Assessment of Net Mitigation in the Context of International Greenhouse Gas Emissions Control Mechanisms

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Abstract

This paper discusses the scope for market mechanisms, already established for greenhouse gas mitigation in Annex I countries that ratified the Kyoto Protocol, for implementing “net mitigation,” defined here as mitigation beyond Annex I countries’ formal mitigation requirements under the Kyoto Protocol. Such market mechanisms could be useful for establishing and extending greenhouse gas mitigation targets also under the Paris Agreement from December 2015. Net mitigation is considered in two possible forms: as a “net atmospheric benefit,” or as an “own contribution” by offset host countries. A main conclusion is that a “net atmospheric benefit” is possible at least in the short run, best implemented via stricter baselines against which offsets are credited; but it can also take the form of offset discounting whereby offset buyers are credited fewer credits. The latter, although generally inefficient, can be a second-best response to certain imperfections in the offset market, which are discussed in the paper. There is less merit for claiming that “own contributions” can lead to additional mitigation under existing mechanisms.
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1. Introduction

In December 2015 the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Paris Agreement, which defines a new international climate policy and cooperation architecture, for limiting global greenhouse gas (GHG) emissions, to be fully implemented from 2020 on.

International market mechanisms for control of GHG emissions form an integral part of the Agreement. Through article 6 the Paris agreement establishes a new international market mechanism. It has similarities and differences relative to the existing mechanisms under the Kyoto Protocol, the Clean Development Mechanism (CDM) and Joint Implementation (JI).

Like CDM and JI the new mechanism is meant to be a baseline and crediting mechanism to generate GHG emissions credits than can be used as a compliance instrument for pledged targets of Parties to the Agreement (so called Nationally Determined Contributions, NDCs).

Different from CDM and JI, and in line with the overall approach of the Paris Agreement, the new mechanism no longer differentiates between developed and developing countries. Each Party to the Agreement can host mitigation activities under the new mechanism and can be a seller or a buyer of carbon credits.

Also the scope of the mechanism is not explicitly limited to a project-by-project approach but might include aggregated crediting approaches, e.g., on a sectoral level and crediting of policy activities pursuant to modalities and procedures still to be defined.

Finally, the Paris Agreement requires that the new mechanism (i) contributes to the reduction of emission levels in the host Party, and (ii) delivers an “overall mitigation in global emissions”.

The first requirement reflects that, as different from the Kyoto Protocol, all Parties under the Paris Agreement have mitigation ambitions (of different kind and rigor) and that therefore all Parties need to consider this context when engaging in transfer of emission reductions to other countries.

The second requirement reflects that despite substantial progress achieved in Paris and during 2015 - 188 countries out of 195 Parties to the UNFCCC submitted NDCs - the sum of the NDCs do not (yet) add up to a mitigation trajectory consistent with the objective of “holding the increase in the global average temperature well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit

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temperature increase to 1.5 degrees Celsius”. More mitigation than what was pledged through the political process so far is needed.

Can a new market mechanism help to deliver this additional mitigation, and if so how?

The last years’ negotiations on reforming CDM and JI - through potential revisions of the respective modalities and procedures/guidelines – has included a discussion of the concept of “net mitigation” that could form the basis for one possible set of mechanisms, among others, to implement the requirements (i) and (iii) above.

This paper offers a deeper dive into this “net mitigation” concept, and for that reason looks once more at the existing climate policy architecture of the Kyoto Protocol and its mechanisms. The findings might be of interest for the ongoing discussion on reforming CDM and JI but also – and probably more importantly – for the new, post-Paris, discussion on how to shape the established new mechanism and build future international markets for control of global GHG emissions.

The paper uses verbal arguments, backed up mainly by results from two analytically-oriented papers (Strand (2013), and Rosendahl and Strand (2015)), to discuss, explain, and expand on the “own contribution” and “net atmospheric benefit” concepts presented above, with focus on global efficiency properties for the latter.

The comparison of offset discounting and baseline tightening is done with the aid of a simplified analytical model, presented in the annex of the paper, and developed for this particular purpose. Constrained efficiency of “net atmospheric benefits” for buyer countries under certain market imperfections is derived from the cited analytical work (Strand (2013) and Rosendahl and Strand (2015)), building on the equivalence of offset price and quantity discounting in the reference case (with an optimal allocation). No full modelling is however offered in the current paper.

The key findings of the paper can be grouped by the two main aims of the paper. First, I find that it is possible to achieve “net atmospheric benefits” in the short run (for given and exogenous “ambition”) through measures such as offset discounting (whereby offset buyers are credited fewer mitigation units than those delivered by hosts), and baseline tightening (implying stricter “baselines” against which offsets are credited). Of these two measures, baseline tightening is more efficient, but often more politically difficult to implement and thus for practical reasons often less applicable.

In the long run (with endogenous ambition) it is doubtful whether “net atmospheric benefits” can be achieved as the effect would most likely be counted in by policy makers setting the targets.

Achieving increasing global mitigation through “net atmospheric benefits”, using offset discounting as a mechanism, is inefficient in cases with no other major distortions (as compared to increasing ambition through the political process). The reason is that it works in a very similar way as a tax on international GHG emissions market transactions, distorting the offset market and resulting in an inefficiently low offset supply (as compared to the global least-cost solution).

The “net atmospheric benefits” approach can still be constrained efficient for offset buyers (optimal for their economies and for given ambition level) given that certain market imperfections prevail. Two such
distortions are pointed out. The first follows from a system with a high degree of free quota allocations given to participating entities in offset markets, on the buyer side, based on updating of previous emissions levels. The second is incompleteness or imperfections of offset markets, with frictions associated with finding the lowest-cost offset hosts. From the point of view of offset buyer countries, offset discounting is in addition optimal for these countries when they coordinate their actions in the offset markets in a monopsonistic fashion.

Secondly, concerning net mitigation in terms of an “own contribution”, there is a need to ensure that GHG emissions reductions accounted against targets of host countries cannot be sold as offsets; otherwise it would lead to double counting of emissions for offset host countries. There is, in general, no economic rationale for breaking down host country targets to the levels of individual mitigation activities. Doing so will reduce the overall efficiency of emissions target achievement.

2. Context

2.1 What is “net mitigation”?

In this paper I attempt to answer the following question: What is the scope for “net mitigation” to reduce global emissions of greenhouse gases (GHGs)? By net mitigation, we here mean, somewhat loosely, mitigation which is achieved beyond that required by accepted formal treaties for limiting GHG emissions. This issue will here be discussed only in the context of international transfers.

Practically speaking, and for the purpose of the presentation here, net mitigation is defined by, and operates via, the following two mechanisms:

A) “Own contribution”. The idea here is, how to count towards total global emissions reductions, mitigation that takes place in countries and in sectors where targets are being established or implemented, but which are not “yet” part of formal climate treaties. Note here first that this GHG mitigation taking place in such countries, which ends up being credited to buyers outside the country, then does not constitute net mitigation since it serves only to facilitate equal amounts of domestic emissions growth in the buying country. Under the “own contribution” approach, only achieved mitigation outcomes which are not accounted for in the host country inventory (serving toward the host country targets that are established or in the process of being established) can serve as offsets by an offset-buying country. The requirement for an “own contribution” to come about is thus that the host country carries out mitigation toward its own country targets; and this emissions reduction is not sold and/or credited through the offset market.

B) “Net atmospheric benefit”. This signifies additional mitigation via offset mechanisms which is not accounted against any existing target. The main proposed approach in the following, for achieving “net atmospheric benefits”, is to “discount” the offsets credited to buyers in offset markets, relative to mitigation taking place in countries that are hosts to offset projects. An alternative approach, which will also be discussed, is to establish and enforce more conservative baselines for crediting purposes by offset host countries. Effectively under the latter approach, additional global mitigation also occurs because the number of emission reduction units credited to offset-buying countries is less than the amount of mitigation actually taking place in offset host countries.
Under prevailing climate policy architectures, case A represents mitigation in host countries for offsets (typically, Non-Annex 1, NA1 countries under the Kyoto Protocol, KP) that have taken on certain climate policy obligations, and as a result of these policy obligations.

Case B describes additional mitigation via offset markets, as exemplified by those under the KP: by NA1 countries under the Clean Development Mechanism (CDM); or by A1 countries under Joint Implementation (JI). A “net atmospheric benefit” will here be considered as achieved insofar as the mitigation in offset host countries exceeds the volume of offsets credited to parties in Annex 1 countries (assuming that leakage is not a problem or taken care of through other mechanisms; see section 2.2 below). It could also in principle be considered in the context of a given current volume of purchased offsets; which would stand for higher mitigation achieved in offset host countries. The implication would be a greater obligation to carry out own mitigation in buyer countries.

As already alluded to above, both mechanisms A and B are perhaps easiest to analyze in the context of a climate policy architecture involving two well-defined country blocs: a “policy bloc” (corresponding to A1 countries under the KP), with a comprehensive cap-and-trade GHG mitigation system, and a “non-policy bloc” or “fringe” of non-Annex 1 (NA1) countries. But it can also, rather similarly, apply as a mechanism within a group of policy-implementing countries. This would arise for example if one subgroup is subject to a stricter policy than another subgroup, e.g., a formal cap on aggregate GHG emissions that binds more severely in one subgroup than another.

Looking ahead, however this perspective ought to be broader. Net mitigation as studied here would in principle apply to all GHG emissions markets post 2020. I will below discuss whether and to what degree the two mechanisms can meaningfully explain or justify such net mitigation, also within the realm of other architectures which can be relevant as part of future climate agreements.

A few further issues, related to net mitigation, can serve as a useful backdrop to this discussion. A key question is whether net mitigation can serve to substantially increase GHG emissions mitigation ambitions, and thus ultimately reduce emissions, in all groups of countries, policy and non-policy countries alike. But a fundamental limitation on the net mitigation concept, as dealt with here, is that overall ambition is taken as given; and that making “ambition” endogenous (as it will be in the long run) erodes much of the basis and rationale for net mitigation. I will come back to this topic at the end of section 4.

Another issue is whether net mitigation can serve as a catalyst for non-policy countries to adopt wider and more ambitious climate-related policies more generally. Without delving deeply into this topic, I will just mention a few issues that may serve to motivate such connections.

