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Adaptation financing as part of a global climate agreement: is the adaptation levy appropriate?

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Adaptation financing as part of a global climate agreement: is the adaptation levy appropriate?

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Abstract

The negotiations for a global climate agreement recognize that substantial and additional funds need to be generated for assisting adaptation in developing countries. Currently, the 2% adaptation levy (AL) on the clean development mechanism (CDM) is intended to serve this purpose under the Kyoto Protocol. This paper analyses whether such an arrangement can achieve its objectives, and thereby discusses its future prospects. Can it deliver the funds needed for adaptation, and are they additional? As the AL is facutally a tax on emission trading, does it cause a significant excess burden? How do the transfers from CDM and AL depend on the commitments to reduce greenhous gas emissions, such that the AL may alter the incentives for reaching a global agreement? I address these questions with a partial equilibrium model based on recent marginal abatement cost estimates for 2020. While former studies have focussed on single values for the AL, this paper determines the expected transfers from CDM and AL for a spectrum of emission reduction targets and the full range of AL levels.

The paper shows that the revenues from a 2% AL are neglectable compared to the requirements. Even when the AL is increased to maximize transfers in the presence of ambitious emission reduction targets, the revenues are not sufficient (e.g. $15 billion for a 30% reduction target and an 47% AL). These revenues are mostly subtracted from the CDM transfers, such that very little additional funds can be raised (e.g. $2.4 billion under the latter assumptions). There are indeed detrimental effects of the AL for reaching a global agreement, that are nevertheless relatively small. While the excess burden of the AL is small in terms of social cost, it accounts for more than 85% of the additional funds. This supports the overall conclusion that (i) the AL slightly disfavors agreements for climate protection, (ii) is far from sufficient to raise additional funds, and (iii) does this at comparatively high social costs.

Keywords: adaptation to climate change, abatement, CDM, developing countries, transfer payments

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1 Introduction

Financing adaptation in developing countries has become a cornerstone of any future global agreement on climate change. This is underpinned by the estimated costs for adaptation measures that are needed to reduce the damage from global warming in developing countries (e.g. US$ 10-40 billion annually, World Bank (2006), or US$ 28-67 billion, UNFCCC (2007)). International assistance in bearing these costs is crucial due to the economic limitations of the most vulnerable regions. Financial transfers may additionally be justified since developing countries are not primarily responsible for climate change. They might also be necessary side payments to stabilize a global climate agreement.

The recent negotiations in Cancún strengthened the concept of a Green Climate Fund to finance adaptation and mitigation projects in developing countries. The Cancún Agreement

> Recognizes that developed country Parties commit, in the context of meaningful mitigation actions and transparency on implementation, to a goal of mobilizing jointly USD 100 billion per year by 2020 to address the needs of developing countries. (COP 16, 2010)

The mechanism for raising these funds is yet not determined, but different options are discussed (UN, 2010), e.g. auctioning of emission permits, an international air passenger duty (e.g. Hepburn and Müller, 2010) or a tax on maritime bunker fuels. Funds can also be generated by taxing the trade of emission permits. This last alternative has some prominence since it is already in place under the Kyoto Protocol. It is thus crucial to assess whether such a mechanism might by able to generate the necessary funds. Morover, when such an institution is introduced to the global negotiation game, transfers will change depending on the commitments for emission reductions and on the choice variables for the financing mechanism. It might thus change the incentives for contributing to mitigation. This is not straightforward to answer for the abovementioned proposals, since they all link adaptation finance to some form of mitigation instrument.

To address these issues I analyze the future prospects of the current adaptation financing mechanism under the Kyoto Protocol. This is tied to emission trading with developing countries via the clean development mechanism (CDM) by an adaptation levy (AL). With the CDM, non-annex I countries under the Kyoto Protocol (those without binding emission reduction commitments) can voluntarily reduce their emissions to obtain certified emission reductions (CERs). These can be sold to annex I countries (to offset their own emission reduction requirements). The AL requires that a 2% share of the CERs issued is given to the Adaptation Fund for adaptation financing.

It is easy see some problems associated with this arrangement, at least in theory. First, the AL is factually a tax on emission trading. The standard theory of taxation shows that this reduces the quantity of traded emission permits and leads to an excess burden. Second, as the transfers for adaptation in developing countries are financed by diverting CERs from the developing countries themselves, there might be, in sum, no additional funds. Third, it can be expected that more ambitious emission reduction targets are associated with more emission trading at higher prices, and therefore with more adaptation financing. Thus, if there were less climate protection, there would also be less funds to support adaptation. This is not exactly the relation between mitigation and adaptation that is needed (supposed that both are substitutes). This raises some central questions: Can the AL generate the required additional funds when its effects on the CDM market equilibrium are considered? How substantial are its social costs? How do social costs and transfers depend on the level of the AL and on emission reduction targets? This paper analyzes whether these problems are only theoretically relevant, or whether they bear empirical significance.

Although modelling the CDM market is now state of the art (see, e.g. Ellerman and Decaux, 1998; Criqui et al., 1999; Matsuhashi et al., 1999), the effect of an AL has not explictly been analyzed yet (with Fankhauser and Martin, 2010, being the only exception to my knowledge). The literature has focused on other extensions of the basic CDM model, e.g. participation scenarios, institutional details, transaction costs, technology diffusion (den Elzen and Both, 2002; Jotzo and Michaelowa, 2002; Brechet and Lussis, 2006). Some studies analyze CDM transfers to developing countries (e.g. den Elzen and Both, 2002; Jotzo and Michaelowa, 2002), strategic effects on climate negotiations (e.g. Rübbelke and Rive, 2008; Wang et al., 2009), or alternative financing principles (Dekker et al., 2009). All these studies ignore the AL or fix it to 2% and do not consider the social costs of the AL. Only Fankhauser and Martin (2010) additionally compare with a 10% levy (and computes the tax incidence), but do not determine the effect on CDM transfers and how results depend on emission reduction targets. All these contributions do not compute the effect of a continuously increasing levy, and how this interacts with climate protection.

I address these questions by setting up a model of emission trading based on marginal abatement cost curves for 2020. The model resolves 13 world regions, in particular the main annex I and non-annex I emitters. This determines the market price for CERs and the amount of emission reductions in the partial equilibrium. It is extended to include the AL, determine the transfers from mitigation, and the revenues of the AL. I first detail out the theoretical problems of the AL by using a simplified analytical model, and then use the full numerical model to compute the transfers for adaptation financing and mitigation depending on a large interval for emission reduction targets and for the level of the AL. This allows for determining the AL that maximizes transfers, quantifying the amount of additional funds, the excess burden, and the change in incentives for contributing to an agreement.

