Aligning climate action with the self-interest and short-term dominated priorities of decision-makers

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ABSTRACT

The global and long-term nature of climate change conflicts with the self-interest and short-term dominated priorities of decision-makers. Climate change mitigation makes sense at the global level, but not at the level of the individual decision-maker. This conflict has been and remains the main obstacle to effective global cooperation and mitigation. This paper proposes a framework that aligns climate action with short-term self-interest through results-based payments to governments. Its key components are: determining an emission benchmark for each country as well as a price for carbon saving; paying countries annually for reducing emissions below their respective benchmark; a new international fund to finance these annual payments by borrowing capital from private investors; and repaying borrowings in the long-term through payments made by countries to the fund based on a pre-determined allocation mechanism. This framework would offer important benefits over an approach focused on allocating climate action or a carbon budget among countries. These include the improved prospect of reaching an effective climate agreement and delivering fast and dramatic mitigation thanks to stronger political commitment, the transformation of short-term self-interest from an obstacle into a driver of climate action, and the additional financing created. The paper also proposes a pilot scheme focusing on hydrofluorocarbon emissions with a considerably lower financing requirement. This offers the possibility of an alternative financing mechanism, and thus a faster and more straightforward implementation path. Short-term financial incentives offered to governments could turn policy action from a burden into an opportunity from their perspective unlocking a huge potential for timely mitigation.

Key policy insights

- A new international framework that offers short-term, results-based payments to governments to promote mitigation action could lead to much more effective global mitigation and international cooperation.
- The financing of such an approach could be solved through a novel financing structure, backed by the long-term commitments of participating countries and thus aligning the timeframe of the financial costs of mitigation with its climate benefits.
- The effectiveness of results-based payments and the concept behind this new approach could be proven through a pilot scheme focusing on hydrofluorocarbon emissions.

KEYWORDS
Carbon pricing; international climate negotiations; international climate agreements; climate finance; results-based payments; pay for performance

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1. Introduction

The 2015 Paris Agreement offers the international community the best chance yet to tackle climate change. For the first time, all countries are expected to undertake mitigation actions towards a common quantified goal, in the form of voluntary nationally determined contributions (NDCs). Strengthening cooperation and increasing the effectiveness of global efforts is now critical to ensuring the Paris Agreement lives up to its potential. The considerable gap between the sum of NDCs and the global goal of keeping average global warming to the 'well below' 2 °C target, let alone the 1.5 °C aspiration, needs to be closed (Höhne et al. 2017), yet global cooperation remains fragile to changing political priorities at the national level. Short-term thinking and narrowly viewed self-interest, two of the most powerful forces of political, social and economic reality, are key threats to the Paris Agreement's implementation. The lessons of history highlight that the risks of failure are very real. Voluntary action has in no area succeeded to solve the undersupply of a public good especially in case of a global public good such as a safe climate (Stiglitz 2015).

This paper argues that the key obstacle for effective and timely climate change mitigation is the conflict between the nature of climate change – which requires long-term, global thinking - and political and social reality – which is dominated by short-term, local priorities. First, the atmosphere is a shared, global resource and it suffers from the dynamics associated with the tragedy of the commons (Hardin 1968). The burden of climate change mitigation is borne by those who act, while the benefits are shared by everyone globally. In a world of self-interested nations and individuals this creates the problem of free riders and leads to insufficient mitigation action (e.g. Barrett 1990). Moral arguments stressing the impact on future generations and the world's poor have proven insufficient, and an effective solution has to appeal to people's and countries' self-interest (Broome 2017). Second, mitigation involves upfront costs, but its benefits materialize over a very long period. This contrasts with the dominance of short-term thinking and focus in politics and business, resulting in climate action being deferred to the future. As a UK House of Commons report notes 'Governing for the future is … difficult because it rubs up against the short-termism that is inherent in the politics of the electoral cycle. Its difficulty is compounded when governing for the future involves painful choices in the present' (House of Commons 2007)[1]. These conflicting interests and time horizons help explain the insufficient political will witnessed to date. Notwithstanding its achievements, the Paris Agreement, with its reliance on non-binding, voluntary contribution targets and a periodic review process, does not resolve these conflicts. Rather than countries' short-term self-interest, it appeals to their ambition, and relies on peer pressure and long-term benefits to entice them to act. There are, of course, other factors at play beyond the mismatch between long-term global and short-term self-interest driven objectives, such as the concentration of mitigation's impact on certain economic sectors compared with the broadly diffused impact of non-action; the fragmentation of power across a widely diverse group of countries; the asymmetry between the responsibility for the problem and the vulnerability to its effects and between poor and rich countries; and the path dependency and lock-in effects of economic systems; all of which contribute to the complexity of the challenge (Underdal 2017).

The aim of this paper is to outline and make the case for a new global framework that is designed for, and indeed utilizes, the reality of self-interested and short-term-oriented countries and decision-makers. Using an innovative approach to global cooperation and by transforming incentives, the proposed framework not only hopes to overcome these obstacles, but also to turn them into drivers of fast and effective climate change mitigation. It seeks to achieve this by offering short-term financial incentives to governments[2], and thus make mitigation action a rational choice at the level of decision-makers. Further, it would create additional financing provided by private sector investors to support the transition to a decarbonized economy, while pushing the financial costs of this transition into the future. Thus, it could provide a major contribution to the successful implementation of the Paris Agreement and the achievement of global temperature goals.