The first is whether offset markets can be a significant or expanded vehicle for GHG mitigation also outside of major international climate agreements, e.g., as a bilateral tool for “non-committed” countries. Some countries may for various reasons choose not to sign on to major multilateral agreements, but may still wish to contribute to global mitigation in the way they find suitable. One such way could be to use offset markets to induce additional GHG mitigation that would otherwise not materialize in countries with relatively low mitigation costs. This would, arguably, amount to an own contribution implemented via offset markets.
The second issue is whether mechanisms of the types discussed here can play a positive role in the wider context of GHG mitigation, e.g. as catalysts for wider improvements in policies that have spillover impacts on GHG emissions in non-policy countries; and to catalyze the institution of climate policies in those countries. The own contribution concept of net mitigation appears well suited to play such a role. Here, the fact that policy countries support policy action in current non-policy countries should have just this effect. But one might view the role of similar policy action or support to be in principle much wider.

One natural target for policy change is the phasing-out of subsidies to fossil fuels. Such subsidies work directly contrary to any GHG emissions efforts discussed here.

Another example of constructive policy change in lower-income countries is expansion of renewable energy production that might be induced or helped by some form of access to offset markets. In addition to direct mitigating effect, this may also make it easier to phase out fossil fuels consumption over time in these countries. In such a case, Annex 1 countries may play important catalyzing roles.

2.2 The climate policy picture

Much of the debate on instrument use for climate policy has to date focused on the choice between two broad policy options: emissions taxes or charges on the one hand; and quantitative policies (including emissions caps, and trading schemes for emissions rights, so-called cap-and-trade or c-a-t schemes) on the other. The practical, future, climate policy world is however likely to be far more complex. Different groups of countries, individual countries, or even provinces within countries, may choose individual solutions which could differ greatly with respect to the methods by which GHG mitigation is implemented.

This paper focuses on some very specific alternative paths to be followed in this context, springing out as potential follow-ups to the KP, based on our experience with that framework, and based principally on analytical arguments. The KP represents the most significant climate policy arrangement so far instituted, and from which we have the most experience. It is a quantitative GHG mitigation agreement between A1 countries, signed in 1997, with first implementation period in 2008-2012, and second period 2013-2020. The core of the KP is a c-a-t system whereby each A1 country was given an aggregate cap for the 2008-2012 period determined based on an emissions baseline which was based on individual countries’ 1990 emissions (plus a markup factor). The centerpiece for implementing this scheme has been, and still is, the European Union Emissions Trading Scheme (EU-ETS) for trading of the rights to emit GHGs, within the most important bloc of Annex 1 countries that have ratified the KP and thus have committed to climate policy targets under this treaty.

As part of the KP, two offset mechanisms were designed, the Clean Development Mechanism (CDM), and Joint Implementation (JI). These mechanisms opened up for countries with emissions caps (A1 countries) to meet part of their cap requirements by purchasing “offsets”, from countries respectively outside of A1 (using CDM), here called NA1 countries; and from countries inside of it (using JI).

These offset markets have played a key role for the operation of the EU-ETS. The costs at the margin of mitigating greenhouse gases (GHGs) in Annex 1 countries have turned out, as expected, to be far higher than the marginal mitigation costs in many or most NA1 countries (where it has so far often been, and probably still is, possible to find projects with very low mitigation costs). This created a natural basis for
the CDM: parties in NA1 countries could carry out GHG mitigation which could be paid for by parties in A1 countries, thereby equivalently reducing the GHG emissions obligation in the latter. Since GHG mitigation costs have been far lower in non-Annex 1 countries than in A1 countries, such trades have been highly beneficial to both groups. The aggregate amount of CER issuance under the CDM by today is more than 1,600 million tons CO2-e; see UNFCCC (website).

A similar rationale and functioning can be found for JI. Within A1, some countries were effectively left with surplus emissions quotas which were not utilized (“hot air”) as the allocated caps, calculated on the basis of 1990 emissions, had turned out to be overly generous. This implied that, in countries with surplus emissions rights, costs of abating GHG emissions were very low for some projects, making offset trading favorable with countries that experienced effective emissions constraints, and where marginal emission reduction costs were much higher. The JI market has, however, turned out to be far less active than the CDM market, with smaller aggregate volumes for emissions reduction units (ERUs) so far. Still, as of today more than 850 million tons of CO2e has been reached in terms of issuance. A further issue with these reductions was less careful control of emissions reduction additionality (under “Track 1” for the JI; see further discussion of additionality below), raising the question of the integrity of these credits in a global emissions reduction context.

The CDM is by many considered a success as it likely has reduced the costs of implementing a given reduction in GHG emissions (below the given “baseline”, defined by what GHG emissions would have been in the absence of any KP agreement whatsoever), substantially. Important in the context of the analysis in this paper, however, and for the general issue of net mitigation, offsets under the CDM do not directly reduce global emissions, at least not for given “ambition” of overall mitigation by the policy-bloc countries. The CDM mechanism then only shifts a given level of allowed emissions from countries without caps (NA1 countries) to countries with caps (A1 countries), and makes the burden of complying with the initial mitigation agreement (here, the KP) easier.

Today the outlook for following up on old offset mechanisms, or establishing new future mechanisms, seems less clear. Due to a lax cap on emissions rights under the EU-ETS, the GHG emissions trading price within the EU-ETS has fallen to a low level, and with it the demand for CDM and JI offsets. In fact, over the brief period since 2013, offset demand has virtually evaporated. This has led to increased pessimism about the future of offset mechanisms; and substantial human capital has moved or is in the process of moving out of this activity.

A question is then whether changes in future climate architectures could revive these mechanisms and make them relevant, and what form they might take under a new architecture.

This paper addresses some issues related to the future operation of offset mechanisms that have recently attracted attention, in particular in Europe, and among European policy makers. The topic addressed is whether such or similar offset mechanisms might enhance global emissions reductions beyond the ambitions defined by a cap under a cap-and-trade (c-a-t) system for GHG emissions reductions; a topic to which I come back in more detail below. This will be studied in terms of the basic incentives of the main actors (the countries establishing a c-a-t policy); and in terms of global efficiency.

Section 3 below discusses these issues with basis in the (mainly, analytical) literature on climate agreements and offset markets. The focus will be on discussing the support from this literature, if any, for “net mitigation” as a rational outcome.
Before that I will discuss some background issues, focusing on broad future alternatives in climate policy and their implications; and on a broader and more general assessment of offset markets, and their place within a future possible climate architecture.

3. Climate policy options and their attractiveness—some overarching issues

3.1 Some fundamental climate policy options for the time ahead

Before going deeper into the “net mitigation” issue, I find it useful to put it in the wider context of alternative climate policy options and their relative merits.

It is then first useful to distinguish between four main basic sets of policies for implementing climate-policy targets: 1) quantitative emissions targets; 2) direct price, cost or charge per unit of GHG emissions; 3) policies involving payment for environmental services; and 4) regulatory approaches. I will briefly explain each, and provide a brief comparison.

Under quantitative GHG emissions targets, individual (or groups of) countries implement policies that directly limit GHG emissions. These can be described by various (complementary or alternative) features including a) ambition or tightness of the overall GHG emissions target; b) the length of the policy period; c) the scope for emissions quota trading within and across periods including the scope for use of offset markets, and where freer trading is generally desirable (providing a cap-and-trade (c-a-t) feature of the policy); d) the amount of free allocations given out to participating entities and the principles by which these are allocated. A quantitative policy is most efficient when it allows for maximal trading of emissions rights between entities, sectors, countries, and time periods. A strength of a quantitative GHG emissions target is certainty about emissions resulting from the climate policy over the relevant policy period. A weakness is less certainty about the emissions price. This price will be highly influenced by quota demand for given cap, and can be highly volatile (as it has been under the EU-ETS). This is a drawback for participating entities who typically would favor a certain and predictable policy environment. This drawback can however be remedied to some degree through imposing floors and ceilings for the emissions trading price. In particular with such policies, governments issue additional emissions quotas when the trading price otherwise would exceed the ceiling; and purchase excessive quotas when the price would otherwise be below the floor. Another potential disadvantage of c-a-t schemes, at least as such have been practiced to date, is that a lower than desirable amount of public revenue is raised by the policy when a (large) fraction of emissions rights are given away for free to participating entities. This is a policy that has so far accompanied most practically implemented c-a-t schemes.

Another problem with c-a-t schemes is that when several disjoint policy areas are not linked, the emissions prices will typically differ between the areas, which leads to inefficient global mitigation. On the other hand this obstacle can be turned to a strength if linking of different schemes, and emissions trading across areas and over time, can be allowed. Linking will tend to equalize emissions prices across, at the outset, quite heterogeneous trading areas; and this is not possible with direct price mechanisms.

Direct emissions price, charge or cost targets generally avoid the two drawbacks identified for quantitative policies (uncertainty about the emissions price; and insufficient revenue generation for governments). Emissions prices facing the participating entities will be set directly by policy makers, and
can, at least in principle, be made more predictable over time. They may be adjusted to changing circumstances, but preferably only gradually and/or in response to new information about long-run background global emissions costs and other environment issues. With direct emissions pricing it is also easier to avoid expensive (and often distortionary) free emissions allocations, thus securing more fiscally sound policies. A drawback of price targets which are stable over time is that they leave the GHG emissions level variable and more uncertain. Using Weitzman’s (1974) analysis, one may however argue that this is a less serious problem than that caused by variable emissions prices. Since GHG accumulation and the resulting climate change are long-run processes, this problem can be remedied by gradual adjustments in the price target over time.

Much of the economics literature indicates that emissions policy which is based on emissions cost or price targets is more efficient than a quantity-based target policy, for various reasons among which are those cited above; see also e.g. Goulder and Schein (2013), Karp, Siddiqui and Strand (2015), Strand (2013), and Wirl (2012). The latter type of policy has so far proven much easier to get accepted, however, mainly for political reasons, and to a large extent with the use of generous free emissions quotas to politically strong participating entities (which otherwise might have been able to block an agreement).