I find that the 2% AL only generates neglectable funds. By increasing the AL excessively, adaptation financing can amount to $1.15 billion (with emission reductions according to the Copenhagen pledges), and at least $15 billion for more ambitous climate protection (30% emission reduction target). However, additional adaptation finance reduces transfers from the CDM. Even for the 30% emission reduction target the additional funds are only slightly above $2.4 billion. Although the excess burden of the AL is less then 5% of the total abatement costs, it is quite high compared to the additional funds. Raising one additional Dollar via the AL comes at total costs of about $1.85. Sensitivity analysis with higher abatement costs show that this result is robust, and that additional funds may double. The positive relationship between the total costs of annex I countries and the total net transfers to non-annex I countries is strengthened by the AL. However, this problematic effect for climate negotiations is only small.

The paper is organized as follows. I first introduce the basic mechanics of the AL and set up a simplified analytical model of emission trading with the AL to clarify the its basic effects. Subsequently, the numerical model is introduced to quantify the stated effects. The main part is devoted to the model results. I conclude with a summary and a discussion about the implications for future adaptation financing.

2 Emission Trading with an Adaptation Levy

The apadation levy (AL) is is tied to emission trading with developing countries via the clean development mechanism (CDM). If an appropriate mitigation project is undertaken by a non-annex I country, emission certificates are issued to the developing country (certified emission reductions, CERs), and can then be sold to an annex I country to meet its emission reduction targets. Now, adaptation financing enters the stage. The AL requires that a 2% share of the certificates issued via the CDM is given to the Adaptation Fund and sold on an emissions market. The proceeds are the revenues of the Adaptation Fund. They are devoted to financing adaptation projects in developing countries. This mechanism is operating since 2009. As a trustee, the World Bank currently sells the CERs and reports the revenues to the Adaptation Fund Board. As of October 2010, it raised total funds of \$130.55 million (Adaptation Fund Board, 2010). The UNDP estimates the total funds that can be raised in the Kyoto commitment period 2008-2012 to be between \$160 and 950 million, the World Bank expects less than \$ 500 million (UNDP, 2008; World Bank, 2006). On the basis of current carbon prices and registered CDM projects, the World Bank expects revenues of \$382 - 496 million over the Kyoto commitment period (Adaptation Fund Board, 2010).

2.1 Analytical Model

The CDM market is modelled in the standard way by assuming market clearance for emission trading by equating demand and supply, that are in turn determined by marginal abatement costs (as, e.g. Ellerman and Decaux, 1998; Criqui et al., 1999; Jotzo and Michaelowa, 2002). By introducing the adaptation levy (AL), the market equilibrium is shifted and the revenues for the Adaptation Fund will change as well.

For this exposition I restrict the analysis to the case of two parties, one being the aggregate of annex I countries that demand CERs, the other one being the aggregate non-annex I countries, that supply CERs. Non-annex I countries generate the quantity of q emission permits at costs $C_2(q)$. Marginal abatement costs C_2' are are assumed to be increasing from zero to infinity. The annex I countries have to achieve an emission reduction target a, either by abating emissions domestically, or by off-setting with emission permits from non-annex I countries (CERs). The abatement costs are thus denoted by $C_1(a - q)$, and for marginal abatement costs C_1' the same assumption as for non-annex I countries holds.

Without the AL τ, the market equilibrium with carbon price p would be determined by equating marginal costs of annex I and non-annex I countries. If $\tau > 0$, supply is determined by maximizing the net transfers of non-annex I countries from the CDM,

$$T_{cdm} = (1-\tau)qp - C_2(q), \tag{1}$$

since the fraction τ of generated emission permits q is given to the Adaptation Fund. On the demand side, however, the full amount of generated emission permits is available, since the permits that are given to the Adaptation Fund are sold on the market to finance adaptation. Thus, the total cost for annex I countries to be minized are

$$TC_1 = pq + C_1(a-q). \tag{2}$$

Consequently, the partial equilibrium is determined by

$$C_2'(q) = (1-\tau)p = (1-\tau)C_1'(a-q). \tag{3}$$

This shows that the AL is formally equivalent to an *ad valorem* tax that is collected on the supply side. The total revenues for the Adaptation Fund are thus

$$T_{al} = \tau pq. \tag{4}$$

Since they are recycled to the non-annex I countries, they are transfers as well, such that the total net transfers to developing countries amount to

$$T = T_{cdm} + T_{al} = pq - C_2(q). \tag{5}$$

In this equation the AL becomes invisible, but note that it influences the actual value of p, q. The total costs of climate protection TC can be decomposed into the total costs for annex I countries $TC_1 = C_1(a-q) + pq$, and the transfers to non-annex I countries:

$$TC = C_1(a-q) + C_2(q) = TC_1 - T. \tag{6}$$

2.2 Comparative Statics

How the market equilibrium changes with respect to the AL τ is given by the standard theory of taxation, while the emission reduction target a introduces an additional paramter. The notation is simplified by using the elasticities of inverse supply and demand,

$$\epsilon_D = \frac{C_1''}{C_1'}q = \epsilon_1 \frac{q}{a-q} > 0, \tag{7}$$

$$\epsilon_S = \frac{C_2''(q)}{C_2'(q)}q > 0, \tag{8}$$

where $\epsilon_1 = \frac{C_1''(a-q)}{C_1'(a-q)}(a-q)$ is the elasticity of the marginal abatement cost curve for the annex I countries. Introducing ϵ_1 will show up to be helpful later on.

