The CDM and Sectoral Crediting Mechanisms: Costs, Rents, and National Commitment Incentives

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Abstract

A Sectoral Crediting Mechanism (SCM) shows promise as a means to encourage the transition from the Clean Development Mechanism to more-efficient climate policies. But as an open ended program, an SCM would discourage financial commitment by developing countries. Hence, a second transition, from profitable SCM programs to financial commitments, needs to be negotiated before an SCM is adopted.

Understanding national commitment incentives requires understanding the cost-coverage and rent-capture opportunities under SCM programs. These depend on design features such as credit discounting and ambitious baselines, as well as on informational asymmetries that effect the process of bargaining over baselines.

A traditional analysis indicates that credit discounting and ambitious baselines provide atmospheric benefits. More realistic assumptions, common in the literature but not previously modeled, moderate these conclusions substantially, and principle-agent considerations moderate similar findings concerning rent recapture.

Because rent transfers cannot be eliminated, SCM programs will more than cover all abatement costs in the developing countries hosting such programs. This can encourage the adoption of effective broad-based climate policies by host countries. However, it will discourage broad financial commitments to climate policy.

If adequate in scope, an SCM will soon become implausibly expensive for developed countries. Because it is not a long-run solution and discourages financial commitment, a global agreement on where it is headed should be in place before an SCM is adopted.

1. Introduction

While the Clean Development Mechanism (CDM) has grown rapidly in recent years, its hefty transaction costs limit its scope. Consequently, policy makers have sought a broader, more efficient, crediting mechanism. The policy-based sectoral crediting mechanism (SCM) is the leading contender but with other sectoral mechanisms close behind. With the CDM, individual projects in developing countries are rewarded with emission-offset credits that they sell to emitters that are under cap-and-trade regimes. Under a policy-based SCM, host governments are rewarded with offset credits for emission reductions relative to a sector-wide baseline. Although sectors are variously defined, it will suffice to imagine the electricity sector in a single developing country.

Early proposals for sector-based mechanisms (Philibert and Pershing, 2001; Samaniego and Figueres, 2002) were followed by a flood of interest in sectoral approaches ranging from binding sectoral targets with allowance trading through technology-oriented approaches that put no explicit price on carbon. But the most promising approach from the start has been a sectoral crediting mechanism (SCM) which has now been recommended by the EU Parliament (2009) — “For advanced developing countries and highly competitive economic sectors, the project based CDM should be phased out in favour of moving to a sectoral carbon-market crediting mechanism.”

In the mean time, by late 2005, a COP/MOP-1 decision had given rise to a programmatic CDM that allowed multiple related projects to be registered as a single CDM project. But the programmatic CDM is still a poor instrument for inducing broader climate policies (Figueres and Streck, 2009). This paper analyzes the ability of an SCM to play that roll and finds that it should be well suited to inducing broad and effective climate policies, but will likely impede financial commitment to those policies. As a result, a transition to financial commitments should be planned and adopted simultaneously with the adoption of an SCM.

1.1. Rent-Capture Analysis in Four Steps

Since an SCM focuses on the adoption of effective climate policies, an analysis of national incentives is required. While such incentives depend on complex relationships, this paper focuses solely on economic incentives. These depend on the costs and profitability of the sectoral mechanism to the nation as a whole. Rent—the proper term for profit in this context—plays a particularly significant, but often overlooked, role. The CDM allows full rent capture by the host country, but an SCM has the potential to recapture some of this rent with the use of "ambitious baselines." The struggle over rent is, in fact, a central economic force driving the sectoral-mechanism game and is consequently a central focus of this paper.

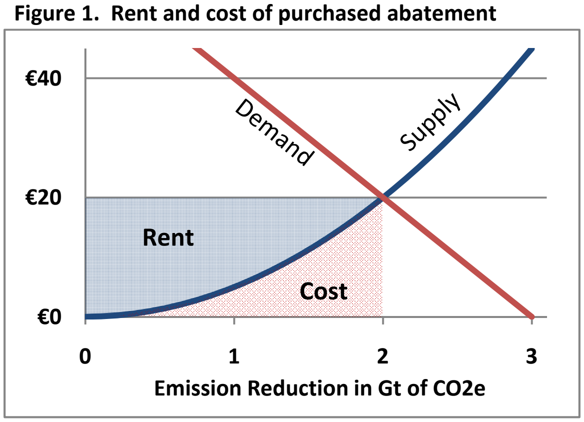
The paper proceeds in four sections (2 – 5), which each introduce one behavioral assumption and analyze its implications. Each assumption increases the realism of the analysis. The paper begins by reproducing the results of path-breaking work by Schneider (2008) concerning the possibility of "atmospheric benefits" from the discounting of offset credits, and adds a parallel analysis of ambitious baselines.

The next section (3), adopts a more sophisticated assumption suggested by Schneider (2008) but not previously modeled. This gives more importance to rent and leads to a more pessimistic result for atmospheric benefits, but to a similar result for rent recaptured with ambitious baselines.

Section 4 assumes uncertainty in the costs of supplying abatement and in the business-as-usual trajectory. This reverses the previous finding that rent transfers to developing countries can be recaptured.

Section 5 assumes that developing countries will avoid implementing policies that reduce their rents under the sectoral mechanism. In spite of this, the SCM may be quite successful in facilitating broader, more-efficient, climate policies in developing countries. However, it will inhibit financial commitments, such as the adoption of binding caps by developing countries.

Figure 1. Rent and cost of purchased abatement



The market clearing price of €20/tonne is paid for all emission reductions, no matter what their cost.

1.2. The Importance of Rent

Rents may easily exceed abatement costs. Business as usual is, by definition, the point at which there has been no additional cost expended on emission reduction. But as emission reduction is increased, the marginal cost of reduction increases steadily. In other words, the cheapest abatement measures are implemented first. In the examples presented here, the marginal-cost-of-abatement curve, which is also the supply curve for emission reductions, increases linearly. (A linear curve with rent equal to cost is also the assumption made by the U.S. Environmental Protection Agency (EPA, 2009, p. 14).) In reality marginal cost almost certainly increases more quickly (see Burniaux et al. 2009, Figure 8.3). Figure 1 shows a plausible supply curve for emission reduction (abatement) from developing countries, and a demand curve for abatement purchased through an offset mechanism. The market-clearing price is $20/tonne. This price will be paid for all purchased abatement no matter how cheaply it can be provided, as now happens in the CDM market.

The shaded area above the supply curve is referred to as rent, because it is the returns to owning a scarce resource such as land. In this case, the scarce resource is the set of opportunities for cheap abatement.

As can be seen in Figure 1, rent payments are substantial. For a linear supply curve they are half the total cost of purchasing abatements, and for a more realistic supply curve with an increasing slope, they are greater. As with any market, profit (rent in this case) is the key driver of behavior, hence this paper pays close attention to the incentives to capture and recapture rents.

