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KYOTO FLEXIBLE MECHANISMS:
OPPORTUNITIES AND BARRIERS FOR INDUSTRY AND FINANCIAL INSTITUTIONS

DR JOSEF JANSSEN

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Abstract

The Kyoto Protocol established global markets for greenhouse gas emissions reductions and permits. Such emerging markets will offer challenging opportunities to a wide variety of different players in industry and commerce. By means of the market-based Flexible Mechanisms Joint Implementation, Clean Development Mechanism and International Emissions Trading it will be possible to trade emissions permits globally. This chapter explores opportunities of the Flexible Mechanisms for industry, including the financial sector. Moreover, it identifies possible barriers to their realisation. This analysis is preceded by a discussion of the possible seize of global markets for emissions permits. In addition, this chapter examines key features of the Flexible Mechanisms that are relevant from an industry perspective.

* University of St. Gallen, Institute for Economy and the Environment (IWOe), head of Emissions Trading and Climate Policy. www.iwoe.unisg.ch/kyoto, Josef.Janssen@unisg.ch.

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1. Introduction

While the previous chapter analysed the incentive to negotiate and adopt agreements to reduce greenhouse gas emissions at the industry level, this chapter analyses the incentives to reduce emissions provided by the so-called “Flexible Mechanisms”.

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), adopted in December 1997 by more than 150 countries, established global markets for greenhouse gas (GHG) emissions reductions.[1] By means of the market-based Kyoto Mechanisms Joint Implementation (JI), Clean Development Mechanism (CDM) and International Emissions Trading (IET) it will be possible to trade emissions permits globally. Demand will be driven by the emissions reduction commitments of industrialised and transitional countries (the group of Annex B countries).[2] JI and IET enable international transactions of emissions permits among Annex B countries. The CDM allows developing countries, i.e. non-Annex B countries, to deliver emissions permits to Annex B countries. This emerging global market, the net value of which is estimated to amount to probably several \$10 billion annually,[3] will offer challenging opportunities to a wide variety of different players in industry and business.

Will the reluctance of the US administration to ratify the Kyoto Protocol threat the emergence of such GHG markets? Yes, but only to some extent.

First, the Intergovernmental Panel on Climate Change (IPPC), in its recent third assessment report, reinforces the need for climate change mitigation. Hence, the issue will not go away. Moreover, the findings of the IPPC have been reconfirmed by a recent study commissioned by the Bush administration from the renowned US Academy of Science.

Second, at the national level industrialised countries, especially in Europe, are continuing to design policies aimed at meeting the Kyoto obligations. In most cases, emissions trading is envisaged to play an important role. Indeed, in October 2001 the European Commission has released a proposal for a directive that envisages the establishment of a mandatory CO2 emissions trading system by 2005 for the following sectors and economic activities:

[1] A general overview of the Kyoto Protocol is Grubb, Vrolijk and Brack (1999) or OECD (1999a). Barrett (1998) explores the political economy of the Kyoto Protocol. Oberthür and Ott (1999) is a detailed discussion of political and legal aspects. Kopp and Thatcher (eds) (2000) is a collection of economic papers on the Kyoto Protocol. Yamin (1998) considers the origins of the Kyoto Protocol and analyses its key provisions.

[2] Throughout this study, to avoid confusion, we refer to Annex B countries (of the Kyoto Protocol), even if the Kyoto Protocol in some provisions refers to Annex I countries (of the UNFCCC). For clarification: The Kyoto Protocol prescribes reduction and limitation commitments for Annex I countries as quantified in Annex B. Both Annexes are almost identical, except for Belarus and Turkey which are included in Annex I but not in Annex B. The Articles on JI and CDM refer to Annex I countries, whereas the Article on IET refers to Annex B countries.

[3] Springer (2000a) gives a comprehensive overview about market and price estimates. See also Section 3. The aforementioned figure does not cover transactions in domestic markets or within the EU.

Combustion installations with a rated thermal input exceeding 20 MW (excepting hazardous or municipal waste installations); mineral oil refineries; coke ovens; production and processing of ferrous metals including iron and steel; production of cement and lime; manufacture of glass and ceramic products; pulp and paper. The emissions trading system of the United Kingdom is to start in April 2002.

Third, any institutional framework that may emerge in alternative to the Kyoto Protocol (what is, however, not very probable), will heavily rely on market-based instruments such as (international) emissions trading. Most importantly for the present chapter, international emissions trading under any alternative institutional framework may expected to resemble the Kyoto Mechanisms as regards many functional and technical elements. To give an example, any form of project-based emissions trading will involve the issue of how to determine baselines, which is a major point in the present debate about the Kyoto Mechanisms. Moreover, any international market for GHG emissions permits, be it under the Kyoto Protocol or any alternative framework, may expected to encompass some form of project-based emissions trading as JI and the CDM represent (see chapter I and section 2 of this chapter). For this reason, the present analysis of barriers and opportunities associated the Kyoto Mechanisms is not specifically tied to the Flexible Mechanisms of the Kyoto Protocol but has general validity, even if explicit reference is made to the provisions of the respective articles of the Kyoto Protocol. Indeed, such explicit reference does not imply, by no means, that this chapter becomes irrelevant or completely outdated if in the future the Parties to the UNFCCC would agree to abandon of the Kyoto Protocol and to search for alternative avenues for consensus.

Fourth, in anticipation of the implementation of the Kyoto Protocol, or any other institutional framework that might emerge as alternative to the Kyoto Protocol, major companies around the globe from a whole range of industries are taking actions to be prepared for emerging national and international markets for GHG emissions permits. This group of proactive companies includes BP, Shell, Transalta, Ontario Power Generation, DuPont, Holderbank and Swiss Re, to name some of them.

Nonetheless, the reluctance of the new US administration to ratify the Kyoto Protocol may be a major threat to emerging global markets for GHG emissions permits, if other major GHG emitting countries abandon their opposition to Bush’s position. In this case, the Kyoto Protocol may fail to enter into force. It would enter into force if the following conditions were fulfilled:

- 55 Parties have ratified the Kyoto Protocol.
- These 55 Parties must include Annex B countries that in 1990 accounted in total for more than 55% of total CO2 emissions of the group of Annex B countries.

As of 26 October 2001, 43 Parties have ratified the Kyoto Protocol. The sole Annex B country that has ratified the Kyoto Protocol is Romania. It accounts for 1.2% of the CO2 emissions of the group of Annex B countries.

Table 1 shows that the Kyoto Protocol could enter into force also without US ratification. Ratification by the EU, the countries with economies in transition and Japan would be insufficient for entry into force. As can be seen from Table 1, it is also necessary for Russia to ratify the Kyoto Protocol. Both, Japan and Russia have declared that the Kyoto Protocol has become ratifiable on the basis of the Marrakech Accords, which have been agreed upon at the seventh Conference of the Parties (COP7) in November 2001.

Table 1-1. Share of CO2 emissions of Annex B countries

Share of CO2 emissions in 1990 in % of total Annex I emissions	
USA	36.1
EU	24.2
Russia	17.4
Japan	8.5
EIT	7.4
Other	6.4

This chapter aims to discuss main opportunities for industry, including the financial sector, associated with the Flexible Mechanisms. Furthermore, it identifies major barriers companies might face in realising such opportunities. To this end, the remainder of this chapter is organised as follows:

The *next section* extends the discussion of the nature of the Flexible Mechanisms in chapter I, adding some aspects which are relevant for industry as their prospective user.

Since it is the aim of the study to explore business opportunities associated with the global GHG market, it is important to have an idea of its size. Therefore, *section three* gives an overview of the results of different economic models that estimate the potential size of the global GHG market. Two basic international trading regimes are distinguished: an international trading regime with unrestricted use of the CDM (global trading), and an international trading regime that encompasses only trading among Annex B countries. The latter may be a realistic scenario if the rules on the CDM would have been very restrictive, which does not seem to be the case after Marrakech. Since prices are the key parameters in business decisions, the study presents also estimates of permit prices under both regimes.

The *fourth section* explores opportunities and barriers for GHG emitting industries that are interested in taking advantage of the Flexible Mechanisms. As regards opportunities, one has to distinguish between potential buyers and sellers of emissions permits. The former would benefit from reduced cost of compliance with domestic climate policy regulations. The latter could take advantage of the Kyoto Mechanisms in order to generate additional profits. Main barriers discussed include uncertain rules, guidelines, procedures and modalities that will govern the Kyoto Mechanisms. They are still uncertain since the Marrakech Accords still need to be implemented at the national level. Other barriers include the lack of incentives at the national level to use the Flexible Mechanisms, transaction costs and uncertain prices.

Section five explores some functions that financial institutions could perform in emerging GHG markets, and the *last section* concludes.

2. Some Additional Key Features of the Kyoto Mechanisms

The nature of the Kyoto Mechanisms has already been discussed to some extent in chapter I of this report. In this section, I want to explore some additional points regarding the basic nature of the Kyoto Mechanisms that are relevant for industry as prospective users.[4]

To call the Kyoto Mechanisms to the reader's mind, they encompass the following instruments:[5]

[4] A more comprehensive discussion of the points raised in this section is provided in Janssen (2001) or (2000a).

- Joint Implementation – JI (Article 6 Kyoto Protocol): international transactions of emissions permits between Annex B countries.[6]
- Clean Development Mechanism – CDM (Article 12 Kyoto Protocol): international transactions of emissions permits from non-Annex B countries to Annex B countries.[7]
- International Emissions Trading – IET (Article 17 Kyoto Protocol): international transactions of emissions permits between Annex B countries.[8]

What strikes one at first glance is that the Kyoto Protocol provides for two forms of international mitigation activities among Annex B countries, i.e. JI and IET. Against this observation, the question arises how JI and IET might be distinguished in essence, and how they relate to each other.

2.1 Distinguishing JI and IET

In the relevant literature, three main criteria for distinction have been advanced:

- Private sector versus government participation.
- Baseline-and-credit versus cap-and-trade or cap-and-allowance trading.
- International investments versus international trade.

In the following, I will briefly discuss these criteria.[9]

Sometimes it had been argued that IET only allows international emissions trading among *governments.* If private entities, that is GHG emitting companies, wish to trade GHG reductions internationally, they would need to use JI. According to this view, the main criterion for distinguishing IET and JI refers to participants: Regarding IET, only governments are allowed to participate, whereas JI is also available for private entities.

This perception originate from the language of the respective Articles of the Kyoto Protocol: Article 6.3 on JI explicitly states that “a Party included in Annex I may authorise *legal entities* to participate … in actions leading to the generation, transfer or acquisition under this Article of emissions reduction units”.[10] Article 17, which refers to IET, does not mention explicitly any private sector involvement. Instead, it only states that “Parties included in Annex B may participate in emissions trading…”

Several arguments might be advanced against the perception that Article 17 only enables government-to-government trading: First of all, it is rather unusual that public international law, as is the Kyoto Protocol, explicitly refers to private sector entities. Hence, the language of Article 6, referring to legal entities, is rather unusual or abnormal. The non-reference to private entities of Article 17 is instead the normal case in public international law. And

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[5] Haites and Aslam (2000); Missfeldt (1998); OECD and IEA (2000a); Petsonk, Dudek and Goffman (1998) and Skea (1999) provide an overview of the Kyoto Mechanisms. Jepma and Gaast (eds) (1999) is a collection of various papers on the Kyoto Mechanisms.

[6] On JI see e.g. Begg, Jackson and Parkinson (2001) or Jackson, Begg and Parkinson (eds) (2001).

[7] The literature on CDM is enormous. An overview of institutional issues is Haites and Yamin (2000). An extensive treatment of technical, financial and institutional issues is Stewart et al. (2000). Werksman (1998) explores the conceptual roots of different aspects of the CDM. A useful collection of papers is Goldemberg (ed.) (1998). See also Michaelowa and Dutschke (eds) (2000).

[8] On IET see e.g. IEA (2001); Kerr (ed.) (2000); OECD (1999d); or Tietenberg et al. (1999).

[9] A comprehensive discussion with references is provided by Janssen (2001) or (2000a).

[10] Emphasis added.

secondly, the Marrakech Accords explicitly state that legal entities may be authorised to participate in IET. Concluding, it does not appear to be appropriate to distinguish between JI and IET by a criterion of allowed participation.

Another criterion for distinguishing JI and IET is the type of emissions trading system to be governed by JI and IET. As discussed already in chapter I, in the literature on emissions trading systems, a most important distinction is drawn between *cap-and-allowance* (or *cap-and-trade*) systems and *baseline-and-credit* systems. In both schemes, the generic term for the unit of trade is an emissions *permit*. As indicated already by the names, permits in the former system are called *allowances*, whereas *credits* are earned in the latter. The most prominent example of a successful cap-and-trade system is the US SO2 trading system.[11]

In a baseline-and-credit system, emissions credits are earned if actual project emissions are below a reference value, or baseline, against reductions are measured. The emissions baseline in a credit scheme can be identical to the emissions cap in an allowance scheme. However, the two schemes have different implications regarding the timing and extent of regulatory involvement: Cap-and-trade schemes, which are comprehensive by their nature, require an extensive regulatory involvement and hence effort at the beginning to set it up. In contrast, credit schemes require less initial design and inception effort, but baselines need to be determined on an individual basis and individual trades must be certified and/or verified by the regulator. A credit system depends on a project-by-project analysis, whereas an allowance system depends on an inventory analysis of the regulated entities.

Both approaches have their advantages and disadvantages, and there is considerable dispute about which system is more efficient and hence more desirable. At present, the parallel implementation of both systems, cap-and-trade and baseline-and-credit, is being considered in some countries, e.g. in the United Kingdom [DETR (2000); UK Emissions Trading Group (2000), and chapters I and II]. What is more important in the present context is how JI and IET might relate to these two systems. Indeed, it may be argued that JI can be regarded as international baseline-and-credit trading, while IET constitute a form of an international cap-and-trade system [Janssen (2001) or (2000a)].