Differentiating Eq. (3) yields

$$C_2'' dq = (1-\tau)C_1''(da - dq), \tag{9}$$

such that

$$\frac{dq}{da} = \frac{(1-\tau)C_1''}{C_2'' + (1-\tau)C_1''} = \frac{\epsilon_D}{\epsilon_S + \epsilon_D}. \tag{10}$$

Since $p = C_2'/(1-\tau)$, it holds that

$$\frac{dp}{da} = \epsilon_S \frac{dq}{da}\frac{p}{q} = \frac{p}{q}\frac{\epsilon_S \epsilon_D}{\epsilon_S + \epsilon_D}, \tag{11}$$

such that

$$\frac{dp}{da} = \frac{C_1'' C_2''}{C_1'' + (1-\tau)C_2''} = \frac{p}{q}\frac{\epsilon_S \epsilon_D}{\epsilon_S + \epsilon_D}. \tag{12}$$

The comparative statics (summarized in Tab.1) are rather intuitive. Increasing gross prices and decreasing quantities due to taxation follow the standard insights from tax incidence. When, ceteris paribus, the mitigation goal is increased, emission trading increases: the more ambitious climate protections makes off-setting via the CDM more attractive to fulfill the commitments. By the same token, the carbon price increases as well, as more expensive off-setting projects in non-annex I-countries need to be used.

$\frac{dq}{d\tau}$	$= -\frac{q}{1-\tau}\frac{1}{\epsilon_S+\epsilon_D}$	< 0
$\frac{dp}{d\tau}$	$= \frac{p}{1-\tau}\frac{\epsilon_D}{\epsilon_S+\epsilon_D}$	> 0
$\frac{dq}{da}$	$= \frac{\epsilon_D}{\epsilon_S+\epsilon_D}$	> 0
$\frac{dp}{da}$	$= \frac{p}{q}\frac{\epsilon_S\epsilon_D}{\epsilon_S+\epsilon_D}$	> 0

Table 1: Overview of comparative statics.

It is crucial to know how the transfers depend on the parameters. This is straightforward to determine by considering Eq. (11), and using that $\frac{dq}{d\tau} = -\epsilon_D \frac{dq}{d\tau}\frac{p}{q}$:

$$\frac{dT_{al}}{d\tau} = pq\frac{(\epsilon_S + \epsilon_D) - \tau(\epsilon_S + 1)}{(1-\tau)(\epsilon_S + \epsilon_D)}, \tag{13}$$

$$\frac{dT_{al}}{da} = -p\frac{\tau\epsilon_D(\epsilon_S + 1)}{(\epsilon_S + \epsilon_D)} > 0, \tag{14}$$

$$\frac{dT}{d\tau} = (\epsilon_D - \tau)p\frac{dq}{d\tau} = \frac{\tau - \epsilon_D}{(1-\tau)(\epsilon_S + \epsilon_D)}pq, \tag{15}$$

$$\frac{dT}{da} = \frac{(\epsilon_S + 1)\epsilon_D}{(\epsilon_S + \epsilon_D)}p > 0. \tag{16}$$

Increasingly ambitious climate protection increases the revenues for the Adaptation Fund since there is more emissions trading at higher prices. The transfers T_{al} follow a Laffer curve where increasing tax revenues are finally offset by reduced trade quantities. However, the non-annex I countries cannot be expected to be primarily interested in transfers for adaptation, but the total net transfers T. Since more stringent climate protection leads to more emission trading at higher prices, both transfers from CDM and from the AL increase. total net transfers will yet begin to decrease since the adaptation levy finally reduces T_{cdm} more than the revenues for the Adaptation Fund increase. The adaptation levy that maximizes total net transfers is thus given by

$$\tau^* = \epsilon_D = \epsilon_1 \frac{q}{a-q}. \tag{17}$$

This is the levy that the non-annex I countries should prefer most in international negotations, supposed that they act as one party and that a would have been agreed on before.

I now turn to the excess burden of the AL, that is defined as

$$D := (C_1(a-q) + C_2(q)) - (C_1(a-q^*) + C_2(q^*)), \tag{18}$$

where an asterix $\cdot^*$ denotes the market equilibrium in absence of an adaptation levy (i.e. $\tau = 0$). Clearly, D increases for higher taxes according to

$$\frac{dD}{d\tau} = \frac{\tau}{(1-\tau)(\epsilon_S + \epsilon_D)} pq = \frac{T_{al}}{(1-\tau)(\epsilon_S + \epsilon_D)} > 0. \tag{19}$$

Interestingly,

$$\frac{dD}{da} = (1 - \frac{\tau \epsilon_D}{\epsilon_S + \epsilon_D})p - p^* \tag{20}$$

can be positive or negative. If the AL is given, a more stringent emission reduction target may increase or decrease the social cost of adaptation financing. For a high levy, a benefit in terms of social costs is more likely. While increasing emission reductions, as a direct effect, spur emissions trading, the excess burden increases. This effect is countered when the market equilibrium shifts to a place with higher price elasticity of demand.

I finally consider the strategic effects of the AL. Suppose that the levy is considered as a crucial component of global climate treaty. Does this help reaching an agreement on more ambitious climate protection? This question can be framed in terms of an international environmental agreement game. If some AL is agreed on, more ambitious emission reduction targets cause two types of cost for annex I countries: costs of mitigation (including the excess burden from the levy) and the costs for transfers to developing countries. Both costs need to be considered in the payoff-functions. I delegate a thorough game theoretic analysis to a later paper, but the following already suggests the direction. The analysis requires to understand how the AL shifts the costs between annex I and non-annex I countries. The total costs for the former change according to

$$\frac{dTC_1}{d\tau} = -\frac{\epsilon_D}{(1-\tau)(\epsilon_S + \epsilon_D)} pq > 0, \tag{21}$$

$$\frac{dTC_1}{da} = (1 - \frac{\epsilon_S \epsilon_D}{\epsilon_S + \epsilon_D})p > 0, \tag{22}$$

both being rather intuitive. As the total costs for non-annex I countries are the negative gains, i.e. $TC_2 = -T$, an increasing AL shifts costs from non-annex I to annex I countries, but costs will finally increase for non-annex I countries as well due to the excess burden from taxation (cf. Eq. 15). In contrast, more ambitious emission reduction targets always decrease the costs for non-annex I countries. Both types of costs are related as follows:

$$\frac{dT}{dTC_1} = \frac{dT}{da}\Big(\frac{dTC_1}{da}\Big)^{-1} = \frac{\epsilon_D(\epsilon_S + 1)}{\epsilon_D + \epsilon_S(1-\epsilon_D)} > 0. \tag{23}$$

When annex I countries bear a larger burden from reducing emissions, they pay more transfers to developing countries at the same time. This relation also holds for $\tau = 0$. A strictly positive AL yet changes ϵ_D, having, in general, an ambigous effect on the slope Eq. (23). It is thus theoretically unclear whether the apatation levy exacerbates or ameliorates the positive relation between mitigation and adaptation financing.