2. The Convenience of a Predetermined Cap

Assuming that a cap has been predetermined and cannot be violated means that the cost of meeting the cap cannot cause problems. This convenient assumption (which may sometimes be true) is reversed in Section 3. That reversal will moderate some of this section's results significantly. But a predetermined cap is analyzed here to establish the commonly accepted basis for later comparisons. This section demonstrates that, with such a cap on Annex I countries, discounting of offset credits or ambitious baselines will reduce global emissions. It also shows that an ambitious-baseline policy does not make developing countries more ambitious, but does recapture rent and force the purchase of additional abatement by industrial countries.

Emission offset credits are "discounted" when a CDM project must reduce emissions by more than one tonne to receive one tonne of credit. As demonstrated by Schneider's (2008) ground-breaking analysis, partially reproduced here, discounting provides an "atmospheric benefit" by decreasing global emissions, and does not necessarily have any adverse impact on project developers. These results depend on the predetermined-cap assumption, which Schneider explains as follows:

> Emission reductions achieved through CDM projects in developing countries enable industrialised countries to increase their emissions above their assigned Kyoto targets. In this regard, the CDM does not reduce global GHG emissions but is, in principle, a zero sum game to the atmosphere – provided that emission reductions from CDM projects are real.

Schneider is concerned with CDM under the already agreed Kyoto protocol. For this situation, the assumption of "assigned Kyoto targets" (predetermined caps) and a zero-sum game is not unrealistic. The assumption can be made more explicit as follows.

Assumption 1: Kyoto-style targets have been accepted by industrialized countries and are sure to be met exactly (counting offset credits), regardless of any change in the offset rules.

This assumption leads straight to the conclusion that offsets will have no effect on global emissions. In other words, without discounting, the CDM provides no atmospheric benefit. If however, offset credits are discounted by giving, say, only one credit for two tonnes of abatement, then purchasing a credit will cause one extra tonne of abatement beyond the cap. But, since discounting will affect how many offset credits are purchased, the magnitude and source of the atmospheric benefit must be discovered by using Schneider's analysis, described next.

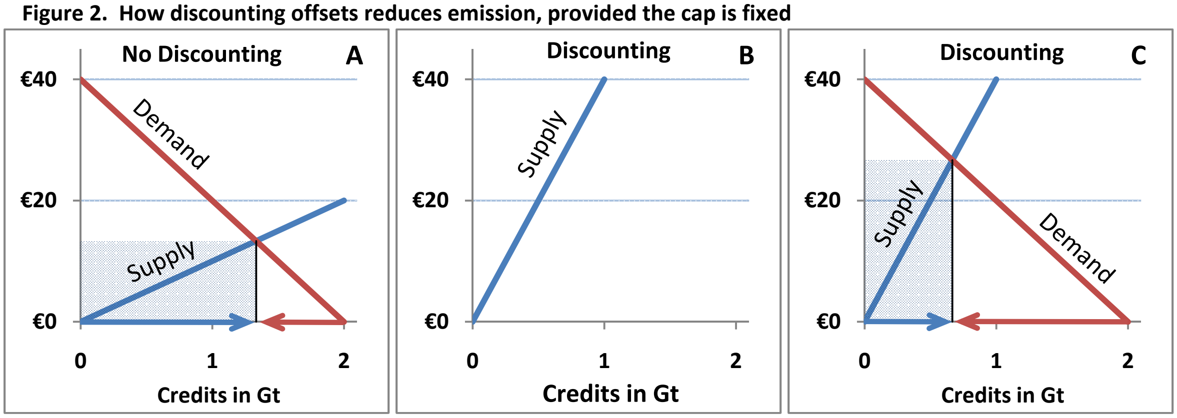
2.1. The Atmospheric Benefits of Discounting Offset Credits

The following example shows that discounting of credits reduces global emissions at a cost paid for by Annex I countries. It considers all cap-and-trade countries as a group. Similarly, it considers the countries supplying offset credits as a group. The first task is to describe the supply and demand for offsets.

To define the demand for offsets, assume that if none were available, the cap-and-trade carbon price would be €40/tonne and consequently the first credit purchased would command that price. As more credits are purchased, the value and price of credits will fall. Once 2 Gt (gigatonnes) of offset credits have been purchased, all emissions are covered by credits and allowances, and the willingness to pay for credits falls to zero. Such a demand curve is shown in Figures 2A and 2C.

The supply of offsets depends on the cost of providing emission reductions in developing countries, and this is thought to be less expensive than abatement in industrialized countries. So the supply curve is given half the slope of the demand curve. Note that the graphs in Figure 2 show the supply of, and demand for, offsets, not abatement. For purchasers, these are the same, but for suppliers subject to discounting, they will be different, which is why the supply curve differs in Figure 2B and 2C from the one in Figure 2A.

Figure 2. How discounting offsets reduces emission, provided the cap is fixed



The blue arrows pointing right show the quantity of offsets purchased. In the "No Discounting" case, this is the amount of emission reduction by developing countries. In the Discounting case, emission reductions are twice a great as the number of offsets sold. The blue shaded area represents the total amount paid for offsets. Note that its area is the same in graphs A and C, and that the emission reduction by developing countries is the same in graphs A and C.

Graph A in Figure 2, shows standard offsets with no discounting. Credit purchases occur up to the point where supply equals demand, and 1.33 Gt of offset credits are bought and sold. This is also the amount of abatement by developing countries. Industrialized countries abate to the extent shown by the red arrow pointing left. Total abatement, as determined by the cap, is 2 Gt.

Graph 2.B shows the supply of offsets when the offset discount factor is two, meaning 2 tonnes of abatement are rewarded with only a single tonne of credit. To understand the change in slope, consider the point at the end of the supply curve shown in Graph A. That indicates 2 Gt of abatement at €20/tonne. That same supply will receive only 1 Gt of credits under discounting, but to supply that much abatement, the same payment is required, so the price of offsets must be €40/tonne. Hence the new endpoint of the supply curve moves to 1 Gt at €40, as shown.

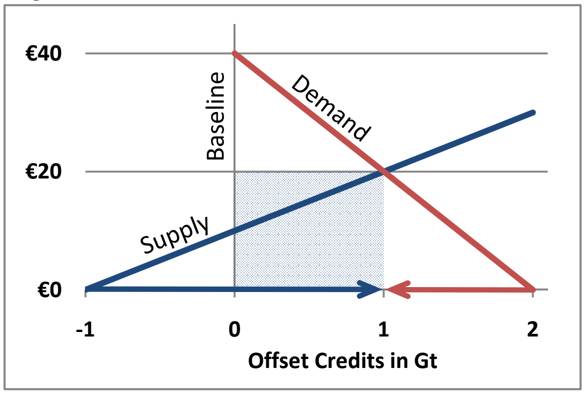
Graph 2.C shows the credit-market equilibrium with discounting. Industrialized countries buy half as many credits because their cost rises more rapidly, so they abate by 1.33 Gt (the red arrow pointing left) instead of only 0.67 Gt. Developing countries sell half as many credits at twice the price, so they are paid just as much. And they abate by double the number of credits sold, so they abate just as much. Abatement increases by 0.67 Gt because of increased abatement in industrialized countries.