Plans to establish climate policies based on price targets could still have serious problems in practice, in themselves and when compared to c-a-t schemes. First, the political will to impose carbon taxes is often not present. This has generally been the situation up until now, not only in the U.S., but also in most other OECD countries; let alone in other parts of the world. This will likely be even more difficult when substantial international transfers (from high- to lower-income countries) will be needed to incentivize policies in low-income countries. Domestic fundraising, and international transfers implemented as part of c-a-t schemes, are likely to be substantially easier to handle politically, than similar schemes implemented via taxes. Secondly, while a relatively stable carbon tax over time could be viewed as efficient, the political will to maintain an initially imposed carbon tax at the same level may be lacking. This is likely to be more of a problem for less politically stable countries. In many countries with more complex governance relations, the seemingly far easier task, to eliminate fossil fuel subsidies, has proven to be an exceedingly hard problem; and a problem subject to frequent policy reversals. A third issue is that c-a-t schemes can more easily open up for international linking across countries and regions, thus making it easier to implement a more uniform GHG emissions price, than with only national emissions taxes (which are likely to be, and remain, highly dispersed).

A third group of climate policy measures are payments for environmental services (PES). Emitters are in this case paid for the service of reducing their GHG emissions (below a certain baseline or level assumed to be the outcome in the absence of such payments). I consider the CDM and JI as belonging to this group of measures. A fundamental difference between this and the two former policy measures is that in the two former, emitters are instead charged for their emissions, and need to reduce their emissions to reduce their emissions-related charges. They correspond to a principle whereby the party responsible for pollution is charged with the resulting damage (the “polluter pays principle” or PPP), and which gives appropriate incentives for emissions reductions. A PES-type policy, by contrast, does not correspond to a

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2 Readers need to note that the more traditional use of the PES classification of instruments has largely been confined to ecological services with a focus on forests; for an overview see Engel et al (2008). I have here found it useful to use the term in this broader context.
PPP. This does not necessarily imply that incentives are less efficient; but PES-type schemes have other aspects that make such policies far less burdensome to emitters. They also provide, under certain conditions, greater opportunities for system manipulation by market participants. Some of these issues are discussed more below.

The fourth group of policies, relevant for GHG emissions control, are regulatory instruments. A variety of legal arrangements can serve to limit GHG emissions, or attempt to do so, by law. For example, the U.S. today relies heavily on two regulatory approaches for its own (limited) climate-policy action. One is the Environmental Protection Agency’s recent action to regulate GHG emissions from power plants in the U.S. The second is (much older) legislation to regulate average fuel economy for non-commercial motor vehicles (the so-called CAFE standards). I will not say much about such policies here; only note that they usually embed rigidities that make them less than fully efficient as means of overall GHG emissions control.

The discussion in this section has been related to policies for implementing climate policy targets; not the setting of these targets themselves, which can be different and much more diverse. It is also more of a political issues which goes beyond the discussion in this paper. In addition to direct quantitative and emissions price targets at the macro level (which correspond directly to the first and second climate policy options just discussed), examples of such policy targets are a) quantitative targets at the sectoral level; b) sectoral GHG intensity targets per output unit; and c) GHG emissions intensity targets per unit of GDP. It should be noted that all these types of targets can, in principle, be implemented through the use of all the four policies noted above; but in general with different degrees of efficiency and, I will argue, in all cases with a direct price per unit of GHG emissions (policy 2 above) as the most efficient implementing policy. In practice other concerns will also usually play a role, as other types of market imperfections may also need correction through such policies. This makes the overall picture of setting the correct policy more complicated.3

In the context of basic instrument design chosen by most countries so far, the most important climate policy measures (as implemented under the KP) are the setting of quantitative emissions targets: the first group of policies considered above. The types of policies most important for the analytically-based discussion of “net mitigation” in this paper however instead combine the first and third policy types indicated above: a quantitative climate policy approach in a set of policy countries, coupled with a payment for environmental services approach, to be applied either in a set of non-policy countries (when taking the CDM form), or in a set of policy countries themselves (when taking the JI form).

The future global policy context is however, as noted above, likely be more complex. Examples of more complex alternatives could involve all countries subject to certain climate policy targets; or only one group of countries is subject to targets and others not; where more than one c-a-t scheme exists, each involving a separate set of countries; and where policy targets can take alternative forms such as GHG emissions intensity.

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3 To quote some examples, for fuel used in road traffic, other road externalities must be corrected for through fuel or road pricing, implying in particular that the fuel tax should be set higher than the carbon tax; and in aviation the GHG externality is greater than the pure carbon externality leading to a higher optimal carbon tax for jet fuel.
3.2 Some aspects of offset markets to date

I start the discussion of offset markets with a more general evaluation of their ability to deliver meaningful contributions to global GHG mitigation. At least four main arguments are relevant. The first argument is generally positive to this role, and the three last negative.

On the positive side (call it factor 1), having had offset mechanisms (the CDM and JI) as part of the KP has likely led to more ambitious mitigation levels, and (within the KP as a purely quantitative mechanism) stricter GHG emissions targets (and a lower cap) for A1 countries. The CDM has served as a “safety valve” for these countries making them confident, from the point of time of KP contract agreement, that the costs of implementing their agreed caps would not be too high. This may have led to more ambitious (and tighter) caps under the KP. The availability of the CDM may for some A1 countries even have been a prerequisite for ratifying the KP. For host countries, the CDM has also had positive learning effects and has raised awareness about the availability of low-cost mitigation alternatives and developmental co-benefits; and better understanding of the needs for, and impacts of, emissions pricing policies and climate policy measures in general. In this sense, the CDM may in reality have led to lower global GHG emissions.

Three factors related to the functioning of the CDM may however have worked to somewhat undermine the effectiveness of the CDM mechanism. Together they imply that some emissions reductions credited under the CDM may not have been “real”, when held up against a (hypothetical) “counterfactual” situation in a world without a CDM mechanism over the relevant period.

It is, first, often difficult to correctly define the “business-as-usual” or “baseline” against which emissions reductions under the CDM ought to be credited (call this factor 2). There is often a basic incentive of host countries to inflate baselines (beyond actual levels), so as to achieve high “baseline” emissions against which reductions can be credited; see Strand and Rosendahl (2012) for a general analytical presentation. Buyers in this market (from A1 countries with binding quotas) have similar incentives to favor a high level of crediting in CDM or JI projects. A regulatory body (for the CDM, its Executive Board; CDM EB) can here serve, and has served, as an effective countervailing force to such incentives, by aiming to enforce “correct” restrictions on emissions crediting through offset markets. Various popular pressures in A1 countries, to make sure that the CDM works according to its intensions, have likely had similar countervailing effects.

The second concern is “additionality” of CDM projects (factor 3). In some cases, the true net costs to a project host, or host country, of implementing a given “CDM project” could be negative (so that the project host would, on net, gain by implementing the project even in the absence of financing from the CDM). This could e.g. be the case for energy efficiency improvements that are profitable on their own. Given that there do not exist serious barriers to the implementation of such projects, they should not receive offset market payments (as they would anyway be carried out by a rational economic actor).4

The third concern is “leakage” (factor 4). Leakage is a potential problem for any type of mitigation project, also in offset-purchasing countries. The basic problem is that GHG emissions reductions due to a emissions-mitigation project may lead to emissions increases elsewhere, either within the same country

4 When there are serious institutional or political barriers to implementing such offset projects, they can sometimes still be allowed by the CDM EB.
or region, or internationally more in general; and this holds also for CDM projects. For a deeper analysis, with simulation of likely quantitative impacts, see Rosendahl and Strand (2011). Leakage often works via local energy markets. For example, when CDM credits are given to a project intended to close down a coal-fired power plant (or retrofit it so that it no longer needs coal), the local coal price may be reduced, and this may spur the start-up or continuous operation of other coal-fired power plants in the same region. It can also work via international markets for intermediate or final goods. For example, CDM crediting related to scaling down or closing a steel mill in one country can improve the market situation for steel in other regions of that country or in other countries, and increase steel production and emissions there.

It is very difficult to determine whether positive or negative factors have been more important for the overall effects of the CDM on global emissions when we see the CDM in the context of its application, as part of the KP.

Policy makers and other relevant parties, and not least the CDM EB, have been keenly aware of these three interrelated problems just listed, which mainly affect the ability of the CDM to deliver real offsets. Elaborate mechanisms have been developed by the CDMEB to counter them, by making the requirements for approval of certified emissions reductions (CERs) under the CDM stricter. But this strictness has in turn led to other problems with the operation of the mechanism, in particular, a burdensome procedure involving tightly specified methodologies to get a project “through the grinder” of the CDMEB, and fully intact. One key problem is lack of full observability, by the CDM EB or other observers. If one then wishes to impose strict rules that, e.g., lead the average project baseline to be correct (in itself an almost impossible task), this will lead to a too strict baseline for many projects giving reasons for complaints and conflict. (For other projects, the baseline will in this case be too lax.)

What can one say about the empirical impacts of these factors, by how much can they have affected real global mitigation? In general, very little concrete information exists on such problems for individual projects, related to factors 2 and 3 above. But such lack of information is the essence of the entire problem, which is one of asymmetric information: if data had existed, it would have been relatively straightforward for the CDMEB to correctly justify or dismiss a claim for CER certification.

Considering all the four factors 1-4 above, factor 1 requires a counterfactual which is impossible to observe for individual projects; and which I will not speculate on here. Factors 2 and 3 deal with individual projects where it has been, in principle, the task of the CDMEB to perform such controls, but where asymmetric information, with project hosts typically having superior information, creates serious problems of observability. Little documentation exists, apart from a few conspicuous examples related to HFC-23-related emissions, in China under the CDM; see Wara and Victor (2008); and in the Russian Federation under JI. Both factors 2 and 3 seem to apply (inflated baselines; and lack of additionality as some of these emissions abatement projects have a separate rationale apart from offset market implementation).

For factor 4 (leakage), estimates very often cannot be provided on a project basis as this factor typically works at the macro level for the individual host country, or in some cases even at the global level. But it is in principle possible to assess this factor through simulations. Rosendahl and Strand (2011) have simulated likely leakage levels, and come up with “best estimates” for leakage of around 30% of credited emissions reductions, as a rough average for the CDM projects carried out by 2010 (when disregarding HFC-23 related projects).
Several of the same qualifications as those applying to the CDM, apply to JI as a mechanism by which global GHG emissions can be increased or reduced. JI has however been less used, and thus attracted less attention to date. Recent experience with JI projects under “host country oversight” has shown some clear cases of baseline manipulation, and missing additionality. Such obvious cases are harder to find for CDM projects where checks are attempted to be built in and obvious manipulation would give rise to action by the CDMEB.