3 Numerical model

The numerical model is based on estimated marginal abatement cost curves (MAC curves) for 13 world regions in 2020. I determine the MAC curves from simulated data computed by an established computable general equilibrium (CGE) model (Böhringer, 2002). The model is sectorally and regionally disaggregated and, in particular, represents energy consumption and associated carbon emissions. The model is calibrated to GTAP 6 data (Dimaranan, 2006), and, for the energy sector and emissions, to historical data from the International Energy Outlook (IEO, EIA, 2009, 2010). For consistency, the 2020 BAU emission projections are taken from the IEO as well. This requires to aggregate GTAP countries to the regions covered by the IEO. This keeps the main emitters represented[1].

It should be noted that this approach only considers emissions and abatement costs from the energy sector. The computations thus come with the caveat that I assume energy emissions to be indicative for the overall numerical results. This might be justified since these emissions comprise the most important fraction of emissions and emissions trading.

I parameterize the MAC curves by a quadratic fit to the CGE model results, that explain the variation of data quite well (see Tab. 2). Units are Mt CO2 and US$(2004). Other polynomial fits were tested as well, but they do not bring about significantly better results. The emissions trade model thus uses isoelastic cost functions. This functional form is in line with earlier work, but quantitatively differs from older estimates for 2010 in that the MACs are substantially reduced (e.g. Criqui et al., 1999). This might be reasonable due to technological progress, but may also be due to the optimistic IEO emissions projections. In a later section the sensitivity of the results to marginal abatement cost estimates is assessed.

The model is further adjusted by considering transaction costs and limited accessibility for CDM projects as it is done in other work (e.g. Jotzo and Michaelowa, 2002; den Elzen and Both, 2002). Transaction costs are assumed to be $ 0.60 per tCO2, and 20% of CDM projects are taken to accessible. The possiblity of hot air is considered as well by determining the rents from excessive permits via the market clearance condition. The complete model is implemented as mixed complementary program (MCP) in GAMS code that allows to run different scenarios and sensitivity studies[2].

[1] I am indebted to Christoph Böhringer for supplying this data.

[2] The code is available from the author upon request.

country or region		MAC parameter	BAU emissions
European Union	EEU	5.1730E-05	4042
Japan	JPN	1.5294E-04	1114
United States	USA	2.2631E-05	5851
Australia&New Zealand	ANZ	1.8190E-03	517
Canada	CAN	2.0625E-03	554
Russian Federation	RUS	1.2005E-04	1648
China	CHI	5.3193E-06	9057
India	IND	1.6209E-04	1751
Brazil	BRA	6.6271E-03	534
Korea	KOR	2.8007E-03	570
Mexico	MEX	3.8924E-03	499
South Afria	ZAF	1.2178E-03	
Rest of World	ROW	8.9673E-06	

Table 2: Region data of the numerical model. Marginal abatement costs amount to αq^2, with MAC paramter α given in the table. Units are Mt CO2 and US$(2004). Projected business-as-usal (BAU) emissions for 2020 according to EIA (2010).

4 Results

This section presents aggregated results from model runs for different scenarios. In the first one I concentrate on the 2020 reduction pledges that were submitted to the UNFCCC Secretariat after the Copenhagen negotiations in January 2010. Assuming these reduction targets to be given, I determine their effects in dependence on any AL $\tau \in [0, 1]$. Second, I vary the reduction targets as well. All results are determined by runnig the numerical model for a large set of parameters and aggregating for annex I or non-annex I countries, respectively. In a last subsection, the sensitivity of the results with respect to annex I marginal abatement costs is assessed.

4.1 Scenario: Copenhagen Pledges

This scenario assumes that all annex I countries commit to the emission reduction targets for 2020 submitted after the Copenhagen negotations. For those countries that submitted multiple pledges, I take the lower one. All reduction targets are adjusted to the baseline year 1990 according to the IEO emissions data for the reference years submitted by the countries. The market equilibrium is numerically solved for $\tau \in [0, 1]$ with 100 steps. The total transfers are determined by summing up all non-annex I countries. The main results in terms of transfers to non-annex I countries is summarized in Fig. 1. Without an AL all transfers stem from the CDM and amount to about $1.35 billion annually. For the current $\tau = 2\%$, the levy is projected to generate only $45.4 million annually in 2020. This value is much smaller than the $127 - $165 million that are expected by the World Bank as annual average for 2010-2012 (Adaptation Fund Board, 2010). This difference is yet not caused by the current AL substantially reducing emissions trading, but due to

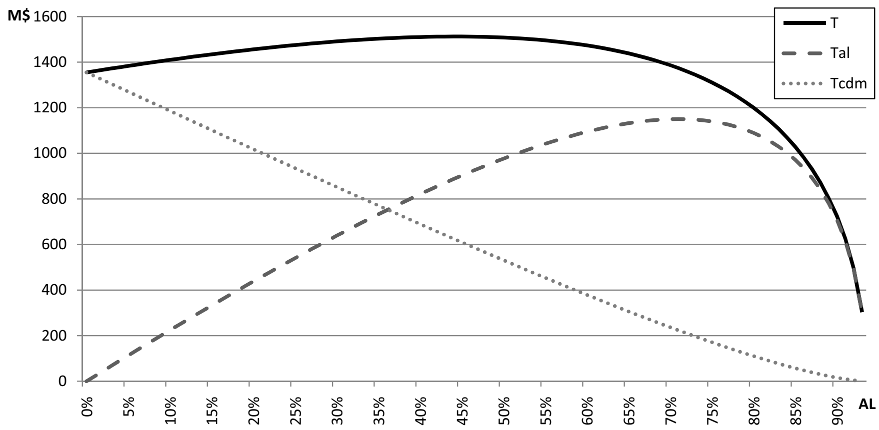

Figure 1: total net transfers T, transfers for adaptation financing T_{al}, and from the CDM T_{cdm} depending on the AL τ. Reduction targets are according to the Copenhagen pledges.

the optimistic abatement cost estimates of the IEO for 2020. Moreover, the computations assume broader participation than under the Kyoto Protocol.

