Discussion Paper No. 03-59

The Role of Transaction Costs and Risk Premia in the Determination of Climate Change Policy Responses

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Non-Technical Summary

Transaction costs and risk have generally not been taken into account in assessing the efficiency gains associated with alternative policy instruments for the reduction of GHG emissions. However, as past experience in other policy areas has shown, they can have a significant influence. It is quite possible, with regard to the Kyoto Mechanisms, that these cost elements may prevent the undertaking of projects that are otherwise cost-effective and even lead to the exclusion of some countries from participating in JI and CDM-projects.

The factor that most determines the influence of transaction costs on the implementation of a project is the size of the project. For some projects transaction costs amount up to over 1000 €/ton C reduced, which proves the necessity of streamlining procedures, as recognised in the Marrakesh Accords. A reduction of transaction costs can be achieved through the bundling of projects, streamlining of information and the development of standardised procedures.

For international emissions trading it will be of high importance to build on experience with past national emissions trading schemes in order to keep transaction costs low. However, international trading schemes of the type envisaged under the Kyoto Protocol are likely to pose significant problems, such as the design of the permit allocation mechanism and its distributional impact, that have not been addressed in great depth in previous national experience. This, combined with the likelihood that transaction costs will decline over time due to learning effects, underlines the importance of establishing a European permit market in the near future in order to get acquainted with such a system before the Kyoto period 2008-2012.

In addition to transaction costs, projects in different sovereign states may attract different risk premia owing to the perceived level of risk of default or project failure due to micro-level or macro-level factors. We determine country risk premia and recognise the need to determine project type risk premia in future research.

The Role of Transaction Costs and Risk Premia in the Determination of Climate Change Policy Responses

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Abstract

Transaction costs and risk have generally not been taken into account in assessing the Kyoto mechanisms JI, CDM and emissions trading. However, they can have a significant influence. With regard to the project-based mechanisms, the factor that most determines the influence of transaction costs on the implementation of a project is the size of the particular project. For some projects transaction costs amount up to over 1000 €/ton C reduced, which proves the necessity of streamlining procedures, as recognised in the Marrakesh Accords. With regard to international emissions trading it will be of high importance to build on experience with past national emissions trading schemes in order to keep transaction costs low. However, international trading schemes of the type envisaged under the Kyoto Protocol are likely to have significant issues that have not been addressed in previous national experience. In addition to transaction costs, we determine country risk premia to account for the fact that projects in different states may induce different levels of risk of default or project failure.

JEL classification: D52, Q51, Q58

Keywords: transaction costs, risk premia, Kyoto Protocol, emissions trading, small scale projects

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1 Introduction

Within the framework of the Kyoto Protocol the industrialised countries committed themselves to a reduction of their greenhouse gas emissions during the period from 2008 to 2012. The flexible mechanisms defined within the Kyoto Protocol are designed to achieve cost-effectiveness of emissions reduction by allowing countries to reduce emissions abroad, either in other Annex B countries, or in non Annex B countries. However, in determining the split of reduction measures between abroad and at home, transaction cost and risk elements that might be associated with the operation of these instruments are not usually taken into account. This paper evaluates the importance of transaction costs and risk premia with respect to the flexibility mechanisms of the Kyoto Protocol. It examines their effect on the up-take of these policy instruments and provides information on how to reduce these cost elements.

This paper is organised as follows: Section 2 provides a generic classification of various types of transaction costs. Section 3 presents estimates of transaction costs associated with the flexible mechanisms, and section 4 those of project risk premia. Section 5 summarises and concludes.

2 The Nature of Transaction Costs

Transaction costs are those costs that arise from initiating and completing transactions, such as finding partners, holding negotiations, consulting with lawyers or other experts, monitoring agreements, etc. (Coase, 1937). Thus, simply being the costs that arise from the transfer of any property right, they occur to some degree in all market transactions. This feature of exchange therefore also applies to the so-called "flexibility mechanisms" of the Kyoto Protocol (as they provide "geographical flexibility" to Parties in fulfilling their commitments). These encompass Joint Implementation (JI) of projects among industrialised countries, Joint Implementation between industrialised and developing countries within the multilateral framework of the Clean Development Mechanism (CDM) and the establishment of a scheme for International Emissions Trading amongst industrialised countries (IET).

Table 1: Definition of Transaction Cost Components in the Kyoto Protocol Flexibility Mechanisms.

Transaction Cost Components	**Description**
Project based (JI,CDM): Pre-implementation	
Search costs	Costs incurred by investors and hosts as they seek out partners for mutually advantageous projects
Negotiation costs	Includes those costs incurred in the preparation of the project design document (i.a. baseline determination and monitoring rules) that also documents assignment and scheduling of benefits over the project time period. It also includes public consultation with key stakeholders.
Validation Costs	Review and revision of project design document by operational entity
Approval costs	Registration and approval by UNFCCC Board and authorisation from host country
Project based (JI,CDM): Implementation	
Monitoring costs	Costs needed to ensure that participants are fulfilling their obligations
Verification costs	Annual verification by the UNFCCC Executive Board/ Supervisory Committee
Certification costs	Including issue of Certified Emission Reductions (CERs for CDM) and issue of Emission Reduction Units (ERUs for JI) by UNFCCC Executive Board
Enforcement Costs	Includes costs of administrative and legal measures incurred in the event of departure from the agreed transaction
International Emissions trading (IET)	
Search costs	Same as project based; to include e.g. market brokerage fees
Negotiating Costs	To include legal and insurance fees associated with participation in the market.
Monitoring costs	Same as project based; to include annual verification
Certification costs	Certification and issue of Assigned Amount Units (AAUs) by UNFCCC Ececutive Board
Enforcement Costs	Includes costs of administrative and legal measures incurred in the event of departure from the agreed transaction

Based on: PriceWaterhouseCoopers (2000) and Dudek et. al. (1996); concerning JI the Second Track has been considered.

The most obvious impact of transaction costs is that they raise the costs for the participants of the transaction and therefore lower the trading volume or even discourage some transactions from occurring. The efficiency gains from the use of market based policy instruments are therefore constrained. Some empirical evidence is provided by Hahn and Hester (1989) for the emission trading programme of the 1977 Amendments of the U.S. Clean Air Act, where the trading scheme has failed to achieve its expected economic benefits due to high transaction costs. Coase (1960) argues that the transaction costs of implementation, enforcement, etc. should determine at the outset how pollution is controlled. In most policy simulations that provide magnitudes of efficiency gains from flexibility mechanisms, however, administrative or transaction costs are not taken into account (cf. for example Böhringer and Löschel (2001) or Klepper and Peterson (2002)).