2. Overview of the proposed framework

The proposed framework can be summarized as follows:

- A new international framework is agreed[3] between participating countries. Participation for countries is voluntary, but the framework is binding for participating countries once they sign up for it.
- The framework determines a future net greenhouse gas emission profile for each country, the country's emission benchmark (referred to as the 'benchmark'). Importantly, the benchmark would not be framed as a commitment or an emission cap.
- The framework also determines a price per unit of net emission saving (referred to as the 'price for carbon saving').
- Under the framework, countries emitting less than their emission benchmark in any year receive an annual cash payment made to the national government. The payment equals the product of the price for carbon saving and the number of units by which the country's actual net emissions are below its benchmark for the year.
- In order to make these payments, the framework establishes an international fund (the 'Fund'). The Fund finances the annual payments made to countries by borrowing from private investors for the long term, for example through issuing long-term bonds. The bonds offer a financial return to investors similar to government or multilateral development bank debt.
- The creditworthiness of the Fund is supported by the international framework and the financial backing of participating countries. The liability of the Fund including interest is repaid in the long-term future through the payments of participating countries to the Fund. The allocation of future payments among countries is based on a pre-determined percentage or formula. For instance, it could reflect countries' share of future net carbon emissions under the respective benchmarks. The important point is that this share of future liabilities is independent of the annual payments countries receive from the Fund for cutting their emissions.

A simplified three-country example together with a more detailed discussion of the financing of the Fund's operations in the online appendix illustrates how the Fund would work.

3. Discussion of the proposed framework

3.1. Agreeing emission benchmark levels for individual countries

Agreeing an allocation of emissions and individual commitments among countries is one of the main challenges of reaching an effective international agreement on climate change. Determining the emission benchmark for each country will be a contentious issue under the proposed framework too. However, for the following reasons, it is considered to be more realistic than agreeing emission caps or allocating carbon budgets.

The benchmarks would be neither commitments, nor legally binding caps. There would be no potential penalties or direct transfers among countries, which would make an agreement on benchmarks more attractive from a political perspective. Further, the sum of individual benchmarks could exceed the targeted total global emissions without risking the success of the scheme, because the price for carbon saving would remain intact and the payment mechanism would create a powerful incentive for every country to emit less than its benchmark. Thus, subject to the predetermined price for carbon saving, total emissions would be highly likely to be lower than the sum of the benchmarks. A framework with higher (i.e. weaker) benchmarks would be more appealing for governments for a variety of reasons, not least because higher benchmarks would mean higher potential short-term receipts from the Fund. However, unlike in a cap-and-trade system with higher caps, the incentive to cut emissions would remain.

Countries could join in stages and, thus, the framework could be launched without every country

participating and agreeing on benchmarks at the same time. This would reduce the risk of a small number of countries sabotaging or delaying an agreement, attempting to capitalize on such a threat to improve their negotiating position, or holding out in the hope of more favourable terms. Even in such a scenario, the framework could determine the emission benchmarks or underlying principles for countries not yet joining. The framework could also deal with uncooperative behaviour, such as a country not joining the framework, thus contributing neither to emission cuts nor to their financial costs. Countries not participating could be subject to trade sanctions, which can be effective (Nordhaus 2017) and can conform to WTO rules (Stiglitz 2006).

Importantly, through its near term annual payments offered to governments, the framework would create a strong incentive for them to find an agreement on benchmark levels and to join. In a world dominated by short-term thinking by decision-makers, the short-term benefit of joining - making a profit on emission abatement and securing additional income for the government - would be an important motivating factor.

The possibility of linking the allocation of the Fund's long-term liabilities to countries' overall emission benchmarks in some form, for example by allocating future liabilities proportional to the sum of annual emission benchmarks over a certain period, could create an offsetting long-term cost to having a higher benchmark. Clearly, this trade-off would be most significant for the largest emitters and could contribute to finding an agreement on benchmarks among them.

3.2. Determining the price per unit of net greenhouse gas emission saving

Setting the price for carbon saving at the right level would be essential to the success of the plan. This price level would be the most important factor determining the level of abatement achieved. It should provide a strong incentive for countries to join the framework and subsequently to reduce emissions. Accordingly, it should be set with reference to the estimated cost of net carbon abatement across countries and its expected impact on emissions. The price signal would favour cutting emissions through the most cost-efficient ways. Countries' different circumstances mean they have different abatement potential, which could be reflected in the allocation of emission benchmarks or the allocation of future financial contributions.

The proposed framework would have the flexibility to use a dynamic price for carbon saving, such as a pre-determined price path or a price indexed to certain variables. A dynamic approach or a periodic review might be necessary to adjust the price for carbon saving in light of the abatement achieved and/or other lessons learnt during implementation. This flexibility would have to be balanced against predictability, which is an important feature of a successful price signal for long-lived investments, and establishing principles for future reviews could help promote predictability.

It is worth noting that, in contrast to proposals promoting a global carbon price (e.g. Cramton, MacKay, Ockenfels,& Stoft, 2017), participants would have a strong short-term and self-interest-based motivation to set the price at a sufficiently high level. As the Fund's payments represent a financial transfer from the future to the present, a higher price for carbon saving would mean higher transfers to the present.[4] The framework would also create a global carbon price signal without constraining national policy flexibility or requiring an international enforcement mechanism.

3.3. Agreeing the allocation of future financial costs

Together with determining the emission benchmarks, the sharing of future costs, i.e. the repayment of the Fund's liabilities, among participants will require an undoubtedly difficult political agreement. Agreeing this allocation of future liabilities should, however, be easier than allocating short-term abatement commitments for a number of reasons.

The proposed framework would offer a lower risk of unreciprocated action. Under the current approach of committing to emission cuts, countries take the risk of free-ridership i.e. that other countries do not deliver on their commitments. Under the proposed framework, a country would

commit only to its share of future liabilities that are linked to emission cuts actually delivered against the benchmarks. Hence, the risk of free-ridership and unreciprocated action would be reduced.

Pushing financial costs into the future would also increase the prospect of reaching an agreement on cost sharing. This is due to the dominance of short-term considerations among most decision-makers' priorities and the tendency to discount long-term costs heavily, especially if there is the possibility of short-term gains.