When the AL is further increased, the transfers from the CDM are reduced, but to a smaller extent than T_{al} increases. Total net transfers T to non-annex I countries slightly increase up to a maximum of \$1.51 billon with an AL of 44%. So, optimal transfers require a considerable high adaptation levy, but deviations don't matter much in terms of additional total transfers. This is a remarkably high tax rate that can be explained by a comparatively small inverse demand elasticity for emission permits at the market equilibrium. Total additional funds do not execeed \$157 million. With an AL below about 70%, the levy mainly determines the *share* of transfers that is devoted to adaptation, while total net transfers always remain slightly above \$1.4 billion. While the AL can yield some revenues, it practically generates no additional funds. The flat curve of total transfers is associated with a quite low inverse demand elasticity of $\epsilon_D = 0.44$ at the maximum, compared to much higher $\epsilon_S = 2.0$.

The Laffer curve of the adaptation levy has its maximum at a remarkably high tax rate $\tau = 71\%$. Not more than \$1.15 billion of funds can be raised for adaptation, but at this level the total net transfers are already \$20 million below the level without an AL. Beyond that, the AL becomes increasingly prohibitive, such that the CDM is not used any more and transfers vanish.

Fig. 2 shows that the excess burden of the tax remains low in comparison to the total costs for annex I countries. For the transfer maximizing levy $\tau = 44\%$, only \$134 million of unnecessary costs occur, that is less than 4% of the total costs, but 15% of the AL's revenues T_{al}. For a high adaptation levy, the social costs D are mainly subtracted from the transfers T, such that the costs for annex I countries TC_1 only moderately increase (by 6.1% for the transfer maximizing AL, and by 15% for a 90% AL). As supply is less price elastic than demand ($\epsilon_S^{-1} = 0.5, \epsilon_D^{-1} \approx 2.3$), the incidence mostly lies on the supply side.

The gains from emissions trading (that can be determined by comparing TC_1 for $\tau = 0$

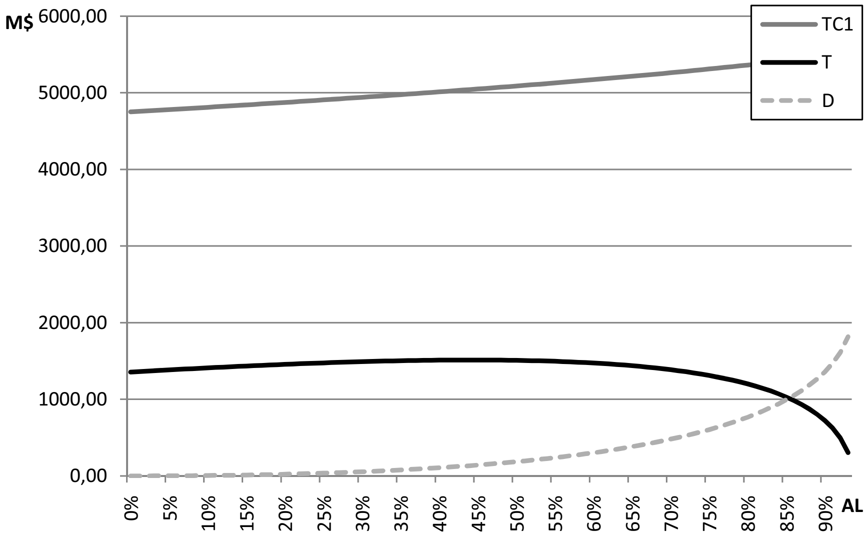

Figure 2: Total costs for annex I countries TC_1, excess burden D and total net transfers T depending on the AL. Reduction targets follow the Copenhagen pledges. Financial volumes are given in million $.

and $\tau = 1$) are much less than in earlier studies (e.g. Brechet and Lussis, 2006) due to the updated abatement cost estimates for 2020 underlying the current paper. It seems that the small funds that the AL generates are associated with only small cost increases to annex I parties, such that the AL may be strategicall insignificant in the climate negotiations. I will address this questions more carefully below.

For now, it must be concluded that – in combination with the Copenhagen pledges – the adaptation levy is far from being capable to generate the funds seen as necessary. Jointly with the CDM it is more than insufficient to finance the $ 100 billion annually that are considered in the decisions of the Cancún negotiations. May this be due to the unambitious Copenhagen pledges?

4.2 Scenario: Homogeneous Reduction Targets

I explore this by considering how different reduction targets determine the results. As there are uncountable options to distribute countries' emission reductions targets, I assume – for sake of simplicity – identical targets for all annex I countries: every annex I country is assumed to reduce emissions by the same fraction relative to its 1990 emissions. This is not meant to be a realistic suggestion, but to illustrate the basic effects. Thus, a large set of parameterizations with the AL varying between 0% and 100%, and the reduction target varying between 5% and 50% is computed.

To address whether the AL and the CDM are able to generate the appropriate funds, consider Fig. 3 first. It compares the 2% AL with the transfer maximizing AL τ^* (that slightly increases with the reduction targets from 40% to 48%). Both cases for τ lead to total net transfers up to $9 billion for a 20% reduction target, and $26 billion for a

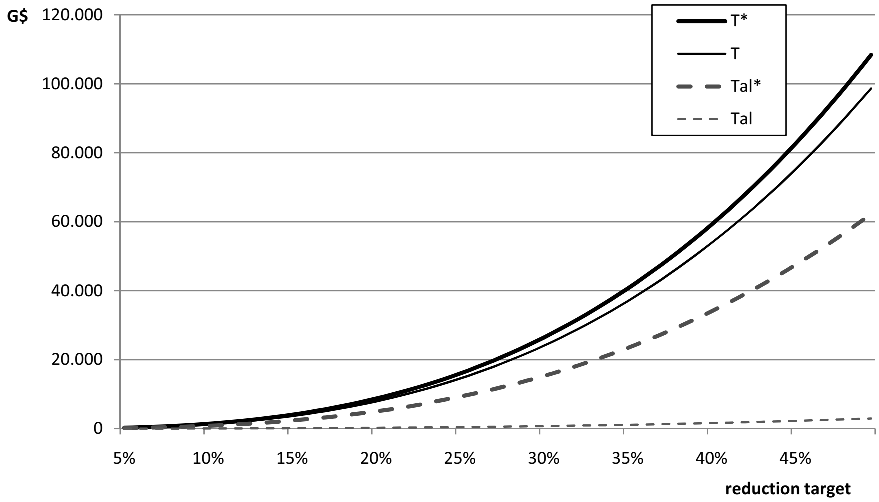

Figure 3: total net transfers T and adaptation transfers T_{al} assuming the 2% AL, compared to T^*, T^*_{al} for the transfer maximizing AL $\tau^* = \epsilon_D$. Financial volumes are given in billion $.