In this paper transaction costs refer to the costs associated with the process of obtaining JI or CDM recognition for a project and obtaining the resulting emission credits (OECD, 2001). Similarly for IET, transaction costs include the costs of obtaining emission credits. Table 1 defines disaggregated cost components, which further sub-divide transaction costs into categories that parallel – in the case of JI and CDM projects - the project cycle. If a host country is out of compliance with certain eligibility requirements (Article 5 and 7 of the Kyoto Protocol), JI has to follow more or less the CDM project cycle, the so-called second track, which is considered in this paper. If a host country can demonstrate compliance with its inventory and reporting requirements and registries, the regulatory intensity is lowered.

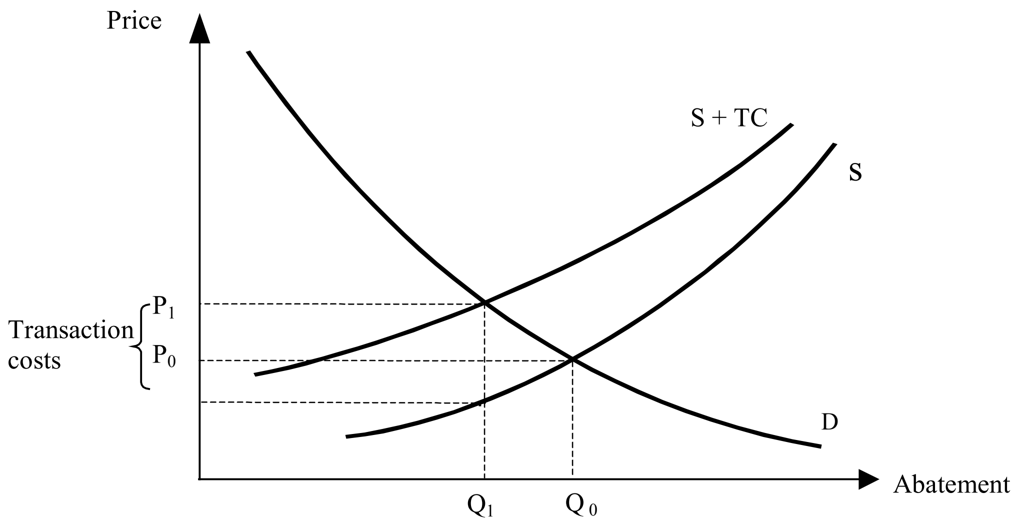

Figure 1: Inclusion of Transaction Costs.

The basic effects of transaction costs are illustrated in Figure 1, for the example of an emission trading scheme. Without transaction costs the trade of emission permits between companies will establish an international permit price that equals marginal abatement costs across companies. The inclusion of transaction costs leads to a left-shift (right-shift) of the supply curve (demand curve) if applied to sellers (buyers). As a consequence the volume of trade decreases and the price rises from P_0 to P_1, indicating that more abatement will be undertaken domestically compared to a situation with no transaction costs.

Particularly in the first stage of the use of the Kyoto Mechanisms, transaction costs are likely to be an essential element in determining the degree of use of the mechanisms and their shares. The level of these costs depends on the rules of the mechanism, the degree of utilisation of the respective mechanism and on the degree of standardisation of procedures. Presumably transaction costs will be higher in countries with an inefficient regulatory framework, leading to a competitive disadvantage vis-à-vis other countries. Whilst the paucity of country level data on transaction costs does not allow us to explore this issue in any depth in our analysis below, it is clearly a priority research area in the effective implementation of the flexibility mechanisms.

3 Estimation of the Transaction Costs Associated with the Flexibility Mechanisms Under the Kyoto Protocol

The great restriction under which this research has been undertaken is that since the Kyoto Protocol has not yet been implemented, the flexibility mechanisms are not formally in existence and so no real evidence of the magnitude of transaction costs presently exists. Evidence therefore has to be based either upon:

- the pilot phase of the UNFCCC promoted Activities Implemented Jointly (AIJ) programme;
- the World Bank supported Prototype Carbon Fund;
- hypothetical estimates of cost components that have been constructed;
- experience from the previous use of similar policy instruments - such as tradeable permit schemes – in other policy contexts.

3.1 World Bank Prototype Carbon Fund (PCF)

The PCF, operated by the World Bank, provides funding to host partners who wish to develop projects consistent with the JI/CDM mechanisms under the Kyoto Protocol. It presently has about 50 projects operating, or in development. One project has formally become a JI project, thereby accumulating emission reduction credits. As a result, it seems reasonable to assume that the transaction costs estimated for PCF projects approximate closely to those that will exist under the implementation of JI in the Kyoto Protocol - at least in the first commitment period, 2008 - 2012.

Table 2: PCF Range of Pre-Implementation Transaction Cost Components.

Pre-Implementation phase	Typical Cost (Euro '000s)	Low Cost (Euro '000s)	High Cost (Euro '000s)
Negotiation	290	160	573
Approval	N/A	N/A	N/A
Validation	20	20	35
Sub-total	310	180	608
10% contingency	31	18	61
Total: Pre-Implementation	**341**	**198**	**669**

PCF transaction cost estimates are presented in Table 2 – Table 4 below. Data has been supplied by staff at the PCF, though is not yet published, or in public circulation. We have consequently been requested to make the country and project-specific data supplied more generic. Accordingly, we have not specified the project host country, but instead specified the world region in which the country is located. Table 2 presents the high and low ranges, together with a "typical" or average, for the transaction costs associated with the pre-implementation phase of the project cycle for the PCF projects. The ranges reflect differences that exist in legal and institutional structures, data availability and consultant expenses in different countries.

Sufficient information exists on seven projects for us to derive transaction costs per tonne of carbon reduction and these estimates are presented in Table 3 and Table 4. Table 3 shows, for two individual projects hosted by Annex B countries, (i.e. where JI projects would be located), the associated transaction costs. Table 4 gives the same information for non-Annex B countries where CDM projects would be located. We assume, therefore, that estimates of transaction costs presented in Table 3 apply to JI - type projects, while those in Table 4 apply to CDM - type projects.

To date, only one project has started and so there is little evidence on implementation costs (e.g. monitoring, verification etc.). PCF estimates that these costs will total between

Euro 100,000 - 200,000 (PCF, 2002). As a starting point, we have therefore assumed a mid-point of Euro 150,000 in our calculations.

Table 3: JI – Country Projects under PCF: Transaction Costs (TCs).

Country Region	Sector	Ton C Redn.	Project lifetime	Ton C Redn. p.a.	Pre-Imple-mentation	Implemen-tation (Estimate)	Total Project TCs	TC/ Ton C
		000s	Yrs	000s	Euro (000)	Euro (000)	Euro (000)	Euro
CEA	LUM	2880	15	192	220	150	370	0.13
CEA	SER	560	25	22.4	287	150	437	0.78

Table 4: CDM – Country Projects under PCF: Transaction Costs.