The discussion below in this paper departs from this background, and abstracts away all problems implied by the three qualifications just discussed. One key question can be formulated as follows: Assume that a climate policy regime is established in a well-defined set of “policy countries”, and where this regime is coupled with an offset mechanism. The offset mechanism could be similar to the CDM (JI) when the countries that are allowed to sell offsets (and be hosts to offset projects) do not themselves have (do themselves have) a climate policy; and thus do not (or do) belong to the “policy bloc” of countries. The offset mechanism must be assumed to have built in sufficient “safeguards” to ensure that the three potential problems with delivery of real global emissions reductions from the just identified (endogenous baselines; lack of additionality; and leakage) are not significant, and/or have been corrected for. Would there be room for additional mitigation, globally and in particular in offset-selling countries, given such a system, and given rational or optimal climate policies by the main actors involved? Such additional mitigation is for our purposes identified as “net mitigation”. As discussed above, we will assume that “net mitigation” can take two forms: a) An “atmospheric benefit” approach whereby offsets are “discounted”, meaning that larger emissions reductions (under the CDM in non-policy countries; under JI in policy countries) are required to achieve a given number of credits in policy countries needing such credits. b) A “net contribution” approach whereby policy countries also are not receiving all emission reductions achieved as offsets, but where some of these are viewed as working toward the fulfilment or establishment of policy targets for CDM host countries. Buyers then render some of their allocated emissions quotas so as to, effectively, make the overall emissions cap tighter than originally agreed.

4. “Net mitigation” based on reductions in offsets – some initial remarks

In discussing “net mitigation” focusing on offset markets, I will concentrate on the case where offset projects’ hosts are located in non-policy countries; offset demanders are always located in policy countries. This is relevant for a world considered to be split into a bloc of countries with formal GHG emissions targets, and others without such targets. It corresponds to an offset mechanism of the CDM type under the KP. The alternative arrangement, relevant as a climate policy option going forward but less discussed in the literature so far, involves project hosts located in countries with formal climate policies. Under the KP, this would correspond to JI or some version of it.

Under CDM-type offset markets, net mitigation can be accomplished, technically speaking, in several (related) ways, some of which have been outlined recently among others by Lazarus et al (2013), and Vrolijk and Phillips (2013). Vrolijk and Phillips distinguish between 13 varieties of schemes for implementing net mitigation through the CDM; although several are quite similar analytically; while a

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5 See Zhenchuk (2012); Kolmuss et al (2015).
similar set of schemes is found in Lazarus et al (2013). Nine of the schemes suggested by Vrolijk and Philips are “at registration”, one “upon issuance of CERs”, and three “at the point of use of CERs”. I will consider as interesting here only two of these: at registration, one can apply a more conservative baseline; and at point of use of CERs, a standard rate of “discount” can be used when converting one unit of mitigation into a credit for the offset buyer.

“Offset discounting” can be implemented in two alternative ways. First, one can credit one unit of GHG reduction (say, one ton CO2-equivalent abated) differently, between offsets in non-policy countries, and primary emissions reductions in policy countries, with a lower relative crediting (or “discount”) applying to offsets. Secondly, one can pay a lower price per unit of emissions reduction achieved through offsets, relative to each unit of emissions reduction achieved in the primary market. The two mechanisms will, generally, be equivalent in the context of a competitive GHG emissions market. I however point out below that, in practice, the two may lead to different solutions depending on the more detailed rules (dictated by the policy countries) under which the two alternatives are implemented and enforced.

In the following I will also discuss the other alternative for implementing “net mitigation”, that is principally relevant and interesting here, namely **tightening the baseline against which crediting is awarded** (setting a more “conservative” baseline).

In the appendix I provide a brief analytical discussion where I compare these two alternatives: either discounting of offset units (“case 1”); or tightening of (more conservative) baselines against which crediting is done (“case 2”). This comparison is done for examples where the expected or average amount of mitigation would or could be implemented in either case.

The simple analytical argument in the appendix shows the conservative baselines alternative to be theoretically preferable to discounting in many or perhaps most cases, in welfare terms and also in terms of profitability for participating offset project hosts. The key reason is that the conservative baseline case implements what is very often an overall more efficient allocation of mitigation activity among hosts, by (in most cases) equaling the marginal cost of mitigation to its marginal gain. With offset discounting the solution takes a different form: discounting then works as a “distortionary tax” which reduces mitigation activity of the host at the margin and in total. The conservative baselines case by contrast does not discourage mitigation at the margin for any given project.

Consider this discussion in terms of similar (less technical) discussions found in the literature. Lazarus et al (2013) discuss both these alternatives for implementing net mitigation, without comparing one against the other. They state (on page 14) that “… stringent baselines and pre-issuance discounts are most applicable for activities with relatively certain additionality but marginal costs well below the offset price”. Both these conditions are well supported by my arguments above. First, it is clear that the offsets need to be fully additional for any registered net mitigation to count fully as an “atmospheric benefit”. Secondly, when marginal mitigation costs for offsetting hosts are “well below the offset price”, there is no difference in outcome between the cases 1 and 2 mentioned above (and discussed analytically in the appendix): mitigation will be “fully implemented” by the project in either case. The two should differ only for projects where the marginal mitigation cost is close to the offset price, and in particular when the marginal mitigation cost could exceed the offset price in the discounting case but not in the conservative baseline case.
A possible qualification of a conclusion that conservative baselines are preferable to offset discounting, is that it is derived under an assumption of full certainty about all parameters, for all involved parties. It is less obvious to hold under uncertainty about the demand for offsets. Note that a scheme that sets a conservative baseline at, say, some fraction of the current emissions of a given potential seller, could expose this seller to high uncertainty on the number of units being credited. A discounting scheme will generally reduce this uncertainty, by making it more certain that at least some crediting will take place under the offset scheme. This factor could make the discounting scheme relatively more attractive, at least for enterprises that rely on one or a small number of credited units. While a complete analytical basis for this argument is not developed (nor treated in the associated literature), the argument appears, potentially, to eliminate some of the above-stated advantages of the conservative baseline scheme over the discounting scheme.

A drawback with conservative baselines as a policy tool is that baseline setting is always arbitrary and it can be difficult to determine (or at least document) what constitutes a “correct”, and a “conservative”, baseline. For discounting of offsets no such technical problem should arise. It should thus perhaps be a “simpler” principle to implement, technically and politically; and the difference in efficiency is often small so that the discounting alternative is chosen for the given political reasons. My approach below is to focus on the discounting case; although results from the appendix should be kept in mind in interpreting the results.

5. “Net mitigation” via offset markets: Some lessons from current literature

The literature (apart from the examples discussed in more detail in sections 5.1-5.3) contains few contributions which discuss the discounting of CDM credits; and most existing contributions discuss problems with leakage and/or lack of additionality. A basic argument is simply that net mitigation is required for additional mitigation beyond agreed levels to take place.

A small number of such contributions have given some justification to discounting of offsets. The justification is typically that CDM projects imply leakage, and/or are not additional. Klemick (2012) derives an optimal rate of discounting given that leakage is a problem, and finds leakage to be a proper justification for such discounting. Her main result is that the optimal offset discount equals the overall rate at which the project fails to reduce global emission (due to a combination of leakage and lack of additionality).

Castro and Michaelowa (2010) find lack of additionality as a key justification for offset discounting. They recognize that offset discounting under the CDM is unfavorable to project hosts, and is likely to reduce the supply of possible projects from these. In that context they view it as advantageous to shift the supply in the CDM market, and make it less attractive to large actors (and countries with large offset potential); thus reducing the dominance of China and other major supplier countries in the CDM market, thus perhaps shifting supply to regions that have so far had small market shares (such as Africa).

I also note a relatively early paper by Schneider (2008), which outlines many of the basic arguments that are offered below, for or against discounting of offsets, and comparing this alternative to baseline tightening.
In discussing analytical approaches to net mitigation through offsetting, I will focus on offset discounting and not on conservative baselines (which has yet been subject to little economic analysis). I will later comment on whether related arguments can be valid also for conservative baseline cases.

I will now (in sections 5.1 and 5.2) present two analytical model frameworks that can serve or help to understand how net mitigation can be achieved through discounting of offsets, based on Strand (2013), and Rosendahl and Strand (2015). In section 5.3 I discuss whether bargaining approaches to pricing and matching in offset markets may provide further such explanations.

5.1 Modeling market power of the policy bloc in the offset market

In Strand (2013), I develop an integrated but stylized global model of GHG mitigation, characterized by three country blocs: 1) Fossil fuel exporters which do not have nor are interested in a climate policy, but set an optimal export tax on their fossil-fuel exports. 2) Fossil fuel importers (the “climate policy bloc”) which set a unified climate policy, either a carbon tax, or a cap-and-trade scheme with a given cap, where unlimited offset purchases from the “fringe” (see below) are allowed in principle. 3) The “rest of the world” (“fringe”) consisting of net fossil-fuel importers without any climate policy. The climate policy bloc purchases offsets centrally from fringe units when the bloc’s climate policy is a carbon tax. When the bloc’s climate policy instead is c-a-t, the production units purchase offsets in a decentralized manner (as under the CDM). I assume that all offsets are additional, no leakage, and no frictions in the offset market (see below on bargaining where frictions are discussed).

Another key assumption is that all potential offsets are offered to the offset market by the potential hosts (and all emissions types are eligible for offsetting). The model then takes the form of a global equilibrium model for the GHG emissions market, where all eligible production hosts in non-policy countries participate in the offset market. There are no low-cost CDM projects that do not come to fruition.

In the carbon tax case, the policy bloc determines a unified offset price offered to all offset project hosts, and which could differ from (and then be lower than) the carbon tax. This differential price has the implication that offsets in the quota market represent only a fraction of the amount of GHGs actually reduced.

In the c-a-t case, I rather assume in this paper that offsets must be traded at the same quota price as that prevailing within the policy bloc, so that there can be no “offset discount”. This is, as discussed below, however not the optimal policy for the policy bloc, given that one is free to determine the offset price independently from the internal quota price.