30% reduction target. This at least reaches the order of magnitude that is recognized in the decision of Cancún. However, total net transfers are not strongly affected by the AL. Although the gap between both options opens with more ambitious reduction targets, additional funds remain small (e.g. $2.4 billion for a 30% reduction target).

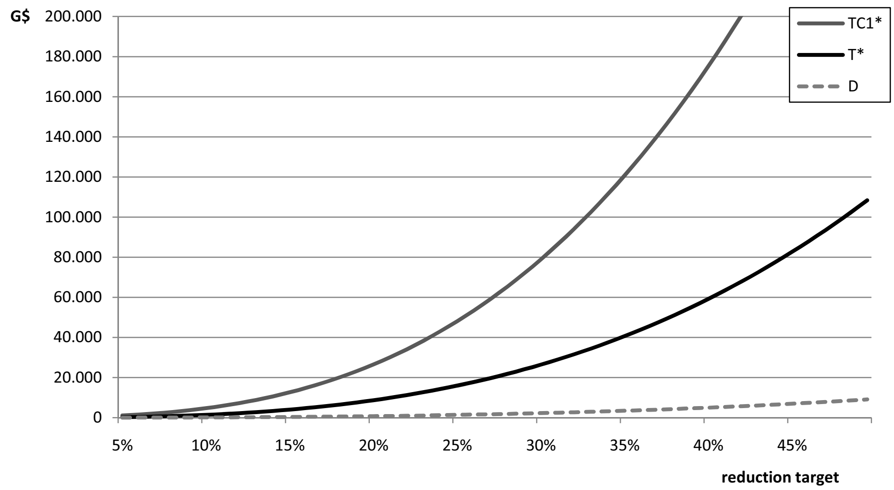

Figure 4: Total costs for annex I countries and excess burden depending on the reduction target. It is assumed that the AL $\tau^* = \epsilon_D$ maximizies total net transfers T.

Yet, the volume of adaptation transfers with an AL of 2% remains below $1.6 billion even for a 40% reduction target. For a 20% reduction target and an 10% AL (the special case analysed by Fankhauser and Martin, 2010), the AL raises $1.2 billion. This is associated with social costs of $25 million. By changing to the transfer maximizing AL, up to $15 billion are raised for adaptation (with a 30% reduction target), which reaches the interval of the World Bank estimate for adaptation costs. The results show that the share of total net transfers that is devoted adaptation does not change much with the reduction target. Fig. 4 shows the effect that transfers for adaptation increase with a more ambitous emission reduction targets, although it is likely that less adaptation is needed in the presence of more climate protection. For the transfer maximizing AL τ^*, the excess burden D remains relatively low. With a 30% reduction target it reaches $2.3 billion (being less than 5% of the total costs, but 15% of the ALs revenues). The total costs for annex I countries sharply increase up to $175 billion for a 40% reduction target. As the excess burden is low compared to that number, the increase can only be attributed to the joint effect of increasing abatement costs and transfers. The latter increase the costs for the country group with reduction commitments disproportionally due to the associated re-distribution.

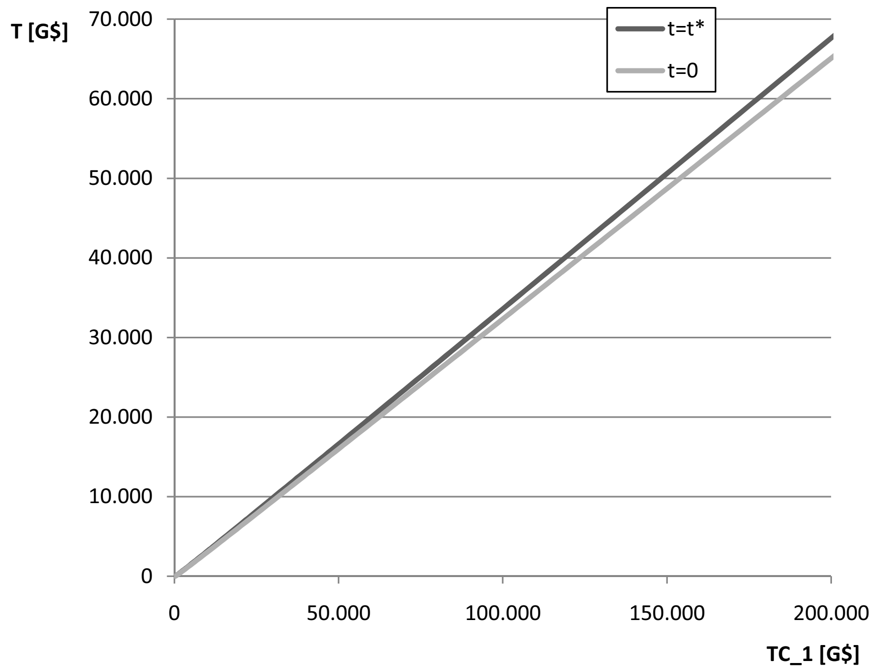

Figure 5: Comparison of total costs for annex I countries TC_1 with total net transfers to non-annex I countries T for $\tau = 0$ and for the transfer maximizing AL $\tau*$. The realized point on the curves depends on the reduction target.

Fig. 5 illustrates the strategic effect of the AL by comparing the costs and transfers. As shown in Eq. (23), this is a positive relationsship. By comparing the curves for the transfer maximizing AL and in absence of the levy, it can be seen that this positive relationsship is strengthened. When annex I countries commit to bear more total costs, the AL brings them also to pay disproportionally more transfers to the developing world. This effect is, nevertheless, not very strong. This is due to the limited additional funds the AL generates.