Which trading system is more appropriate? It is conceivable that for certain countries, JI is the more efficient trading institution whereas for other countries transactions under IET are more efficient. Indeed, it is sometimes argued that the countries in transition do not have the (financial) resources required to set up a comprehensive cap-and-trade system. Hence, it could be more efficient for them to participate in international emissions trading under JI. Other countries which value differently the costs associated with setting-up a comprehensive cap-and-trade system could find it more desirable to opt for this trading institution. Moreover, one has to distinguish between different GHGs and different sources. It could be true that IET is more efficient in the context of CO2 emissions from the power sector. Regarding other GHGs and sources, like methane emissions from agriculture or CO2 emissions from industrial processes, transactions under JI might be associated with less regulatory set-up or transaction costs.

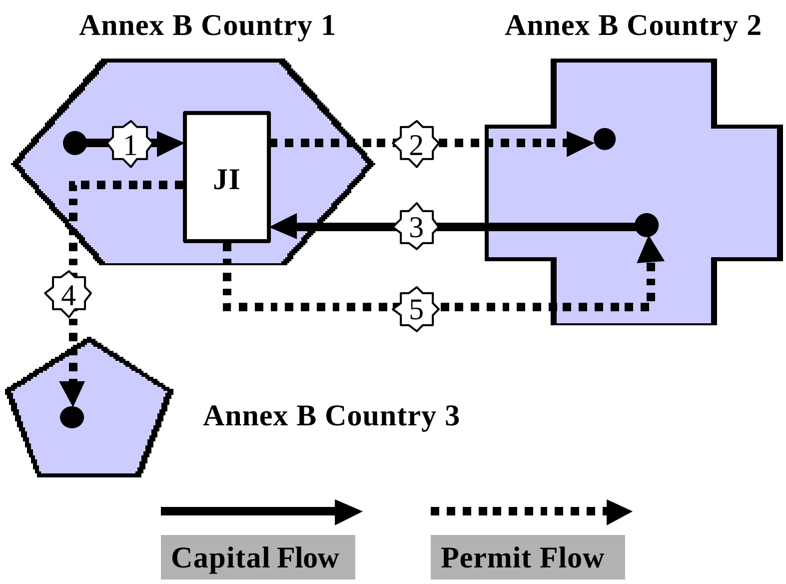
Coming to the third criterion, it is frequently argued that JI involves international (equity) investments: Grubb, Vrolijk and Brack, e.g., states that "JI enables emissions savings … arising from cross-border investments between Annex B parties to be transferred between them" [Grubb, Vrolijk and Brack (1999), p. 131]. And "the two project-level mechanisms JI

[11] On the US SO2 trading system, see for example Burtraw (1999); Ellerman et al. (2000); Joskow, Schmalensee and Bailey (1998); Klaassen and Nantjes (1997); Montero (1999a); Schmalensee et al. (1998) or Stavins (1998).

and CDM are intended to use international corporate investment as an engine for the generation and transfer of emissions credits" [Grubb, Vrolijk and Brack (1999), p. 195]. From this perspective, another distinction that might be drawn between JI and IET is that the former represents international production of emissions permits involving international investments whereas the latter constitute international trade in emissions permits. And it is important to note that production and trade are two fundamentally different economic activities.

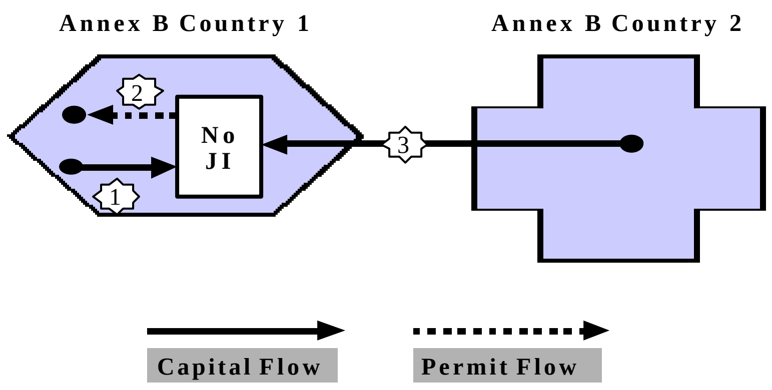
However, in the Kyoto Protocol there is no provision that prescribes that JI *must* involve *international* investments. Hence, it seems to be more convincing to distinguish between JI and IET according to the criterion *baseline-and-credit* versus *cap-and-allowances* trading. *International* investments are *not* to be regarded as distinguishing quality of JI projects, but the *international transaction* of resulting emissions permits. JI projects *may* involve *international investments*, but *do not require* them from a regulatory or legal point of view. This is illustrated by Figure 2-1.

Figure 2-1. International permit flows as necessary attribute of JI projects



JI projects may involve combinations of the following investment and permit flows: (1;2), (1;4), (3;2), (3;4), (3;5). On the other hand, international (and national) investments in climate protection projects the emissions credits of which are sold and used for compliance in the host country, would not qualify as JI projects. Thus, the combinations of transactions (1;2) or (3;2) in Figure 2-2 would not be governed by JI.

Figure 2-2. International capital flows as insufficient attribute of JI projects



2.2 CDM as baseline-and-credit trading and the issue of unilateral model

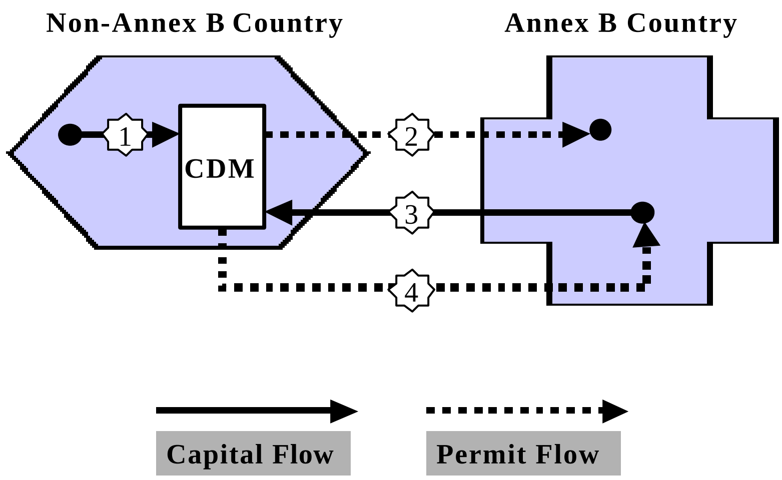
What does the previous discussion imply for the CDM? Regarding the first criterion, the Kyoto Protocol clearly allows private sector participation. With respect to the second criterion, the wording of Article 12 on CDM suggests that international GHG transactions under the CDM would constitute some form of baseline-and-credit trading: Article 12.5(c) requires that "reductions in emissions … are *additional to any that would occur in the absence* of the certified project activity". In this wording, the emissions that would *occur in the absence of the certified project activity* may be regarded as baseline emissions.

Concerning the criterion *international production versus international trade*, it is frequently said that CDM projects involve *international investments*, thus constituting *international production* of emissions permits. On the other hand, it is also argued that CDM projects formally would not necessarily require any foreign investments. Instead, "a host country could already finance projects on its own and sell credits earned. Article 12 would not prevent this" [Tietenberg et al. (1999), p. 49]. Such a financing (and trading) model has been referred to as *unilateral model*.

In Figure 2-3, it is characterised by the combination of investment and permit flows (1;2). Under the unilateral model "the developing country would … itself be acting as the main project *investor* and would attain the benefits as well as absorb the associated project risks" [Stewart et al. (1999), p. 28].[12] In such a unilateral model there would be no foreign equity capital involvement as opposed to the bilateral model which is characterised by international investments by entities from Annex B countries (see combination (3;4)). On the international political agenda, the issue of the unilateral model had attracted some attention. It seems that the Marrakech Accords do not prevent developing countries to apply the unilateral model. Indeed, it may be expected that the majority of CDM projects will be implemented unilaterally, since capital formation in most developing countries is financed predominantly by domestic sources.

[12] International investments as opposed to international trade are strongly burdened with the risk of contract breach due to weak international compliance regimes, even if there are instruments for stabilising international CDM contracts [Janssen (1999a)] and managing associated investment risks [Janssen (2001) and (2000b)]. However, the possibility to apply the unilateral model could reduce significantly such political risks.

Figure 2-3: Unilateral and bilateral CDM model



2.3 Which type of Kyoto mechanism for international transactions in greenhouse gas emissions permits?

It seems that JI and CDM would represent some form of international *baseline-and-credit* system. In addition, they *could* involve *international* investments.

Since international transactions of GHG permits in a baseline-and-credit system between Annex B countries seem to be governed by JI, it follows that Article 17 on IET would only apply to international transactions out of a *cap-and-trade* system. Otherwise, either Article 6 on JI or Article 17 on IET would be redundant due to institutional arbitrage by market participants.

Emissions permits of all three Kyoto Mechanisms are fungible, at least as regards international guidelines. As a consequence, all three Kyoto Mechanisms will compete with each other: Prospective buyers want to achieve compliance at lowest costs. This means that they will buy those emissions permits that sell at minimum price. Thus, if emissions permits generated from a CDM project are less expensive than emissions permits available under JI or IET, prospective buyers will use CDM credits for compliance.

Regarding such a competition between the different Kyoto Mechanisms it is frequently maintained that CDM projects might involve lower abatement costs as compared to projects in industrialised countries. On the other hand, it is becoming apparent that CDM projects will be burdened by more administrative regulations and procedures such as validation, verification and certification, thus involving higher transaction costs. In addition, from the perspective of potential investors, CDM projects, being located in developing countries, are associated with higher political and country risks.

Regarding the level of implementation of emissions trading schemes, one can distinguish different categories:

- National/domestic, regional (e.g. EU-wide), and international trading schemes.
- Intra-firm, inter-firm, firm to government, and government to government emissions trading.

All *cross-country* transactions will be governed by the Kyoto Mechanisms or similar forms of project-based or inventory-based emissions trading.

Concluding, international transactions related to abatement activities could be classified on the basis of the following different criteria:

- Transferring entity is from (1) Annex B country or (2) non-Annex B country.
- Acquiring entity is from (1) Annex B country or (2) non-Annex B country.
- Transferring entity has (1) a baseline or (2) operates under a cap.
- Production of emissions permits involves (1) no international investments or (2) international investments.

Table 2-1 shows the 16 different transaction types that emerge when combining these criteria. In the last row an attempt is made to assign the different types of transactions to the three Kyoto Mechanisms. Even if policy makers, researchers and practitioners might not agree with this assignment, it would be desirable to be clear about the precise nature of JI, CDM or IET in terms of transaction types when discussing the Kyoto Mechanisms. This is true as regards policy-making, research and practice: To design efficient rules and guidelines for JI, CDM and IET, policy makers should have a clear idea of the nature of underlying transactions. The same is true for economic research on the Kyoto Mechanisms: In order to analyse, e.g., the implications of JI, CDM and IET for technology innovation and diffusion, one would obviously need to have a clear understanding about the economic characteristics of these concepts. And firms involved in international GHG transactions need to have a clear understanding about the regulatory framework, in terms of Kyoto Mechanisms, that governs these transactions.

Table 2-1: Types of international greenhouse gas transactions

Transaction number:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Transaction features:																
Transferring entity is from																
Annex B country	X	X	X	X	X	X	X	X								
Non-Annex B country									X	X	X	X	X	X	X	X
Acquiring entity is from																
Annex B country	X	X	X	X					X	X	X	X				
Non-Annex B country					X	X	X	X					X	X	X	X
Transferring entity has a																
Baseline	X	X			X	X			X	X			X	X		
Cap			X	X			X	X			X	X			X	X
Production of emissions permits involves																
No international investments	X		X		X		X		X		X		X		X	
International investments		X		X		X		X		X		X		X		X
Institutional Framework	JI	JI	IET	IET	na	na	na	na	CDM u.m.	CDM b.m.	??	??	na	na	na	na

n.a. = not available; u.m. = unilateral model; b.m. = bilateral model.

3. Size of Emerging Global Markets for Greenhouse Gas Emissions Permits

The Kyoto Mechanisms constitute the instrumental basis of emerging global GHG markets. Examining opportunities for industry that are associated with these markets, it is interesting to have a rough idea about their size.

Several economic studies have tried to quantify the costs of reaching the commitments of the Kyoto Protocol, thereby also focusing on the scope of reducing these costs through the Kyoto Mechanisms. In this section, I give an overview of the results of these models.[13]

[13] This chapter is based on the excellent survey by Springer (2000a). Another similar market survey is Edmonds et al. (1999), covering however only some of the models included by Springer (2000a). The range of models reported in Springer (2000a) covers Integrated Assessment Models, Computable General Equilibrium Models, Neo-Keynesian Macroeconomic Models, Energy System Models, and

Different model types as well as diverging projections of emissions growth without climate policy (reference case) are the main reasons for the large differences found between the model results. A common finding of all studies is that *trading lowers the costs* of achieving the commitments in the Kyoto Protocol. Model results can serve as indicators of the permit prices and the likely size of the emerging market for GHG permits. However, their limitations and implicit assumptions should be noted carefully.[14]

All models (around 20) discussed by Springer (2000a) share one common finding: Trading lowers costs substantially. If no emissions trading is allowed, each country has to meet its reduction obligation on its own. However, for some countries with high carbon efficiency (like Japan), this would be very expensive. Therefore, autarkic abatement costs without trading would be very high. Trading allows those countries and industries with lower costs to reduce more and those with higher costs, to abate less. Of course, the overall reduction is the same under trading. But overall, costs are substantially lower. This is shown by Table 3-1.

Table 3-1: Marginal abatement costs with domestic action only and with global trading

Model	**Marginal abatement costs with domestic action only** (1998 US$/tonne CO_2)			**World market price** (1998 US$/tonne CO_2)
	USA	**Japan**	**EU**	
EPPA	64	201	94	8
G-Cubed	26	33	53 (other OECD than USA, Japan, Australia)	7
SGM	51	139	40	8
MS-MRT	91	161	70	10

Sources: Bernstein, Montgomery, Rutherford (1999); Ellerman, Jacoby and Decaux (1999); MacCracken et al. (1999); McKibbin et al. (1999).

The second, third and fourth column show estimates of marginal abatement cost by different models for the USA, Japan and the EU, respectively, in a situation without international trade. The last column lists estimates of world market prices with global trading. Such prices would be equal to marginal abatement cost if global trading is allowed.