Consider now the offset policy for the policy countries within this framework. Under a carbon tax I show that it is, quite generally, optimal for the policy bloc to “discount” the bloc’s purchases of offsets, by setting the offset price lower than the carbon tax within the policy bloc. This can be equivalent to reducing the number of offsets within the policy bloc, for any number of emission reductions that is actually achieved in the fringe. This reduction in crediting of achieved emission reductions is what gives rise to “net mitigation” as this concept is defined here; see the discussion at the end of this section. The optimality of such a policy follows from a standard monopsony argument. One big buyer (the unified policy bloc of countries), purchases offsets from many small sellers (non-policy country hosts). The
buyer then sets the price at which it offers to buy, below the “competitive” rate; the latter would correspond to its own carbon tax or price per unit of emissions within the policy bloc.

One may here also compare offset purchases from outside of the bloc (from the fringe) under the scheme described, to instead purchasing offsets from inside of the bloc; this would correspond to a JI solution under the KP. Under JI, the payments going to offsetting units would be part of the policy bloc’s objective function. When offsets are instead purchased from the fringe (as under CDM), the payments going to these units would not be counted as part of the policy bloc. This makes a substantial difference for the optimal offsetting price (given that the policy bloc has no altruistic preferences for fringe countries’ welfare): Under JI, the optimal offset price would equal the carbon tax; while under the CDM, the optimal offset price would be lower.

How large is the optimal discount under the CDM? In a standard, so-called linear-quadratic case, which I consider (where all unit profit functions and regional welfare functions are quadratic), I show, strikingly, that the optimal offset price set by the unified policy bloc is exactly half the optimal, uniform carbon tax within this bloc. This is however not an entirely general result, as it follows from the linear-quadratic specification; in more general cases, the policy bloc’s optimal offset price could be either higher or lower than half the carbon tax. It is however likely to be close to the optimal solution in more general cases when the optimal carbon tax is relatively small (as the linear-quadratic specification is then a good second-order Taylor approximation to a more general, true, specification).

With optimal offsets given c-a-t for a unified policy bloc, this bloc also now prefers to “discount” offset purchases from outside the bloc, in the same way as with taxes discussed above; and the optimal rate of discount (from the point of view of the policy bloc) is the same as under taxes.

Another important aspect of optimal offset pricing of the policy bloc in my model is that the optimal carbon tax for the policy bloc is higher, the larger is the policy bloc relative to the fringe. Since the optimal offset price is always half the optimal carbon tax, the optimal offset price is then also higher when the policy bloc is larger, and the fringe smaller. The same basic feature holds under c-a-t. This feature however does not affect the property that the optimal offset price is lower than the optimal carbon tax or quota price.

Note that discounting offsets is “optimal” (for the policy bloc in the context of my model) only as viewed by policy-bloc countries alone; and not necessarily from a global perspective. Globally, in my model, the optimal policy is still to set the offset price equal to either the carbon tax (in the tax case) or to the quota price (in the c-a-t case). One may still perhaps justify the policy as optimal since, after all, the policy countries are in charge of whatever climate policy initiative is being carried out.

In the context of my model, “offset discounting” can be implemented either as discussed above, by letting each unit of emission reductions achieved in host countries count for less than one offset for policy-bloc entities (quantity discounting); or as a “tax” on offsets by policy-bloc governments (price discounting). Only in the former case will net mitigation be achieved by offset discounting.

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6 This corresponds to any “development motive” of the CDM being unimportant for policy bloc countries; an assumption which can be discussed and perhaps questioned.

7 It can, however, be argued that the linear-quadratic specification is correct (as a good second-order Taylor approximation) for relatively small changes in economic behavior; thus for moderate emissions pricing rates.
When instead offset discounting is implemented as a tax on offsets, there will be no net mitigation. Intuitively, with an offset tax, the number of offsets received by buyers will now still equal the actual emission reductions achieved by hosts. The allocation will then be (almost) the same, in terms of both mitigation in policy countries, and offsets in host countries.8

Moreover, I have shown that under these model assumptions, net mitigation through quantity discounting is part of an optimal strategy from the point of view of policy-bloc countries.

Note that offset discounting reduces the amount of offsets. This is because the supply of offsets must decrease when the price paid is reduced, which happens under both price and quantity discounting.9

Note also that for net mitigation to come about, and at the same time fewer offset to be purchased, the amount of mitigation carried out in the policy bloc must increase as a result of offset discounting. Emissions from the policy bloc itself must be reduced by more than the reduction in offset purchased, as global mitigation is increased.

Certain restrictive assumptions lie behind these results. First, the offset market is assumed to be in general equilibrium, and with perfect information, so that all possibilities for offsets at a given supply price to hosts are exhausted. When this supply price in the offset market is reduced, supply of offset projects must also be reduced, and the amount of realized offsets reduced, not increased. This property must hold under both quantity and price discounting. These assumptions may not be realistic in practice. Secondly, I have assumed perfect information in the offset market, which is also very unrealistic. As will be seen on the basis of Rosendahl and Strand (2015), discussed in section 5.2 below, this could open up net mitigation as an optimal or efficient policy response for policy-bloc countries.

Consider now implications when instead of offset discounting, baselines for project hosts are tightened. Assume the “most favorable” condition for such a policy, where baseline tightening does not reduce the number of offset projects supplied by hosts. This is possible (although unlikely); it requires that such tightening is chosen very carefully, so that all potential offset projects still remain profitable for hosts. In this case, there will be no change in the supply of offset projects by hosts, as the marginal project revenue will be unchanged for hosts. The only real implication of the policy would then be a transfer of revenue, from non-policy countries to the policy bloc. This is because that, in this particular case, the only effect would a reduction in offsets needing to be paid for by policy countries; actual mitigation in non-policy countries would be unaffected. The baseline tightening itself would then constitute the “net mitigation”. The amount of offsets purchased by the policy bloc would then be reduced, and mitigation in the policy bloc itself increased equivalently. A reduction in global GHG emissions would then follow, directly from the baseline tightening. In more realistic cases, some projects in non-policy countries would then no longer be profitable.

In more realistic cases, baseline tightening would lead to some otherwise viable offset projects becoming unprofitable, and thus a reduction in the supply of offset. Such a supply reduction would tend

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8 A potential, likely moderate, change in outcome will follow from a reduction in offset supply from hosts as the selling price they achieve in the offset market is reduced by the offset tax; see paragraphs below. This effect could be small when most offset hosts earn substantial rents from their projects in absence of the offset tax.
9 Similar conclusions were drawn by Schneider (2008).
to reduce or eliminate the gain from a possible resulting improvement in ambition, in terms of the global level of GHG emissions.

Consider finally the possibility that an offsets discounting policy is optimal for the (dominant fraction of the) policy bloc, with offsetting done by hosts in another group of countries within the bloc. This is a potentially relevant case if one considers, perhaps realistic for future climate policy arrangements, a “middle ground” where the policy bloc consists of two distinct sets of countries: one set required to mitigate (think of Western Europe (WE) under the Kyoto Protocol); and another set of countries where mitigation requirements are less restrictive (think of East Europe (EE) under the KP). WE is then not likely to fully incorporate the preferences and utility of the EE in its preference function. It could then be optimal for WE to discount offsets purchased through JI schemes from EE, in a similar way to those purchased from the fringe under the CDM.

To sum up, “offset discounting” will lead to “net mitigation” through a “net atmospheric benefit”. But this policy has also negative impacts. One is overall reduction in offsets as noted above. More mitigation must thus be done by policy countries themselves.

“Baseline tightening” also leads to net mitigation, as this tightening raises the demands on hosts for offset projects to do some mitigation before they can start to sell offsets. It also would tend to raise the offset price, and increase mitigation in policy countries. This is discussed further in the appendix. This would appear to be a preferred alternative for policy countries. It means that baseline tightening would lead to greater “ambition” in policy countries than offset discounting. Overall, baseline tightening is a more efficient policy alternative than offset discounting.

5.2 Net mitigation with updating of free quota allocations and incomplete GHG emissions markets

A second analytical set of arguments which might justify offset discounting is from Rosendahl and Strand (2015). We here focus on c-a-t policies in policy bloc countries with offsets purchased from non-policy countries. A difference from Strand (2013) is that demand for offsets from the policy bloc is “shallow” in not exhausting the full potential for offset from potential hosts. This assumption opens up for possible additional offset supply at the current offset price offered to potential offset project hosts.

This paper analyzes a steady-state equilibrium for a recurring c-a-t solution where a fraction of quotas are given out for free to participating units, using a combined grandfathering and updating rule whereby a fraction of the GHG emissions allocations in period t are given for free to participating entities with GHG emissions targets within the policy bloc, on the basis of either carbon emissions or production in period t-1. This analysis assumes, as in Strand (2013), monopsonistic behavior by the policy bloc in setting the rules for optimal offset pricing and thus discounting in the offset market.

The assumed rule for updating free quota allocations here introduces an additional element which further increases the policy bloc’s optimal degree of offset discounting. The reason is that the updating rule makes mitigation more attractive, but also more expensive, to emitting agents within the policy bloc. This leads to a higher equilibrium price of quotas within the bloc, and drives a wedge between this price and the marginal mitigation cost. The presence of such a distortion when free offset are updated is well documented in the literature; see e.g. Böhringer and Lange (2005); Rosendahl (2008); Harstad and Eskeland (2010); and Rosendahl and Storrøsten (2011). In the offset market, by contrast, there is no
similar bidding-up of the price to suppliers of offset projects, since these do not enjoy any form of updating; and thus no similar distortion. We show that this wedge at the same time increases the optimal rate of discounting facing suppliers in the offset market. Under the same parametric conditions as in Strand (2013) (“linear-quadratic” functional forms), the offset discount rate that is considered optimal by the policy bloc reduces the optimal offset price in the offset market to (perhaps, substantially) less than half of that in the quota market in the policy bloc.

Note also that under such quota updating/grandfathering, at least some discounting of offsets will be optimal, not just from the point of view of policy bloc countries, but also from a global perspective (and thus differing from Strand (2013)). This is because the discounting chosen by the policy bloc is now assumed to be non-distortive in itself, and chosen to correct for another distortion (that resulting from the free allocation updating rule).

The offset market is under this model as noted assumed to be “shallow” so that additional offset projects can be contracted at a given going offset price offered to project hosts (even at the lower, discounted, price). We assume that the “quality” of additional CDM projects is the same as for already existing CDM projects.

