / IEA International Energy Agency (2002), National Systems for Flexible Mechanisms: Implementation Issues in Countries with Economies in Transition, Information Paper.

Oetzel, Jennifer M., Richard A. Bettis and Marc Zenner (2001), Country Risk Measures: How Risky Are They? *Journal of World Business*, Vol. 36, Issue 2, p. 128-145.

Perkaus, James F. and Kevin A. Baumert (2001), Risky Business: Lessons in Risk Management for an International Greenhouse Gas Emissions Market, World Resources Institute, Climate Notes, July 2001.

Point Carbon (2006), CDM/JI Host Country Rating – Methodology. Available online at www.pointcarbon.com.

Sijm, J.P.M., F.T. Ormel, J.W. Martens, S.N.M. van Rooijen, M.H. Voogt, M.T. van Wees, and C. de Zoeten-Dartenset (2000), Kyoto Mechanisms. The Role of Joint Implemen-

tation, the Clean Development Mechanism and Emissions Trading in Reducing Greenhouse Gas Emissions, ECN Report C-00-026, Petten.

Schwarze, Reimund (2000), Activities Implemented Jointly: Another Look at the Facts, *Ecological Economics*, Vol. 32, Issue 2, p. 255-267.

Springer, Urs (2003a), Can the Risks of the Kyoto Mechanisms be reduced through Portfolio Diversification? Evidence from the Swedish AIJ Program, *Environmental and Resource Economics*, Vol. 25, Issue 4, p. 501-513.

Springer, Urs (2003b), International Diversification of Investment in Climate Change Mitigation, *Ecological Economics*, Vol. 46, Issue 1, p. 181-193.

Springer, Urs (2003c), The market for tradable GHG permits under the Kyoto Protocol: A survey of model studies, Energy Economics, Vol. 25, Issue 5, p. 527-551.

UNCTAD United Nations Conference on Trade and Development (1998), *World Investment Report 1998*. New York and Geneva.

UNCTAD United Nations Conference on Trade and Development (2006), *World Investment Report 2006. FDI from Developing and Transition Economies: Implications for Development.* New York and Geneva.