Country Region	Sector	Ton C Redn.	Project lifetime	Ton C Redn. p.a.	Pre-Imple-mentation	Implemen-tation (Estimate)	Total Project TCs	TC/ Ton C
		000s	Yrs	000s	Euro (000)	Euro (000)	Euro (000)	Euro
N.Afr	ELE	1590	20	80	397	150	547	0.34
CAM	AGR	684	8	86	482	150	632	0.92
S. Am 1	ELE	1081	50	22	150	150	300	0.27
S. Am 2	AGR	3070	21	146	220	150	370	0.12
S. Am 3	ELE	1600	20	80	176	150	326	0.20

Note: where possible the GTAP nomenclature of countries/regions is used. For entries where country data is confidential, we classify the country according to world region. Thus, CEA = Central European Associates; S. Asia = South Asia; S. America = South America; CAM = Central America; N.Afr. = North Africa. There are three South American projects, and these are numbered to distinguish them; LUM = Lumber and Wood; SER = Commercial and Public Services; ELE = Electricity and Heat; AGR = Agricultural Products.

The figures reveal a correlation between project size (in terms of carbon reductions) and transaction cost per ton of carbon reduced - as we would expect in the absence of any size-related streamlining. Table 4 allows further sectoral and geographical comparison, excepting the fact that the generic implementation cost is a constraint on drawing firm conclusions. There is no pattern of correlation between the agricultural sector and the electricity sector and their associated transaction costs per tonne of carbon. Indeed, the estimates for the agricultural sector provide the high and low range limits. It is notable, also, that the agricultural projects account for the largest and smallest total reductions in carbon, of the small number of projects for which we have data - supporting the argument that project size dominates sectoral differences. One other pattern that is apparent is that those projects that are based in South America are lower than those in other CDM host regions, though the explanation is not clear from the data available.

3.2 UNFCCC Activities Implemented Jointly (AIJ) Projects

The UNFCC launched a pilot phase of Activities Implemented Jointly (AIJ) in 1995 – prior to the proposed implementation of the Kyoto Protocol - in order to learn more about the possible operation of JI and CDM projects under the Protocol's flexibility mechanisms and build confidence in this approach. The projects that have been implemented under this initiative are therefore thought likely to reflect current UNFCCC thinking on monitoring, and other requirements for establishing JI and CDM projects, and the associated transaction costs.

Table 5 presents a selection of the project-based AIJ evidence on transaction costs available to date. Of the 157 AIJ projects proposed and/or initiated by March 2002, 70 have reported some of the above mentioned transaction cost elements whilst 25 projects have transaction costs identifiable for all categories in both the pre-implementation and implementation project phases. The cost categories reported in the Uniform Reporting Forms (URFs) on the UNFCCC web-site that can be attributed to transaction cost elements include:

- administration costs (for capacity building);
- technical assistance (of consultants until project commissioned);
- reporting (annual reporting to UNFCCC), and;
- follow-up (including monitoring and verification).

We interpret the administration costs and technical assistance elements as pre-implementation costs, whilst the reporting and follow-up elements are taken to be implementation costs. However, the reporting categories are not transparent in relation to their interpretation as transaction costs. In reality, therefore, there is likely to be some overlap of costs within these categories between the pre-implementation and implementation project phases. It should also be noted that the vast majority of the projects for which there is data have been undertaken by Sweden, whose implementing agency has presented average annual implementation costs across all projects in the individual project description.

Table 5 shows a wide variation in transaction costs per tonne of carbon reduced. The variation is explained not so much by the differing absolute project transaction costs as by the differing carbon emission reductions associated with each project, i.e. project size. The data has been sorted so that the lowest carbon reducing (smallest) projects are listed at the top, and the largest at the bottom of the table. A strong negative correlation between size of project and transaction cost per ton of carbon reduced is apparent. This reflects the fact that so far little flexibility - in relation to project size - has been granted to monitoring, verification etc., which determine transaction costs. In other words, no streamlining is evident.

Table 5: AIJ Project Cycle Transaction Costs (Totals and per ton carbon reduced).

Sector	Region	Lifetime	Ton C Redn. per annum	Total TC (Pre-Impl) '000 Euro	Pre-Impl Tran Cost/ Ton C	Total TC (Impl.) '000 Euro	Impl. Tran Cost/ Ton C	Total TC '000 Euro	Total TC/Ton C
Ele	CEA	10	39	160	410	53	136	213	547
Ser	CEA	10	39	126	322	32	83	158	405
Ele	CEA	10	46	165	356	43	93	208	449
Ele	CEA	6	80	76	158	10	22	87	180
Ele	CEA	10	71	164	232	33	46	197	279
Ele	CEA	10	82	26	31	30	36	55	67
Ele	CEA	10	90	77	85	32	35	109	120
Ele	CEA	10	92	108	118	32	35	140	153
Dwe	CEA	10	97	141	146	62	64	203	210
Dwe	CEA	10	104	129	124	27	26	156	150
Ele	CEA	10	115	155	135	78	67	232	202
Dwe	CEA	10	128	241	189	62	48	303	237
Ele	CEA	10	159	171	107	27	17	198	125
Ele	CEA	10	228	135	59	30	13	165	72
Ele	CEA	10	260	68	26	32	12	100	39
Ele	CEA	10	323	101	31	32	10	133	41
Ele	CEA	10	341	116	34	43	13	159	47
Ele	CEA	10	845	88	10	32	4	120	14
Ele	CEA	10	1119	154	14	30	3	184	16
Ele	CEA	10	1178	154	13	30	3	184	16
Ele	CEA	10	1510	114	8	32	2	147	10
Ele	CEA	10	1916	173	9	53	3	226	12
Ele	CEA	10	2082	35	2	30	1	65	3
Ele	CEA	10	30651	127	0.4	32	0.1	159	0.5
Agr	MEX	30	27994	153	0.2	43	0.1	196	0.2

Note: CEA = Central European Associates; MEX = Mexico; SER = Commercial and Public Services; ELE = Electricity and heat; AGR = Agricultural Products.

Source: UNFCCC (2002), own calculations

3.3 PriceWaterhouseCoopers (PwC)

PriceWaterhouseCoopers (2000) estimates are constructed using different assumptions regarding the number of organisations, or “operating entities”, (OEs), that are involved in the activities that give rise to transaction costs over the project cycle. Three elements are identified, namely validation, verification and certification, that require different OEs if possible conflicts of interests are to be avoided. Three "levels" of transaction costs are therefore defined.

- Level 1 assumes a single OE (OE1) to undertake all elements of the project cycle.
- Level 2 assumes that OE1 undertakes the validation in the pre-implementation phase, whilst a second OE (OE2) undertakes the verification and certification in the implementation phase.
- Level 3 assumes the same as Level 2 except that the verification is undertaken by OE2 whilst a third OE (OE3) undertakes the certification.