In addition, a framework that promises to be more effective and less risky has a better chance of being reached. Even though countries are likely to have different views on how to allocate costs fairly and equitably, these differences might be overcome by the prospect of an effective mitigation framework.

Linking the future cost allocation to countries' emission benchmarks in some form (as discussed in section 3.1) would also represent an opportunity to create a trade-off between higher benchmarks and higher future cost allocations. This could contribute to reaching an agreement on both these questions.

3.4. Financing the operations of the Fund

Attracting sufficient, low-cost private capital to finance the annual payments to participants will be critical for the framework's success. In turn, ensuring the Fund has strong credit worthiness based on the financial backing of participating countries and a robust political and legal framework will be important.

The financing structure's attractiveness to investors could be optimized. As an example, participants could collectively over-collateralize their commitment to deal with the potential default of some participants, for example members could provide a guarantee for 105% of their respective share of the Fund's liabilities. In addition, countries' obligations to the Fund could be structured to benefit from the preferred creditor status of multilateral organizations like the IMF and therefore rank higher than unsecured commercial creditors. Further, the Fund's credit quality and the market for its bonds could be enhanced by linking membership in international organizations, such as the WTO, IMF or World Bank, to countries' honouring their commitments to the Fund and by making its bonds eligible as international reserve assets (Broome and Foley 2016). Positioning its bonds as sustainable investment could be an additional attraction.

The long-term financial strength and robustness of the Fund are important both for private investors and for participating countries. Checks and covenants could ensure that the finances of the Fund are sustainable irrespective of future developments. One such mechanism could be establishing a cap on total annual payments. If the sum of individual entitlements from the Fund exceeds this cap, all payments could be scaled back on a pro-rata basis either by reducing the price for carbon saving or by lowering the individual benchmarks. The former would reduce the marginal benefit of additional emission cuts, while the latter would keep the price signal intact. A second safeguard against an unsustainable build-up of the Fund's debt could be capping its liabilities to those relating to a certain period on a rolling basis. As an example, setting this period at 20 years, all liabilities that relate to the period preceding the past 20 years would always need to be repaid through contributions from participants as opposed to through new debt issuance. Such covenants would also mitigate the risks of prediction errors. The example set out in the online appendix examines the ability to finance the framework in detail.

Importantly, neither of these covenants would significantly reduce the incentive of countries to join and to curb emissions. Twenty years is likely to be long enough for decision-makers to discount future obligations in light of short-term gains. Similarly, even if an annual cap on Fund payments is operational, any marginal reduction a country could achieve would still secure it a larger share of the overall payments.[5]

3.5. Equity among countries

The framework offers significant flexibility in terms of its distributional effects. The two most important drivers in this regard are the individual emission benchmarks of countries and the allocation of the Fund's future liabilities. To achieve the desired equity outcome, countries' emission benchmarks could, for example, reflect their current stage of economic and social development, their projected development, and their differing mitigation potential and costs. The allocation of future liabilities could reflect considerations such as the economic strength of countries and their historic contribution to global greenhouse gas emissions. As both emission benchmarks and the allocation of future liabilities can be determined along a broad spectrum without risking the mitigation objective and its effectiveness, the framework offers a wide range of potential equity outcomes and thus flexibility for international negotiations.

3.6. Legal and institutional setup

The implementation of the proposed framework raises a number of legal and institutional questions. These include the question of the most suitable form of international law instrument, such as an international treaty or accord, and their advantages and disadvantages. Another question concerns the relationship and coordination between the proposed framework and the Paris Agreement and its implementation mechanisms. A related consideration is the ideal institutional setup. A separate institution, implementation under the UNFCCC, the World Bank or other international organizations could be explored, each of which would have different implications for governance and the cost-efficiency of implementation.

The political and technical challenges of agreeing a new international framework should not be underestimated. The scope of the above analysis from a political economy, international relations, legal and governance perspective is clearly limited and does not capture the important cleavages and coalitions of climate diplomacy. Further developing it to reflect these aspects or to consider implementation with the participation of sub-national actors should be the subject of additional research.

4. A pilot scheme focusing on hydrofluorocarbon emissions

The viability and benefits of the proposed mechanism of offering short-term financial incentives to national governments to promote policy action could be tested, and hopefully demonstrated, through a pilot scheme with a more limited scope, and thus with faster and easier implementation. Hydrofluorocarbon (HFC) emissions would be an attractive candidate for such a pilot scheme.

HFCs are short-lived greenhouse gases with a very high global warming potential and their global emissions are growing at 10–15% p.a. (IGSD 2016). The Kigali Amendment to the Montreal Protocol aims to limit and eventually reduce emissions of HFCs through a differentiated phasedown of HFCs across countries over the next three decades. This phasedown is projected to avoid over 70 GtCO2e emissions by 2050 (EIA 2016b) and additional indirect emissions through improved energy efficiency. HFC emission reductions are very cost-effective with their abatement cost estimated to be in the range of $0.05–$0.54/CO2et (EIA 2016a) even without assuming significant technological advances.

Faster emission reductions than those mandated by the Kigali Amendment represent a great opportunity for climate change mitigation. A more ambitious and complete phase-out by 2020 could reduce greenhouse gas emissions by 100–200 GtCO2e by 2050 and avoid up to 0.5 C warming by 2100 (IGSD 2016).

The proposed framework could help capitalize on this opportunity by offering countries annual payments to reduce their respective HFC emissions beyond the caps established by the Kigali Amendment. The implementation of such a scheme would be facilitated by the emissions caps agreed under the Kigali Amendment, which could serve as benchmarks for the scheme; the cost-effectiveness

of these emission reductions, which means that even a very low price for carbon saving, e.g. $1/CO2e ton, could provide a strong incentive; and the track-record of the Montreal Protocol's organizations and processes. The very significant climate benefits that such a scheme could deliver in its own right also make it an attractive area for a pilot scheme.