The light blue shaded rectangle shows the total amount paid for offset projects or programs. Notice that it is bisected by the supply curve. As explained in Section 1, the area above the curve is the rent and the area below the curve is the abatement cost. So there is no change in rent paid.

The details of this example are all a matter of coincidence. But a few important generalities can be counted on. First, discounting, as opposed to not discounting, will reduce total emissions. Second, this extra reduction may not impose any cost on developing countries. Third, it will certainly cost industrialized countries more. Finally, this approach does not directly tamper with the distribution of rents—for the same abatement, developing countries will capture the same rent.

Since we can increase the atmospheric benefit by discounting offset credits, its seems natural to ask just how large an increase can be achieved. For this example, the maximum atmospheric benefit of 2.73 Gt (compared to 2 Gt without discounting) is reached at a discount factor of 2.73 (coincidentally).

Figure 3. The most ambitious baseline that is effective



Maximum atmospheric benefit is achieved when offset revenues (shaded area) equals the cost of supply (the area under supply curve from −1 to 1).

2.2. The Atmospheric Benefits of Ambitious Baselines

Instead of discounting offsets, as discussed above, additional atmospheric benefits may be achieved by setting a more ambitious baseline for the sectoral mechanism. Instead of giving credits relative to business as usual, credits can be given relative to a lower baseline.

In Figure 3, the base line is ambitious by 1 Gt, which effectively slides the supply curve of credits to the left by 1 Gt. Zero credits are given for the first gigatonne of abatement. Beyond 1 Gt, full credit is given. As can be seen, the industrialized countries will now provide 1 Gt of reduction and the developing countries will provide 2 Gt, for a total of 3 Gt, which is more than was achievable using offset discounting.

But why not be more ambitious and slide the supply curve further left? The answer is that developing countries would realize that they would lose money no matter what, and refuse to participate. Figure 3 shows the point at which the rent paid to developing countries has gone to zero. They will not accept negative rent. That rent is zero can be seen by noting that the shaded area above the supply curve is exactly equal to the unshaded triangular area below the supply curve and below the baseline. In other words the uncovered cost of meeting the ambitious baseline equals the profits (rent) on the credits sold.

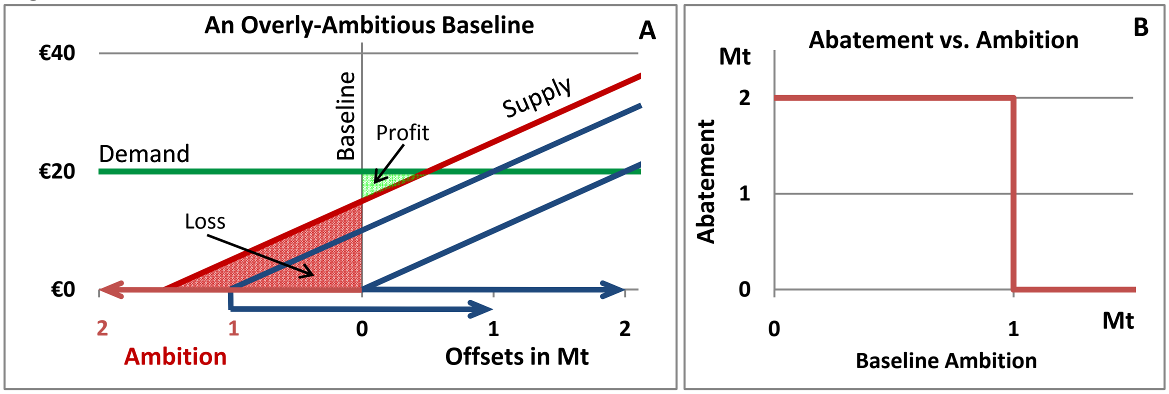
2.3. Ambitious Rent Recapture

Quite often in the literature, statements can be found indicating that a more ambitious baseline will provide a stronger incentive to reduce emissions. There may be some truth to this view, but if so, it is based on psychology and not on the economics of baselines and crediting. Unfortunately the psychological effect, to the extent it exists, will likely wear off rapidly once the design phase has passed and real money is being spent on abatement. At that point, pencils will be sharpened, and profits calculated.

The above analysis of ambitious baselines applies to the entire global market, but Figure 3, has taken a significant shortcut. In reality, different sectors will have different supply curves and different baselines. However, in aggregate, if each baseline is set as ambitiously as possible while remaining effective, the result will be as shown in Figure 3.

But to understand the incentive generated by a particular baseline, consider a sector that is a small-enough part of the global carbon market that its performance will affect the global price of carbon only negligibly. In this case, the demand for offset credits can be viewed as horizontal—any number of credits can be sold at the global price of credits. Figure 4 depicts this situation.

Figure 4. The effect of an ambitious baseline on abatement



In graph A, the blue arrows pointing right show the induced abatement. The small green triangle shows profit from the portion of abatement above the overly-ambitious (red) baseline, which is set to 1.5 Mt below BAU. The red "Loss" triangle shows the costs incurred just to achieve baseline abatement. Since loss exceeds profit the host country would choose not to perform.

Figure 4 shows three levels of ambition: none, optimal, and excessive. The optimally ambitious baseline is like the one in Figure 3, so profits just cancel the costs incurred to reach the baseline. The overly-ambitious baseline of 1.5 Mt below BAU increases the cost to reach the baseline and decreases profits above the baseline. As a consequence, such a baseline would not be accepted except by mistake. If this baseline were accepted due to a miscalculation, and the SCM contained a no-lose clause (Ward et al., 2008), the host country would simply stop its abatement policies once it learned of its error.

It is especially important to notice that the same level of abatement in this one sector is obtained with either the no-ambition baseline or the optimally ambitious baseline (see the two blue arrows pointing right). This is because abatement is determined by the condition: "marginal abatement cost equals the price of credits." The sector must abate the same amount before marginal cost rises to the offset price, no matter what the baseline. (Even with a downward sloping demand curve, the ambitious baseline cannot increase ambition, it can only raise the price of offset credits.) As graph B shows, the baseline has no effect on performance until it becomes overly ambitious and degrades performance. In no case does increased baseline ambition provide an increased economic incentive for better performance.