At present, several European countries such as the UK, Germany, Norway, Sweden and Switzerland are considering to set up domestic GHG trading schemes. The European Commission strives for the establishment of an EU-wide trading scheme by 2005. The Danish trading system is already operational. What would such a European market look like as

hybrid models. The market survey by Marenzi and Varilek (2001) also reports data on real transactions. The results reported here are based on the assumption that the USA would have ratified the Kyoto Protocol. Recently, some research has started to explore the implications of the withdrawal of the USA. Hagem and Holtsmark (2001), e.g., predict that permit prices will be reduced to one third of what it would have been with the USA participating.

[14] For a discussion of some modeling issues and main differences between model types see Springer (2000a).

regards market prices?Table 3-2 reports marginal costs if all EU countries would meet respective Kyoto targets through domestic action only. In addition, this table shows market prices for different trading scenarios. As can be seen easily, marginal abatement costs for the EU as a whole could be significantly reduced by opening up internationally an EU wide trading scheme.

Table 3-2: Marginal abatement costs and market price with and without emissions trading within the EU

	Kyoto target	***Marginal costs of domestic action***	***Trading scenario***	***Market price***
		EUR 1999 / tCO2		EUR 1999 / tCO2
Austria	-13	28.4	EU-wide emissions trading among energy suppliers	32.3
Belgium	-7.5	89.3	EU-wide emissions trading among energy suppliers and energy intensive sectors	33.3
Denmark	-21	47.9	EU-wide emissions trading, all sectors	32.6
Finland	0	63.5	Annex-I-wide emissions trading	17.7
France	0	20.6		
Germany	-21	13.5		
Greece	25	39.0		
Ireland	13	53.5		
Italy	-6.5	33.3		
Netherlands	-6	150.7		
Portugal	27	41.1		
Spain	15	27.7		
Sweden	4	39.7		
United Kingdom	-12.5	31.9		

Source: Capros et al. (2000).

Coming back to the more aggregate international level, Table 3-3 Table 3-3shows permit prices and net international trade volumes both in physical and value terms estimated by the models for an international trading regime with unrestricted CDM (*full global trading* scenario).[15]

[15] *Full global trading scenario* means that developing countries, or non-Annex B countries, can sell any permits that result from emissions reductions below their business-as-usual scenario. The results in Table 3-3 are from models that consider *only carbon dioxide* (CO_2) emissions. Springer (2000a)

Table 3-3: Prices and net international trade volumes under international trading regime with unrestricted CDM

Model	**Permit price** (1998 US$/tonne CO_2)	**Net international trade volume as annual average** (million tonnes CO_2)	**Net international trade volume as annual average** (million 1998 US$)
AIM	12	1,833	21,996
ECN	4	2,119	8,476
EPPA	8	3,428	27,424
G-Cubed	7	3,318	23,226
GEM-E3	8	-	-
GRAPE	13	1,540	20,020
GREEN	7	2,427	16,989
MERGE	22	-	-
MS-MRT	10	-	-
POLES	6	2,295	13,770
RICE-98	5	-	-
ZEW	13	-	-
Average	9.6	2,423	18,843
Median	8.0	2,295	20,020

Sources: Springer (2000a); based on Bernstein et al. (1999); Böhringer (2000); Capros (1999); Criqui and Viguier (2000); Ellerman, Jacoby and Decaux (1999); Kainuma, Matsuoka and Morita (1999); Kurosawa et al. (1999); Manne and Richels (1999); McKibbin et al. (1999); Mensbrugghe (1998); Nordhaus and Boyer (1999); Sijm et al. (2000).

Average estimated price is $9.6 per tonne of CO2, which is quite close to the median ($8 per tonne of CO2). The range of estimated prices is broad, the lowest price is $4; the highest $22 .[16] But this wide price range is not necessarily a problem for decision-makers in affected industries, since abatement costs of single projects are not continuous but discrete. Consequently, it may be that known costs of different abatement technologies vary to an even greater extent than prices indicated above.

Only some models explicitly estimate the amount of permits traded. Average annual net international trade volumes in *physical terms* range from 1,540 million tonnes CO_2 (GRAPE) to 3,428 million tonnes (EPPA).

also considers models that incorporate emissions of other GHGs, too. Main results are, however, not affected. None of the models includes terrestrial sinks. Prices reported in dollar values of a different year are inflated. Trade volumes in physical terms are stated in tonnes of CO_2. If necessary, they were transformed from carbon to CO_2 by multiplication with the factor 44/12.

[16] The low estimate from ECN is due to the fact that a technology-oriented bottom-up approach was used which included a considerable potential of options with negative marginal costs.

Estimates about average net international annual trade volume in *value terms* are much closer together than estimates about permit prices and trade volumes in physical terms.[17] They range from $8,476 million to $27,424 million . Under global trading, the average trade volume of all models is $18,843 million , being very close to the median ($20,020 million).

Under a scenario in which international trading is restricted to Annex B countries, i.e. if the rules on the CDM are extremely restrictive, all prices are higher and trade volumes in lower compared to the global trading scenario (see Table 3-4). The results again differ significantly, the lowest price estimate is $5 per tonne of CO_2 and the highest $70.[18] On average, models predict a price of $24.6 per tonne of CO2, which is close to the median ($18).

Table 3-4: Prices and trade volumes under international trading regime with restricted CDM

Model	**Permit Price** (1998 US$/ tonne CO_2)	**Trade volume** (million tonnes CO_2)	**Trade volume** (million 1998 US$)
AIM	21	1,467	30,807
ECN	5	-	-
EPPA	44	1,265	55,660
G-Cubed	18	2,017	36,306
GEM-E3	16	-	-
GRAPE	22	1,283	28,226
GREEN	18	1,503	27,054
GTEM	36	-	-
MS-MRT	29	1,852	53,708
Oxford	70	1,074	75,180
POLES	17	1,467	24,939
RICE-98	18	-	-
WorldScan	6	2,592	15,552
Average	*24.6*	*1,613*	*38,604*
Median	*18.0*	*1,467*	*30,807*

Source: Springer (2000a); based on Bernstein et al. (1999); Bollen, Gielen and Timmer (1999); Capros (1999); Cooper et al. (1999); Criqui and Viguier (2000); Ellerman, Jacoby and Decaux (1999); Kainuma, Matsuoka and Morita (1999); Kurosawa et al. (1999); McKibbin et al. (1999); Mensbrugghe (1998); Nordhaus and Boyer (1999); Sijm et al. (2000); Tulpulé et al. (1999).

[17] Since low prices lead to more permit trade and vice versa, the products of these two factors exhibit less variance.

[18] The high permit price estimated by the Oxford model can be attributed to the model type: Econometric models are based on estimated values of how imperfect markets react to changes in their environment. These frictions and imperfections are not included in bottom-up models like ECN, that report much lower prices.

As expected, trade volume in physical terms is smaller under international trading regime with restricted CDM because of the smaller number of potential sellers and a higher permit price. All models estimate that permit trades would decrease significantly. The average trade volume in physical terms is 1,613 million tonnes CO_2 under Annex B trading, compared to 2,423 million tonnes under global trading.

Interestingly, most models predict a higher trade volume in value terms with restricted than with unrestricted CDM. The average trade volume in value terms under Annex B trading is $38,604 million, more than twice as much as under global trading.

Major seller countries under an international trading regime with unrestricted CDM are China, India and the Russian Federation. Important buyer countries are the European Union, Japan, and the United States (if the latter would participate in the Kyoto Protocol). Within the European Union, Greece, Italy and the Netherlands are the largest buyers. In an international trading regime with restricted CDM, major importing countries are quite the same. On the supply side, Austria, Eastern Europe, France, Germany and the Russian Federation emerge as exporters of GHG emissions permits.

Table 3-5 shows that shares of permit imports in total reductions for three major importing regions, namely the USA (if they would participate in the Kyoto Protocol), the EU, and Japan. Under an Annex B trading scenario, these regions meet between one and two thirds of their reductions requirements through imported permits. Obviously, less domestic measures are undertaken under global trading because permit prices are lower. The estimated shares of imported permits in total reductions are from 50 per cent up to 92 per cent.

Table 3-5: Share of international permit imports on total reductions (%)

	International trading regime					
	World trading			Annex B trading		
Country	USA	EU	JPN	USA	EU	JPN
Model						
ECN	83	59	86	-	-	-
EPPA	68	76	92	19	35	66
GREEN	50	68	67	29	48	48
POLES	82	78	-	51	52	62

Source: Springer (2000a); based on Burniaux (1998); Criqui and Viguier (2000); Ellerman, Jacoby and Decaux (1999); Sijm et al. (2000).

Several studies have tried to determine the relative size of international imports under the CDM as opposed to international transactions among Annex B countries (see Table 3-6).[19]

[19] Model results are for scenarios with no restrictions on any of the Kyoto Mechanisms and competitive supply. JI/IET includes 'hot air' from Eastern Europe and the Former Soviet Union.

Table 3-6: Market share of the CDM

Model / Author	International Emissions Trading and Joint Implementation			CDM		
	Trade volume (million tonnes CO_2)	Trade volume (million 1998 US$)	Market share (%)	Trade volume (million tonnes CO_2)	Trade volume (million 1998 US$)	Market share (%)
ECN	3,227	3,227	42	4,543	4,543	58
EPPA	774	6,189	23	2,651	21,208	77
G-Cubed	1,503	10,523	45	1,815	12,705	55
GREEN	972	6,802	40	1,456	10,190	60
Haites	1,192	11,920	36	2,108	21,083	64
POLES	986	7,891	38	1,606	12,848	62
SGM	1,309	10,472	44	1,665	13,317	56
Zhang	576	1,727	35	1,071	3,212	65

Source: Springer (2000a); based on Criqui and Viguier (2000); Ellerman, Jacoby and Decaux (1999); Haites (1998); MacCracken et al. (1999); McKibbin et al. (1999); Mensbrugghe (1998); Sijm et al. (2000); Zhang (2000a).

Estimates of the value of annual permit trade under *JI* and *IET* range from $1,727 million (Zhang) to $11,920 million [Haites (1998)].[20] The market share of these two Kyoto Mechanisms is expected to lie between a quarter and half of the unrestricted global market for tradable GHG permits in the first commitment period. Emissions reductions generated under the CDM have a larger share of the market, estimates range from 55 to 77%. In value terms, the market volume is between $3,102 and $21,208 million. The market shares could change due to transaction costs or political restrictions. Political constraints could be placed on the use of the Kyoto Mechanism by individual countries, for example by not allowing certain project types under the CDM. Such restrictions could influence the demand for permits of specific project types.

4. Opportunities and Barriers for Greenhouse Gas Emitting Industries

Key players on both demand and supply side of global GHG markets are GHG emitting industries. They will benefit from GHG markets by achieving compliance at lower cost or by producing and selling GHG emissions permits to other companies, thus earning additional income.

Knowing the GHGs controlled by the Kyoto Protocol, it is straightforward to deduce the sectors and industries emitting GHG.[21] They include [Watson, Zinyowera and Moss (eds.) (1996), part III]:

[20] Because the models represent emissions trading among regions, they cannot distinguish between the Kyoto Mechanisms JI and IET.

[21] The Kyoto Protocol controls the following GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6).

- Production of natural gas and hydrocarbon oil;[22]
- coal mining;
- transmission and distribution of natural gas;
- refining of hydrocarbon oil and petrochemistry;
- power production based on fossil fuels;[23]
- production of basic metals including iron and steel, aluminium and copper;[24]
- chemical industry;
- pulp and paper production;
- production of construction materials including cement and concrete, brick and glass;[25]
- fossil fuel based transportation;
- fossil fuel consumption in residential and commercial buildings;
- waste and wastewater disposal;
- agriculture and forestry.

Depending on the comparative cost advantage of individual firms operating in these industries, they will be potential buyers or sellers of emissions permits. In the following, I will explore potential opportunities and barriers existing on the demand and supply side.

4.1 Opportunities and barriers for greenhouse gas emitting industries: Demand side

All sectors and industries in Annex B countries which are emitting GHGs controlled by the Kyoto Protocol will *potentially* be on the demand side. It is important to note that these industries are only *potentially* on the demand side. This is for several reasons.

First, some governments may decide to regulate only *certain* GHG emitting industries by climate policies. Experience in recent energy and environmental taxation initiatives in several European countries indicate that governments tend to exempt energy intensive and export oriented industries from taxation [Ekins and Speck (1999) or Hanisch (1998)]. Here is not the place to discuss the efficiency or possible political economy explanations of such policy approaches. However, they make evident that it cannot necessarily be expected that the intensity of climate policy regulations will coincide with the GHG emissions quantities of different industries.

Second, climate policy regulations may be implemented at various stages of the production cycle: The literature distinguishes between upstream and downstream regulation.[26] The

Milich (1999) discusses in detail economic activities resulting in emissions of methane. OECD (2000) provides a survey of economic activities resulting in emissions of non-CO2 GHGs.

[22] See Janssen (1999b) for a discussion of applying the Kyoto Mechanisms at the production stage of oil and gas.

[23] On applying the Kyoto Mechanisms in the power sector see OECD and IEA (2000b), chapter 3.

[24] On applying the Kyoto Mechanisms in the iron and steel industry see OECD and IEA (2000b), chapter 5.

[25] Regarding the potential to reduce GHG emissions in the cement industry, see e.g. Soares and Tolmasquim (2000) or Worrell, Martin and Price (2000). On applying the Kyoto Mechanisms in the cement industry see Jansen and Vleuten (1995) and OECD and IEA (2000b), chapter 2.

former refers to policies that aim at restricting the carbon input to the economy. They address *producers and importers* of primary energy like natural gas, coal and oil. The latter aim at directly regulating *final emitters* of GHGs like power plants, and households and firms that use fossil fuels for heating and transportation. Both approaches can be designed effectively. But from an economic perspective, they are not necessarily equivalent, since they may involve different price signals and transaction costs. In any case, it will depend on the concrete policy approaches adopted in Annex B countries, if upstream industries like oil & gas companies or downstream emitters like power producers and processing industries represent the major groups of final buyers of GHG permits.