Further, the HFC scheme would have a much lower financing requirement thanks to its more limited scope and cost-effectiveness. This opens up the possibility of an alternative financing mechanism, one relying on unilateral donations or carbon investments. Businesses, governments or other organizations pursuing carbon targets could finance the scheme voluntarily in exchange for inexpensive carbon credits. This could further speed up implementation of the scheme, as it avoids the need for a new international agreement or the support of governments. Governments would not need to commit to anything and the scheme would simply offer them cash payments for faster emission reductions.

Such an HFC scheme could not only deliver very meaningful climate benefits, but could also prove the concept of accelerating policy action through financial incentives and pave the way towards a more comprehensive scheme.

5. Conclusion

The paper proposes a new framework to reinforce and boost international climate cooperation. The idea is to resolve the conflicting timescales and global versus local interests that exist between the nature of climate change and political, economic and social realities. The framework would align climate action with the self-interest of decision-makers, as it decoupled financial costs from taking action. The cost for any country, i.e. its share of the Fund's future liabilities, would be independent of whether it, or another country, reduced emissions by a certain amount. This would transform countries' incentives from free riding on others' efforts to maximizing their benefits from the Fund. Currently, mitigation efforts are characterized by individual costs and shared benefits. Under the proposed framework, climate action would result in individual benefits and shared costs. The framework would also align climate action with the time horizon of decision-makers, as borrowing by the Fund would push the financial burden into the future. Consequently, the benefits and costs of mitigation would both materialize in the future and be more closely aligned in time. This would improve the prospect of governments taking action, as short-term costs would be replaced by short-term benefits from their perspective. Clearly, this approach would imply leaving a financial debt to the future. However, as long as the costs of today's mitigation were smaller than the future costs and risks linked to the climate impact of no mitigation, leaving a financial debt to the future would be preferable to a dangerously changed climate. Due to its alignment with short-term and local priorities, the framework would support strengthened political commitment to mitigation and global cooperation, and could deliver rapid and effective climate change mitigation.

Importantly, the framework would raise significant additional financing from private investors and distribute these funds to individual countries. These could help finance the investment needed for the low-carbon transition and secure the necessary political and public support, for example, through compensation for the losers of the transition (e.g. regions dependent on coal).

This paper focuses on climate change mitigation. However, the concept and mechanism it proposes could be used to address other problems arising as a result of a conflict between the short-term self-interest of individual actors and the long-term shared interest of a group. Rewarding an action that is in the long-term interest of the group through short-term incentives offered to individual actors together with a pre-determined sharing of the incentives' financing costs could for example help secure investment in other ecological services, address certain challenges in public health or education, undertake large scientific or technological projects, or deal with the consequences of immigration affecting a larger community.

The best way to consolidate the achievements of the Paris Agreement and achieve its goal is to align climate action with the short-term self-interest of nations. Taking global cooperation to this next

level could dramatically boost climate action. The framework proposed in this paper, while it clearly needs further development and is not without its challenges, offers a new approach towards this goal.

Notes

1. For another discussion of short-termism in political decision-making refer to Boston (2014).
2. While recognising the important role in climate action of sub-national actors, the focus of this proposed framework is on national governments, which are able to deploy a wide range of policy tools to direct emission reductions.
3. The legal form that the framework would take remains to be decided.
4. For a discussion of the effects of social borrowing, see Broome and Foley (2016).
5. It is interesting to note that such a scenario with an annual payment cap by the Fund bears similarity to the tragedy of the commons, but in this case, the common resource overused is the Fund's annual payment pool. Individual countries' interest is to cut emissions beyond the level that would maximise their collective short-term benefits defined as the sum of Fund payments less the cost of abatement.

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APPENDIX

Examining the Fund's financials and countries' incentives through an example

Let us consider an example in order to illustrate the financing sources and uses of the Fund and countries as well as the incentives of individual countries. The following three-country example is based on the following assumptions.

(1) The agreement comes into effect and the Fund starts operations in 2017.
(2) The price of carbon is set at USD 50 per ton of CO2e in 2017 prices. All figures in the example are in 2017 real values.
(3) The three countries A, B and C are assumed to have an equal share, 18 GtCO2e, of total carbon emissions amounting to 54 GtCO2e globally in 2016.
(4) Total emission benchmarks are assumed to be flat at 18 GtCO2e, the 2016 level, for all three countries for the entire period until 2050. To put this assumption into perspective, the sum of unconditional Intended Nationally Determined Contributions under the Paris Agreement by 2030 is 56 GtCO2e (UNEP, 2015), which roughly equals current global emission levels.
(5) The marginal cost of abatement compared to initial emission levels is a linear function of the size of emission cuts and declines over time. This decline reflects that a more gradual decarbonization can be achieved at a lower cost than a rapid one. MAC(i) = k(i) * q(i) / t, where MAC(i) is the marginal cost of abatement for country i; k(i) is a constant specific to country I; q(i) is the quantity of abatement by country i; and t is the number of years passed. k(A) is assumed to be 150 USD/t, k(B) is 175 USD/t and k(C) is 200 USD/t meaning that country A can cut emissions at a lower cost than B and C.
(6) Countries optimize their abatement i.e. they cut emissions until the marginal cost of abatement equals the carbon price.
(7) Real interest expense is assumed to be 1.5% p.a. Compared to current market conditions this implies a rise in interest rates. (Note that this example was created in 2016)
(8) Global GDP is assumed to be USD 85 trillion in 2017 and is assumed to grow by 3% p.a. in real terms in the future.
(9) The Fund is assumed to have an annual payment cap of USD 1,000 billion in 2017 real terms.
(10) The allocation of the Fund's liabilities, i.e. countries' future contributions to the Fund, is based on their respective share of aggregate emission benchmarks. In this example, this means that each country carries one third of future liabilities.
(11) In order to limit an unsustainable build-up of the Fund's debt, liabilities (including related interest costs) incurred more than 20 years earlier are assumed to be repaid through contributions by participants as opposed to through new debt issuance by the Fund.