Since the involvement of each additional OE requires that they have a detailed knowledge of the project in order to carry out the prescribed functions, there maybe a trade-off between the achievement of environmental goals of the project and the transaction cost. This is because the additional OE(s) spend time acquainting themselves with the project details, thereby adding to the transaction costs but ensuring (through the avoidance of conflicts of interest) the achievement of the carbon reductions being claimed. These assumptions, made in the year 2000, were primarily based on the Consolidated Text (FCCC/SB/2000/4), and before COP6. The Marrakesh Accords, agreed at COP7 in November 2001, explicitly rule out the possibility of Levels 2 and 3. Therefore, whilst the full range of transaction costs are presented below, we only include those from Level 1 estimates for further conclusions.

The transaction costs for five generic project types are presented in Table 7 – Table 11, based on the following assumptions on the daily rates of OE employees:

- Project developers: range Euro 750 – 1200; central value Euro 1000;
- Project consultants -local engineers/NGOs in host country: Euro 200;
- International management consultancy in host country: Euro 300;
- International management consultancy in OECD states: Euro 1500.

However, whilst the number of days are separately identified for the pre-implementation and implementation phases in the PwC report, the split between the different day rate categories is not made explicit. Nevertheless, as a first approximation, it is possible -

using the split of total days - to apportion the percentage of total transaction costs to the two project phases.

The emissions reduction estimates are obtained by multiplication of energy (per lifetime, i.e. fifteen years for each of the projects) for the new plant (capacity x load factor x 131,400 h) with the difference between old and new emissions. Table 6 provides the data for these calculations. Conversion from CO_2 to carbon is achieved through division by 3.65. As a baseline for emissions we chose 800g/kWh for a coal burning power station. PwC suggest a baseline of 944g/kWh for an Indian coal powered energy generator. However, with many power stations having emissions much below 944g/kWh, this baseline appeared to be too high. The figures for the load factor are rough estimates based on IKARUS (KFA, 1994), a comprehensive techno-economic database which has been developed for the German Ministry for Technology and Research.

Table 6: Carbon Reduction for Technologies Considered in PwC (2000).

	G/kWh	Load factor	Reduction (t/lifetime)	Reduction (t/a)
Base (400MW)	800	--	--	--
CCGT(400MW)	365	0.79	4,948,560	329,904
RetrofitCCGT(")	365	0.79	4,948,560	329,904
Wind (50MW)	0	0.30	432,000	28,800
PV (1MW)	0	0.17	4,896	326
PV (100kW)	0	0.17	490	33

The resulting transaction costs (in Euro 2000 prices) are presented in Table 7 – Table 11 in absolute terms, and as Euro/ton carbon reduced, for the range of five projects. Discussion with PwC[1] points out that these results are to be taken as geographically generic in the sense that there is no distinction made between countries or regions where the CDM project would be located, since the data is averaged over a number of country experiences.

[1] Ian Milborrow, PWC, personal communication, April 19, 2001

Table 7: Transaction Costs (TCs) for new 400 MW Combined Cycle Gas Turbine (CCGT) Plant.

CDM Structure	Total TCs (Euro 000s)	Euro/ Ton C	Phase 1 TCs (Euro 000s)	Euro/ Ton C	Phase 2 TCs (Euro 000s)	Euro/ Ton C
Level 1	558	0.11	103	0.02	455	0.09
Level 2	675	0.14	103	0.02	582	0.12
Level 3	1057	0.21	103	0.02	986	0.20

Table 8: Transaction Costs (TCs) for 400 MW Retrofit Project.

CDM Structure	Total TCs (Euro 000s)	Euro/ Ton C	Phase 1 TCs (Euro 000s)	Euro/ Ton C	Phase 2 TCs (Euro 000s)	Euro/ Ton C
Level 1	489	0.10	73	0.02	416	0.08
Level 2	584	0.11	73	0.02	511	0.10
Level 3	897	0.18	73	0.02	824	0.17

Table 9: Transaction Costs (TCs) for 15 MW Wind Project.

CDM Structure	Total TCs (Euro 000s)	Euro/ Ton C	Phase 1 TCs (Euro 000s)	Euro/ Ton C	Phase 2 TCs (Euro 000s)	Euro/ Ton C
Level 1	392	0.91	61	0.14	331	0.77
Level 2	446	1.03	61	0.14	385	0.89
Level 3	610	1.41	61	0.14	549	1.27

Table 10: Transaction Costs (TCs) for 1 MW PV Project.

CDM Structure	Total TCs (Euro 000s)	Euro/ Ton C	Phase 1 TCs (Euro 000s)	Euro/ Ton C	Phase 2 TCs (Euro 000s)	Euro/ Ton C
Level 1	387	79.0	57	11.6	330	67.4
Level 2	441	90.1	57	11.6	386	78.8
Level 3	605	123.6	57	11.6	548	111.9

Table 11: Transaction Costs (TCs) for 100 kW PV Project.

CDM Structure	Total TCs (Euro 000s)	Euro/ Ton C	Phase 1 TCs (Euro 000s)	Euro/ Ton C	Phase 2 TCs (Euro 000s)	Euro/ Ton C
Level 1	387	790	57	116	330	674
Level 2	441	900	57	116	386	788
Level 3	605	1235	57	116	548	1119

The differing absolute transaction cost estimates reflect the fact that the renewable projects, (shown in Table 9 – Table 11), with zero emissions require minimal verification effort in the implementation phase (phase 2). The results also confirm the fact, that total transaction costs increase when more OEs are involved in a project. More significantly is however the fact, that the transaction costs expressed per ton of carbon reduced rise strongly as the size of the project becomes smaller.

Note that these results are for the first year of operation. PwC state that they would expect a learning curve effect in subsequent years such that the verification cost component of the project cycle would be 20% lower in these subsequent years.

Only recently, transaction costs became an issue in the discussion on the Kyoto mechanisms. Simplified modalities and procedures for small-scale CDM projects were adopted at the eighth Conference of the Parties in November of 2002, in New Delhi. The elaboration of baselines and monitoring methodologies is currently being undertaken by the Methodologies Panel of the Executive Board.

3.4 EcoSecurities

EcoSecurities (2000) provides estimates of the transaction costs for JI electricity generation projects, assuming that JI requirements will be similar to the CDM project cycle. Transaction cost estimates are applied in net present value calculations for two project types:

- 150MW gas plant, 20 year lifetime, resulting in reductions of 350,000 tCO_2/year;
- 2MW biomass plant, 20 year lifetime, resulting in reductions of 35,000 tCO_2/year.

The data is presented in Table 12 and gives ranges of transaction costs on the basis of 50 similar energy sector projects. The ranges of transaction costs reflect the relative complexity – and therefore resource requirements – that these projects need. EcoSecurities suggest[2], for example, that a wind project is likely to be typical for the lower range of transaction costs whilst a bio-mass CHP or landfill project is more representative for the top end of the range.