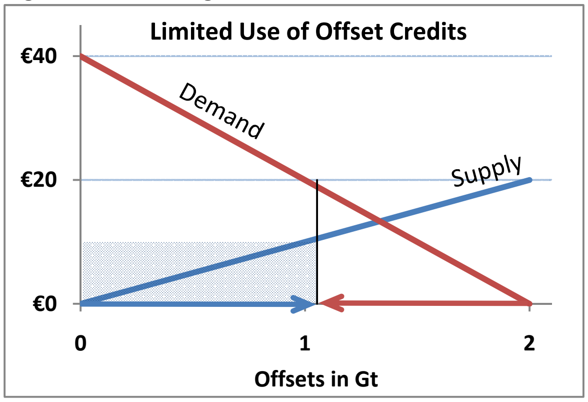
If ambitious baselines do not increase the ambition of countries that host a sectoral program, how do they cause an increase in atmospheric benefit? The ambitious baseline results in abatement which cannot be counted toward meeting the caps of Annex I countries. Industrial countries make up for this by buying more of the cheapest mix of credits and domestic abatement available. Developing countries respond as always to such purchases, unless the baseline it too ambitious and they leave the market.[1]

2.4. Limiting the Use of Offset Credits

A third technique, which seems on occasion to be considered beneficial to the climate, is placing a limit on the use of offset credits. The point is said to be to keep the price of carbon from falling too low. However, under the present assumptions of valid offsets and a strict cap, offsets are a zero-sum game and cannot effect global emissions. The technique does, however, recapture rents for Annex I countries. If the idea is that offsets represent less abatement than claimed, then that should be corrected by discounting. And if the idea is that more abatement in industrialized countries is better for the climate, that should be explained.

[1] A close look at Figures 3 and 4 shows an apparent contradiction. In Figure 3, the abatement provided by all sectors together increases due to baseline ambition. But Figure 4 demonstrates that for any particular sector, abatement remains constant when baseline ambition increases. The paradox is resolved by taking account of the effect of extra demand for abatement from the ambitious baseline. This extra demand raises the price of credits (the horizontal demand curve of Figure 4) for all sectors. When the effects of each sector on all others are combined, they explain the price increase found in Figure 3.

Figure 5. Minimizing Annex I cost with a limit on credits



The use of offset credits is limited to 1 Gt. This minimizes the total cost to industrialized countries by paying developing countries €10 when the marginal value is €20.

In the next section, rent recapture will be seen to have atmospheric benefits, so for comparison, the Assumption-1 result is examined here. Limiting the use of offset credits reduces the price of credits, and this can reduce the total cost of abatement to industrialized countries. The level of credit limitation that minimizes industrial-country costs is 1 Gt for the present example (Figure 5).

The total cost to the industrialized country is reduced from $22.2 to $20 billion in this example. This is an exercise of monopsony market power by industrialized countries. The global cost of abatement is actually increased, due to the price distortion—the marginal cost of abatement is €20/tonne in the industrial country and only €10/tonne in the developing country.

3. Costs-Constrained Caps: An Inconvenient Truth

The previous section ignored the role of cost in the determination of caps and in compliance with caps. Both methods of increasing atmospheric benefit that were demonstrated in Section 2, raise the cost to Annex I countries. But if costs can be increased, it is always possible to accomplish more. In essence, Assumption 1, claims that the cap will be the same and will be met regardless of any cost-increasing changes in the offset rules.

But when the cap is being negotiated, raising the cost of compliance will make any given cap less acceptable. Those who negotiate for a tight cap know that if they could convince emitters to spend more, they could reduce emissions more. So, while pushing emitters as far as they can on cost, they design the cap and the offset rules to buy as much abatement as possible, given the inevitable cost constraint.

Of course, costs can be hidden and some costs may be more acceptable than others, but these effects should be analyzed as deviations from the basic economic effects analyzed here. The most reasonable economic first approximation to the negotiation process is to assume there is a limit on the cost emitters will bear and that the negotiators will reach that limit. That limit is the negotiators' "budget constraint." Given that budget constraint, they need to know how to design the cap and offset rules to maximize the atmospheric benefit.

Burniaux et al. (2009) point out this same effect: "Nevertheless, because it lowers mitigation costs, sectoral crediting might still indirectly help achieve more ambitious targets by encouraging Annex I countries to adopt more stringent objectives." This implies offsets are not a zero-sum game and can confer atmospheric benefit even without discounting or ambitious baselines.

For his credit-discounting results, presented above, Schneider assumes a zero-sum game for the period after the cap has been committed to. But before industrialized countries have committed to their emission cuts, he gives a different explanation that corresponds closely to the budget-constraint view:

> The current CDM has two main objectives: assisting developing countries … and helping industrialised countries to lower their costs incurred in meeting their emission reduction

> targets. By lowering the global costs of mitigation, the CDM makes it easier for Annex I Parties to commit to deeper emission cuts. In this way, the CDM indirectly facilitates the achievement of deeper global emission reductions and thereby contributes to the ultimate objective of the Convention. (Schneider, 2008)

Here Schneider agrees that CDM offset credits are not a zero-sum game, and that they increase atmospheric benefits by making it easier for industrialized countries to "commit to deeper emission cuts."

This assumption is relevant when the cap level has not been decided or when it might be violated. Hence it currently applies to sectoral mechanisms, which will mainly come into play after the Kyoto caps expire. It also applies to CDM offset credit rules in the United States where commitment is still very much an open question. Even for Canada, which has nominally "committed" to emission cuts, real commitment is not the case, and CDM offsets are central to its discussion about whether to actually meet its Kyoto commitment. The budget-constraint assumption can be made more explicit as follows:

Assumption 2: The political process constrains the total cost to an Annex I country of the capping mechanism, but does not directly constrain the cap itself.

This assumption implies that, if a stricter cap can be found that costs no more than the one under consideration, the stricter cap can be implemented. From here on, Assumption 2 replaces Assumption 1.

3.1. Optimal Discounting of Offsets

Changing the assumption which drove the results of Section 2 requires redoing that analysis. Under the new assumption, when atmospheric benefits come at higher abatement costs, this requires that the tightness of the cap be reduced enough to hold total costs constant. This cancels part of atmospheric benefit but not all of it.

First consider the case of offset-credit discounting under the new assumption. Can discounting offset credits still increase atmospheric benefits?

Table 1. Discounting offsets to maximize atmospheric benefit at a fixed cost to industrialized countries

Discount Factor	Reduction Due to Cap	Offset Price	Offset Quantity	Industrial Emission Reduction	Sectoral Emission Reduction	Total Emission Reduction	Cost to Industrialized Country
1.0	2.00	€ 13.3	1.33	0.67	1.33	2.0000	€ 22.2
1.9	1.60	€ 20.5	0.57	1.03	1.08	2.1075	€ 22.2
2.0	1.58	€ 21.1	0.53	1.05	1.05	2.1082	€ 22.2
2.1	1.57	€ 21.6	0.49	1.08	1.03	2.1076	€ 22.2

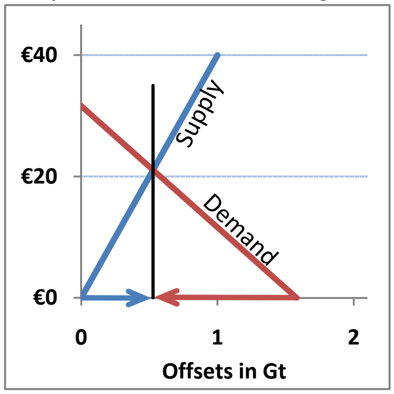
Price is per tonne CO2e. Cost is in billions of Euros, and other values are in Gt of CO2e (see stoft.com for calculations).