Note that these assumptions lead to results that are broadly consistent with a path of keeping global warming below 2 °C with a probability of >66%. Such a path requires that global emissions are cut to 42 GtCO2e by 2030 and to 23 GtCO2e by 2050 (UNEP, 2015). In this example, global emissions amount to 42 GtCO2e by 2030 and to 24 GtCO2e by 2050. Clearly, the level of abatement is dependent on the carbon price and the abatement cost function of countries among others. Estimating the abatement cost function, calibrating the carbon price and thus targeting a certain level of abatement is beyond the scope of this paper. The focus of the paper and this example is to discuss the features of the proposed framework and the incentives it creates.

Table 1 shows the financials of the Fund.

Table 1. Fund financials

Year	Year	Total abatement v benchmarks (GtCO2e)	Carbon price (USD/tCO2e)	Annual financing need (USDbn)	Financing from members (USDbn)	Cumulative debt incl interest (USD bn)	Global real GDP (USD bn)	Cumulative liability as % of global GDP
1	2017	0.9	50.0	43	0	43	85,000	0.1%
2	2018	1.7	50.0	87	0	131	87,550	0.1%
3	2019	2.6	50.0	130	0	263	90,177	0.3%
4	2020	3.5	50.0	174	0	441	92,882	0.5%
5	2021	4.3	50.0	217	0	665	95,668	0.7%
6	2022	5.2	50.0	261	0	936	98,538	0.9%
7	2023	6.1	50.0	304	0	1,254	101,494	1.2%
8	2024	7.0	50.0	348	0	1,620	104,539	1.5%
9	2025	7.8	50.0	391	0	2,036	107,675	1.9%
10	2026	8.7	50.0	435	0	2,501	110,906	2.3%
11	2027	9.6	50.0	478	0	3,016	114,233	2.6%
12	2028	10.4	50.0	521	0	3,583	117,660	3.0%
13	2029	11.3	50.0	565	0	4,202	121,190	3.5%
14	2030	12.2	50.0	608	0	4,873	124,825	3.9%
15	2031	13.0	50.0	652	0	5,598	128,570	4.4%
16	2032	13.9	50.0	695	0	6,377	132,427	4.8%
17	2033	14.8	50.0	739	0	7,211	136,400	5.3%
18	2034	15.6	50.0	782	0	8,102	140,492	5.8%
19	2035	16.5	50.0	826	0	9,049	144,707	6.3%
20	2036	17.4	50.0	869	0	10,053	149,048	6.7%
21	2037	18.3	50.0	913	59	11,058	153,519	7.2%
22	2038	19.1	50.0	956	117	12,063	158,125	7.6%
23	2039	20.0	50.0	999	176	13,068	162,869	8.0%
24	2040	20.9	50.0	1,000	234	14,030	167,755	8.4%
25	2041	21.7	50.0	1,000	293	14,948	172,787	8.7%
26	2042	22.6	50.0	1,000	351	15,821	177,971	8.9%
27	2043	23.5	50.0	1,000	410	16,648	183,310	9.1%
28	2044	24.3	50.0	1,000	468	17,430	188,810	9.2%
29	2045	25.2	50.0	1,000	527	18,165	194,474	9.3%
30	2046	26.1	50.0	1,000	585	18,852	200,308	9.4%
31	2047	26.9	50.0	1,000	644	19,491	206,317	9.4%
32	2048	27.8	50.0	1,000	702	20,081	212,507	9.4%
33	2049	28.7	50.0	1,000	761	20,621	218,882	9.4%
34	2050	29.5	50.0	1,000	819	21,111	225,448	9.4%

The example uses a scenario with high financing needs by the Fund. Emission benchmarks are kept flat at current levels until 2050, implying limited willingness by countries to contribute to global mitigation without financial incentives. At the same time, actual emissions are assumed to be cut to levels that are consistent with a 2 °C warming path and the carbon price is set at a meaningful level. Even under this high financing need scenario, the Fund's cumulative liabilities peak at a level below 10% of global GDP. This, of course, is a significant level of debt, and in order to motivate countries to join and act, it has to be, as they will be the beneficiaries of the annual payments. To the extent more ambitious benchmarks can be agreed, the financing requirements could be reduced. However, even this level of debt could be financed by private investors, especially considering the gradual rise in the Fund's debt over 30 years. To put these financing requirements into perspective, global non-financial sector debt increased by USD 50 trillion during the six and half years between the fourth quarter of 2007 and the second quarter

of 2014 (MGI, 2015). This represents an approximately 25 percentage point increase as a proportion of global GDP.

The impact of the annual payment cap for the Fund, which becomes effective after 24 years, and the contributions from countries from year 21 onwards can also be seen in the example. Both have a limiting effect on the build-up of the Fund's liabilities.

Tables 2, 3 and 4 show the perspective of individual countries.