The EcoSecurities estimates are country generic and do not differentiate according to size of project, since they argue that a similar amount of time/resources is required for the project cycle activities, regardless of project size. As a consequence, the transaction costs expressed as per ton of carbon reduced are lower, the larger the project (in terms of

[2] Paul Soffe, EcoSecurities, personal communication, 15 May 2001.

size of resulting emission reductions). The two above mentioned projects are both medium or large sized projects with small costs per t CO_2 reduced.

Jotzo and Michaelowa (2001) propose emission reduction unit (ERU) market price estimates of 1-5€ per ton CO_2. This leads to the following transaction cost ranges for the above projects:

Table 12: JI Transaction Cost Estimates for Gas Plant.

JI Project Cycle	**Transaction Cost (€ 000s)**		
Pre-Implementation phase			
Search	12 – 20		
Negotiation	25 – 45		
Validation	10– 15		
Approval	10		
Total Pre-Impl. Phase	57 – 90		
Implementation phase		***ERU value 1 €/t***	***ERU value 5 €/t***
Monitoring (annual)	3 – 15		
Certification	5-10% of ERU value		
Gas plant*		17.5 – 35	87.5 – 175
Biomass plant*		1.75 – 3.5	8.75 – 17.5
Enforcement (annual)	1-3% of ERU value		
Gas plant*		3.5 – 10.5	17.5 – 51.5
Biomass plant*		0.35 – 1.05	1.75 –5.15
Total Implementation Phase (20 years, undiscounted)			
Gas plant*		480 – 1,210	2,160– 4,830
Biomass plant*		102 – 391	270 – 753
Total Project Cycle			
Gas plant* (costs per t CO_2)		537 – 1,300 (0.1 – 0.2€/t)	2,217 – 4,920 (0.3 – 0.7 €/t)
Biomass plant* (costs per t CO_2)		159 – 481 (0.2 – 0.7€/t)	327 - 843 (0.4 – 1.1 €/t)

Source: EcoSecurities (2000), own calculations
* Reductions as quoted above

The calculation shows that the bulk of costs falls on certification and enforcement costs. However, it is very unlikely that there will be no reduction of costs in later years of a project. In addition to this certification costs are expected to decline with the amount of certificates and therefore be not proportional to the amount of ERUs.

3.5 Comparison of JI/CDM Type Transaction Costs

The analysis above has identified estimates of transaction costs for the JI and CDM project types established under the Kyoto Protocol. The estimates are derived from different sources and reflect different institutional procedures. Consequently, the transaction costs may not be directly comparable. Nevertheless, due to the consistency in the range estimates of the values presented above, we are confident that these will approximate the transaction costs in the first commitment period. It is apparent, in any case, that a number of the current PCF and UNFCCC projects will convert to JI status - as one PCF project already has. The exception to this is the possibility for streamlining CDM - the details for which are still currently being worked out. This is discussed separately below.

Table 13: Classification of Project Sizes for JI Projects.

Type	Reduction (t/a)	Low (€/ton C)	Central (€/ton C)	High (€/ton C)
Very large	> 50,000	0.05	0.1	0.2
Large	5,000 - 50,000	0.5	1	2
Medium – upper	500 - 5,000	3	10	15
Medium – lower	50 - 500	35	100	300
Small	< 50	400	500	600

Table 14: Classification of Project Sizes for CDM Projects.

Type	Reduction (t/a)	Low (€/ton C)	Central (€/ton C)	High (€/ton C)
Very large	> 50,000	0.08	0.2	1
Large	5,000 - 50,000	0.25	0.5	2
Medium – upper	500 - 5,000	5	10	15
Medium – lower	50 - 500	67	100	300
Small	< 50	670	1,000	2000

Table 15: Correlation of Projects and Project Size.

Type	Typical projects
Very large	Large hydro, gas power plants, large CHP, geothermal, landfill/pipeline methane capture, cement plant efficiency, large-scale afforestation
Large	Wind power, solar thermal, energy efficiency in large industry
Medium – upper	Boiler conversion, DSM, small hydro
Medium – lower	Energy efficiency in housing and SME, mini hydro
Small	PV

The data is most usefully expressed in terms of transaction costs per ton of carbon reduced. Clearly, if the costs per ton of carbon are too high, this will prohibit an otherwise profitable carbon exchange. As can be seen from the data reported from individual sources above, there is a strong correlation between the size of project in terms of carbon reductions, and costs per ton of carbon. This pattern is highlighted in Table 13 and Table 14, which present a categorisation that roughly fits the different data sources for JI and CDM projects respectively. Table 15 presents typical project types for the different project sizes.

Whilst the data for JI and CDM projects are presented separately, the ranges that we have adopted to account for project specification, location etc., do not allow us to identify significant cost differences between the two instruments. Indeed, communication with the PCF[3], suggests that estimates for both instruments will fall substantially over time as learning effects, combined with increased competition in these markets, bring cost reductions in both the pre-implementation and implementation project phases. The 20% cost reduction in the implementation phase assumed by PwC may therefore be seen as a minimum reduction.

As noted above, the provision of streamlined procedures for small scale CDM projects means that these projects will have significantly lower transaction costs than presented above. The Parties agreed that the following categories of small-scale project activities are eligible under simplified procedures:

- Renewable energy projects with a maximum output capacity of 15 megawatts.
- Energy efficiency improvement projects that reduce energy consumption by up to 15 gigawatt hours per year.
- Other project activities that reduce anthropogenic emissions by source, which directly emit less than 15 kilotonnes of CO_2 equivalent annually.

Thus, the medium-low and small categories in Table 14 above can be adjusted to the levels presented in Table 16.

Table 16: Transaction Costs for Streamlined Small-Scale CDM Projects (PwC).

Type	Reduction (t/a)	Low (€/ton C)	Central (€/ton C)	High (€/ton C)
Medium – lower	50 - 500	6	9	27
Small	< 50	60	90	180

The estimates presented in Table 16 may, however, differ from those generated when the CDM becomes operational. This is because two further streamlining rules - not anticipated in the PwC analysis - have been recommended. These are:

[3] Ken Newcombe, PCF, personal communication 19 April, 2001

- the allowance for unilateral projects (where projects are developed, financed and implemented by the host country).
- The bundling of small-scale projects that are similar (so that the international CDM investor only has to deal with the organisation that bundles the projects).

The adoption of these two rules may mean that further reductions in transaction costs than identified in Table 16 may be possible. However, no quantitative estimates exist of such reductions at present.

3.6 International Emissions Trading (IET)

The estimation of transaction costs associated with IET is even more problematic than is the case for JI and CDM-type projects. This is because there has been little experience to date in the operation of internationally-based emission trading schemes. There is as yet no evidence on transaction costs that arise on domestic carbon trading e.g. in UK and Denmark. On the other hand, there is some evidence on transaction costs that have been incurred in domestic trading schemes for other pollutants than carbon, e.g. lead and SO_2 in the US. However, caution is urged in transferring transaction cost estimates from these schemes, since in international emissions trading search and negotiation costs are likely to be more significant, as the levels of technical competence will differ broadly among the firms in different countries, compared to domestic programs (Woerdman, 2001).