4.3 Sensitivity of Results

As the marginal abatement cost curves are relatively optimistic, I now determine how results change when abatement becomes more costly in annex I countries. It is assumed in a high cost scenario that only 80% of domestic abatement options are accessible in developed countries. See Fig. 6 for the results. Since the CDM becomes more attractive under such conditions, more total net transfers are generated, increasing the *additional* funds roughly by a factor of 2.4 for the transfer maximizing levy. So, if one is more pessimistic about abatement in annex I countries, total transfers become substantial, but are still below the range suggested in Cancún (e.g. \$5.8 billion additional funds for a 30% reduction target). Since more emission trading at higher prices is associated with more

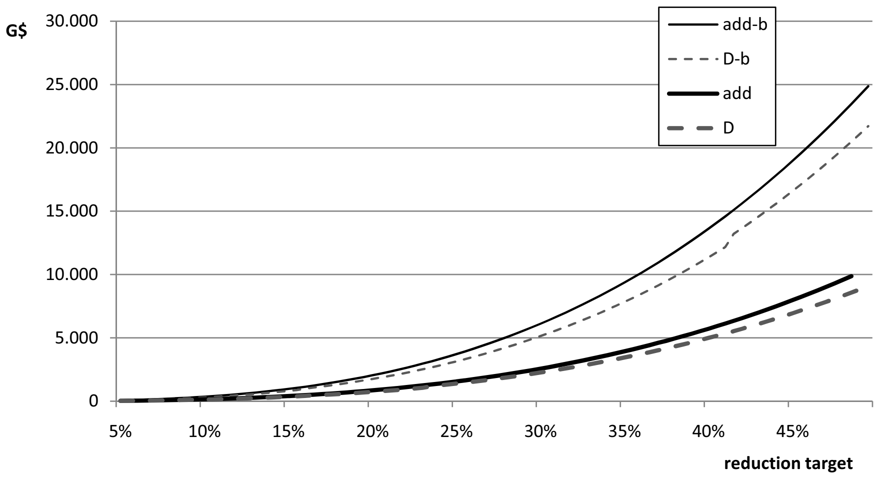

Figure 6: Comparison of total additional funds and social costs D with the transfer maximizing AL $\tau*$ for different assumptions about annex I abatement costs (a: base case, b: high cost scenario).

taxation, the excess burden also increases (by a similar factor as total net transfers). As Fig. 6 compares social costs with additional funds, the excess burden gets a rather significant share between 85% and 90% (depending on the reduction target). This ratio roughly holds for both the high cost scenario and the base case: a given volume of additional transfers comes at social costs that are in the same order of magnitude.

Fig. 7 again compares the strategic effect of the CDM jointly with the AL. With more expensive abatement in annex I countries the positive relationship between total costs for annex I countries and transfer payments is further strengthened. This reflects that the AL generates more funds in the high cost scenario.

5 Discussion and Conclusions

This paper contributes to the current debate about how to generate the revenues of a Green Climate Fund that might become part of future global climate agreement. Such a fund should finance mitigation and adaptation in developing countries. My analysis focusses

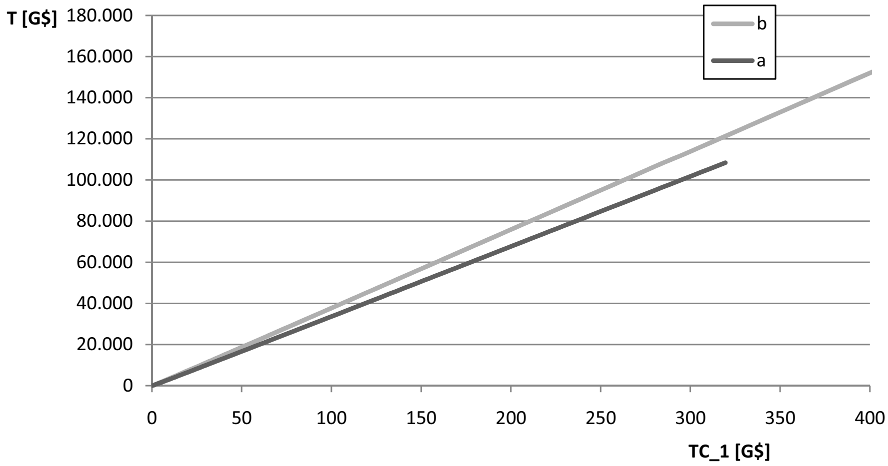

Figure 7: Comparison of total costs for annex I countries TC_1 with total net transfers to non-annex I countries T with the transfer maximizing AL $\tau*$ for different assumptions about annex I abatement costs (a: base case, b: higher costs).

on the future prospects of one option for adaptation financing that is already in place under the Kyoto Protocol: the adaptation levy (AL) on the clean development mechanism (CDM). Is it wise to upscale this mechanism as part of a Green Climate Fund?

The paper determines the volume of additional financial transfers to developing countries that are possible with this institutional arrangement in the partial equilibrium – depending on the level of the AL. The volume is compared to the transfer sums recognized in the Cancún Agreement. Since the AL is factually a tax on emission trading, I numerically estimate its social costs. Finally, it is explored whether the negative effects of CDM and AL on the incentives for climate protection are substantial.

The numerical model is based on marginal abatement cost estimates of 13 world regions for the year 2020. As emission reduction target, I first consider the pledges submitted after the Copenhagen negotiations, and second the full range from 5% to 50% emissions reductions. The basic effects of the AL are underpinned by an analytical model.

I find that the AL can generate some funds for adaptation. Yet, for the current 2% AL the revenues are far from being appropriate (when emission reductions follow the Copenhagen pledges). Its future revenues are significantly lower than the current revenues of the Adaptation Fund (about $87 million per year, Adaptation Fund Board, 2010) or than the expectations for 2010-2012 (World Bank, 2006; UNFCCC, 2007). By rising the AL, the revenues can be substantially increased up to $1.15 billion, but this comes at the expense of transfers from the CDM. Together, both mechanisms cannot generate more than $157 million additional funds. For more ambitious climate protection the same picture prevails: additional adaptation finance reduces transfers from the CDM. With a 30% emission reduction target for 2020 (compared to 1990) the transfers from CDM and AL can jointly reach $26 billion (of which $15 billion are devoted to adaptation). This reaches the range of the World Bank estimates. The AL revenues are comparable to, but smaller than the estimates of Fankhauser and Martin (2010), that do not consider the effect on total net transfers. However, *additional* funds from the AL are only slightly above $2.4 billion. All this is far below the volume of \$100 billion that is recognized as necessary for the Green Climate Fund in the Cancún Agreement. The maximal excess burden of the AL reaches nearly \$2.3 billion (for a 30% reduction target). This is less than 5% of the total abatement costs, but when compared with the amount of additional funds, it is dramatic. This ratio does not change much for other emission reduction targets. Raising one Dollar additional funds via the AL comes at total costs of about \$1.85. The tax incidence mostly lies on the supply side, i.e. it is mainly subtracted from the transfers. When climate protection is more ambitous (or expensive), increasing transfers are added to the rising total costs for annex I countries. With an AL, more consequent climate protection increases both total costs and transfers to developing countries disproportionally. Although this effect may make an international agreement less likely, it is nevertheless only small. Most of these results are qualitatively robust for varying emission reduction targets and changes in marginal abatement costs. In sum, the results of this paper suggest that the AL is not sufficient in terms of additional funds, comes at social costs that are in the same order of magnitude as the additional funds, and slightly worsens the prospects for reaching a global climate agreement with ambitious emission reduction targets.