The two latter aspects (updating of free allocations; and CDM market incompleteness) both represent distortions that, if present, lead to a more sound justification for net mitigation through offset discounting being optimal. A discounting policy in this case also leads to a greater amount of offsets being purchased, instead of fewer offsets as in Strand (2013).

Could this model apply in practice, to our arguments concerning net mitigation? I will argue that it (or in some modified version) can realistically apply whenever a share of emissions quotas is given away for free to emitters; the offset market is “incomplete” and is small as a fraction of overall emissions in offset host countries; and the offset policy is implemented through an additional mitigation requirement and not as a tax on offsets.

For the magnitude of net mitigation that can be realized in such cases, the degree of incompleteness of the offset market is particularly important. This applies, first, when offset demand far from exhausts the non-policy bloc’s potential supply of offset projects. But it is also connected to the discussion of bargaining and frictions in the offset markets, see section 5.3 below, is, e.g. due to costs of matching sellers and buyers in the offset market. Plausibly, this market may be particularly prone to such frictions.

Regarding our assumption that free allocations are updated, what matters most is emitters’ beliefs about this issue, in particular whether future free allocations are understood to be provided at least in part based on the firm’s current emissions or output. If so, our model applies in principle. To what degree offsets ought to be discounted on this basis is however less obvious.

In principle baseline tightening could accomplish basically the same net mitigation also in this modeling context, and in an at least equally attractive manner to the policy bloc; this is subject to the same discussion as in the previous section.

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10 This could easily be the case also with explicit statements from regulators and politicians that future updating will not take place. Such statements are never fully credible when updating rates can be affected in practice by politically powerful economic actors with interests in such policies being pursued.
Under this model, it is assumed that the offset price is determined centrally by the policy bloc governments. One could instead assume that individual countries determine individual offset discount rates. This would change nothing fundamental, except that the discount rates would tend to differ between countries. We would also find that when individual countries or country groups set their own discount rates, there will be less discounting as the monopsony power of each rate-setting country or country group would be less.

Table 1: Main results from sections 5.1-5.2

| Model variant               | Net mitigation | Global mitigation | Offsets | Own mitigation |
|-----------------------------|----------------|-------------------|---------|----------------|
| Model 1, offset discounting | Limited        | Somewhat higher   | Reduced | Increased      |
| Model 1, baseline tightening| Positive       | Higher            | Reduced | Increased      |
| Model 2, offset discounting | Positive       | Higher            | Increased | Ambiguous     |

Table 1 sums up a few important conclusions from this section. We consider the results from three model variants: a) Model 1 (Strand 2013) as applied to offset discounting (with no taxation of offsets); b) Model 1 as applied to “baseline tightening” (considered as an alternative policy to offset discounting); and c) Model 2 (Rosendahl and Strand 2015) as applied to offset discounting. Note in particular that while own mitigation will need to be reduced under model 1 (due to reduced offset volume when the offset price is reduced), this need not occur under model 2 where the offset volume can, by assumption, be increased together with a reduction in the offset price.

In conclusion, “net mitigation” will result under all three model variants, but least with offset discounting under model 1 (given that tightening of baselines qualifies as net mitigation). The amount of offsets will however be reduced under model 1, and most with offset discounting as this policy has the effect to strongly discourage offsets through reduced offset supply. Under model 2, by contrast, we assume no negative supply reaction for offsets in response to discounting; here offsets are increased by this policy due to increased demand. The reality is probably somewhere in between these two extreme assumptions.

5.3 Bargaining over offsets

Instead of being subject to a central offsetting policy by policy-bloc countries (with or without discounting), offsets can be arranged in bilateral bargains between a particular buyer (from the policy bloc) and seller (from the fringe), with an offset price agreed between them, and such that this price is not necessarily the same as the quota price but possibly lower. An issue arises in this context, whether such bargaining can form a basis for explaining, and perhaps justifying, offset discounting leading to net mitigation. I will in this section look into this issue.

The treatment of search and bargaining in the climate-policy-related literature has so far been limited. This is perhaps surprising as the real world seems to make bargaining in offset markets highly realistic.
Only a quick glance at data from the CDM market reveals that offset prices (per ton of CO2-e) achieved by project hosts have varied a lot across both projects and host countries, and have often (or even typically) been substantially below the respective (policy bloc-internal) quota prices. Several reasons exist why we could observe offset prices well below quota prices. First, the buyer often contributes expertise, or even perhaps project finance, in implementing the investments necessary for a successful CDM project, and thus in practice provides capital to the host, and where the return for the buyer can be reaped (in part) through a lower offset price. Secondly, uncertainty related to eventual delivery of CERs from CDM projects (or similarly, Emission Reduction Units – ERUs – from JI projects) at project start-up can lead to highly variable offset prices, even for actually delivered CERs.

Still, the situation in the CDM market strongly indicates the possibility that bargaining between project hosts and buyers is widespread. Implications could then differ from those under standard, friction-less market conditions largely dealt with above. A substantial share of the bargaining surplus is then likely to go to offset demanders in the policy bloc. If this is the case, the CDM conveys additional benefits upon the policy bloc when compared to those accounted for above (from the cited papers).

Such situations, with project search and bargaining, leads to a more complicated picture around CDM-type mechanisms, as compared to my discussion above. I will in this section discuss some of these complications and changes in market function. It is, in particular, not entirely clear whether such bargaining can lead to a separate justification for “net mitigation”: I will here argue that it does not.

At a general level, such bargaining leads to rent sharing between individual buyers (firms in policy-bloc countries) and sellers (project hosts in fringe countries). This will generally result in project hosts being paid lower prices for offsets than the quota price in the primary market; but at the same time generally higher offset prices than production costs so that hosts operate with a positive net profit, in total, and often also at the margin.

The literature has only a few examples of work where bargaining in the CDM market is modeled analytically. We will here discuss two key such papers, by Liski and Virrankoski (2004) (LV),11 and Bréchet, Ménière and Picard (2012) (hereafter BNP); starting with the latter paper.

BNP’s presentation is simplest to present. They consider a framework with alternative relative “bargaining strengths” for the host and buyer, respectively, in the context of a partial-equilibrium model with no limitation on offset host supply, for a given offset price offered to hosts. This means that the fringe is assumed to be “large” relative to the policy bloc, which is clearly a general feature of the CDM to date (at least in a notional sense: in terms of the potential total supply of CDM projects from the entire fringe). They assume that the sharing of the bargaining surplus, between host and buyer, is governed by a “bargaining parameter” for the sharing of the bargaining surplus. Their main approach is to argue that higher bargaining shares going to offset hosts (offset buyers) leads to a less (more) beneficial offsetting solution for offset buyers. This in turn leads to a lower (higher) optimal mitigation ambition for the policy bloc, and thus to a less tight cap.

The approach of LV is different, and builds on matching models developed for the labor market mainly by Mortensen and Pissarides (see Pissarides (2000), Mortensen and Wright (2002)). LV explicitly assume search frictions in offset markets, with resulting costs, which take two forms: a) search and

11 See also Liski (2001) for a similar model.
On informational costs; and b) bargaining and decision costs. The bargaining surplus would be split between the two actors, which would result in an effective offset price for the buyer below the regular quota price. An interesting result in LV is that greater matching frictions typically lead to a greater share of the bargaining surplus going to the host. This could give project host countries, less of an incentive to reduce search frictions when that would be possible; and thus efficiency may be hampered.

A crucial difference between the BMP and LV models is that while the former makes no explicit assumptions about the supply of offsets (simply, assumes that supply meets demand), the latter makes such assumptions. Arguably, the BMP assumptions are unrealistic in this regard; and unduly favor our conclusion that net mitigation can be optimal (principally, on the basis of the arguments in section 5.2). On the other hand, the LV model assumptions may be too pessimistic. Bargaining frictions (and other frictions) in the offset markets could in practice be extremely serious and preclude anything close to efficient matching from taking place; and lead to a situation where project matching is, to a very large extent, driven by the demand side of the CDM market. This is more likely, the larger the non-policy bloc (or fringe) is relative to the policy bloc (and, thus, the larger is the potential; relative supply of offset projects, relative to offset demand). Such cases would seem to open up better opportunities for net mitigation here; although this is not yet well explored in the analytical literature.

Introducing bargaining as such seems to not provide a separate argument for net mitigation, since bargaining does not involve discounting of offsets (only different pricing of these, where buyers typically face lower prices than under standard assumptions). The overall discussion of bargaining models in the context of net mitigation is however somewhat inconclusive, in particular as this literature is still rather undeveloped. This literature rather explains how inefficiencies can arise in the offset market which eliminate part (but not all) of the net rents associated with offsetting; and also how rents can be shared between offset buyers and project hosts. Note that the result from the models discussed in sections 5.1 and 5.2 above, that buyers earn no net rents from matching with project sellers, differs from the standard conclusions from the bargaining literature.

The perhaps most important and relevant insight from the bargaining literature is here to give a better basis for understanding the nature and severity of market frictions in offset markets. Such frictions might appear as a necessary ingredient in a fully satisfactory model to explain net mitigation in the first place.

Note that bargaining models may, as pointed out above, help to explain the degree of ambition in setting climate policy targets for countries with climate policies, thus also helping to explain the level of global GHG emissions.

Considering determination of the degree of ambition more widely, however, raises more serious issues for the net atmospheric benefit concept. The discussion of this concept in sections 5.1 – 5.2 was based on the (often implicit) assumption that ambition was exogenous (apart from a “real cap tightening” impact of the net mitigation outcome); and that for given ambition global mitigation could be increased through offset discounting (the net atmospheric benefit channel). But it is easy to see that this is an inferior alternative to simply raising the overall ambition level in the absence of offset discounting. The reason is simply that offset discounting reduces offset purchases in an inefficient way: it forces a too high mitigation relative to that taking place through the offset market. An equally great (or greater) level of global mitigation could take place more efficiently by not discounting offsets, and instead increasing the ambition level equivalently to the increase in net mitigation that results under offset discounting. In
fact, policy-bloc countries would then find that ambition should be increased even further, beyond this level. This argument clearly limits the usefulness of the concept of net atmospheric benefits, as an efficient policy alternative, to relatively short-run analysis.