US SO_2 Allowances Trading

Tietenberg et al. (1999) emphasise that transaction costs play a key role in the success or failure of emission trading systems. Some national emissions trading schemes, like the U.S. SO_2 allowances trading programme introduced in the 1990 Amendment to the Clean Air Act, proved to be very successful. The evidence on transaction costs under this programme is not transparent. However, brokerage fees – which are likely to be the most significant component of transaction costs in trading schemes – are estimated to be in the range of 2% to 5% of the transaction value (Klaassen and Nentjes, (1997), and Joskow et. al. (1998). This magnitude is supported by Solomon (1995) and Montero (1997), who estimate transaction costs to be 5% and 8% of the transaction value, respectively.

US Lead Trading

Kerr and Maré (1997) provide quantitative estimates for transaction costs in lead permit trading. They state that transaction costs in the market between 1982 and 1987 were equivalent to 10% of the total transaction value.

Transferring these estimates to the carbon IET context a key determining factor will be the number of participants in the market (Woerdman, 2001). Theory suggests that transaction costs will decline as the number of potential traders and the number of transactions per source increase (Stavins, 1995). The estimates from US experience presented above have been derived in national markets with a large number of participants. The number of participants in carbon IET context will depend on the detail of the market design that finally emerges from the Conference of Parties. The scheme for greenhouse gas emission allowance trading within the EU, which is envisaged for the period 2005 to 2008, covers large installations of energy-intensive industries. Therefore the number of participants will be large and we would expect to see transaction costs equating to 2 – 4% of total transaction value.

On the other hand, several problems will arise in the operation of trading schemes at an international level, that are not existent at a national level. These include the difficulty of installing appropriate monitoring and penalty systems and, for the national inventories, monitoring their overall emissions. An estimate of 10% (Barrett, 1995) has therefore been suggested. However, as for JI and CDM projects, a learning effect is expected in emissions trading so that transaction costs are likely to be higher in initial stages of a trading program. This is in line with the experience of the U.S. trading schemes (see studies by Gangadharan (2000) and Aidt and Dutta (2001)) and suggests that over time 10% may be too high.

4 Estimates of Project Risk Premia

In addition to transaction costs, projects in different sovereign states may attract different risk premia owing to the perceived level of risk of default or project failure due to micro-level or macro-level factors. For instance, past actions such as default on loans may impact upon this perceived level of risk, as may macroeconomic variables such as inflation and the perceived level of economic development in the economy. This section focuses on the issue of the determination of the different types of risk faced by projects and identifies estimates for risk premia that can be used in the modelling applications.

4.1 Determining the Risk Premia

Dailami and Liepziger (1999) suggest that the required rate of return for a project in a given country is the sum of the risk-free interest rate and a risk premium that reflects the market's assessment of country and project risk.

Risk premia estimation can be based on a number of variables at both country and project level. These include: past projects, sovereign debt ratings, equity values and risk. Econometric analysis tries to incorporate both country and project level risk, and separates these two levels of risk through the use of macroeconomic and project level indicators as explanatory variables in regression analysis. One study is Dailami and Liepziger (1999) which uses a sample of 26 greenfield infrastructure projects[4] to estimate the credit risk premium and relate these to macroeconomic and project-specific variables. The macroeconomic variables included the rate of inflation, GDP per capita, ratio of external debt to exports, ratio of short term debt to foreign exchange reserves and the ratio of reserves to imports. Project size, leverage ratio (proportion of project loan to total project cost) and sector-specific dummy variables were used to estimate the impact of project-specific variables.

Given that CDM and JI projects are to be placed in developing countries and economies in transition, the above analysis suggests that differential risk premia may have to be used in project analysis. One technique is to calculate risk premia for different countries using equity returns and risk of default compared to a base country. Damadoran (undated) presents a methodological framework from which the risk premia for equities in different countries can be estimated. Damadoran (1999) calculates this for the USA relative to a number of other countries in the world, using average default spreads for different credit rankings. The results of this analysis are presented in Table 18. The estimates can be used as rough indicators of the country risk element to be applied to

[4] Note that this study was based on an initial sample of 78 projects. Of these projects, only 26 had sufficient data for the analysis of the risk premia.

projects in the different countries since they relate the risk of failure to the countries own rating. The credit rating of an individual firm within a nation, and thus the cost of financing a project, is unlikely to be below that of the national government, given that financial resources are open to the government.

Table 17 reports the average risk premium attributed to countries of different credit ratings. Clearly, the level of risk rises as the credit rating falls.

Table 17: Average Risk Premia by Credit Ranking.

Credit Ranking	Ave Risk premia
Aaa	0.00%
Aa1	0.60%
Aa2	0.65%
Aa3	0.70%
A2	0.90%
A3	0.95%
Baa1	1.20%
Baa2	1.30%
Baa3	1.45%
Ba1	2.50%
Ba2	3.00%
Ba3	4.00%
B1	4.50%
B2	5.50%
B3	6.50%
Caa	7.50%

Source: own estimates based on Damodaran (1999).

These average risk premia in different countries provide the basis for first estimations of the country risk premia to which projects under JI and CDM are exposed.

As noted above, one dynamic extension to the straight adoption of the values given in Table 18 is to relate forecast macro-economic indices for individual countries to the changes in credit rating (and therefore risk premia) that these indices would imply. This would be possible as long as the relationships between the indices and the credit rating are quantified. In a similar exercise, Cantor and Packer (1996) examined the extent to which sovereign credit ratings were determined by such variables, using econometric analysis of Standard and Poors' and Moodys' credit rating systems. Table 19 presents the main results of this analysis.

Table 18: Estimates of Country Risk Premia for Equities.

Country	Long-Term Rating	Adj. Default Spread	Total Risk Premium	Country Risk Premium
Alderney	Aaa	0	5.51%	0.00%
Andorra	Aa1	60	6.11%	0.60%
Argentina	B2	550	11.01%	5.50%
Australia	Aa2	65	6.16%	0.65%
Austria	Aaa	0	5.51%	0.00%
Bahamas	A3	95	6.46%	0.95%
Bahamas - Off Shore Banking Center	Aaa	0	5.51%	0.00%
Bahrain	Ba1	250	8.01%	2.50%
Bahrain - Off Shore Banking Center	A3	95	6.46%	0.95%
Barbados	Baa2	130	6.81%	1.30%
Belgium	Aaa	0	5.51%	0.00%
Belize	Ba2	300	8.51%	3.00%
Bermuda	Aa1	60	6.11%	0.60%
Bolivia	B1	450	10.01%	4.50%
Botswana	A2	90	6.41%	0.90%
Brazil	B1	450	10.01%	4.50%
Bulgaria	B2	550	11.01%	5.50%
Canada	Aa1	60	6.11%	0.60%
Cayman Islands	Aa3	70	6.21%	0.70%
Cayman Islands - Off Shore Banking Center	Aaa	0	5.51%	0.00%
Chile	Baa1	120	6.71%	1.20%
China	A3	95	6.46%	0.95%
Colombia	Ba2	300	8.51%	3.00%
Costa Rica	Ba1	250	8.01%	2.50%
Croatia	Baa3	145	6.96%	1.45%
Cuba	Caa1	750	13.01%	7.50%
Cyprus	A2	90	6.41%	0.90%
Czech Republic	Baa1	120	6.71%	1.20%
Denmark	Aaa	0	5.51%	0.00%
Dominican Republic	B1	450	10.01%	4.50%