Table 2. Individual country perspective through a three-country example: Abatement

		Emissions becnhmark			**Emission abatement**		
Year	Year	Q(A) (GtCO2e)	Q(B) (GtCO2e)	Q(C) (GtCO2e)	q(A) (GtCO2e)	q(B) (GtCO2e)	q(C) (GtCO2e)
1	2017	18	18	18	0.33	0.29	0.25
2	2018	18	18	18	0.67	0.57	0.50
3	2019	18	18	18	1.00	0.86	0.75
4	2020	18	18	18	1.33	1.14	1.00
5	2021	18	18	18	1.67	1.43	1.25
6	2022	18	18	18	2.00	1.71	1.50
7	2023	18	18	18	2.33	2.00	1.75
8	2024	18	18	18	2.67	2.29	2.00
9	2025	18	18	18	3.00	2.57	2.25
10	2026	18	18	18	3.33	2.86	2.50
11	2027	18	18	18	3.67	3.14	2.75
12	2028	18	18	18	4.00	3.43	3.00
13	2029	18	18	18	4.33	3.71	3.25
14	2030	18	18	18	4.67	4.00	3.50
15	2031	18	18	18	5.00	4.29	3.75
16	2032	18	18	18	5.33	4.57	4.00
17	2033	18	18	18	5.67	4.86	4.25
18	2034	18	18	18	6.00	5.14	4.50
19	2035	18	18	18	6.33	5.43	4.75
20	2036	18	18	18	6.67	5.71	5.00
21	2037	18	18	18	7.00	6.00	5.25
22	2038	18	18	18	7.33	6.29	5.50
23	2039	18	18	18	7.67	6.57	5.75
24	2040	18	18	18	8.00	6.86	6.00
25	2041	18	18	18	8.33	7.14	6.25
26	2042	18	18	18	8.67	7.43	6.50
27	2043	18	18	18	9.00	7.71	6.75
28	2044	18	18	18	9.33	8.00	7.00
29	2045	18	18	18	9.67	8.29	7.25
30	2046	18	18	18	10.00	8.57	7.50
31	2047	18	18	18	10.33	8.86	7.75
32	2048	18	18	18	10.67	9.14	8.00
33	2049	18	18	18	11.00	9.43	8.25
34	2050	18	18	18	11.33	9.71	8.50
Total 2017-2050		**612**	**612**	**612**	**198**	**170**	**149**

Table 2 illustrates that the country with lowest marginal abatement cost, country A, achieves the highest abatement level. It can also be seen that abatements increase overtime, as the abatement cost function assumes that the longer the adjustment period, the lower the marginal cost of abatement for any given quantity.

Table 3. Individual country perspective through a three-country example: Cash flows

		Payment received			**Contribution to Fund**			**Gross Profit**			**Discounted Gross Profit**		
Year	Year	P(A) (USDbn)	P(B) (USDbn)	P(C) (USDbn)	C(A) (USDbn)	C(B) (USDbn)	C(C) (USDbn)	GP(A) (USDbn)	GP(B) (USDbn)	GP(C) (USDbn)	PV GP(A) (USDbn)	PV GP(B) (USDbn)	PV GP(C) (USDbn)
1	2017	17	14	13	0	0	0	17	14	13	16	14	12
2	2018	33	29	25	0	0	0	33	29	25	30	26	23
3	2019	50	43	38	0	0	0	50	43	38	43	37	32
4	2020	67	57	50	0	0	0	67	57	50	55	47	41
5	2021	83	71	63	0	0	0	83	71	63	65	56	49
6	2022	100	86	75	0	0	0	100	86	75	75	64	56
7	2023	117	100	88	0	0	0	117	100	88	83	71	62
8	2024	133	114	100	0	0	0	133	114	100	90	77	68
9	2025	150	129	113	0	0	0	150	129	113	97	83	73
10	2026	167	143	125	0	0	0	167	143	125	102	88	77
11	2027	183	157	138	0	0	0	183	157	138	107	92	80
12	2028	200	171	150	0	0	0	200	171	150	111	95	84
13	2029	217	186	163	0	0	0	217	186	163	115	98	86
14	2030	233	200	175	0	0	0	233	200	175	118	101	88
15	2031	250	214	188	0	0	0	250	214	188	120	103	90
16	2032	267	229	200	0	0	0	267	229	200	122	105	92
17	2033	283	243	213	0	0	0	283	243	213	124	106	93
18	2034	300	257	225	0	0	0	300	257	225	125	107	93
19	2035	317	271	238	0	0	0	317	271	238	125	107	94
20	2036	333	286	250	0	0	0	333	286	250	126	108	94
21	2037	350	300	263	(20)	(20)	(20)	330	280	243	119	101	87
22	2038	367	314	275	(39)	(39)	(39)	328	275	236	112	94	81
23	2039	383	329	288	(59)	(59)	(59)	325	270	229	106	88	75
24	2040	384	329	288	(78)	(78)	(78)	306	251	210	95	78	65
25	2041	384	329	288	(98)	(98)	(98)	286	231	190	84	68	56
26	2042	384	329	288	(117)	(117)	(117)	267	212	171	75	60	48
27	2043	384	329	288	(137)	(137)	(137)	247	192	151	66	51	40
28	2044	384	329	288	(156)	(156)	(156)	227	173	132	58	44	34
29	2045	384	329	288	(176)	(176)	(176)	208	153	112	51	37	27
30	2046	384	329	288	(195)	(195)	(195)	188	134	93	44	31	21
31	2047	384	329	288	(215)	(215)	(215)	169	114	73	37	25	16
32	2048	384	329	288	(234)	(234)	(234)	149	95	54	31	20	11
33	2049	384	329	288	(254)	(254)	(254)	130	75	34	26	15	7
34	2050	384	329	288	(273)	(273)	(273)	110	56	15	21	11	3
Total 2017-2050		**8,819**	**7,559**	**6,614**	**(2,048)**	**(2,048)**	**(2,048)**	**6,771**	**5,511**	**4,566**	**2,774**	**2,308**	**1,958**
	2051-2070	0	0	0	(8,274)	(8,274)	(8,274)	(8,274)	(8,274)	(8,274)	(951)	(951)	(951)
Total 2017-2070		**8,819**	**7,559**	**6,614**	**(10,323)**	**(10,323)**	**(10,323)**	**(1,504)**	**(2,763)**	**(3,708)**	**1,823**	**1,357**	**1,008**

Table 3 illustrates the cash flows between countries and the Fund. It also shows the gross profit of countries, which is simply the difference between the annual payments received from the Fund and contributions made to the Fund. It is shown that country A receives higher payments than country B and C as a result of its higher abatement levels. However, the contribution of countries to the Fund follows a pre-determined formula based on the emission benchmarks and, accordingly, the contribution of the three countries are equal. Consequently, the gross profit differs among countries. The gross profit outcome could be made more equitable by setting individual emission benchmarks with reference to countries' potential to curb emission i.e. their implied abatement cost function. In the above example this would imply a lower emission benchmark for country A be than for country B and C.