Third, some regulated industries and companies might be able to reduce emissions internally at marginal abatement costs that are lower than present or future market prices for GHG emissions permits. In this case, it is economically rational to reduce GHG emissions at regulated sources instead of buying emissions permits on national or international markets.[27]

Fourth, the potential to take advantage of the Kyoto Mechanisms will also depend on the size of the firm in question. Most companies outside the USA are not familiar with emissions trading schemes and the Kyoto Mechanisms. Thus, many firms would need to build up relevant expertise and know how. This is true even more in the case of the Kyoto Mechanisms, the application of which may be expected to be more complicated than purely national transactions. Now, such investments in required human capital, infrastructure and networks involve additional costs which, to a large extent, are fixed. Such fixed costs may prevent small and medium sized enterprises from the outset to develop a compliance strategy based on the Kyoto Mechanisms. The same considerations apply on the supply side. Presently, some state governments in Germany, e.g. in Baden-Württemberg, are trying to promote involvement of medium sized companies in the Kyoto Mechanisms by supporting capacity building initiatives.

4.1.1 Opportunities on the demand side

Opportunities of the Kyoto Mechanisms are straight forward for GHG emitting companies which potentially are on the demand side of global GHG markets: If they are regulated by domestic climate policies, and if they are faced with relatively high internal abatement cost, they could reduce costs of compliance by means of the Kyoto Mechanisms. Such a minimisation of compliance costs constitutes a most significant opportunity of the Kyoto Mechanisms for GHG emitting firms. Figure 4-1 illustrates this point, assuming that a GHG emitting firm is regulated by a domestic tradable permit system.

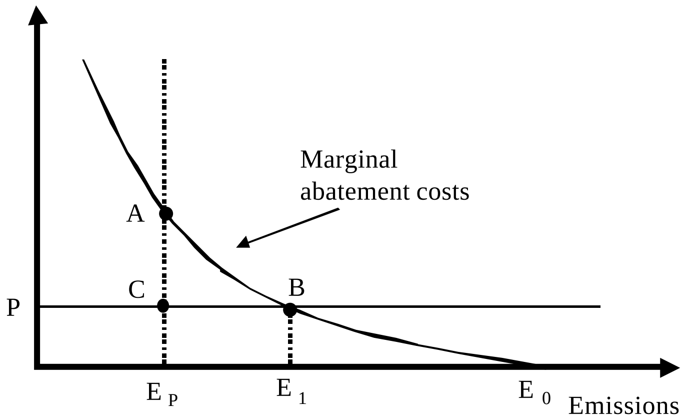
The company in question has an initial allocation of emissions permits equal to E_P. Its original emissions are E_0. At the end of the compliance period, e.g. at the end of one year, the firm must hold emissions permits equal to its actual emissions in order to be in compliance. For the first emissions reduction units, it is cheaper to abate internally than to buy emissions permits at price P. Consequently, the firm reduces emissions internally up to that amount where marginal abatement costs equal the market price of emissions permits (E_1). In order to be in compliance, the firm could continue to reduce emissions internally or just buy emissions

[26] On a discussion of the different systems in the context of emissions trading see e.g. Australian Greenhouse Office (1999a); CCAP (1998a) and (1998b); Heinz Center (1998) or TPWG (2000).

[27] It might indeed by expected that to some extent companies and industries might find it cheaper to reduce emissions at regulated sources. The survey by Springer (2000a) reveals that Annex B countries will meet their Kyoto targets to a significant extent through domestic action. Some energy experts also argue that there exist a wide range of no-regret or no-cost options to reduce GHG emissions. Regarding the debate on no-regret options see e.g. Sutherland (2000).

permits on national or international markets, the latter through the Kyoto Mechanisms. Since any further internal reduction would be more expensive than purchasing emissions permits at price P, a cost minimising firm would buy emissions permits in a quantity equal to the difference (E_1 - E_P). If no trading were allowed, it had to reduce emissions internally up to E_P. Cost savings achieved through emissions trading amount to the area (ABC).

Figure 4-1: Economic benefit of Kyoto Mechanisms: demand side



Cost savings associated with the Kyoto Mechanisms are expected to be even higher than those obtained through domestic emissions trading (see above). These compliance cost savings associated with the Kyoto Mechanisms represent the main opportunity for GHG emitting companies that are regulated by climate policies and that face comparatively high abatement costs. And all economic studies on the costs of Kyoto indicated that potential costs savings would be huge (see Section 3).

4.1.2 Barriers on the demand side

Opportunities of the Kyoto Mechanisms are straightforward. However, companies may face significant barriers that might prevent them from realising these opportunities.

For analytical clarity, it is useful to distinguish between barriers associated with the market itself, and barriers induced by regulatory restrictions at the international and national level.

- Market barriers: price uncertainties and liquidity risks.
- Regulatory barriers imposed by international rules: import restrictions, levies on transactions and eligibility requirements for countries.
- Regulatory barriers at the national level: low compatibility of domestic regulations with the Kyoto Mechanisms and lack of incentives for legal entities to engage in the Kyoto Mechanisms.

4.1.3 Price uncertainties

The discussion of section 3 has shown, that future prices of emissions permits are quite uncertain, estimates ranging from \$4 to \$22 per tonne of CO2 equivalents under an international trading regime with unrestricted CDM, and from \$5 to \$70 under an international trading regime with very restrictive rules on the CDM. On average, models discussed in section 3 predict a price of approximately $10 and $25 per tonne of CO2 equivalents for both regimes, respectively. Experience with the US SO2 emissions trading system indicates that future prices might be significantly overstated [Schmalensee et al. (1998)].[28] Costs of internal emissions reduction programmes may appear to be more certain. Consequently, regulated companies that are faced with the need to develop compliance strategies may regard these price uncertainties as obstacles that prevent them from using the Kyoto Mechanisms.

However, it is quite probable that tools for hedging such price risks will emerge, as has been the case in other (emission) markets. Such risk management tools encompass forward and future contracts, call and put options, swaps and others. It may be expected that financial institutions will enter this market and offer such derivative instruments.[29]

4.1.4 Liquidity risks

Liquidity risks are a major obstacle for emissions trading. Low (expected) liquidity of emissions markets is generally considered to be one of the most important reasons for their failure: If potential buyers anticipate that it could be very difficult or even impossible to purchase emissions permits required to get into compliance, they might adopt a compliance strategy of internal emissions abatement from the outset. In addition, low liquidity will increase search costs associated with finding an interested seller, thus raising barriers to trade.[30] Search costs will increase directly or indirectly, depending on the arrangement of trades. If trades are arranged bilaterally between buyer and seller, the buyer will need more time and money to find a counterparty. If they are mediated through a broker, increases in search costs will be reflected in higher brokerage fees.

Liquidity risk may be mitigated if national markets are integrated at the international level.

4.1.5 Import restrictions

Closely linked to liquidity risks are barriers created by import restrictions. Why import restrictions? The text of the Kyoto Protocol on JI, CDM and IET requires that

“the acquisition of emissions reduction units shall be *supplemental* to domestic actions for the purposes of meeting commitments under Article 3”,

“Parties included in Annex B may use the certified emissions reductions ... to contribute to compliance with *part of* their quantified emissions limitation and reduction commitments under Article 3”, and

“any such trading shall be *supplemental* to domestic actions for the purpose of meeting quantified emissions limitation and reduction commitments ...”.[31]

These provisions are also called *supplementarity* provisions. The European Union, supported by some developing countries, had been strongly advocating to define such supplementarity in quantitative terms. Quantitative restrictions on the use of the Kyoto Mechanisms (“ceiling”) would constitute import quotas for emissions permits, rising the domestic price of

[28] For a detailed analysis of possible explanations of this empirical fact see Montero (1999b).

[29] On the use of derivative instruments in emissions markets see e.g. Bailey (1998); Byrd and Zwirlein (1994); ETEI (1999) and Tucker (2001).

[30] Liski (2001) provides a theoretical analysis of GHG market liquidity and transaction costs.

[31] Article 6.1(d), Article 12.3(b), and Article 17, respectively. Emphasis added.

emissions permits.[32] From the perspective of potential buyers, such import restrictions, if expected to be binding, constitute additional barriers. First, permit buyers will need to pay higher prices as compared to a situation without ceiling. Second, import quotas involve additional information costs for importers associated with required learning effort about their administration. Third, if rationing is implemented on the basis of a first-come, first-served approach, such a ceiling could jeopardise liquidity of the market at an increasing rate, thus involving risks of non-compliance and associated financial penalties for companies counting on the use of the Kyoto Mechanisms. Anticipating such risks, potential buyers will be reluctant to rely on the Kyoto Mechanisms.

At COP7, Parties agreed that there will be no obligation to impose quantitative restrictions on the use of the Kyoto Mechanisms. However, some countries might still wish to do so.[33]

4.1.6 Levies on transactions

Article 12.8 on the CDM states that "a share of proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation". This provision constitutes the basis for a levy on transactions under the CDM.

At COP7, Parties have decided that the share of proceeds for adaptation measures shall be 2% of the CERs issued for a CDM project activity.[34] The level of the share of proceeds to cover administrative expenses of the CDM shall be determined at a later stage. From the perspective of potential buyers, such transaction fees on the CDM increase the barriers to its use.

4.1.7 Eligibility requirements for countries

Some countries may not be eligible to acquire emissions permits from other countries. According to the agreement reached at COP7, countries that want to acquire emissions permits for compliance must meet the following criteria:

- It is a Party to the Kyoto Protocol.
- It has established its assigned amount.
- It has in place a national system for the estimation of anthropogenic GHG emissions and removals.
- It has in place a national registry for emissions permits.
- It has submitted the most recent required inventory.

If a country fails to meet these obligations, companies in that country intending to buy emissions permits through the Kyoto Mechanisms may be disallowed to use such permits for compliance.

4.1.8 Possible incompatibility of domestic regulations with the Kyoto Mechanisms

This issue involves two aspects: First, crediting procedures could involve high transaction costs due to technical or institutional reasons. Some domestic climate policy instruments

[32] Bernstein et al. (1999); Bollen, Gielen and Timmer (1999); Ellerman and Wing (2000); Gusbin et al. (1999); Ybema, Kram and Rooijen (1999) and Zhang (2000b) provide an economic analysis.

[33] An example is Switzerland that despite the agreement reached at COP7 intends to limit quantitatively the use of the Kyoto Mechanisms [Janssen and Springer (2001)].

[34] CDM projects in least developed countries will be exempt from this share of proceeds.

might simply not be compatible with the Kyoto Mechanisms in terms of providing incentives for their use (see also chapters I and II regarding compatibility of the Kyoto Mechanisms with domestic climate policies). Second, domestic climate policy regulations may simply not allow the use of the Kyoto Mechanisms for compliance.

Concerning the first point, different domestic climate policy instruments involve different transactions costs in terms of using the Kyoto Mechanisms for compliance. In general, governments of Annex B countries can induce their economies to reduce GHG emissions by means of different climate policy instruments.[35] They include [OECD (1999b)]:

- regulatory standards, e.g. energy efficiency standards, automobile fuel efficiency, renewable energy quotas;[36]
- emissions and carbon taxes and charges;[37]
- environmental subsidies;
- domestic tradable permits;[38]
- voluntary agreements (see chapter II);
- green government purchasing; and
- removal of fossil energy subsidies.

The different policy instruments do not have the same degree of compatibility with the Kyoto Mechanisms in terms of technical feasibility and transaction costs.[39] Domestic cap-and-allowances trading systems and carbon taxes are easy to combine with the Kyoto Mechanisms. Voluntary agreements may be compatible with the Kyoto Mechanisms, if the consequences of agreed actions can be directly expressed in terms of tonnes of GHG emissions. The same consideration applies in the case of regulatory standards [Haites and Aslam (2000), pp. 27-28]. Transaction costs associated with using the Kyoto Mechanisms for compliance with domestic climate policies will generally increase if such policies define relative or intensity targets as opposed to absolute targets.

Regarding the second point, governments of Annex B countries are free to decide that regulated firms within their jurisdiction are not allowed to comply (with part of) their

[35] Article 2 of the Kyoto Protocol gives Annex B countries high flexibility in the choice of domestic climate policies. Gummer and Moreland (2000) provides an overview on national climate policy programmes in the European Union.

[36] Helfand (1991) gives an overview of different modes of defining standards and explores their economic properties. On emerging renewable energy quotas see Berry and Jaccard (2001); Drillisch (2000); EURELECTRIC (2000); Morthorst (2000) or Schaeffer et al. (1999).

[37] On carbon taxes see e.g. Baranzini, Goldemberg and Speck (2000). On the potential for using taxes to reduce non-CO2 GHG see OECD (2000).

[38] On the design of domestic emissions trading markets see e.g. Australian Greenhouse Office (1999a); (1999b); (1999c) and (1999d); Hinchy, Fisher and Graham (1998); Ministry of Environment of New Zealand (1998) and TPWG (2000).

[39] See e.g. Hahn and Stavins (1999); Haites and Aslam (2000); Michaelowa (1996) for a general discussion. On the compatibility of tradable renewable energy quotas and GHG emissions trading see Morthorst (2001). On the interaction between the European directive on integrated pollution prevention and control (IPPC), which prescribes the use of best available technologies, and emissions trading see Smith and Sorrell (2000).

commitments by means of the Kyoto Mechanisms, e.g. in order to achieve local environmental objectives.[40]

4.2 Opportunities and barriers for greenhouse gas emitting industries: Supply side

4.2.1 Opportunities on the supply side

All sectors and industries that are on the demand side, are potentially also on the supply side, depending on their comparative advantage in reducing GHG emissions. In concrete, those companies which accomplish to generate surplus GHG emissions reductions at marginal costs that are below the governing world market price for GHG permits, will potentially be on the supply side.[41] This point is illustrated by Figure 4-2, assuming that a GHG emitting firm is regulated by a domestic tradable permit system. The company in question has an initial allocation of emissions permits equal to E_P. Its original emissions are E_0. At the end of the compliance period, e.g. at the end of one year, the firm must hold emissions permits equal to its actual emissions in order to be in compliance. For the company considered, it is easy to reduce its emissions to an amount that equals its initial allocation of emissions permits (E_P). The company is now in compliance. But it could reduce emissions even further at relatively low costs. It is profitable to reduces emissions up to that amount where marginal abatement costs equal the market price of emissions permits (E_1). The surplus emissions reductions (E_P - E_1) can be sold on national or international markets, thereby making a profit that corresponds to the area (ABC).