Country	Long-Term Rating	Adj. Default Spread	Total Risk Premium	Country Risk Premium
Ecuador	Caa2	750	13.01%	7.50%
Egypt	Ba1	250	8.01%	2.50%
El Salvador	Baa3	145	6.96%	1.45%
Estonia	Baa1	120	6.71%	1.20%
Eurozone	Aaa	0	5.51%	0.00%
Fiji Islands	Ba2	300	8.51%	3.00%
Finland	Aaa	0	5.51%	0.00%
France	Aaa	0	5.51%	0.00%
Germany	Aaa	0	5.51%	0.00%
Gibraltar	Aaa	0	5.51%	0.00%
Greece	WR	750	13.01%	7.50%
Guatemala	Ba2	300	8.51%	3.00%
Guernsey	Aaa	0	5.51%	0.00%
Honduras	B2	550	11.01%	5.50%
Hong Kong	A3	95	6.46%	0.95%
Hungary	A3	95	6.46%	0.95%
Iceland	Aa3	70	6.21%	0.70%
India	Ba2	300	8.51%	3.00%
Indonesia	B3	650	12.01%	6.50%
Iran	B2	550	11.01%	5.50%
Ireland	AA2	65	6.16%	0.65%
Isle of Man	Aaa	0	5.51%	0.00%
Israel	A2	90	6.41%	0.90%
Italy	WR	750	13.01%	7.50%
Jamaica	Ba3	400	9.51%	4.00%
Japan	Aa1	60	6.11%	0.60%
Jersey	Aaa	0	5.51%	0.00%
Jordan	Ba3	400	9.51%	4.00%
Kazakhstan	B1*	450	10.01%	4.50%
Korea	Baa2	130	6.81%	1.30%

Table 18: continued.

Country	Long-Term Rating	Adj. Default Spread	Total Risk Premium	Country Risk Premium
Kuwait	Baa1	120	6.71%	1.20%
Latvia	Baa2	130	6.81%	1.30%
Lebanon	B1	450	10.01%	4.50%
Liechtenstein	Aaa	0	5.51%	0.00%
Lithuania	Ba1	250	8.01%	2.50%
Luxembourg	Aaa	0	5.51%	0.00%
Macau	Baa1	120	6.71%	1.20%
Malaysia	Baa2	130	6.81%	1.30%
Malta	A3	95	6.46%	0.95%
Mauritius	Baa2	130	6.81%	1.30%
Mexico	Baa3	145	6.96%	1.45%
Moldova	B3	650	12.01%	6.50%
Monaco	Aaa	0	5.51%	0.00%
Morocco	Ba1	250	8.01%	2.50%
Netherlands	Aaa	0	5.51%	0.00%
New Zealand	Aa2	65	6.16%	0.65%
Nicaragua	B2	550	11.01%	5.50%
Norway	Aaa	0	5.51%	0.00%
Oman	Baa2	130	6.81%	1.30%
Pakistan	Caa1	750	13.01%	7.50%
Panama	Baa1	120	6.71%	1.20%
Panama - Off Shore Banking Center	Aa2	65	6.16%	0.65%
Papua New Guinea	B1	450	10.01%	4.50%
Paraguay	B2	550	11.01%	5.50%
Peru	Ba3	400	9.51%	4.00%
Philippines	Ba1	250	8.01%	2.50%
Poland	Baa1	120	6.71%	1.20%
Portugal	A3	95	6.46%	0.95%
Qatar	Baa2	130	6.81%	1.30%
Romania	B3	650	12.01%	6.50%

Country	Long-Term Rating	Adj. Default Spread	Total Risk Premium	Country Risk Premium
Russia	B2	550	11.01%	5.50%
San Marino	A2	90	6.41%	0.90%
Sark	Aaa	0	5.51%	0.00%
Saudi Arabia	Baa3	145	6.96%	1.45%
Singapore	Aa1	60	6.11%	0.60%
Slovakia	Ba1	250	8.01%	2.50%
Slovenia	A2	90	6.41%	0.90%
South Africa	Baa3	145	6.96%	1.45%
Spain	Aa1	60	6.11%	0.60%
Sweden	Aa1	60	6.11%	0.60%
Switzerland	Aaa	0	5.51%	0.00%
Taiwan	Aa3	70	6.21%	0.70%
Thailand	Baa3	145	6.96%	1.45%
Trinidad & Tobago	Baa3	145	6.96%	1.45%
Tunisia	Baa3	145	6.96%	1.45%
Turkey	B1	450	10.01%	4.50%
Turkmenistan	B2	550	11.01%	5.50%
Ukraine	Caa1	750	13.01%	7.50%
United Arab Emirates	A2	90	6.41%	0.90%
United Kingdom	Aaa	0	5.51%	0.00%
United States of America	Aaa	0	5.51%	0.00%
Uruguay	Baa3	145	6.96%	1.45%
Venezuela	B2	550	11.01%	5.50%
Vietnam	B1	450	10.01%	4.50%

Source: Damodaran (1999)

Table 19: Determinants of Sovereign Debt Ratings.

	Dependent Variable			
Explanatory variable	**Average Ratings**	**Moody's Ratings**	**Standard and Poor's Ratings**	**Moody's/Standard and Poor's Rating Differences**[a]
Intercept	1.442 (0.633)	3.408 (1.379)	-0.524 (0.223)	3.932** (2.521)
Per capita income	1.242*** (5.302)	1.027*** (4.041)	1.458*** (6.048)	-0.431*** (2.688)
GDP Growth	0.151* (1.935)	0.130 (1.545)	0.171** (2.132)	-0.040 (0.756)
Inflation	-0.611*** (2.839)	-0.630*** (2.701)	-0.591*** (2.671)	-0.039 (0.265)
Fiscal balance	0.073 (1.324)	0.049 (0.818)	0.097* (1.71)	-0.048 (1.274)
External balance	0.003 (0.314)	0.006 (0.535)	0.001 (0.046)	0.006 (0.779)
External debt	-0.013*** (5.088)	-0.015*** (5.365)	-0.011*** (4.236)	-0.004 (2.133)
Indicator for economic development	2.776*** (4.25)	2.957*** (4.175)	2.595*** (3.861)	0.362 (0.81)
Indicator for default history	-2.042*** (3.175)	-1.463** (2.097)	-2.622*** (3.962)	1.159*** (2.632)
Adjusted R-squared	0.924	0.905	0.926	0.251
Standard error	1.222	1.325	1.257	0.836