Table 3 also shows discounted gross profits. This reflects the fact that decision-makers place a higher value on near term cash flows than more distant ones, which is one of the premises of the

proposed plan. The example assumes a discount rate of 5% p.a. In order to incorporate future liabilities in the discounted total, the example assumes that the Fund ceases to make payments to countries after 2050, but countries continue to make their contributions as before and repay the Fund's liabilities over the period 2051-2070. Note that this assumption makes the example conservative as it ignores benefits that the continuation of the plan could offer.

As gross profit does not include the cost of abatement, it measures the benefit a country gets from joining the agreement compared to not participating in it with equal levels of abatement between the two scenarios. The example shows that all three countries, including country C, which receives the smallest payments in relation to its fixed contribution, derive a significant overall benefit from the Fund. The total discounted gross profit depends, of course, on the discount rate. However, the positive result for all countries is robust to changes in the discount rate. The rate would have to be as low as 2.2% p.a. for the impact on country C to turn negative. Collectively, the countries will derive a positive benefit as long as the interest paid by the Fund is lower than decision-makers' discount rate. It is fair to assume that the discount rate decision-makers apply explicitly or implicitly is considerably higher and the limited climate action to-date is evidence of this. If future climate and co-benefits benefits were discounted at a rate of 2% or less, mitigation would be seen as very compelling. This could have helped overcome other hurdles and we should have seen a lot more abatement than we have seen to date.

Table 4. Individual country perspective through a three-country example: Costs and profits

		Cost of Abatement			**Discounted Cost of Abatement**			**Net Profit**			**Discounted Net Profit**		
Year	Year	c(A) (USDbn)	c(B) (USDbn)	c(C) (USDbn)	PV C(A) (USDbn)	PV C(B) (USDbn)	PV C(C) (USDbn)	NP(A) (USDbn)	NP(B) (USDbn)	NP(C) (USDbn)	PV NP(A) (USDbn)	PV NP(B) (USDbn)	PV NP(C) (USDbn)
1	2017	(8)	(7)	(6)	(8)	(7)	(6)	8	7	6	8	7	6
2	2018	(17)	(14)	(13)	(15)	(13)	(11)	17	14	13	15	13	11
3	2019	(25)	(21)	(19)	(22)	(19)	(16)	25	21	19	22	19	16
4	2020	(33)	(29)	(25)	(27)	(24)	(21)	33	29	25	27	24	21
5	2021	(42)	(36)	(31)	(33)	(28)	(24)	42	36	31	33	28	24
6	2022	(50)	(43)	(38)	(37)	(32)	(28)	50	43	38	37	32	28
7	2023	(58)	(50)	(44)	(41)	(36)	(31)	58	50	44	41	36	31
8	2024	(67)	(57)	(50)	(45)	(39)	(34)	67	57	50	45	39	34
9	2025	(75)	(64)	(56)	(48)	(41)	(36)	75	64	56	48	41	36
10	2026	(83)	(71)	(63)	(51)	(44)	(38)	83	71	63	51	44	38
11	2027	(92)	(79)	(69)	(54)	(46)	(40)	92	79	69	54	46	40
12	2028	(100)	(86)	(75)	(56)	(48)	(42)	100	86	75	56	48	42
13	2029	(108)	(93)	(81)	(57)	(49)	(43)	108	93	81	57	49	43
14	2030	(117)	(100)	(88)	(59)	(51)	(44)	117	100	88	59	51	44
15	2031	(125)	(107)	(94)	(60)	(52)	(45)	125	107	94	60	52	45
16	2032	(133)	(114)	(100)	(61)	(52)	(46)	133	114	100	61	52	46
17	2033	(142)	(121)	(106)	(62)	(53)	(46)	142	121	106	62	53	46
18	2034	(150)	(129)	(113)	(62)	(53)	(47)	150	129	113	62	53	47
19	2035	(158)	(136)	(119)	(63)	(54)	(47)	158	136	119	63	54	47
20	2036	(167)	(143)	(125)	(63)	(54)	(47)	167	143	125	63	54	47
21	2037	(175)	(150)	(131)	(63)	(54)	(47)	155	130	112	56	47	40
22	2038	(183)	(157)	(138)	(63)	(54)	(47)	144	118	98	49	40	34
23	2039	(192)	(164)	(144)	(62)	(53)	(47)	133	106	85	43	34	28
24	2040	(200)	(171)	(150)	(62)	(53)	(47)	106	79	60	33	25	18
25	2041	(208)	(179)	(156)	(62)	(53)	(46)	78	53	34	23	16	10
26	2042	(217)	(186)	(163)	(61)	(52)	(46)	50	26	8	14	7	2
27	2043	(225)	(193)	(169)	(60)	(52)	(45)	22	(1)	(18)	6	(0)	(5)
28	2044	(233)	(200)	(175)	(60)	(51)	(45)	(6)	(27)	(43)	(1)	(7)	(11)
29	2045	(242)	(207)	(181)	(59)	(50)	(44)	(34)	(54)	(69)	(8)	(13)	(17)
30	2046	(250)	(214)	(188)	(58)	(50)	(43)	(62)	(81)	(95)	(14)	(19)	(22)
31	2047	(258)	(221)	(194)	(57)	(49)	(43)	(89)	(107)	(121)	(20)	(24)	(27)
32	2048	(267)	(229)	(200)	(56)	(48)	(42)	(117)	(134)	(146)	(25)	(28)	(31)
33	2049	(275)	(236)	(206)	(55)	(47)	(41)	(145)	(161)	(172)	(29)	(32)	(34)
34	2050	(283)	(243)	(213)	(54)	(46)	(40)	(173)	(187)	(198)	(33)	(36)	(38)
Total 2017-2050		**(4,958)**	**(4,250)**	**(3,719)**	**(1,755)**	**(1,504)**	**(1,316)**	**1,813**	**1,261**	**847**	**1,019**	**803**	**642**
	2051-2070	0	0	0	0	0	0	(8,274)	(8,274)	(8,274)	(951)	(951)	(951)
Total 2017-2070		**(4,958)**	**(4,250)**	**(3,719)**	**(1,755)**	**(1,504)**	**(1,316)**	**(6,462)**	**(7,013)**	**(7,427)**	**68**	**(147)**	**(309)**