6. Explaining “own contributions”

As discussed in the introduction, the “own contribution” approach to net mitigation relies on reducing the rate of emission reduction crediting to buyer countries, based on the premise that part of the offsetting serves to meet climate policy targets for host countries themselves. The idea is to view host countries as (in a CDM context) being in a transition phase from no climate policy to a policy; or (in a JI context) as being required to fulfill their obligated GHG emissions targets in part based on the JI offset projects.

Consider as an example in a CDM context, where a host country has set as a target to improve its energy efficiency to a certain benchmark. A CDM project which serves to reach (or surpass) this benchmark then cannot be fully credited to a buyer country. Doing so would lead to double counting, as part of the credit given to the buyer, would also be given to the seller; this would create double counting. In such cases, an “own contribution” would result by necessity.

In other cases, whether “own contributions” should be accounted for might be viewed as optional. Consider a case where a host or seller country itself targets to reduce its emissions from the electricity sector (below a given baseline) by 20%. The relevant question to raise here is then whether this percentage share should be broken down to the level of the individual CDM project. If so, 20% of the offsets created by an electricity sector offset project could not be credited to the buyer; this would constitute an “own contribution”.

A question arising here is whether a “breaking-down” of such a target to the level of the individual offset project, when such break-down is not required by the nature of the target, is rational or reasonable. In my view such breaking-down is not warranted in general. A main point here is that an overall intensity target for a given sector involving many units ought to be implemented on a case-by-case basis with the greatest intensity reduction for the projects with the greatest promise for such reduction. But double-counting needs to be avoided: emissions reductions that are credited toward host country targets cannot at the same time be used to offset buyer countries.

There is in my view, rather generally, no compelling justification from economic theory why such offset projects should not be fully credited to the buyer (as long as they are not credited toward a country target set by the host country). The less than full crediting situation would lead to loss of efficiency relative to full crediting. And there is neither any logical reason for tying the overall mitigation ambition of the host country to similar “ambitions” for individual projects.

One might, similarly, argue that when a mitigation project in a host country is the result of payments (in full) for offset provided by a buyer, the resulting mitigation should be credited to the buyer and not toward a host country target. This could constitute a more compelling reason why such “own contributions” cannot be expected on a voluntary basis. And it seems unlikely that individual buyers will refrain voluntarily from capturing their offset benefits. A different issue is however that the country of the buyer (or a group of such countries) may choose to discount its offsets in such cases. The market will
in such cases be subject to similar issues as those resulting under discounting as basis for “atmospheric benefits” as discussed above.

The basic conclusion is then that while offset discounting can be justified and explained from basic economic modeling, it is more difficult to come up with good theoretical explanations for why “own contributions”, should be part of an optimal or economically efficient policy.

7. Conclusions, and climate policy arrangements going ahead

A brief summing-up of the above discussion is that “net mitigation” can to some degree be supported by arguments from economic theory, but only under certain assumptions, all of which amount to pre-existing distortions leading to inefficiencies that can, to some degree, be ameliorated by such policies.

The first and most important issue taken up in this paper, and discussed in section 5 above, is whether a “net atmospheric benefit”, based on offset discounting by policy country offset buyers, can be justified as efficient based on fundamental theoretical-economic arguments from the existing analytical literature. I show that this can be a policy for achieving such “net atmospheric benefits” for a bloc of policy countries, which selects an emissions cap and purchases offsets from another group of countries, where the second group could be either a non-policy, or a policy group of countries. Offset discounting then in fact always leads to net mitigation and in that sense provides a “net atmospheric benefit” for a given set cap.

On the other hand, in cases where the offset market works “relatively smoothly” (so that most of potential low-cost offset projects are first brought to market), offset discounting has the general effect of discouraging offsets, since it leads to a lower price, and consequently lower supply, of these. The increase in total or global mitigation that will result under offset discounting must then take place through sufficiently great increases in mitigation in offset buyer countries. It may thus be argued that a better policy for achieving “net atmospheric benefits” would be to raise the ambition level of the original climate policy, in policy-bloc countries, by tightening their overall emissions cap (or by raising the carbon tax in the case of a tax instrument implementation). Note that offset seller countries under this framework can be countries with climate policies; but still in a distinctly different group than the buyer countries.

I also show that certain types of failure of the markets for controlling GHG emissions lead to additional justification for “net mitigation”. The most important of these are a) a high level of frictions in relevant offset markets; b) high potential supply of offset projects relative to projects that are realized; and c) a high rate of free allocations given to participating policy-country entities, coupled with free-allocation updating based on historical emissions or outputs of the entities. Given that such distortions exist and are significant, the offset market will not work “smoothly” as indicated above, but will be highly distorted. It is then possible to justify both “discounting” of offsets, and that “discounts” result in greater than otherwise mitigation in non-policy countries.

One could also visualize offset discounting as a sometimes useful tool for attaining certain climate policy targets which are widely viewed as desirable. One is to promote small and today insignificant supplier countries in the offset markets, and discourage other (currently dominating) countries. This can be done by differentiating the discount rate by discounting offset substantially for the latter countries, and less
or not at all for the former. One might even consider subsidizing offsets in some latter-group countries. This would not be inconsistent e.g. with the basic objectives of the CDM, as a joint mechanism to promote both mitigation and development in lower-income countries; such differentiation would simply imply that the development aspect be given a more prominent role than currently.

I also show that the alternative to offset discounting that is studied above, namely baseline tightening in offset host countries, also leads to “net atmospheric benefits”, and in a more efficient way. The burden of additional mitigation is here, as under the offset discounting alternative, placed largely on offset host countries, in this case by reducing their ability to sell offsets (while under offset discounting the main factor is a reduced price of offsets achieved by hosts). One problem with such a policy is however the arbitrariness of the tightening of baselines, generally or for individual hosts.

At the end of section 5, I discuss the net atmospheric benefit issue in the context of an endogenous ambition level, relevant for a long-run analysis. The conclusion here is that when policy countries’ overall mitigation targets are set endogenously, there is little scope left for “net atmospheric benefits” as an efficient or rational policy: it will be better for a policy country to contribute to greater global mitigation by tightening its own cap. Thus the net atmospheric benefit concept plays a constructive role for global mitigation only in a relatively short-run context.

The “own contribution” approach (whereby participating “policy countries” voluntarily agree to render some of their offsets as the related emission reductions at the same time work toward targets set or being established by host countries) is more difficult to explain and justify on the basis of traditional arguments from economic theory. One option for implementing an “own contribution” would be to “discount” offsets, when broken down to the individual project level, in proportion to relative emissions reduction targets set by host countries. I find no compelling theoretic arguments in favor of such practices.

It may on the other hand be easier to argue that interests in tighter climate emissions targets, and thus greater “ambition levels”, should instead form the basis for renegotiating existing climate policy agreements, as this could imply a greater potential for achieving globally more favorable outcomes by involving more countries in additional, meaningful, mitigation action; and by increasing the ambition of those countries which already have a policy. The main issue here is that countries with high climate-policy ambitions might fare better by leveraging a potential for increasing their individual ambitions, so as to seek additional policy tightening or action also by other countries. This feature is well-known from the academic literature on climate agreements; see e.g. Barrett (2003); Carraro and Siniscalco (1993); Finus (2001); and Hoel (1991); but it needs reinforcement to the policy community.

My discussion of net mitigation has been framed largely in the context of traditional climate policy mechanisms and architectures. Some of the arguments however apply more widely, or could easily be amended to do so. It is in any case obvious that the lessons gained here, in order to be a useful basis for the analysis of future policy, must be framed in a context of relevant climate policy arrangements going ahead.

It seems however reasonable to predict that the climate policy road going ahead will be more complex and varied than that which has passed so far. This seems clear in the aftermath of the PA. I will here only offer a few general viewpoints, which go beyond the scope of this paper in other respects.
1] When choosing between price or tax mechanisms instead of quantitative incentives to reduce GHG emissions, price mechanisms may sometimes have certain efficiency advantages over quantitative policies; but are often politically more difficult to implement in an efficient way. The choice of mechanism will then need to involve considerations of both efficiency and political feasibility. Also, c-a-t schemes may be preferable over tax schemes in cases where there is the possibility of linking across countries, leading to globally more homogeneous emissions prices.

2] The group of “policy countries” should be expanded as much as possible. Preferably, no major group of countries should remain without a deliberate climate policy; although policy ambition may differ. Ideally, current non-policy countries should be provided incentives to join the policy group of countries through international transfers that are independent of offset mechanisms. The PA should, hopefully, open up for a radical expansion of the set of policy countries, as most countries now are, at least in principle although not in a binding fashion, committed to reducing their GHG emissions.

3] We need to think innovatively about how to apply and implement offset markets and similar schemes for the future. Offsets purchased from non-policy countries can then be used as a supplement to emissions price mechanisms in policy countries, not only to quantitative mechanisms. Policies can also be established whereby offsets are purchased from an international climate policy body, without being part of a formal crediting scheme for policy countries.12 And one may think of solutions where a given country is subject to climate policies (such as emissions taxes) for one sector of the economy, while the rest of the economy faces offset markets.

4] Access to offset markets can be used as leverage to affect emissions policies in offset host countries.

5] When different countries belong to different groups, seek maximal linking so as to avoid costly differences in mitigation costs between groups.

6] “Climate finance” options should be used to incentivize countries to remove harmful policies (such as fossil energy subsidies), and instead engage in active climate policies.

7] Similarly, private markets should be mobilized e.g. for investments in renewable energy.

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12 See in particular Bradford’s (2008) proposed scheme whereby a global institution is set up to purchase emissions mitigation as a global public good. Following Bradford’s untimely and tragic death in February, 2005, this wide-ranging idea has however been all but lost to the economics profession.
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Appendix: Some simple analytics

1. Accounting for net mitigation in the form of “net atmospheric benefit” and “own contribution” with discounting

Most of this analysis will focus on CDM-type offset markets. Here, net mitigation can be accomplished in several ways (as outlined e.g. by Lazarus et al (2013), and Vrolijk and Phillips (2013)). Net mitigation can take the form of a “net atmospheric benefit”, or as an “own contribution”, as these terms are explained in the text above.

I focus on the “net atmospheric benefit” explanation, which is analytically the more interesting case, and follows from discounting of purchased emissions rights in the offset market. This can be considered as implemented by only partially credit one unit of GHG reduction (say, one ton CO2-equivalent) achieved in a host country as offset (and thus in the form of “quantitative discounting”).