Sales on international markets would occur under one of the Kyoto Mechanisms, depending on the location of the permit producing entity (Annex B versus non-Annex B country) and the climate policy instrument by which it is regulated.[42] Thus, companies in GHG emitting industries may take advantage of the Kyoto Mechanisms to realise additional business opportunities.

A general question is, how to determine surplus emissions. In order to answer this question, it is useful to distinguish between two situations: If a company or a plant is regulated by a cap-and-allowance system, surplus emissions are any positive difference between holdings of emissions permits and actual emissions (see above). Under any other climate policy regulation, an emissions surplus is any emissions reduction below a certain reference scenario or baseline.[43]

In addition to having the potential to generate surplus emissions permits at competitive costs, firms need to be allowed by national and international law to trade possible surplus reductions internationally. I will discuss this point under the heading *barriers.*

In conclusion, the emerging global GHG market will enable companies in GHG emitting industries to make additional profits through the production and subsequent sale of surplus emissions permits. As the discussion in section 3 has shown, business opportunities associated with the by-product *emissions permits* are deemed to be quite large.

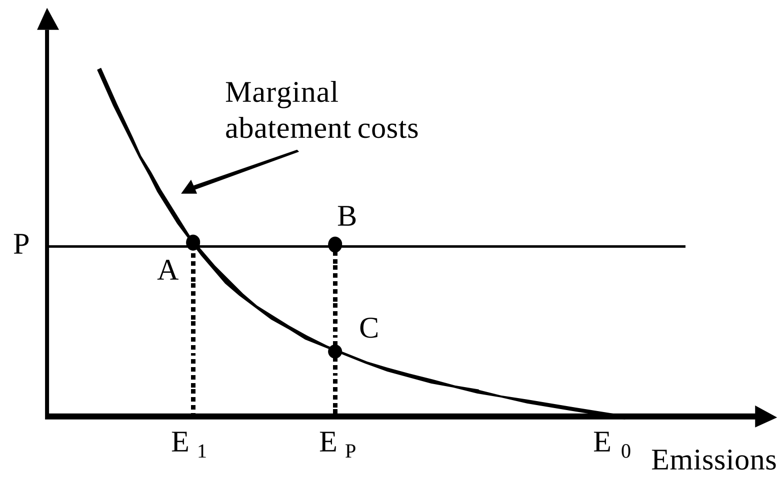
[40] Obviously, such a policy approach would only be second or third best. A first best policy would try to tackle a given policy objective with a more targeted instrument.

[41] Contrary to frequent perceptions, surplus reductions are not necessarily tied to specific technologies. They are always case-specific.

[42] The latter determines whether the company participates in emissions trading under a cap-and-trade or baseline-and-credit system, see above.

[43] On baselines see section 2.

Figure 4-2: Economic benefit of Kyoto Mechanisms: supply side



4.2.2 Barriers on the supply side

Business opportunities on the supply side of the global GHG market are expected to be huge. However, firms that have the potential to deliver emissions permits at competitive costs to the market, may be prevented from doing so due to the existence of different kinds of barriers. As on the demand side, they may be classified into different categories:

- Market barriers: price uncertainties and liquidity risks.
- Regulatory barriers imposed by international rules: levies on transactions, eligibility requirements for countries, transaction costs associated with baseline determination etc.
- Regulatory barriers at the national level: transaction costs and complicated procedures associated with exports.

Barriers on the supply side are quite similar in their nature to those pertinent to the demand side (see above). Consequently, I will touch only on some additional or different aspects.

4.2.3 Price uncertainties and liquidity risks

Here, similar considerations apply as those mentioned in the context of the demand side.

4.2.4 Levies on transactions

Levies on transactions, as discussed before in the context of barriers related to the demand side, will also affect the supply side.

4.2.5 Country eligibility

Regarding JI and IET, the same country eligibility criteria apply for transfers as for acquisitions of emissions permits (see above). In case a country has not in place a national registry, emissions reductions to be transferred under JI need to be verified by an independent entity under the supervision by the JI supervisory committee.

Host countries of CDM projects are eligible to transfer CERs if they have ratified the Kyoto Protocol and if it has designated a national authority for the CDM.

4.2.6 Transaction costs involved with baseline determination, verification and certification

Prospective sellers of emissions permits to be generated through JI or CDM projects need to determine emissions baselines of such projects. Article 6.1(b) on JI states “any such project provides a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur”. Article on 12.5(c) on CDM requires that “reductions in emissions that are additional to any that would occur in the absence of the certified project activity”. Those emissions that would *otherwise* occur or that would occur *in the absence* of the certified project activity are the baseline emissions.

Several approaches for baseline determination of JI and CDM projects are under discussion.[44] At COP7, an agreement has been reached on some guidelines for baseline determination. In any case, baseline determination brings about considerable costs that constitute barriers to the implementation of JI and CDM projects.

CDM projects need to be validated, verified and certified. JI projects require verification, and possibly also validation. In any case, associated fees of accredited companies that perform these tasks will increase transactions costs. In order to reduce validation, verification and certification fees at a minimum, it is important to establish accreditation procedures that promotes intensive competition among these service suppliers.

4.2.7 Domestic climate policies may not allow the export of emissions permits

Governments of Annex B countries are free to decide if companies within their jurisdiction are allowed to export emissions permits to other countries.

5. Opportunities for Financial Institutions

Financing and risk management are important functions performed by financial institutions like banks and insurance companies. The supply of optimised financial products and services is essential for the efficiency of markets. Emerging GHG markets represent challenging new opportunities for financial institutions to supply innovative financial products and services that are tailored at the needs of market participants. In the following, I will highlight some areas that appear to be particularly interesting. They include project finance, carbon investment funds and insurance.

In the past, the role of financial institutions in contributing to implementation of the Kyoto Protocol and the Kyoto Mechanisms has rarely been explored. Discussion has centred on the issue of how financial institutions could contribute to sustainable development in general. With regard to climate change and financial institutions, discussion has predominantly been directed towards the question of how climate change might impact financial institutions, and of how financial institutions could adapt to climate change impacts [Berz (1997); Dlugolecki (1996); Knoepfel et al. (1999); Leggett (ed.) (1996); Tol (1996); Tucker (1997)]. An

[44] Ellis (1999); Ellis and Bosi (1999); OECD (1999c); OECD and IEA (2000b); Parkinson et al. (2001); Sugiyama and Michaelowa (2001); or Willems (2000). Janssen (2001) and (2000b) argues that from the perspective of risk management it makes an important difference if baselines are defined in terms of (relative) emissions intensities or rates, or in terms of absolute emissions levels.

exception is Janssen (2000b) and (2001) who discusses some functions financial institutions could perform to facilitate use of the Kyoto Mechanisms.[45]

In advance of the academic debate, several major private-sector financial institutions like Crédit Lyonnais, Deutsche Bank, Sanpaolo Imi, Société Générale, SwissRe, among others, are already designing new financial products and services targeted at the needs of corporate clients that wish to take advantage of the Kyoto Mechanisms and GHG emissions trading. Against this observation it is interesting to explore how banks and insurance companies could contribute to the use of the Kyoto Mechanisms and GHG emissions trading, thus facilitating the implementation of the Kyoto Protocol. This section discusses the role of carbon investment funds set up by financial institutions and explores the possible role of insurance in emerging GHG markets.

5.1 Carbon investment funds

5.1.1 Introduction

Emissions trading generally induces investments in abatement activities. In the case of JI and CDM, which represent post-verification or project-based trading, emissions permits are generated only if abatement activities reduce project emissions below baseline emissions. In cap-and-allowance trading systems, the transfer of emissions permits does not require abatement activities to be undertaken ex ante. Still, unless the initial allocation of emissions permits exceeds business-as-usual emissions, the transferring party needs to abate emissions within the relevant compliance period in order to be in compliance. As a consequence, the sale of emissions permits requires investments in abatement activities at some point in time.

As with all kinds of investments, the willingness of private-sector companies to invest in commercial GHG reduction projects (defined as climate protection projects that generate marketable emissions permits) will depend on respective risk-return profiles. Commercial climate protection projects represent attractive investment opportunities only if financial risks associated with required investments are not too high. One classical instrument to reduce investment risks is risk diversification through efficient portfolio construction.

This subsection aims to discuss how specific risks associated with JI and CDM investments may be managed by taking advantage of portfolio diversification and carbon investment funds. To this end, I will first identify sources of investment risks associated with JI and CDM projects. Starting point of risk analysis is the net present value (NPV) of JI and CDM investments. A distinction is made between price and quantity risks. My analysis is limited to project-based emissions trading, i.e. JI and CDM, for several reasons. First, it helps to keep the analysis relatively simple and focused. Second, most insights gained may be easily extended to cap-and-allowance trading systems. After having identified specific risks associated with JI and CDM investments, I will discuss from a conceptual angle the potential of risk diversification. The concluding part of this subsection will analyse how risk diversification could be achieved by taking advantage of indirect investment vehicles like carbon funds. In addition, it describes some carbon investment funds that are emerging in practice, including the World Bank's Prototype Carbon Fund.

[45] Whitmore (2000) is another but rather curious exception. He argues that compulsory liability insurance for damages caused by emitting GHGs could be a feasible and efficient instrument for dealing with climate change. However, there seem to be some flaws in his argument.

5.1.2 Identifying investment risks of JI and CDM Projects

JI and CDM projects aim at producing emissions credits for subsequent sale on international markets or for transfer to the project sponsor. In both cases, the value of such investments is affected by different kinds of risk.

To identify the different risk sources that could affect the value of JI/CDM projects, it is useful to distinguish between different sources of uncertainty:

- **Technological** risks are tied to the process of production. They refer to uncertain output quantities. In the present context, technological risks involve uncertain quantities of emissions reductions achieved.
- **Economic** risks depend on uncertainties generated by markets and refer to uncertain input and output prices.
- **Political** risks refer to uncertainty over property rights. Political risks may involve currency control, unexpected changes in tax laws or regulation, or expropriation in the extreme case.

Net present value of JI and CDM investments as starting point of risk analysis

From the investor's perspective the value of a JI/CDM project may be measured by the NPV of the project considered. Investment risks of JI/CDM projects refer to a risky NPV of such projects. Thus, in order to analyse investment risks of JI/CDM projects, one needs to explore the main elements of their NPV.

In a simple form, the NPV of investment projects is defined as the difference between the discounted cash inflow and the discounted cash outflow associated with the project over its economic lifetime. The discount rate is also called hurdle rate or opportunity cost of capital. It should be equal to the rate of return offered by comparable investment alternatives. It is called the opportunity cost of capital because it is the return foregone by investing in this project rather than investing in the next best investment opportunity. In principle there can be a different discount rate for each future period. In the simple discounted cash flow formula, it is assumed that the discount rate is the same regardless of the date of the cash flow.

Concerning the decision to invest in a project, the investor should apply the NPV rule. According to this investment decision rule, investment projects should be accepted if they have a positive NPV. In a situation of uncertainty, it may be appropriate to expand the discounted cash flow in order to take properly into account possible real options embedded in different investment alternatives or project designs [Teisberg (1995); Trigeorgis (ed.) (1995)]. Real option values reflect the value of flexibility to adapt and revise later decisions in response to unexpected developments. Despite the relevance of real option theory, it is beyond the scope of this chapter.[46]

These basic investment considerations may also be applied in the context of JI/CDM projects. The main challenge is to define costs and revenues appropriately. Generally, the NPV of investments in JI/CDM projects may be stated as

$$NPV = \sum_{t=0}^{T} \frac{R_t - C_t}{(1+r)^t} \qquad (0.1)$$

where

[46] Edleson and Reinhardt (1995) apply real option theory in the context of the US SO_2 trading scheme.

R_t denotes the revenue of the JI/CDM project in period t,

C_t are the costs of the JI/CDM project in period t, composed of abatement and transaction costs,

r is the discount rate and

T denotes the crediting lifetime of the JI/CDM project.

The remainder of the present part of this subsection will discuss the different components and associated risk factors of the NPV of JI/CDM projects. Due to space restrictions I will discuss only some risk sources. For a more comprehensive and detailed analysis the reader is referred to Janssen (2001).

Revenue side

The revenue R_t of JI/CDM project investments is composed of

$$R_t = p_t \cdot EP_t \qquad (0.2)$$

where

p_t is the unit value or price of emissions credits and

EP_t is the amount of emissions credits or permits generated by the project in question.

The amount of emissions credits generated by JI/CDM investments is defined as the difference between baseline emissions and actual GHG emissions of the project. Various approaches for baseline determination of JI/CDM projects are available.

Several ways to classify baseline approaches have been proposed. One common classification, which is based on criteria of aggregation and standardisation of baseline setting, distinguishes between the following types [Ellis and Bosi (1999); OECD and IEA (2000b)]:

- Project-specific baselines,
- multi-project baselines and
- hybrid baselines.

Project-specific baselines apply to one project only. They are the least aggregate type. These baselines are drawn up by using project-specific assumptions, measurements, comparisons, estimates or simulations for all key parameter.

Multi-project baselines are defined and applied to multiple projects of a similar type. They aim to standardise emissions levels and rates or intensities. They are more aggregated than project-specific baselines, but there may be various levels of aggregation such as by technology, sector, country or region. Multi-project baselines correspond to an activity standard or policy target that is aggregated at a certain level. For example, baseline emissions for a new or refurbished power plant could be specified on the basis of the average or marginal emissions per kilowatt-hour of electricity produced in the country or region. At a more disaggregated level, baseline emissions of such a project could be established by determining the average or marginal emissions per kilowatt-hour of the technology to be applied in this project.

Under the hybrid approach, baselines are determined in a hybrid fashion, with some key components or methodologies project-specific, and others standardised.

In the present context it is useful to look at baselines from the angle of uncertainty involved for the investor. To this end it is constructive to distinguish between baselines based on emissions levels versus baselines defined in terms of emissions intensities or rates, e.g. as tonnes of CO_2 emissions per kilowatt-hour (see below).

Actual emissions are generally determined by the activity level multiplied by a corresponding emissions factor [Houghton et al. (eds.) (1997)]. To give an example, process-related CO_2 emissions from cement production are determined by multiplying the output of cement produced (measured in tonnes) by the emissions factor 0.4985.