Source: Cantor and Packer (1996)
Notes: The sample size is forty-nine. Absolute t-statistics are in parentheses.
[a]The number of rating notches by which Moody's ratings exceed Standard and Poor's.
*Significant at the 10 percent level
** Significant at the 5 percent level
***Significant at the 1 percent level

Table 19 shows that per capita income - an indicator of the level of political stability or the tax base from which a sovereign government can draw to repay debts - is statistically significant in all ratings. Similarly, inflation is significant in all equations, with a negative sign, indicating that a high level of inflation has a negative impact on the perception of risk of default. This one would expect as inflation is often associated with underlying structural problems in the economy. A negative relationship is shown between the ratings level and external debt, indicating that the higher the level of debt taken by a country the higher the level of risk involved with additional loans. Economic development, measured by a dummy variable showing whether a country is considered "industrialised" by the International Monetary Fund, has a positive effect on the ratings. Default history also has a significant impact, with the indicator showing whether a country has defaulted on a loan since 1970 having a negative influence on the ratings. GDP growth is significant at the 10% level in equation with average ratings as the dependent variable. The adjusted R-squared values for all three equations based solely on ratings are high, suggesting a high level of accuracy, which is borne out by assessment of the strength of the equation system in predicting sovereign ratings, with no predictions for countries being very far from the actual rankings. This indicates that the parameters from this equation can be used to derive estimates of credit ratings for countries or regions that as yet do not have credit ratings.

4.2 Recommendations

The risk premia applied to projects in developing countries and economies in transition may be crucial in determining whether a project goes ahead or not. Hence the determination of the risk premia may play a central role in the development of CDM or JI projects in developing countries. Several studies have examined the determinants of such risk premia, and a number of investment organisations provide ratings for investment risk in developing countries. The work by Damodaran (1999, undated) is of particular use since it provides estimates of risk premia for different countries based on average levels of risk in equity markets. Combined with the estimation of the determinants of credit rankings by Cantor and Packer (1996) it may provide the basis for an iterative model of risk premia for countries as they develop through the timeframe of the simulation process. This would be valuable in future simulations since it may indicate the additional premia needed for CDM and JI projects to be accepted for financing by governments, international institutions and corporations seeking to gain carbon credits.

These estimates, however, only give a lower bound of the *country risk* involved in project investment in any country. The same is true of estimates based on equity returns and risk of default. Analysis of project level data is required to examine the levels of project level risk and country level risk in developing countries. A study by Dailami et al (2001) includes project-level variables but does not report complete econometric results and does not present the data set on which the econometric analysis is based.

5 Summary and Conclusion

It is evident that transaction costs are significant cost elements in the proposed implementation of the flexible mechanisms under the Kyoto Protocol. Moreover, it is likely that they will matter in the decision as to whether an individual JI or CDM project will be undertaken or not. The existing data illustrates, that the absolute level of transaction costs is similar across all project types. Therefore the size of a project is significant for the costs per ton of carbon reduced. While the effect of transaction costs on large projects is negligible they will be prohibitive for small projects. This will therefore prevent the undertaking of projects that are otherwise cost effective, and may even lead to the exclusion of some countries from participating in CDM-projects.

The strong impact of transaction costs on the uptake of small projects underlines the importance of simplified modalities for small-scale projects, which were decided in the Marrakech Accords. An elaborate project cycle may enhance up-front transaction costs but lower them ex post. Moreover, rules that enhance transparency will be critical to reduce search costs even if they entail ex-ante costs. Dudek and Wiener (1996) argue for a voluntary bulletin board; the UNFCCC CDM Executive Board will develop a website where project ideas can be posted. Funds such as the Prototype Carbon Fund (PCF) can reduce transaction costs by developing generic procedures such as standardised contracts. They can also specialise in certain project types.

Further methods for reducing transaction costs include

- Bundling of projects to jointly undertake each step of the project cycle
- Verification and certification undertaken not annually but at long intervals
- Exemption of projects from one or more steps of the project cycle; this however endangers environmental credibility and could lead to moral hazard.
- Streamlining of information that is needed for each step of the project cycle

It is worth noting at this point that the answer to the question of who bears the transaction costs may be important in determining their effect on the up-take of the flexible mechanisms. At this stage in the establishment of the mechanisms it is impossible to say whether public or private sector agents will be liable for the costs, and how this liability will affect the up-take. One can envisage, however, a future where the burden shifts from public to private sectors over time as learning effects reduce costs.

While the importance of project size is apparent, there is not enough data to draw detailed conclusions on which countries or sectors are likely to have lower or higher transaction costs.

However, the renewable energy sector projects will have relatively low costs since monitoring in the implementation phase will have negligible costs.

The analysis on emissions trading showed that transaction costs are vital to the success or failure of an emissions trading scheme. Since there does not exist an international emissions trading scheme yet, transaction costs can only be quantified for national trading programmes. Data from such schemes, like the SO_2 or lead trading markets in the U.S. points out the importance of brokerage fees, which constitute the major part of transaction costs, and learning effects, which lead to an increase of trade and decrease of transaction costs in later years of trading programs.

In order to keep transaction costs low it will be desirable to build on the experience with past emissions trading schemes. Some problems do however occur in transferring the concept of national trading schemes to an international level. These include the difficulty to install appropriate monitoring and penalty systems and, for the national inventories, to precisely specify their overall emissions.

Experience with national emissions trading schemes provides transaction cost values given in per cent of traded volume. We think that total average transaction costs at the beginning of a trading program will constitute 10% of the traded volume and decrease gradually to approximately 2% of the traded volume, due to learning effects.

A key additional motivation for estimating the transaction costs associated with the different flexibility mechanisms is that the non-compliance penalty will be effective only if it is larger than the net costs of using the flexibility mechanisms. In a similar vein, if the net costs for JI and CDM, including transaction costs and risk premia, don't equal the net costs for IET, the up-take of individual flexible mechanisms will be affected. Continued monitoring of their current and proposed implementation will be necessary to determine what strategy should be taken in the next decade in promoting the different individual mechanisms. It is not yet clear, how far the transaction costs will be reduced through streamlining, learning effects, etc., however, it can be expected, that streamlining will lead to similar marginal costs for all three flexible mechanisms.

Risk premia constitute another important factor in the determination whether a project is undertaken or not. This holds in particular for projects in developing countries and economies in transition. We have determined country risk premia, based on Damodaran

(1999), that can be used as rough estimates of the country risk element to be applied to projects in the different countries. Since project-specific risk premia were not yet available, further research in this area is recommended in order to better be able to analyse take-up of the flexibility instruments.

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