Table 4 adds the abatement costs faced by countries to the calculation. The cost function and optimization criteria used imply that the total cost of abatement equals half of the product of emission reduction and carbon price. The net profit measure is also introduced, which is defined as the difference between gross profit and the total abatement cost. Thus, net profit compares the financial situation of countries if they join the agreement and reduce emissions with the alternative of not participating and not reducing emissions at all. This measure and comparison is relevant if we assume that zero climate change mitigation is an option considered. Further, it is important to note that while net profit incorporates abatement costs and financials benefits and costs linked to the Fund, they exclude all climate benefits, co-benefits and other advantages of climate action. Similar to gross profits, net profits are also discounted including the liabilities repaid by participants between 2051-2070.

The results of the example show that even net profits can be positive. Country A's total discounted net profit is positive, while country B and C have a negative net profit. Again, these results depend on the discount rate. Assuming that future benefits and costs are discounted at a rate higher

than 6.2% would result in all three countries ending up with positive discounted net profits. This means that depending on how governments value and discount future outcomes, the proposed plan could be more advantageous than no mitigation action at all even including the costs of abatement and, excluding climate benefits.

Clearly, the assumptions and details of the agreement used for the example should be the subject of further research and refinement. Nevertheless, the conclusion of the example can be summarized as follows:

- The proposed framework could create a significant and over the next decades increasing financing need by the Fund. However, even in a scenario of keeping emission benchmarks at current levels while reducing actual emission by 55% by 2050, which is in line with the global warming target of 2 °C, the financing of the plan should be viable.
- From the perspective of countries, the scheme renders climate change mitigation more attractive as they derive a benefit from joining it compared to not participating.
- The benefits of countries – capturing near term financial rewards and pushing the financial costs into the future – are so large that under certain scenarios they can offset even the cost of abatement. How decision-makers value the future is a key parameter in this regard. Assuming their implied discount rate is around 5-6% – which, arguably, is a conservative assumption given the political reality – means that even ignoring climate benefits and other advantages, the plan can be beneficial to participants.

The example demonstrates many of the benefits of the proposed framework. It makes commitment to an effective cooperation agreement more attractive for governments. Second, decoupling the allocation of financial costs from mitigation efforts, the countries' interests change from free riding to curbing emissions. Finally, the more short-term focused decision-makers are, the more attractive this approach and mitigation within its framework becomes.

Finally, while this section focused on the costs of the proposed plan, it is important to keep in mind the difference between the financial and economic cost. The costs discussed above and shown in the example are financial costs of the proposed framework, i.e. the payments that are made to participants by the Fund to incentivize them to cut emissions as well as the related financing costs. On the other hand, the economic cost of climate change mitigation is the opportunity cost of the real resources (such as labor or capital goods) used for the mitigation efforts, as they are not available to produce other goods and services. In other words, while the proposed framework creates the incentives and the financing required to accelerate climate change mitigation, it does not create new real resources. This distinction highlights the fact that, in contrast to financial costs, the economic costs are highly dependent on the state of the economy and the utilization of resources. When the resource utilization of the economy is high, real resources will have to be diverted to climate action from other uses and this sense the cost of mitigation is carried by the current generation not withstanding the borrowing and debt left to the future (Broome and Foley, 2016). On the other hand, financial costs might not be a good proxy for economic costs under certain circumstances. In an environment where resources are idle or underutilized, the economic cost of climate change mitigation will be smaller than suggested by the financial costs. In such a situation, using idle resources could even have a negative cost, i.e. an economic benefit, through creating additional income and demand, the multiplier effect. Many economists consider the period that followed the 2007-2008 financial crisis and the Great Recession to be one characterized by a chronic underutilization of resources. Common descriptions of the economic situation – such as secular stagnation, structural shortfall of aggregate demand compared to the potential economic output, depressed real interest rates due to the imbalance between intended savings and investment – all imply that resources are idle. The fiscal multiplier, an indicator of the growth impact of additional spending and a measure linked to resource utilization levels, has also been revised higher. There is evidence that fiscal multipliers are larger when monetary policy is constrained by the zero lower bound on nominal interest rates and the financial sector or the

economy is weak (IMF, 2013). This has important implications for the trade-off between climate action and economic welfare and growth. Under such conditions, the economic costs of climate change mitigation could be significantly lower than the financing requirement of the necessary adjustment and investment. Financial costs would still need to be incurred. However, their impact on welfare or on measures such as total debt as a percentage of global GDP could be partially offset by the investment's positive impact on economic growth.