After having discussed the two major determinants of the amount of emissions credits earned by JI/CDM projects, it is possible to have a closer look at quantity risks. In case baselines are defined in absolute terms, the quantity of emissions credits earned per period is defined as

$$EP_t^{absolute} = E_t^b - E_t^p = e_t^b \cdot x_t^b - e_t^p \cdot x_t^p \qquad (0.3)$$

where

$EP_t^{absolute}$	are the emissions credits earned in period t in case the baseline is defined in absolute terms, i.e. tonnes of CO_2,
E_t^b	are the absolute baseline emissions in period t, measured in tonnes of CO_2,
E_t^p	are the absolute project emissions in period t,
e_t^b	is the baseline emissions rate, e.g. tonnes of CO_2 per kilowatt-hour,
e_t^p	is the actual emissions intensity or rate of the project,
x_t^b	is the baseline level of the activity to which the baseline emissions rate refers, e.g. kilowatt-hours and
x_t^p	is the actual project level of the activity to which the baseline emissions rate refers.

This is a reduced formula for calculating emissions credits earned by JI/CDM projects that does not make explicit all parameters and technical relations that would be used in an engineering approach.[47] However, for the present purpose such a reduced form is sufficient.

As can be seen easily, the following factors can lead to uncertainty about the quantities of emissions credits actually earned:

- E_t^b : Baselines of ongoing projects may need to be adjusted unexpectedly. This is, however, not foreseen by the guidelines agreed upon at COP7.
- e_t^p : The actual emissions intensity of the project may deviate from expected values due to technological under-performance (or over-performance) of the mitigation technology employed.
- x_t^p : The actual level of the activity to which the emissions rate refers may deviate from the projected level: A power plant may produce less power than projected due to unexpected low demand for power or business interruption.

The last risk factor is particularly interesting, since economic activities associated with GHG emissions, e.g. power generation or cement production, generally exhibit high fluctuations. Such variability will have a significant impact on the amount of emissions credits earned by JI/CDM projects. Will such variances be positively or negatively correlated? This question may be answered by taking the first derivative of the amount of emissions credits earned with respect to the activity level. Since in the above formula this derivative is negative, the quantity of emissions credits earned will ceteris paribus increase with decreasing level of the underlying economic activity. The same affect would apply to projects in a cap-and-allowances trading systems which by definition involve allocations of absolute amounts of emissions permits.

In the case of baselines defined in relative terms, the amount of emissions credits earned by a JI/CDM project is defined as

$$EP_t^{relative} = \left(e_t^b - e_t^p\right) \cdot x_t^p \,. \qquad (0.4)$$

where

$EP_t^{relative}$ are the emissions credits earned in period t in case the baseline is defined in relative terms, e.g. tonnes of CO_2 per kilowatt-hour.

The project earns emissions credits if actual project emissions rates are lower than baseline emissions rates. Taking the first derivative with respect to the actual level of the project's economic activity, one finds that the amount of emissions credits earned will increase with increasing product output, et vice versa. This is a most interesting result because it is diametrically different from the case where baselines are defined in absolute terms. From an

[47] For a more detailed formula which takes into account all relevant technical parameters and relations see Parkinson et al. (2001).

environmental perspective it means that the more product output is produced, the more credits are earned and exported, even if total absolute emissions of the project may be increasing. For a JI host country this could imply that it may get out of compliance if the product output increases beyond a critical value which depends on the difference between the baseline emissions rate and the actual project emissions rate.[48]

So far, international rules and guidelines on baseline determination of JI/CDM projects provide little guidance regarding the issue of relative emissions baselines versus absolute emissions baselines. The previous discussion has made evident that both approaches have diametrically different implications regarding investment risks and environmental effectiveness. Thus it would be desirable that rules and guidelines address this fundamental issue.

An additional risk factor is the conversion of non-CO_2 GHGs into CO_2 equivalents (CO_2e). If the project in question involves other than CO_2 emissions, then the effect of reductions in non-CO_2 GHG needs to be compared relative to reductions in CO_2 emissions. This is done by converting the non-CO_2 GHGs into CO_2e by means of the global warming potentials of the different GHGs as provided by the Intergovernmental Panel on Climate Change in its Second Assessment Report, based on the effects of the GHGs over a 100-year time horizon. GHG conversion factors may change during the lifetime of JI/CDM projects, thus affecting the quantity of emissions credits earned.

As regards the price component of the revenue side, future prices of emissions permits are quite uncertain. Nonetheless, some practical experience has already been gained. Some companies have already entered into option contracts for the first commitment period. The World Bank's Prototype Carbon Fund aims for a portfolio price outcome of \$5.5/tCO_2e at the termination of the fund in 2012 [PCF (2000a)]. The public tender of the Dutch government for procurement of emissions permits earned from JI projects discovered prices from 5 to 9 EUR/tCO_2e.

On the theoretical side, several economic models have tried to estimate market prices for the first commitment period (see section 3). On average, the models surveyed predict a price of approximately \$9 (1998)/tCO_2e in a global trading regime. If rules for the CDM are very restrictive this value is much higher, corresponding to \$22 (1998)/tCO_2e. However, in both scenarios estimated prices vary widely.

Cost side

Costs of JI/CDM projects are composed of GHG emissions abatement or mitigation costs and transaction costs involved. Abatement costs may be calculated by applying the concept of incremental costs [Parkinson et al. (2001)]. Incremental costs are the difference between the costs of the baseline project and the JI/CDM project. Abatement costs will depend on the concrete technology and the plant location. They involve investment costs, operating and maintenance costs, fuel costs and other variable costs. All abatement cost components are affected by uncertainties.

In addition to abatement costs, one needs to consider transaction costs, which are costs associated with carrying out transactions. Along the JI/CDM project cycle, a wide variety of different transaction costs may arise which often are uncertain ex ante.

[48] This is the reason why the UK trading scheme envisages a restriction on net exports from those sectors which only have relative emissions targets.

Further risk source of JI and CDM investments

Further JI/CDM investment risks comprise the following [Janssen (2001)]:

- Uncertain crediting lifetime: The crediting lifetime T in the NPV formula of JI/CDM projects is the length of time emissions credits can accrue. This may be uncertain both in the case of JI and CDM.
- Discount rates are uncertain due to financial risks in capital markets.

5.1.3 Risk Management through Risk Diversification

This subsection examines how JI/CDM investment risks may be managed through risk diversification. It first explains the basic economics of risk diversification. Then it discusses how JI/CDM risks as identified in the previous subsection may be diversified.

Basic economics of risk diversification

Risk diversification is a fundamental notion in modern financial economics. It is the basis of portfolio theory and modern capital market theory. Risk diversification means that investment risks may be reduced by investing a given investment budget into different assets instead of just one. At its core, risk diversification is based on a simple statistical relation, which implies that the risk of a portfolio of assets is less than the sum of the risks of individual assets, unless they are perfectly positively correlated. This can be seen by the following formula, which describes the risk of a portfolio as measured by the variance of the expected portfolio return:

$$s_P^2 = \sum_{j=1}^{N} a_j^2 \cdot s_j^2 + \sum_{j=1}^{N} \sum_{\substack{k=1 \\ k \neq j}}^{N} a_j \cdot a_k \cdot s_{j,k} \qquad (0.5)$$

where

s_P^2	is the variance of a portfolio consisting of N assets,
s_j^2	is the variance of the return of asset j,
a_j	is the portion of asset j in the portfolio and
$s_{j,k}$	is the covariance of the returns between asset j and asset k.

The first term is the sum of the variances of the single assets, whereas the second term is the sum of terms describing the covariance between any pair of single assets. The covariance is a statistical measure of the relationship between two random variables. That is, it gives information on how two random variables, here uncertain returns, move together. A positive value for covariance indicates that the realisation of random variables tends to move in the same direction. For example, a better-than-expected value for the first random variable is likely to occur with a better-than-expected value for the second random variable. A negative covariance indicates a tendency for the realisation of two random variables to offset one another. A zero covariance indicates that there is no relationship between the realisations for two random variables.

Investors are interested in both risk and expected return. So, how will diversification affect expected return? Expected return of a portfolio of assets is defined as

$$E(r_P) = \sum_{j=1}^{N} a_j E(r_j) \qquad (0.6)$$

where

$E(r_p)$ is the expected return of a portfolio of *N* assets and

$E(r_j)$ denotes the expected return of asset *j*.

As can be seen easily, the expected return of the portfolio is just the sum of the expected returns of single assets in the portfolio, weighted by their portion in the portfolio.

To illustrate the potential of diversification, assume that there are two assets described by the following statistical qualities:

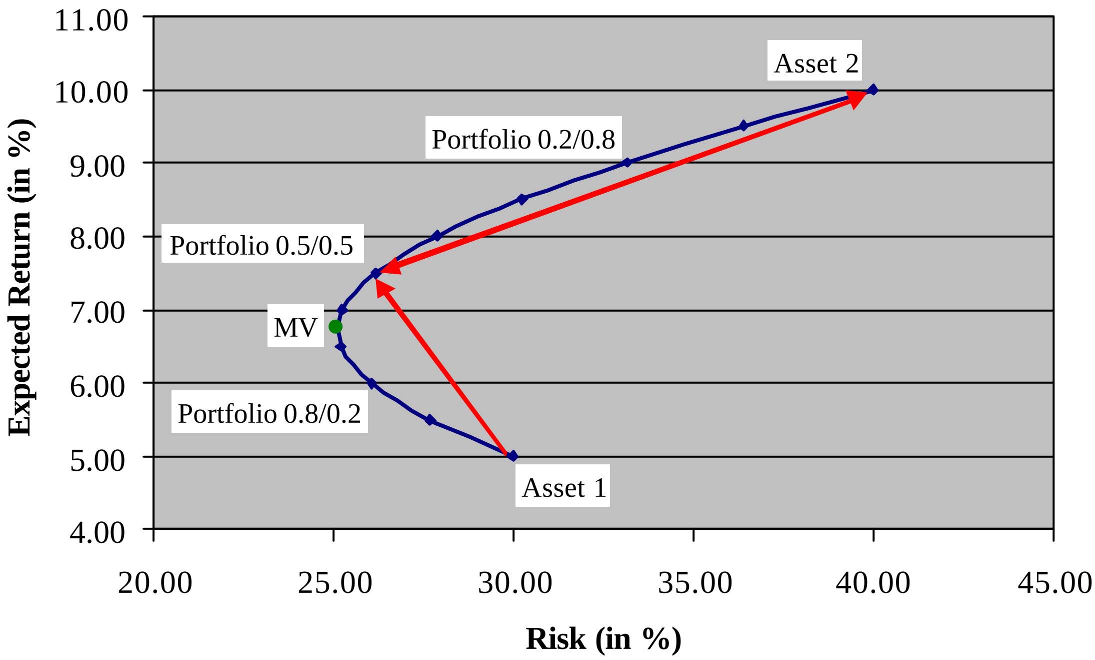
$$m_1 = 0.05; \quad s_1 = 0.3; \quad m_2 = 0.1; \quad s_2 = 0.4; \quad s_{1;2} = 0.012 \qquad (0.7)$$

If both assets are held in the portfolio in equal portions $[a_1 = a_2 = 0.5]$, then the portfolio's expected return and risk are $m_P = 0.075$ and $s_P = 0.26$, respectively. A rational risk-avers investor would clearly prefer this portfolio over the asset 1, because it has a lower risk and a higher expected return (see Figure 5-1). Comparing asset 2 and the portfolio, none is superior with respect to the other. Thus the choice between asset 2 and the portfolio will depend on the investor's specific preferences.

It is also possible to construct other portfolios characterised by different combinations of asset 1 and asset 2. The dots in Figure 5-1 depicts the risk-return profile of portfolios in which the portion of asset 1 is reduced in steps of 10% (thus the portion of asset 2 being increased in steps of 10%). Drawing a line between those points one obtains the set of all feasible portfolios that may be constructed by combining asset 1 and asset 2 in any portion.

Which combinations are efficient? In the present context, a portfolio is efficient if there is no other portfolio that has a higher return for a given risk, or that involves a lower risk at a given return. It is evident that all portfolios on the line between the points *MV* and asset 1 are inefficient, because for a given risk a higher return may be achieved by investing in portfolios that lie on the upper part of the curve. Only those portfolios are efficient that lie on the upper half of the hyperbola, here on the curve between points *MV* and asset 2. Point *MV* is the efficient portfolio with minimum variance.

Figure 5-1: Simple portfolio of two assets



Risk diversification of JI and CDM investments

What does the previous discussion on basic portfolio theory imply for risk diversification of investment risks associated with JI/CDM projects?

First, standard statistical information required for portfolio construction, i.e. asset prices, is not available for JI/CDM projects since there are not yet any JI/CDM projects implemented. One could argue that some experience has already been gained in the JI/CDM pilot phase 'Activities Implemented Jointly', and that quite a lot of projects that potentially could qualify as JI/CDM projects, including renewable energy projects, have already been implemented.[49] Though, the relevant asset price data are not available, at least not explicitly, and will probably never be available, even if hundreds or thousands of CDM and JI projects will be implemented in the next decade or so.

Why? It is most important to note that the previous discussion has analysed the construction of portfolios of financial assets or securities like stocks or bonds that are publicly traded on (organised) markets or exchanges. This means that there is plenty of information available on asset prices. In contrast, financial assets of JI/CDM projects, or existing projects that potentially may qualify as JI/CDM projects, are not publicly traded. In the real world, only shares of whole companies are traded publicly, but not the shares of single projects that are under legal and economic control of a particular firm. Even in off balance sheet or project finance where single projects like power plants are legally and economically independent from sponsor companies, shares are not publicly traded. Thus it is difficult to imagine that equity shares in JI/CDM projects will be securitised.

Against these observations, one might raise a question about the value of portfolio theory for JI/CDM investments. To answer this question, it is helpful to consider the following points: First, portfolio theory does not depend per se on the existence of markets on which financial

[49] Springer (2000b) explores the potential of risk diversification using data from the JI/CDM pilot phase 'Activities Implemented Jointly'. His findings are indeed positive.

assets are traded. Portfolio theory is about selecting between assets of different risk-return profile. The existence of markets for those assets that are considered for inclusion into the portfolio would facilitate decision making. Second, there exist approaches that allow one to make the necessary statistical estimates by using fundamental data of the company or project in question instead of historical data generated on markets. Third, one could take advantage of experiences gained with another asset class that is not publicly traded, namely real estate. Since single real estates are unsecuritised as may be expected from assets of JI/CDM projects, experience gained from management of real estate portfolios in the form of Real Estate Investment Trusts (REITs) may provide some guidance in the present context.