The numerical results of this paper cannot be better than the underlying marginal abatement cost estimates. Alternative scenarios could be compared that include more than abatement in the energy sector. It might also be objected that the computed cases stick to the old distinction of annex I and non-annex I countries, although transfer payments in a global climate agreement may be interpreted as an effort to integrate high emitters as China and India with mitigation commitments into a future treaty. This has, however, seldom be stated as an objective of the AL. While it may not raise substantial additional funds, it may redistribute transfers within the group of non-annex I countries. Yet, if new contries commit to emission reductions, this would possibly require a new architecture for taxes on emission trading: the current AL discriminates the CDM against trading between annex I countries.

Nevertheless, the main results of this paper seem strongly indicative for such extensions. First, as the sensitvity analysis shows, there is no reason to assume that the total transfers become substantially larger. Second, also an extended strategic analysis would need to consider that by taxing emission trading with countries that do not have commitments for own reductions, more ambitious climate protection remains connected to additional costs for adaptation financing – being just the opposite of what is needed.

It is thus the main implication of this study that it is unwise to link mitigation and adaptation in the way as CDM and AL jointly do. It seems inapropriate to finance more adaptation when climate protection is more effective, and to finance less adaptation if more global warming is admitted. However, this effect is only slightly changed by the AL, and is mainly rooted in the CDM itself. The same problem holds for an air passenger duty or a tax on bunker fuels as a means to finance adaptation. Instead, it would be preferable to build on institutional arrangements where transfers decrease with more climate protection. This would provide additional incentives for climate protection. Auctioning of emission permits could be an option in this sense: With less mitigation more emission permits are allocated, such that auctioning may generate more funds if certificate prices do not fall too elastically. Alternatively, adaptation funding mechanisms that are not linked to mitigation could be an appropriate choice.

References

Adaptation Fund Board (2010). Financial status of the adapatation trust fund (as at 31 October 2010), AFB/EFC.3/7Rev.1. http://www.adaptation-fund.org/system/files/AFB.EFC_.3.7 Financial Status of the Adaptation Fund Trust Fund .pdf (accessed 31.1.2011).

Böhringer, C. (2002). Climate politics from Kyoto to Bonn: from little to nothing? *Energy Journal 23*(2), 51–71.

Brechet, T. and B. Lussis (2006). The contribution of the clean development mechanism to national climate policies. *Journal of Policy Modeling 28*, 981–994.

COP 16 (2010). Outcome of the work of the ad hoc working group on long-term cooperative action under the convention, Draft decision -/CP.16. UNFCCC. http://unfccc.int/files/meetings/cop_16/application/pdf/cop16_lca.pdf (accessed 31.1.11).

Criqui, P., S. Mima, and L. Viguier (1999). Marginal abatement costs of CO2 emission reductions, geographical flexibility and concrete ceilings: an assessment using the POLES model. *Energy Policy 27*, 585–601.

Dekker, T., R. B. Dellink, and M. den Elzen (2009). Sharing the burden of adaptation financing. In *Proceedings of 17th Annual Conference of the European Association of Environmental and Resource Economists, Amsterdam.*

den Elzen, M. and S. Both (2002). Modelling emission trading and abatement costs in FAIR 1.1, case study: the Kyoto Protocol under the Bonn-Marrakesh Agreement. Technical Report RIVM report 728001021/2002, National Institute of Public Health and the Environment (RIVM).

Dimaranan, B. V. (Ed.) (2006). *Global Trade, Assistance, and Production: The GTAP 6 Data Base*. Center for Global Trade Analysis, Purdue University.

EIA (2009). *International Energy Outlook 2009*. Energy Information Administration, U.S. Department of Energy.

EIA (2010). *International Energy Outlook 2010*. Energy Information Administration, U.S. Department of Energy.

Ellerman, A. D. and A. Decaux (1998). Analysis of post-Kyoto CO2 emissions trading using marginal abatement curves. Technical report, MIT Global Change Joint Program.

Fankhauser, S. and N. Martin (2010). The economics of the CDM levy: Revenue potential, tax incidence and distortionary effects. *Energy Policy 38*(1), 357–363.

Hepburn, C. and B. Müller (2010). International air travel and greenhouse gas emissions: A proposal for an adaptation levy. *The World Economy*. doi: 10.1111/j.1467-9701.2010.01287.x.

Jotzo, F. and A. Michaelowa (2002). Estimating the CDM market under the Marrakech Accords. *Climate Policy 2*, 179–196.

Matsuhashi, R., W. Chang, and H. Ishitani (1999). A study on systems for a clean development mechanism to reduce CO2 emissions. *Environmental Economics and Policy Studies 2*, 289–303.

Rübbelke, D. T. G. and N. Rive (2008). Effects of the CDM on poverty eradication and global climate protection. Technical Report Nota di lavoro 93.2008, Fondazione Eni Enrico Mattei.

UN (2010). *Report of the Secretary-General's High-level Advisory Group on Climate Change Financing*. www.un.org/climatechange/agf.

UNDP (2008). *Human Development Report 2007: Fighting Climate Change: Human Solidarity in a Divided World*. United Nations Development Program.

UNFCCC (2007). Investment and financial flows to adress climate change. United Nations Framework Convention for Climate Change.

Wang, S., H. L. F. de Groot, P. Nijkamp, and E. T. Verhoef (2009). Global and regional impacts of the clean development mechanism. Technical Report Discussion Paper TI 2009-045/3, Tinbergen Institute.

World Bank (2006). Clean energy and development: Towards an investment framework, DC2006-0002. Washington, DC. http://siteresources.worldbank.org/DEVCOMMINT/Documentation/20890696/DC2006-0002(E)-CleanEnergy.pdf (accessed 31.1.11).

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