The first row of Table 1 shows the basic example from Figure 2A, in which there is no discounting of offsets. The third (shaded) row, shows the optimal amount of discounting, which happens to use a discount factor of two.[2] Optimality can be checked in the next-to-last column, "Total Emission Reduction," which is seen to peak in row three. The right column checks that only policies with equal cost have been considered. At the optimal discount, 2.0, the cap only calls for a reduction of 1.58, but the discount factor requires an extra reduction of 0.53 by those supplying 0.53 offset credits. This sums to a total reduction of 2.11 Gt.

Notice that discounting can increase abatement without adding cost to the industrialized countries, but only by about 5 percent. Clearly this result will vary with changes in the supply and demand functions. But, while a sizable benefit (42% in this example) appears to be possible when we ignore the political-economy implications of raising cost, far less atmospheric benefit is obtainable in reality. It should also be noted that because the supply and demand curves will remain uncertain, we will not know what value to select for the optimal discount factor.

[2] This is the same value as used in graphs B and C of Figure 2, but in that case, it was not optimal because there was no budget constraint in Section 2. Rather, 2.73 was the optimal discount factor.

Figure 6. Optimal discount with a budget constraint



3.2. Optimizing Ambitious Baselines

The ambitious-baseline approach, like credit-discounting, increases costs to industrial countries. However, the ambitious-baseline approach transfers rent from developing to industrial countries, which helps considerably. The net result is that the ambitious-baseline approach can provide considerably more atmospheric benefit than can the discounting approach.

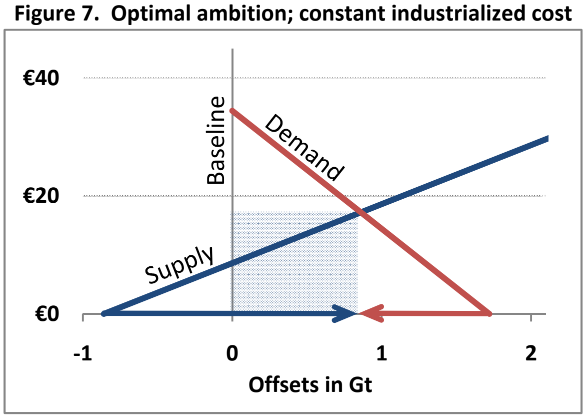
Table 2: Ambitious baseline selection used to maximize atmospheric benefit under a budget constraint

Baseline Shift	Reduction Due to Cap	Offset Price	Offset Quantity	Industrial Emission Reduction	Sectoral Emission Reduction	Total Emission Reduction	Sectoral Rent	Cost of Cap to Industrialized
0.00	2.00	$ 13.3	1.33	0.67	1.33	2.00	$8.89	$ 22.2
0.50	1.82	$ 15.5	1.05	0.77	1.55	2.32	$4.24	$ 22.2
0.86	1.72	$ 17.2	0.86	0.86	1.72	2.58	$0.00	$ 22.2
1.00	1.69	$ 17.9	0.79	0.90	1.79	2.69	−$1.86	$ 22.2

The first column shows the policy variable, and the last column shows that the budget constraint has been respected. The next-to-last column shows that atmospheric benefits are maximized by a baseline shift of 0.86 Gt. Price is per tonne CO_2e, Cost and Rent is in billions of Euros, and other values are in Gt of CO_2e (see stoft.com for calculations).

Table 2 shows that, as before, the ambition of the shift is limited by the sectoral rent hitting zero. This time, because the cap is weakened to hold costs to industrialized countries constant, the zero-rent condition occurs at a baseline shift of 0.86 Gt instead of 1.00 Gt. This still allows for an increase in atmospheric benefits, from 2.00 Gt to 2.58 Gt, instead of to 3.00 Gt as in the Section-2 analysis. Notice that in Figure 7 both developing and industrialized-country abatement have decreased relative to Figure 3.

Figure 7. Optimal ambition; constant industrialized cost



Maximum atmospheric benefit is indicated by offset revenues (shaded area) equal to the cost of supply (area under supply curve from −0.86 to 0.86).

3.3. Optimizing Credit Use Limitations

Section 2.4 demonstrated that a limitation on credit use could reduce total cost for Annex I countries. This allows a tighter cap under the budget constraint, which benefits the atmosphere. The optimal credit limit under Assumption 2 is 1.054 Gt, and this reduces emission by 2.11 instead of 2 Gt. So credit limitations, like discounting, are not likely to be particularly effective at increasing atmospheric benefits.

4. Uncertainty, Rent, and the Principle-Agent Problem

In essence, the problem of implementing an effective sectoral program is a “principal-agent problem.” The U.N.’s SCM Authority being the “principal” and the host country being the “agent.” The principle pays the agent for some service, in this case, emission reductions. The root of such problems is that the performance and costs of the agent are inherently difficult to observe. This creates uncertainty, particularly for the principle. In the present case, it is difficult to tell how much it will cost to achieve the abatement and how much abatement has been achieved.

These uncertainties are caused by “informational problems,” and if the agent has better information than the principle, the agent is able to earn an “information rent” on top of the normal payment for the cost of service. Under the CDM, emitters earn a scarcity rent because the supply of inexpensive abatement is limited. But, under SCM, with perfect information, as assumed in Section 3, that scarcity rent can be recaptured through individually-tailored ambitious baselines. This section shows that, due to information asymmetry, agents (host countries) will command information rents, and so, ambitious baselines must leave significant rents on the table for host countries to collect.

Uncertainties concerning the BAU trajectory and abatement costs will affect the parties negotiating the sectoral program—the SCM Authority and the host country. A separate critical factor is the relative uncertainty of the negotiating parties. Assumption 3 captures this relative uncertainty.

Assumption 3: The supply curve for sectoral offset credits will be uncertain, but better known by the host country than the SCM Authority.

This assumption is additional to Assumption 2, although this section does not make use of Assumption 2.

4.1. Uncertainty and Asymmetric Information

Regulatory mechanism design addresses principal-agent problems in the regulatory arena. The CDM Executive Board or the “SCM Authority” is in essence a regulator, that allows the host country some profit if it performs as desired. The Authority tries to minimize that profit and, as Baron and Ellis (2006) explain, “Potential ‘host’ countries for the SCM have the incentive to set as high a baseline as possible.” In other words, host countries seek to maximize their profit.

This conflict takes place under uncertainty. Neither party knows the exact relationship between the baseline and profit. Assumption 3 states that the host country knows more about this relationship. If the Authority sets too low a baseline (because of poor information), the host country will refuse to participate. Hence the Authority must leave some leeway (some rent on the table) in case it has misestimated. But even if the Authority sets a reasonable baseline, the host country will likely claim the baseline is too low, and that profits would be negative and that it will not participate. Since the Authority cannot be absolutely sure this is a bluff, it will likely raise the baseline considerably above the bare minimum.

This is only a problem because the SCM Authority does not know the BAU emission trajectory and the cost of abatement. Since it does not, it has an informational problem, and can be bluffed by the agent. Aside from its more esoteric findings, the theory of regulatory-mechanism design provides one fundamental insight.