What insights might be gained? First, regarding methodology it is constructive to understand how relevant data are being estimated for unsecuritised real estate assets. Indeed, data on expected returns and respective variances and covariances are usually estimated by means of fundamental variables like average monthly rent per square meter and vacancy.

Second, it has proved useful to identify as many distinct but homogeneous groups of sub-asset classifications as possible and to maximise inter-group heterogeneity. In the context of real estate, the following groups of sub-asset classifications have been proved to result in significant risk diversification effects among different groups [Seiler, Webb and Myer (1999)]:

- Property type, e.g. offices, retail, warehouse, apartments,
- city and geographic and economic regions,
- property size and
- urban versus suburban real estate.

In this context, (empirical) research has been directed towards the question of which classification yields higher diversification effects, in part leading to ambiguous results.

What insights can be gained from real estate portfolio construction for JI/CDM diversification? First, risk correlation coefficients may be calculated by means of some fundamentals of JI/CDM projects. Second, it could be useful to identify sub-classes of JI/CDM projects with different qualities in order to explore which categories exhibit highest risk diversification potential.

Recalling the results of the previous discussion on risk identification of JI/CDM investments, one remembers that two main risk categories affect the return on JI/CDM investments: Price uncertainties and quantity risks. The latter may stem from uncertain baseline and project emissions. Is there any diversification potential associated with these risks?[50]

To examine this question it is useful to define different categories of JI/CDM projects. It is then possible to discuss if risks may be diversified across different groups of a given category. In the following, price risks are not being discussed, but quantity risks only.

In the following, two asset categories will be discussed for illustration, though some additional categories have proved promising for risk diversification [Janssen (2001)]:

- ♦ Type of Kyoto Mechanism: JI or CDM (or commercial climate protection projects under a cap-and-allowance trading system)
- ♦ Type of sector:

[50] The following discussion will only deal with some issues for illustration. For a more comprehensive and thorough analysis see Janssen (2001).

- Energy:[51]
  - Fuel combustion in energy industries.
  - Fugitive emissions from coal mining, and production, processing and transport of oil and natural gas.
- Industry: Energy-related and process-related emissions associated with production of cement, lime, soda ash, glass, ammonia, nitric acid, adipic acid, carbide, iron and steel, ferroalloys, aluminium, pulp and paper.
- Agriculture: Domestic livestock, rice cultivation, agricultural soils.
- Land-use change and forestry.
- Waste: Solid waste disposal on land, wastewater handling, industrial wastewater and sludge streams, human sewage, waste incineration.

As explored before, quantity risks stem from uncertain baseline emissions and uncertain actual emissions of a JI/CDM project. Is there any scope for diversifying quantity risks across different groups of a given category?

Type of Kyoto Mechanism: It is quite conceivable that rules for baseline determination for JI and CDM projects will differ. In addition, it is possible that rules for baseline determination of JI and CDM projects may be adjusted at different times and with different consequences. This assertion is based on the observation that baseline determination in the context of JI is less controversial regarding the issue whether JI projects lead to additional emissions reductions due to the fact that total emissions of JI host countries are limited by the Kyoto targets. If rules for baseline determination differ between JI and CDM, baseline risks may be diversified across sub-classes of this category.

What is about actual project emissions? They are not affected by the type of Kyoto Mechanism. Therefore, risks associated with actual project emissions can not be diversified across different groups in this category.

Type of sector: Baseline rules may expected to be sector-specific or source-specific. Consequently, changes in baseline rules may affect different sectors and types of emissions sources differently, thus not being perfectly positively correlated.

Variations in actual project emissions will clearly depend on the sector in which the JI/CDM project is realised. As discussed in before, project emissions are generally defined as the product of the economic activity level and the corresponding emissions factor $\left(e_t^p \cdot x_t^p\right)$, e.g. tonnes of cement produced multiplied by tonnes of GHG emissions per tonne of cement. Emissions factors are rather fixed in the short and medium term. Therefore actual emissions will strongly depend on the economic activity level x_t^p. Economic activities are subject to economy-wide fluctuations of production, or business cycles. However, different economic activities are not perfectly positively correlated with the general business cycle and with each other. As a consequence, GHG emissions of different industries in a given country may not be expected to be perfectly positively correlated. Thus, risks associated with project emissions levels may be diversified across different industries.

[51] This category should not be interpreted as referring exclusively to the energy sector since it also comprises energy-related emissions from any other sector.

Investment vehicles for risk diversification and carbon funds in practice

JI/CDM investors can realise diversification potentials in two basic modes. First they can try to build up on their own an efficiently diversified portfolio of JI/CDM projects through direct investments inside or outside the company. The latter seems to be reasonable if the investor operates a sufficiently large number of climate relevant plants. Second, investors interested in earning emissions permits could invest indirectly in a portfolio of viable climate protection projects through dedicated investment vehicles offered by financial institutions.

Indirect investment vehicles may generally be called investment funds even if one needs to remember that in some countries the term 'fund' has a legally well defined meaning. Such funds may be constituted under the law of contract (as common funds managed by management companies) or trust law (as unit trusts) or under statute (as investment companies).

In the USA, the Investment Company Act classifies investment companies into unit investment trusts and managed investment companies:

Unit investment trusts are registered investment companies that buy and hold a relatively fixed portfolio of stocks, bonds, or other securities. Unit investment trusts have a stated date for termination. To establish a unit investment trust, a sponsor purchases a specific set of securities and deposits them with a trustee. Then a number of units known as redeemable trust certificates are sold to the public. These certificates provide their owners with pro rata interests in the securities that were deposited with the trustee.[52]

Managed investment companies: The assets of a managed investment company are professionally managed in accordance with the fund's investment objectives and policies. They are divided into closed-end and open-end investment companies.

- **Closed-end investment companies** are normally established with a fixed capital. A close-end fund is not obliged to redeem issued shares at the request of the shareholder and typically do offer its shares for sale for a limited period only. Because a close-end fund is not obliged to redeem issued shares, it may invest in less liquid portfolio assets.
- **Open-end investment companies or mutual funds** are funds with variable capital which can continually issue new units but which must also redeem the units issued upon request at their net asset value.

In the following, I will give a brief description of some emerging carbon funds, including the World Bank's Prototype Carbon Fund on which extensive information material is publicly available. These case studies show how carbon funds could be designed in practice.

The following carbon funds have been launched:

- World Bank's Prototype Carbon Fund,
- Dexia-FondElec Energy Efficiency and Emissions Reduction Fund,
- Clean Energy Fund sponsored by D&B Capital and
- Renewable Energy and Energy Efficiency Fund initiated by the International Finance Corporation.

Other financial institutions including Credit Lyonnais and UBS have announced plans to launch indirect investment vehicles aimed at generating GHG emissions permits [Cooper

[52] In some countries like the United Kingdom the term unit trust refers to an open-end investment company.

(2000b) and Grice (1999)]. Recently, UBS has withdrawn its commitment. There also exist some renewable energy funds including Merrill Lynch's New Energy Technology Fund. So far, these funds have not announced any intentions to capture directly the value of GHG emissions permits.

World Bank's Prototype Carbon Fund (PCF): The establishment of the PCF was approved by the World Bank in July 1999. Its operations formally started in April 2000. The PCF is the first indirect investment vehicle whose explicit purpose is to earn GHG emissions permits through JI and CDM projects [IBRD (1999); PCF (2000a)].

The PCF will use the fund resources to support prospective JI and CDM projects. In return, fund investors will receive a pro rata share of the emissions reductions.[53] The PCF is established as a trust fund of the IBRD, not as a partnership or corporation as other carbon funds (see below). The maximum size of the fund is restricted to $180 million. After its second closing at the end of 2000, it has attracted investments equal to $145 million. The PCF is scheduled to terminate in 2012.

In the present context it is interesting to note that the PCF is the sole carbon fund that has established and made publicly available its portfolio selection criteria. They encompass the following criteria:

- Broad balance between JI projects in countries with economies in transition and CDM projects.
- Major emphasis on projects in the area of renewable energy technology such as, but not limited to, geothermal, wind, solar and small-scale hydro energy.
- No less than approximately 2% and not more than 10% of the PCF's assets should be invested in any one project.
- No more than approximately 20% of the fund's asset will be invested in projects in the same host country.
- No more than approximately 10% of the fund's assets should be invested in land-use projects. Unless the Parties to the UNFCCC do not decided positively about the eligibility of land-use, land-use change and forestry projects under the CDM, no such project shall be located in a non-Annex I country.
- No more than approximately 25% of the fund's assets should be invested in projects using the same technology.

Originally, the PCF was conceived as an investment vehicle. At early implementation stage, the PCF's structure was changed. Under the new structure, its function is one of purchasing emissions reductions and credits, as opposed to conventional project finance with investments in specific project components or activities [PCF (2000a)]. Since purchase agreements such as power purchase agreements do not involve investment risks but rather contract default risks, one may wonder whether there is still any scope for or benefit from portfolio construction.[54]

[53] Investors or participants in the PCF are the governments of Canada, Finland, Netherlands, Norway and Sweden, Japan Bank for International Cooperation, and the following private sector companies: Electrabel (Belgium), Fortum (Finland), Gaz de France (France), Deutsche Bank and RWE (Germany), Chubu Electric Power Co., Chugoku Electric Power Co., Kyushu Electric Power Co., Mitsubishi Corp., Mitsui, Shikoku Power Co., Tohoku Electric Power Co., Tokyo Electric Power Co. (all from Japan), RaboBank (Netherlands), Norsk Hydro and Statoil (Norway), and BP (UK).

[54] Emissions reduction purchase agreements may be quite similar to power purchase agreements (PAAs).

To answer this question it is instructive to have a closer look at the emissions reduction purchase agreement (ERPA) related to the PCF's first project [PCF (2000b)].

This project aims at generating GHG emissions reductions through maximum collection and utilisation of landfill gas in Liepaja City and Liepaja Region in Latvia. The ERPA is entered into by the IBRD and the Republic of Latvia. It stipulates that the host country delivers a minimum amount of emissions reductions to the PCF. The total minimum amount is equal to 105,800 metric tonnes of carbon equivalents. Annual minimum deliveries are also specified. In addition to the minimum emissions reductions, the PCF receives 50% of all additional emissions reductions earned by the project, provided that the average market price for emissions reductions applicable to the period for which any such additional emissions reductions are being delivered is not above \$6.80 /tCO_2e. In case the market price exceeds this value, the percentage is reduced as a function of the market price. At a minimum, the PCF receives 25% of the additional emissions reductions, namely at a market price of over \$25.90 /tCO_2e.

The PCF pays to the host country a total of \$2,477 million. Disbursements occur as an advanced payment, in five intermediate payments upon the achievement by the project of certain specified milestones, and a final payment.

Coming back to the point of departure of this case study, it is evident that such a kind of purchase agreement clearly shows qualities of a risky investment, even if the time profile of cash flows deviates from the one typical observed in common project investments.

First, the ERPA foresees that any additional emissions reductions above a well defined minimum level are to be shared. By its nature, ex ante the amount of additional or residual emissions reductions is uncertain to both parties. It may be presumed that the PCF had expectations about the amount of additional emissions reductions when negotiating the financial terms of the purchase agreement. However, the amount of additional emissions reductions that will actually be generated is highly uncertain. The risk associated with the residuum 'additional emissions reductions' definitely goes beyond the delivery risk associated with the minimum amount of emissions reductions, and resembles the risk associated with equity capital investments.

Second, the purchase agreement may be regarded as a form of investment beyond the agreed advance payment. This is because part of the PCF's assets are already now being allocated to a particular future use, and are tied to that use. If future project developments prove unfavourable, thus diminishing the prospects for additional emissions reductions, the PCF will face difficulties in withdrawing its commitment.

In conclusion, to minimise the risks associated with the additional emissions reductions it makes perfect sense to take advantage of risk diversification techniques as indicated by portfolio theory and as discussed above.

Compared to the PCF, there is much less information available on the other indirect carbon investment vehicles. Since they are different in certain aspects with respect to the PCF, it is worthwhile mentioning some of their features.

Dexia-FondElec Energy Efficiency and Emissions Reduction Fund: This closed-end equity fund was originated and sponsored by the European Bank for Reconstruction and Development (EBRD) and Dexia Group, a Franco-Belgian banking group. It will make investments that improve the energy efficiency of existing plant and equipment, including investments in generating plant retrofits and fuel conversions, heat recovery systems, electric transmission grids, gas and district heating system improvements, illumination, and industrial energy efficiency enhancements.

The fund aims at raising 100 to 150 million EUR and will invest primarily in the countries of central and eastern Europe. The EBRD and Dexia have each committed 20 million EUR. In addition, the fund has already attracted several other investors, including Marubeni Corporation, Kansai Electric Power Co., Electric Power Development Corporation and Mitsui & Co. Europe Limited. Investors will earn equity return and emissions permits. It is intended to establish a number of energy service companies (ESCOs) to assist the fund in the acquisition and disposition of projects. Fund manager is FondElec Group, a private equity fund management firm. The fund is a closed-end equity investment fund and is structured as a ten-year limited liability partnership with domicile in the Cayman Islands.

Clean Energy Fund: This private equity fund is sponsored by D&B Capital. and will invest in sustainable energy projects worldwide. It aims to refinance and restructure existing fossil fuel power plants in order to make them more environmentally friendly. In addition, the fund will finance new power generation projects using renewable energy including hydro, tidal, wind, solar, geothermal and biomass. Completed projects will be sold to third parties. The fund is structured as a 10-year limited liability partnership with domicile in Bermuda. The fund aims at raising $100 million and, besides common equity return, the fund also expects to generate GHG emissions permits from some of its investments [Cooper (2000a)].

Renewable Energy and Energy Efficiency Fund: This private debt and equity fund was initiated by the International Finance Corporation, the private sector arm of the World Bank. It aims at raising $100 million and will also be able to draw on a $100 million debt facility. Equity investors in the fund are among others private-sector utilities and financial institutions. Besides normal returns, the fund will also try to capture the financial value of emissions permits that might be generated by the fund’s investment projects [Cooper (2000c)].