The other interpretation of “offset discounting”, to pay a lower price to a unit of emissions reduction (price discounting), would need to go together with taxation of offsets. As argued above, this is not compatible with net mitigation as the volume offsets is not increased under this policy.

Consider then a case where one unit of GHG emissions reduction through offsets is credited to a buyer of offsets with only $\alpha < 1$ units of GHG emissions reduction toward the emissions target for the buying country. Assume that the country has a cap $E_0$ on its emissions. The country emits $E_T (> E_0)$, and meets its target by purchasing $(E_T - E_0)/\alpha$ offsets. Net mitigation (NM), is in this case:

\[
NM = ([1-\alpha]/\alpha) (E_T - E_0).
\]

As long as the overall emissions target $E_0$ is given and unchanged, discounting of offsets will yield a “net atmospheric benefit” ($NM > 0$) as long as $\alpha < 1$; and will be greater when $\alpha$ is smaller, and $(E_T - E_0)$ (the amount of emission reductions credited to the policy bloc) is greater.

I will now introduce an additional source of mitigation, in the form that this country in addition retires (and thus does not use) an amount $E_R$ of its potential quotas, increasing NM equivalently. This could be done either subsequently, after the target has been met through offsets. Mitigation will then in total increase by an amount

\[
NM = ([1-\alpha]/\alpha) (E_T - E_0) + E_R.
\]

Alternatively, the country could first retire an amount $E_R$ of allowances in its ETS; and then let this lead to a reduction in its cap to $E_0 - E_R$; and subsequently purchase additional offsets so as to fulfill its new capped quota. In this case, the increase in mitigation will be

\[
NM = ([1-\alpha]/\alpha) (E_T - E_0) + E_R/\alpha.
\]

Here, mitigation will increase by more since the emissions reduction corresponding to retired quotas is achieved via the offset market (where the discounting rule applies), and not through ex post retirement of quotas as in (2) (where no discounting applies to this part of mitigation). Again the “own contribution” to net mitigation is the same as in (2). The net mitigation taking the form of a “net atmospheric benefit” is however now greater and equals

\[
NM(1) = ([1-\alpha]/\alpha) (E_T - E_0) + E_R/\alpha - E_R = ([1-\alpha]/\alpha) (E_T + E_R - E_0).
\]
A further possible case is here to set $E_f = E_0$, in which case the policy country purchases no offsets initially, but implements a direct reduction in its emissions cap, $E_R$, that also gives rise to an overall reduction in emissions given by

$$\text{(5)} \quad \text{NM}(2) = \frac{(1-\alpha)}{\alpha} E_R,$$

and to offsets in the amount

$$\text{(6)} \quad H(2) = \frac{E_R}{\alpha}.$$

An interesting practical case, to which this modeling argument can be applied, is Norway, which has taken on additional voluntary mitigation (beyond its obligation by the KP) in an amount of about 10% of its allocated quota for the KP implementation period ($= E_R$). This is thus fully an increase in overall mitigation equal to $E_R$ (since $\alpha = 1$), and with additional offsets also equal to $E_R$.

2. **Comparing discounting and conservative baselines as mechanisms for implementing net mitigation**

**Case 1: Discounting of individual offsets**

Call the price of ETS allowances in the primary quota market $q$. Assume also as before that $\alpha$ is the fraction of the quota price that is paid to one unit of actually offset emissions through mitigation below the baseline in offset market host countries. Set also:

- $B =$ baseline emissions for a given offset project
- $E =$ actual emissions in this project

Thus, $B-E =$ achieved mitigation by the project.

The payment to the host is then given by

$$\text{(7)} \quad P_1 = a q(B - E_1)$$

where $E_1$ is project emissions in this case.

Consider the following project costs for the host:

$$\text{(8)} \quad C_1 = C_0 + f(E_1)$$

where $C_0$ is a fixed set-up costs for the project, and $\phi(E_1)$ is the variable cost if implementing an emissions level $E_1$, where $\phi'(E_1) < 0, \phi''(E_1) > 0$ (representing the natural property of such a function that mitigation costs are lower the less ambitious is mitigation; and marginal mitigation costs are higher for more ambitious mitigation).

Consider now the optimal behavior of the host in response to these parameters, given that the host finds an offered mitigation project (potentially) attractive. Calling net profit to the host from a project $G_1$ in this case, we have

$$\text{(9)} \quad G_1 = a q(B - E_1) - C_0 - f(E_1).$$
Maximizing $G_1$ with respect to $E_1$ now yields

$$\frac{dG_1}{dE_1} = -aq \cdot f'(E_1) = 0.$$  

(10)

This solves for the optimal slope of the mitigation function for the host, as follows:

$$f'(E_1) = -aq.$$  

(11)

**Case 2: More conservative baseline**

Assume now that there is full crediting of achieved emission reductions, but that the project baseline is moved, and made tighter and with lower emissions (“more conservative”). Assume then that when the host implements mitigation that leads to emission $E$, only $B - B_0 - E$ is credited to the host; where $B_0$ represents the “degree of tightening” of the baseline. Assume that the host cost function is the same, except that now an emissions level $E_2$ is generally implemented. The host’s net profit function will in this case take the following alternative form:

$$G_2 = q(B - B_0 - E_2) \cdot \alpha \cdot f(E_2).$$  

(12)

Which is now maximized by the host with respect to $E_2$, to select the optimal mitigation level in this case. This now yields:

$$\frac{dG_2}{dE_2} = -q \cdot f'(E_2) = 0,$$  

(13)

with the following solution for the slope of the mitigation function:

$$f'(E_2) = -q.$$  

(14)

The marginal emissions cost (alternatively, marginal benefit from increased mitigation through offsets) is higher here than in case 1 insofar as $\alpha < 1$. Thus there is more mitigation taking place in this case. The impact on the volume of offsets transacted in the offset market is however indeterminate. The reason is that, while emissions reductions are higher “at the margin” relative to the discounting case (as demonstrated from (14)), there is now a reduction in the offset amount as host firms are subject to a reduction in the amount of offset they sell, due to the baseline tightening.

Does net mitigation take place in this case? Yes, because the (arguably, arbitrary) baseline tightening implies that host firms, and consequently most countries, must do some mitigation (by tightening their baselines) before being able to sell any of their offset emissions units in the offset market. The scheme implies, in effect, that hosts are subject to an added burden of mitigation that will constitute the “net mitigation” under this scheme.

Which is more favorable, case 1 or case 2? To study this we must make the two cases comparable. Assume, in particular, that the discounting case (1) is taken as the case of departure and for comparison. Assume then that the parameters $B_0$ and $\alpha$ are calibrated such that the amount of credited mitigation
would be the same in the two cases, given that actual mitigation is the same. This implies, first, for actual mitigation to be the same, that

\[(15) \quad a q(B - E_1) = q(B - B_0 - E_1),\]

where \(E_1\) is actual emissions level in the discounting case.

The second condition is that net mitigation is the same in the two cases given that \(E = E_1\), such that

\[(16) \quad (1 - a)(B - E_1) = B_0,\]

In comparing these two cases, both credited and actual mitigation will be greater in the conservative baseline case than in the discounting case.

I am now interested to compare the discounting and the conservative baseline cases, in terms of welfare and effective mitigation. The main difference between the two is in terms of the seller’s mitigation activity which is greater in the conservative baseline case. Since the seller’s profit would be the same in the two cases for \(E = E_1\) in both, profits must be greater in the conservative baseline case. Achieved offsets are also greater in the latter case. The conservative baseline case then dominates, in welfare terms.

**Glossary of terms used in the paper**

Additionality = GHG emissions reductions achieved via offset projects which would not materialize in the absence of the respective offset mechanisms.

Allowances = GHG emission rights allocated under a cap-and-trade policy, either within an international emissions trading scheme or within an installation-level ETS.

Annex 1 (A1) = List of countries which under the KP have obligations to implement particular GHG emissions levels, for the respective implementation periods.

Baseline = The level of emissions that forms the “starting point” for calculating the amount of real emissions reductions achieved, either via a c-a-t policy in policy bloc countries, or via offsets.

Credits = offsets (see below), used synonymously.

c-a-t = “Cap-and-trade”; a policy mechanism whereby participating countries implement their GHG emissions targets, for respective implementation periods, and which may involve trading of emissions rights both among economic entities within the group of participating countries, and with countries outside of the group (via offsets).

CDM = Clean Development Mechanism; the offset mechanism under the KP where by offsets are purchased from parties in non-Annex 1 countries.

CDM EB = the CDM Executive Board (body that rules on approval of CDM methodologies and crediting).

CER = Certified Emissions Reductions; unit of accounting for certified credits under the CDM.
ERU = Emissions Reduction Unit; unit of accounting for certified credits under JI

EU-ETS = The European Union’s Emissions Trading Scheme, for implementing the agreed-upon GHG emissions reductions under the KP.

GHG = Greenhouse gases; these are the emitted gases that cause climate change and global warming; the most important of which is CO₂ (carbon dioxide).

JI = Joint Implementation: the offset mechanism under the KP whereby offsets are purchased from parties in Annex 1 countries.

KP = The Kyoto Protocol; a global agreement on reductions in GHG emissions under the UNFCCC, signed in Kyoto, Japan, in 1997.

Leakage: Net increases emissions of GHGs “elsewhere”, as a result of emissions being initially reduced as a result of a given set of policies or projects. Leakage can be either positive or negative. Positive leakage leads to reduced global mitigation due to such policies or projects.

Mitigation (of GHGs) = Reduction of GHG emissions below a “baseline” or “business-as-usual” state.

Non-Annex 1 (NA1) = List of countries which under the KP do not have obligations keep their GHG emissions at particular levels.

Offsets = Mitigation of GHG emissions, claimed toward an emissions target by a country different from the country implementing the GHG reductions.

Quotas = allowances, used synonymously.

UNFCCC = United Nations Framework Convention on Climate Change. This is the United Nations’ basis policy framework for limiting and regulating climate gases.

List of mathematical symbols:

B = mathematical symbol for baseline

C = project costs for offset project hosts

E = Mathematical symbol for level of GHG emissions

G = profit function for offset project host

H = mathematical symbol for offset amount

NM = net mitigation

P = payment to project host