Mechanism-design insight: The more relevant information that an agent has that the principal does not have, the more rent the agent can extract.

In this case, the more a host country knows about its BAU trajectory and its abatement costs compared to what the SCM Authority knows, the more rent the host country will be able to capture.

This is not too surprising. Consider a typical negotiation, for example, buying a car. Having more information about the dealer's cost is an advantage. That is why car dealers do not disclose their costs. Suppose the host country knew BAU exactly, but the SCM Authority had little idea what it was. Then the Authority will end up relying heavily on the host country's assertions, to the benefit of the host country.

If there were no uncertainty regarding BAU and abatement costs, the host country could not have an informational advantage, but it is relative uncertainty that drives the result, not uncertainty per se. If the agents have better information, as is almost always the case, then no matter how aggressive the policy of the SCM Authority, the host countries will win the contest and collect positive rents. In other words the strategy of pushing the ambition of the baseline to the zero-rent point as suggested in Section 3 is not achievable.

4.2. Why Host Countries Have Better Information

Why exactly would host countries have better information than the SCM Authority about the costs of abatement? First, the Authority may not know how much the host country values a reduction in coal use as a way to reduce other environmental damage. Second, the Authority may not know how much the host country values a reduction in oil use for independence from the world oil market. Third, the Authority may not know the host country's intentions to scale up its manufacturing abilities for some renewable technologies it wishes to export. All of these reduce the effective cost of emissions abatement to the host country. There are, of course, many domestic technical costs as well, such as the quality and quantity of local gas and coal deposits, and these will be better known to the host country.

Once uncertainty is introduced into the analysis, the theory of regulatory mechanism design explains why rents cannot be fully recaptured from host countries. Given the high level of uncertainty in the design of individual sectoral-crediting programs, and the informational advantages of the host country, it must be expected that SCMs will allow host countries to capture significant amounts of rent.

5. Protecting Rents by Avoiding Commitment

The central questions of this study can now be addressed. Will a policy-based SCM facilitate the achievement of two key goals for Non-Annex-I countries? Would it encourage them to:

1. Adopt broad and effective climate policies, and
2. Bear some of the net cost of these policies?[3]

The first of these goals applies to all but the poorest countries, and the second applies to the more advanced developing countries. The second goal implies an end to rent capture as well as a contribution to the costs of climate policy.

Both of these goals are often lumped together under the term "commitment," but if a broad and effective climate policy is adopted only because it is profitable, that should not qualify as commitment. Hence the term commitment will be reserved for the second goal, *financial commitment*.

The question of commitment is closely related to the criticism of the CDM's two perverse incentives, which discourage the adoption of climate-friendly policies. One of these has been remedied by the CDM Executive Board, but the other, an incentive to avoid binding caps, cannot be. These incentives are examined first. Then a close look at a policy-based SCM shows that its implementation would naturally include the Executive Board's partial solution.

Consequently SCM should be quite successful at achieving the first goal—broad and effective policies. But because it pays rent, it would actually hinder the achievement of financial commitment. To avoid this problem it will be necessary to negotiate a transition from SCM to financial commitment before adopting a policy-based SCM.

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[3] As Baron et al. (2009) explain, the introduction of market-oriented sectoral mechanisms is "about the challenge to create acceptance in developing countries to move beyond the CDM-based offsetting approach and towards own mitigation contributions, until economy-wide objectives can be adopted."

Again it is useful to make an explicit assumption regarding behavior. It links the financial commitments of the developing countries to the availability of offset rents.

Assumption 4: The future availability of rent payments on top of full cost coverage discourages developing countries from taking actions that would jeopardize the availability of rents.

5.1. CDM's Perverse Incentives: Half Fixed

The CDM has discouraged commitment to climate policy. In fact, Wara and Victor (2008) suggest that:

> [T]he actual experience under the CDM has had perverse effects in developing countries—rather than draw them into substantial limits on emissions it has, by contrast, rewarded them for avoiding exactly those commitments.

Indeed, Hinostroza et al. (2007) report specific examples from Latin America of climate-friendly policies being derailed in order to "avoid the risk of losing additionality" of CDM projects. However, Hinostroza et al., among others, also claim this problem has been solved. Apparently, in 2004 there was a shift in view regarding the proper linkage between climate-friendly policies and the determination of CDM baselines (Figueres and Streck, 2009). Initially it was assumed that introduction of a climate-friendly policy should lower the baseline for projects covered by that policy, making them eligible for fewer credits or perhaps no longer eligible for accreditation under the CDM.

But later, the CDM Executive Board (2004, 2005) ruled that such policies, if implemented after 2001, need not be taken into account when determining a project's baseline.[4] This was intended to eliminate the CDM's "perverse incentive" to avoid policy commitment. But, did it?

Burniaux et al. (2009) help to clarify the seeming contradiction between Wara and Victor's observation and the claims that the CDM Executive Board has succeeded. "Crediting mechanisms such as the CDM may also reduce the incentives for non-Annex I countries to take on binding targets in the future. This is because most developing countries – not least China – would obtain a larger income gain under a scaled-up CDM than under most rules for allocating emission rights in a world ETS [cap-and-trade system]."

Wara and Victor, like Burniaux et al., seem concerned with developing countries taking on binding targets. The reason to avoid such large-scale commitments is different from the reason to avoid targeted climate-friendly policies of the type discussed by Hinostroza et al.

The Executive Board has eliminated the perverse incentive caused by concern over losing offset credits for specific types of projects. But it has not, and cannot, eliminate the perverse incentive caused by concern over losing the CDM itself. And large-scale climate commitments, such as binding national targets, could jeopardize the CDM itself. In this way, the CDM is still working against the essential goal of the Kyoto Protocol—a global commitment to solve the climate problem. Does a policy-based SCM do better?

5.2. A Policy-Based SCM: A Little Better from the Start

The CDM's perverse incentive that was fixed by the Executive Board will not arise with a policy-based SCM. Under such an SCM, there can be no question of changing the BAU estimate because a good policy is implemented—that would punish the very behavior a policy-based SCM is designed to encourage. Schneider and Cames (2009) suggest avoiding such a self-defeating SCM implementation by setting the day that the Copenhagen summit approves an SCM as the cutoff date for the consideration of policies used to estimate the BAU trajectory for sectoral programs. Let us assume such a rule is adopted as part of the policy-based SCM.