5.2 Insurance

Very recently, some insurance companies like Swiss Re, Gerling, Jardine Lloyd Thompson or Aon have been showing growing interest in providing risk management tools tailored at the needs of prospective users of the Kyoto Mechanisms and GHG emissions trading. Indeed, it might be expected that insurance companies will have a role to play in managing risks associated with the Kyoto Mechanisms and GHG emissions trading. The aim of this subsection is to discuss the relevance of insurance for managing risks associated with JI/CDM projects.

To this end, it is organised as follows: First, it discusses insurability of risks. It is a frequent misperception that any kind of risk may be managed through insurance. To be able to apply insurance mechanisms, the risks to be insured need to exhibit certain features. This analysis is then applied to explore if specific risks associated with JI/CDM investments may be managed by insurance.

Like stock markets, insurance is also a way for society to share risk. Insurance mechanisms aim at reducing uncertainty for a group as a whole through the pooling of risks that exhibit certain probabilistic features. The risk that an insurance company faces is not merely a summation of the risks transferred to it by individuals or firms. Instead, insurance companies may achieve risk reduction due to the law of large numbers.

The strong law of large numbers states that the arithmetic average of the realisations of independent and identically distributed random variables tends towards the expected value or mean as the number of random variables becomes very large. This means that the standard deviation of the expected arithmetic average converges towards zero. In other words, the average value is much less uncertain than the individual realisation of a random variable.

In the context of insurance the law of large number implies that the average loss in an insurance pool will become more certain as more independent and identically distributed exposure units are added to the pool. Figure 5-2 shows that the probability that the average loss will equal the expected loss becomes greater as the number of exposure units (N) increases. Indeed, the risk per exposure unit in an insurance pool, i.e. the standard deviation of the average loss, will converge towards zero as the number of exposure units becomes very large. This is shown by Figure 5-3.

Figure 5-2: Average Loss Distribution with Different Number of Exposure Units

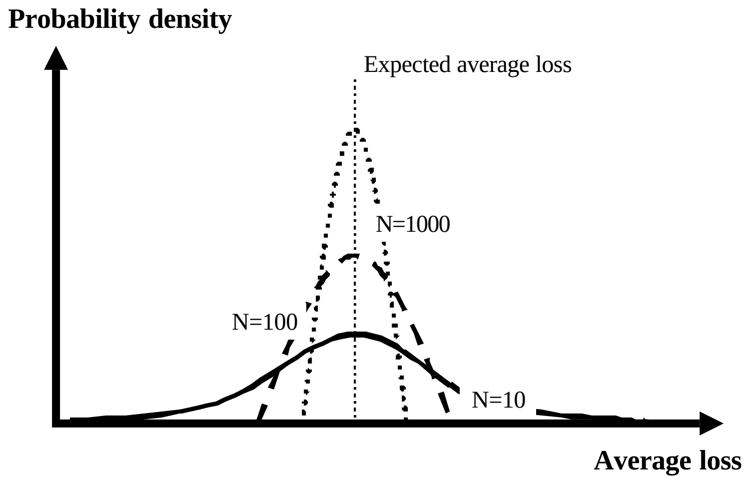
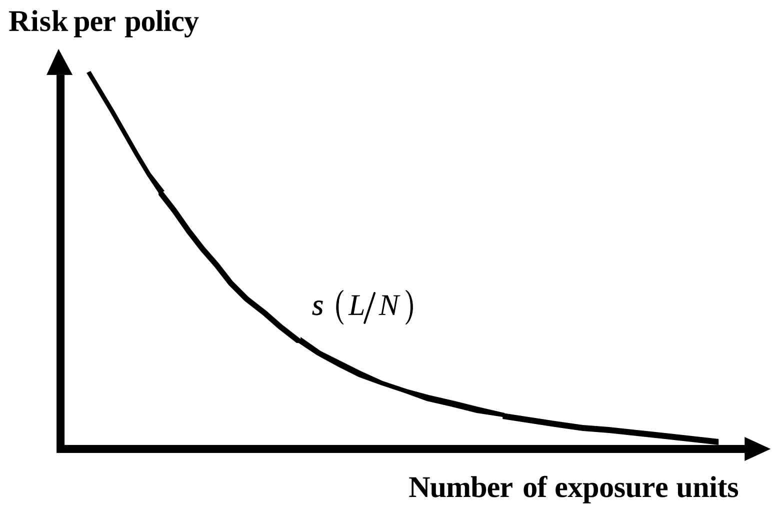


Figure 5-3: Risk per Policy as Function of Number of Exposure Units



This observation on the basic mechanics of insurance leads to the issue of insurability of risks. In contrast to frequent perception, not all risks are insurable. In the insurance literature and practice, the issue of insurability of risks has attracted major interest [Faure (1995); Holsboer

(1995); Karten (1997); Vermaat (1995)]. A standard reference on insurability criteria is Berliner (1982), a Swiss Re executive. He has proposed to check insurability of risks according to the following criteria:

(1) Losses occur with a high degree of randomness,

(2) the maximum possible loss is very limited,

(3) the average loss amount upon loss occurrence is small,

(4) the average time interval between loss occurrences is short, losses occur frequently,

(5) the insurance premium willing to be paid for the coverage is high enough,

(6) there is a low possibility of moral hazard,

(7) coverage of the risk is consistent with public policy and

(8) the law permits the coverage.

Conditions (1), (2), (3) and (4) concern actuarial issues. Together with conditions (5) they basically enable the application of risk pooling mechanisms by the law of large numbers. Condition (6) is critical from an economic perspective. The last two conditions involve political considerations.

From an economic perspective, the question of insurability is closely linked to the issue of moral hazard and adverse selection. Both problems are caused by asymmetric information between the insurer and the insured.

Considering that not all risks are insurable, then which risks associated with JI/CDM investments may be covered by insurance? This question comes at the very beginning of any analysis of JI/CDM insurance.

Based on the general criteria of insurability as mentioned above, it is possible to explore which of the specific JI/CDM risks may possibly be covered by insurance in the future. Recalling the results of the previous sub-section, the following main risk sources will affect the value of JI/CDM investments:

- Uncertain baselines due to uncertain rules and guidelines,
- uncertain crediting lifetime due to uncertain rules,
- uncertain emissions factors due to
  - uncertain rules and guidelines and
  - uncertain fuel prices,
- uncertain level of economic activity due to
  - uncertain product demand and
  - uncertain technological performance of production plants or breakdown of machinery,
- uncertain GHG conversion factors,
- uncertain permit prices, and
- uncertain abatement and transaction cots.

Obviously, JI/CDM projects involve also other risks that are common to any conventional project. For some of those risks insurance exists. But since they are not specifically related to JI/CDM projects they are not dealt with here.

As discussed above, a fundamental requirement for insurance is that the insurance company can pool a large number of independent and identically distributed events that give rise to a loss. Thus a necessary condition for insurability of JI/CDM investment risks is that respective risk sources approximately exhibit this statistical quality.

Many of the aforementioned risks may probably not be covered by insurance [Janssen (2001)]. However, some risks appear to be quite promising for insurance.

To give an example, actual project emissions levels as one component of the quantity of emissions credits earned are determined by both emissions factors and the level of economic activity. As explained before, **activity level risks** are either due to uncertain product demand or to uncertain technological performance or breakdown of production plants and machinery. Uncertain market demand is a typical market risk for which no insurance is available since it affects all agents operating in that market.

The latter risk source may be covered by business interruption insurance.[55] Business interruption insurance indemnifies companies for loss of income during the period required to restore property damaged by an insured peril. Most business interruption insurance policies provide compensation for loss of operating profits and for any fixed costs insured that can not be reduced if a business interruption occurs. Business interruption insurance is a form of consequential or indirect loss coverage.

What does this imply in the present context? First, net revenues from production and sale of emissions credits is part of the operating profit of JI/CDM projects. Second, if the baseline of a JI/CDM project is defined as emissions rate relative to the activity level, then business interruption implies a drop or loss of production of both the company’s primary product and emissions credits. Loss in operating profits due to a loss of production of the primary product is covered by conventional business interruption insurance. It would be straightforward to extend such coverage also to additional operating profits earned by the sale of emissions credits that are generated by JI/CDM projects.

Statistical data on the frequency of loss occurrence are readily available from traditional business interruption insurance. Additional operating profits earned from the JI/CDM project component may be estimated with the help of data on current and projected permit quantities and prices. As in the case of conventional business interruption insurance, the JI/CDM coverage must specify the insured peril. In this regard, two basic options exist: named perils and all risks covers. With the former the property is only insured against explicitly named and listed events. With all risks cover, all losses are covered that arise from direct and unforeseeable causes as long as they have not been explicitly excluded from the policy.

[55] On business interruption insurance see e.g. Meier et al. (1998) and Vaughan and Vaughan (1999).

6. Conclusions

The Marrakech Accords agreed upon at the seventh Conference of the Parties (COP7) in November 2001 pave the way for ratification of the Kyoto Protocol. The European Union strives for the Protocol's entry into for force by the end of 2002. This will be possible despite the persisting reluctance of the USA to ratify the Kyoto Protocol, if the two pivotal countries Japan and Russia ratify the Kyoto Protocol as promised.

Both, domestic and international emissions trading will play a key role in national climate policies designed to meet a country's Kyoto target. In Europe, Denmark has already established a system of tradable carbon dioxide permits for its power sector. The UK will launch its comprehensive emissions trading system in the beginning of 2002. And in October 2001, the European Commission has released a proposal for a EU-wide trading system to start by 2005. This system would cover around 40% of its projected GHG emissions in the first commitment period and would involve a large number of different sectors.

International transactions of emissions permits will be governed by one of the three Kyoto Mechanisms. Joint Implementation (JI) and International Emissions Trading (IET), as respectively established by the Articles 6 and 17 of the Kyoto Protocol, enable international transactions of emissions permits among Annex B countries. The Clean Development Mechanism (CDM), as defined by Article 12 of the Kyoto Protocol, allows developing countries, i.e. non-Annex B countries, to earn emissions permits and to sell them to Annex B countries.

The distinguishing difference between JI and IET is that the former involves project-based or baseline-and-credit trading, whereas the latter encompasses inventory-based or cap-and-allowance trading. If governments wish to implement a mix of different climate policies, thus not relying exclusively on cap-and-allowance trading, the two trading systems will co-exist. In this case, inventory-based emissions trading may be complemented by project-based emissions trading for those emissions sources and GHGs that are not regulated by cap-and-allowance trading, but other policy instruments like energy efficiency standards or negotiated environmental agreements (see chapter II on the latter).

In contrast to a frequent misperception, from a regulatory perspective JI and CDM projects do not necessarily require *international* investments. Host countries may expected to implement the largest number of JI and CDM projects unilaterally, as is the case with common economic activities. The Kyoto Protocol, as put in concrete terms through the Marrakech Accords, would not prevent them from doing so.

When exploring opportunities and barriers associated with the Kyoto Mechanisms, it is useful to distinguish between demand and supply side. Opportunities on the demand side of GHG markets mainly involve significantly lower costs of compliance for industries that are regulated by climate policies. On the supply side, companies with comparatively low abatement costs may benefit from emissions trading and the Flexible Mechanisms by marketing emissions permits, thus making additional profits.

Main barriers that prevent companies to take advantage of GHG emissions trading and the Flexible Mechanisms include market risks and regulatory barriers at the international and national level.

Important market risks are permit price uncertainties and liquidity risks. Regulatory barriers induced by international rules include levies on transactions, eligibility requirements for countries and transaction costs caused by the modalities and procedures as stipulated by the Marrakech Accords. At the national level, low compatibility of domestic climate policy regulations with the Flexible Mechanisms and lack of incentives for legal entities to engage in the Flexible Mechanisms may represent major barriers.

Price risks may be managed through derivatives. In contrast, regulatory barriers need to be removed through appropriate design of climate policies and regulations. In particular, governments need to provide incentives for companies to use the Flexible Mechanisms for compliance. To this end, companies that apply the Flexible Mechanisms need to get relief from domestic climate policy regulations in a corresponding amount. Transparent and stable regulations governing the Kyoto Mechanisms are essential for their use by the private sector.

Financing and risk management are important functions performed by financial institutions such as banks and insurance companies. The supply of optimised financial products and services is essential for the efficiency of markets. Emerging GHG markets represent challenging new opportunities for financial institutions to supply innovative financial products and services that are tailored at the needs of market participants. Areas that appear to be particularly interesting include project finance, derivatives related to GHG markets, carbon funds and insurance.

In the past, the role of financial institutions in contributing to implementation of the Kyoto Protocol and the Kyoto Mechanisms has rarely been explored. Discussion has predominantly been directed towards the question of how climate change might impact financial institutions, and of how financial institutions could adapt to climate change impacts.

In advance of the academic debate, several major financial institutions like Deutsche Bank and SwissRe, among others, are already designing new financial products and services targeted at the needs of corporate clients that wish to take advantage of the Kyoto Mechanisms and GHG emissions trading. This chapter has explored some aspects of carbon investment funds and insurance related to JI and CDM projects.

Not all risks are insurable. Indeed, the role of commercial insurance for managing specific risks of JI and CDM projects is limited since many risks are regulatory or market risks which are difficult to cover by classical insurance. A promising area may be business interruption insurance to cover the loss of income associated with the generation of emissions permits.

Carbon investment funds have the potential to diversify away some risks associated with investments in abatement activities that aim at resulting in marketable emissions permits. Such funds may be set up and managed by investment banks and other financial institutions. Indeed, some carbon funds such as the World Bank’s Prototype Carbon Fund are already emerging in reality.

Concluding, the Kyoto Protocol has established the basis for nascent national and international markets for GHG emissions reductions and permits. These markets, whose size is estimated to amount to several $10 billion annually, will offer challenging opportunities to a wide variety of different players in industry and business. Financial institutions may benefit from providing new and optimised financial products and services that increase efficiency of GHG markets.

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Centre for European Policy Studies
1 Place du Congrès
1000 Brussels, Belgium
Tel: 32(0)2.229.39.11 Fax: 32(0)2.219.41.51
E-mail: info@ceps.be Website: http://www.ceps.be