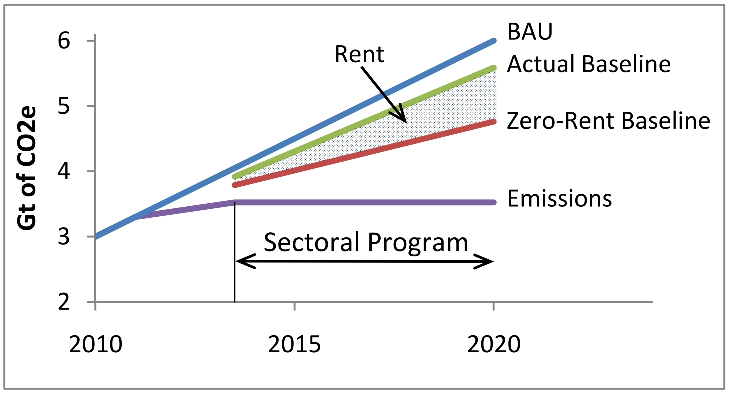
Schneider and Cames also suggests choosing a more ambitious level than BAU for the crediting baseline, and this seems to be the standard view. So assume this is the rule. Given these prescriptions for a policy-based SCM, consider the process of baseline determination.

[4] As Hampton et al. (2008) point out, there is a cost to this fix in that it will "eventually end up benefiting business-as-usual projects."

The process requires four steps. First, estimate a BAU trajectory. Since the SCM adoption date is assumed to be December 2009, the BAU, as shown in Figure 8, is not affected by subsequent policies, such as the emission-reduction policy shown as starting in 2011.

Second, estimate the optimal emission path. Since a uniform global carbon price is efficient, the optimal path will include all emission reductions that are economical up to the price of offset credits. Such a path may well imply the use of climate-friendly policies (such as the 2011 policy) that were enacted after the adoption of SCM. But this does not discourage such policies because they would be included in the optimal emission level whether or not they have already been adopted.

Figure 8. An SCM program



The business-as-usual trajectory (BAU) is based on policies in place in December 2009, the adoption date of the sectoral crediting mechanism.

Third, determine the zero-rent baseline. As explained in Section 2, this is the point at which rent is zero because the cost of reaching the baseline is as great as the profits made by surpassing the baseline. Also, as explained in Section 4, it cannot be accurately determined, so Figure 8 shows its true position, but this is not known to the negotiating parties. As with the linear supply curves used in the paper's examples, the zero-rent baseline is placed half way between BAU and actual emissions.

The fourth and final step is to determination, most likely through bargaining, the actual baseline. As explained in Section 4, the uncertainty in the zero-rent baseline and informational asymmetries both play key roles in determining the actual baseline. Except for the occasional mistake, host countries will only accept an SCM baseline that is above the zero-rent line. And as assumed, the SCM Authority will only accept a baseline that is "ambitious," in other words, below the BAU trajectory. Figure 8 shows the actual baseline as between these two limits, but closer to BAU, indicating an expectation that bargaining will be difficult, given the high degree of uncertainty and risk. It could, in fact, end up very close to BAU.

Note the meaning of the zero-rent baseline. As an emissions path, it has no special meaning. It is simply used to indicate a rule for crediting the host country. (The same is true for the actual baseline.) If everything goes as planned, the zero-rent baseline would confer just enough credits to cover abatement costs. Of course this holds only if credits are worth the expected amount. Clearly, if the actual baseline were set at the zero-rent baseline, there would be a serious risk that the host country would lose money. Risk is another reason the actual baseline will be set higher than the zero-rent baseline. Since it is set higher, the host country will, on average, earn considerable rent on an SCM program, but in any particular case, that rent is far from guaranteed.

Note the effect of the SCM program on the emissions policy started in 2011. Already on the day the sectoral program starts, it should cover the costs of this policy and provide some rent—the difference between the two base lines. This shows that a policy-based SCM will not discourage policies that start before such an SCM program.

5.3. Entity-Based SCMs?

Entity-based SCMs are an alternative to policy-based SCMs and award credits to private entities instead of to the government. And while a policy-based sectoral approach is widely favored (Sawa, 2008), a contrary view holds that, to be effective, sectoral market mechanisms should ideally relay the price signal directly to private entities. In other words, credits should be distributed by the SCM Authority directly to, for example, renewable generators. However, economics demonstrates that the correct price signal is a uniform price on carbon. Implementing an equivalent to the carbon pricing signal by having the SCM Authority hand out credits to private entities, would be cumbersome if it were not impossible. A policy-based SCM can induce carbon pricing, but an entity-based SCM cannot mimic it.

Besides being better economics, only a policy-based SCM can achieve the first goal listed above, adoption of broad climate policies by the host country. This is because it makes no sense for a country to implement a proper climate-friendly incentive for, say, the electricity sector if the SCM Authority is already providing a direct incentive to emitting entities. This would create a double reward and a reason for the SCM Authority to reduce its incentive. An entity-based SCM requires the SCM Authority to, in effect, usurp the policy role of the local government.

The beauty of a policy-based SCM is that, by giving the credits to host governments, it encourages governments to learn to implement the best possible climate policy. This is because the most cost-effective climate policy will maximize the rent captured under the SCM. Policy-based SCMs will also provide a strong incentive for building the local capacity needed to implement good policy.

5.4. Discouraging Financial Commitment

A full-scale SCM approach seems unlikely to endure for long. As Figure 8 shows, an SCM does not induce financial commitment. The SCM will become progressively more expensive as the Annex I countries pay for ever-larger emission reductions plus ever-increasing rent. In fact Burniaux et al. (2009) studied this problem and concluded:

> Given the fast projected BAU emission growth in most developing countries, meeting ambitious world targets through sectoral crediting alone would require *negative emission level objectives* for developed countries by 2030-2040 … This would impose large economic costs on developed countries, while developing countries would gain from such a world mitigation framework. Insofar as such arrangement is implausible, sectoral crediting, if adopted, will have to *evolve into binding caps*, at least in key developing country emitters [emphasis added].

Note the "negative emission level" by 2030–2040. A negative level would be achieved by buying large quantities of offset credits. So "negative emissions" are possible. But it is difficult to imagine public acceptance of such a policy. Burniaux et al. suggest that instead, SCM must evolve into binding caps. However Hart et al. (2008) suggest that even the acceptance of SCM will be resisted precisely because the developing countries already foresee this evolution into binding caps:

> Sectoral targets are likely to face strong opposition by developing countries who fear that even limited, no-lose targets, will eventually lead to binding caps in the future – an outcome the vast majority are strenuously seeking to avoid.

So Burniaux et al. conclude that SCM "will have to evolve into binding caps," and Hart et al. conclude that this is exactly what developing countries "are strenuously seeking to avoid." This conflict is not surprising. This is the same impasse that has blocked progress since before the Kyoto Protocol was signed. And since a sectoral crediting mechanism does nothing to address it, the impasse remains. In fact an SCM will make the conflict worse. Once developing countries are being paid for doing their share of emissions reduction and being paid a profit on top of that, they have all the more reason to resist binding caps. This is the meaning of Assumption 4, and this is the uncorrected perverse incentive of the CDM. It carries over with full force to an SCM.

The first step toward reaching an agreement on financial commitment is to admit that binding caps are not the only, or necessarily the best, form of commitment. Most of the economics profession, the inventors of cap and trade, Nicholas Stern (2007), and two of the most respected U.S. economists to work on the climate-change problem, William Nordhaus (2008) and Joseph Stiglitz (2007) all prefer a carbon tax. While most economists consider caps and taxes roughly interchangeable, Nordhaus and Stiglitz both strongly recommend a carbon tax instead of a cap. After reviewing the objections of developing countries to a cap, Stiglitz states that "Under the common tax proposal, all of these issues are avoided."

A policy-based SCM could require a carbon tax as a non-exclusive sectoral policy. This would advance the cause of global carbon pricing while avoiding the main objections of developing countries to a binding cap. It would also give them the assurance that if the SCM were terminated unexpectedly, they would not be stuck with a messy termination of their domestic cap-and-trade system. The carbon-tax approach would facilitate the achievement of the first goal, adoption of broad and effective climate policies, and it would help a little with the second, financial commitment.

But to avoid the SCM's incentive to reject broad and effective financial commitments, negotiation over commitment must take place before an SCM is adopted. An agreement specifying how developing countries will transition to financial commitments should take account of national emission levels and not treat all non-Annex-I countries the same. Low-emission countries would be allowed to benefit more or longer from the SCM. This in itself will provide a strong incentive for reducing emissions.

Obviously such a transition agreement will not be easy to negotiate. But if it is not negotiated now, and an open-ended crediting mechanism is adopted, it will only be more difficult to negotiate in the future. Given the finding of Burniaux et al. that any effective SCM will soon become implausibly expensive, there is no sensible alternative to early negotiation.

The problem of negotiating the transition to broader financial commitments is inherent in the nature of the climate dilemma. Its root cause is a global externality, so an effective climate organization is exactly like a cartel. Members must act against their own self interest, narrowly defined, and this is inherently difficult to negotiate and enforce. No cleverly designed mechanism can avoid this difficulty, but unnecessary barriers can be removed. The first of those is the demand for binding caps. The second could become a lucrative SCM with no exit plan. We should not let that happen. Instead, a policy-based SCM can be used as a reward for making the transition, provided that transition is scheduled in advance.

6. Conclusions

This paper analyzes the incentives and outcomes generated by a policy-based sectoral crediting mechanism and reaches the following conclusions:

1. Ambitious baselines can recapture some rent for Annex I countries and thereby allow an increase in atmospheric benefits without an increase in cost to Annex I countries.
2. When bargaining over ambitious baselines, the informational advantages of host countries will leave them with a significant level of rents.
3. Because of rent capturing, a policy-based sectoral crediting mechanism (SCM) can strongly encourage broad-based, cost-effective climate policies in developing countries.
4. Also because of profitable rents, an existing SCM will discourage host countries from taking on broad climate-friendly financial commitments, because these could undermine the need for an SCM.
5. A successful SCM will impose large economic costs on developed countries, leading to its curtailment.
6. To succeed, a policy-based SCM needs to be preceded by an agreement with developing countries on how the transition to financial commitments by developing countries will proceed.

References

Baron, R., Buchner, B. and Ellis, J. (2009): "Sectoral Approaches and the Carbon Market." OECD/IEA information paper. COM/ENV/EPOC/IEA/SLT(2009)3.

Baron, R. and Ellis, J. (2006): "Sectoral Crediting Mechanisms for Greenhouse Gas Mitigation: Institutional and Operational Issues." OECD/IEA information paper. COM/ENV/EPOC/IEA/SLT(2006)4.

Burniaux, J. et al. (2009): "The Economics of Climate Change Mitigation: How to Build the Necessary Global Action in a Cost-Effective Manner."OECD Economics Department Working Papers, No. 701, OECD publishing, © OECD. doi:10.1787/224074334782

CDM EB (2005): "Additional Clarifications Regarding the Treatment of National/Sectoral Policies and Circumstances." CDM Executive Board, Annex 3 of the 22th meeting report.

CDM EB (2004): "Clarifications on the treatment of national and/or sectoral policies and regulations in determining a baseline scenario." CDM Executive Board, Annex 3 of the 16th meeting report.

EPA, (2009): *EPA Analysis of the American Clean Energy and Security Act of 2009 H.R. 2454 in the 111th Congress.* U.S. Environmental Protection Agency, Office of Atmospheric Programs, 6/23/09.

EU Parliament, (2009): *Towards a comprehensive climate change agreement in Copenhagen.* Commission of The European Communities. Brussels, 28.1.2009. COM(2009) 39 final.

Figueres, C. and Streck, C. (2009): "Enhanced Financial Mechanisms for Post 2012 Mitigation." World Bank Policy Working Paper, WPS5008, July. A background paper to the 2010 World Development Report.

Hall, D., M. Levi, W. Pizer and T. Ueno (2008): "Policies for Developing Country Engagement." Harvard Project on International Climate Agreements Discussion Paper No. 2008-15, Cambridge, Massachusetts.

Hampton, K., Gray, S., Barata, P., (2008): "Sectoral CDM." Center for Clean Air Policy, August 8.

Hinostroza, M., Cheng, C., Zhu, X., Fenhann, J., Figueres, C., and Avendaňo, F., (2007): "Potentials and Barriers for end-use energy efficiency under programme CDM." CD4CDM Working Paper Series, Working Paper No. 3, September.

Nordhaus, W., (2008): *A Question of Balance: Weighing the Options on Global Warming Policies.* ISBN 0300137486, 9780300137484, Yale University Press. books.google.com/ books?id=qgeoZDu5SbQC

Samaniego, J. and Figueres, C. (2002): "Evolving to a Sector-Based Clean Development Mechanism." Chapter 4 of the book Building on the Kyoto Protocol: Options for Protecting the Climate. World Resources Institute, Washington DC, (2002).

Sawa, A. (2008): "A Sectoral Approach as an Option for a Post-Kyoto Framework?" The Harvard Project on International Climate Agreements, Discussion Paper 08-23, December.

Schneider, L. and Cames, M. (2009): "A Framework for a Sectoral Crediting Mechanism in a post-2012 climate regime." Report for the Global Wind Energy Council. Öko-Institut, May.

Schneider, L. (2008): "A Clean Development Mechanism (CDM) with atmospheric benefits for a post-2012 climate regime." Öko-Institut e.V. Discussion Paper, 25 September.

Stern, N. (2007), *The Economics of Climate Change: The Stern Review*. Cambridge University Press, Cambridge.

Stiglitz, Joseph E. 2007. "Chapter 6: Saving the Planet," in *Making Globalization Work*, W.W. Norton & Co. September 17.

Philibert, C., Pershing, J., (2001): "Considering the options: climate targets for all countries." Climate Policy, Vol. 1, No. 2. (2001), pp. 211-227.

Wara, M. and Victor, D. (2008): "A Realistic Policy on International Carbon Offsets." Program on Energy and Sustainable Development, Stanford University. Working paper #74, April.

Ward M., C. Streck, H. Winkler, M. Jung, M. Hagemann, N. Höhne, R. O˝Sullivan, (2008): "The Role of Sector No-Lose Targets in Scaling Up Finance for Climate Change Mitigation Activities in Developing Countries." Climate Focus, Ecofys, GTripleC report to DEFRA, UK. May.