

The Compensation Fund for Climate Impacts

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ABSTRACT

Climate change is very likely to lead to undesirable climate impacts. How to compensate for such negative impacts at the international level has, hitherto, received little attention. This article reviews the most frequently discussed grounds for legal obligations of states vis-à-vis climate impacts (damages) and concludes that no convincing mechanism has yet been found to compensate climate impacts. The authors outline an architecture for a voluntary, international compensation fund with specialized, independent climate courts. Subsequently, this article addresses three strategic considerations related to the fund, namely, the incentives for founding it, the merits of double proportionality with respect to contributions and payments, as well as the benefits of employing prediction markets to enhance trustworthiness.

1. Climate change, climate impacts, and compensation

With a growing likelihood of unavoidable damages, climate change has become a serious challenge for policymakers. There is considerable convergence in science and politics regarding the causes and consequences of climate change. Mitigation measures to reduce the pressures on climate change, and policies of adaptation to lessen climate impacts have been advised (e.g., Alley et al. 2007; Bernstein et al. 2007). Given present policies, it appears likely that much of the world will face increasing climate-related damages. This raises the prospect of compensation for adverse climate impacts. At the 2010 United Nations Framework Convention on Climate Change (UNFCCC) Conference of the Parties at Cancun, a “work programme in order to consider approaches to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change” was initiated (United Nations Framework

Convention on Climate Change 2012a). In December 2012, at the 18th Conference of the Parties in Doha, the countries went further by agreeing that “comprehensive, inclusive and strategic responses are needed to address loss and damage associated with the adverse effects of climate change” (United Nations Framework Convention on Climate Change 2012b).

These decisions clearly demonstrate that considerations of compensation have left the specter of academic research and become a concern for global public policy. This article proposes an architecture for a structured system of compensation for adverse impacts of anthropogenic climate change.

The legal relevance of the topic has been strengthened in 2012 by an initiative of several small island states to seek an advisory opinion from the International Court of Justice on “the responsibilities of States under international law to ensure that activities carried out under their jurisdiction or control that emit greenhouse gases do not damage other States” (United Nations Department of Public Information 2012). Although Farber (2007) already concluded that

... at least in principle the United States and other signatories to the framework agreement already seem to have agreed to compensation at the international level. It

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is also worth noting that the parties to the Kyoto agreement have embraced the use of an adaptation fund, which is financed by a share of the proceeds generated by the Clean Development Mechanism (p. 1645),

we still lack a structured effort to compensate for climate impacts. While an advisory opinion of the International Court of Justice can provide general directions, Farber's observation in combination with the incipient work program under the UNFCCC attest to the legal and political relevance of compensation. While there have been suggestions for national compensation systems for climate impacts (e.g., Farber 2007; Farris 2009), we direct our proposal more universally to the international level.

Our proposed architecture for a global compensation fund for climate impacts embraces (i) the buildup of such a fund among dedicated countries, (ii) a court-like legal system that adjudicates compensation claims, and (iii) the disbursement of funds to countries which have effectively demonstrated that damages on their territories are created by anthropogenic climate change.

Before introducing our proposal, we review the various legal bases for obligations of states vis-à-vis climate impacts (damages) and concur with the mainstream of the literature that, so far, no practical mechanism has been found to deal with climate impacts (section 2). Subsequently, we propose a voluntary international compensation fund with a specific system of adjudicating cases of adverse climate impacts (section 3). In the fourth section, we focus on the incentives for founders to voluntarily start a fund system, suggest that double proportionality is both an enabling condition for the fund and protects it against early depletion, and conjecture that prediction markets be established to monitor the trustworthiness of the climate compensation fund. In the final section, we offer our conclusions.

2. Compensation through state responsibility?

Climate change is not the first challenge to bring the issue of redress for residual transboundary environmental harm to the attention of the international community. In fact, earlier cases have led to the emergence of customary law that governs the responsibility for such damages under international law. Before calling for new climate change-specific compensation instruments we review the existing legal mechanisms.¹

¹ For a detailed analysis of state responsibility for climate change see, e.g., Faure and Nollkaemper (2007), Kilinski (2008), and Verheyen (2005).

It is a basic principle of international law that states are responsible for breaches of international law. This responsibility entails the duty to compensate residual damages that have occurred as a result of that breach (Shaw 2003, p. 694). Hence, if both an obligation can be found to limit the emissions of greenhouse gases to a specific ceiling and if breach of that obligation can be demonstrated, international compensation should (in theory) be provided. Liability purely on the basis of harm without an element of wrongdoing (direct state responsibility) has been agreed upon for some specific activities (United Nations 2002, Article VII), yet none of these agreements would cover climate change damages.²

Two sources for obligations exist that, when infringed upon, could trigger state responsibility and compensation: international treaty law and international customary law. We will review relevant customary law first, reiterating which elements are required to form a binding rule; review related aspects, and highlight potential difficulties arising from its application to compensation of climate change damages. Thereafter, we scrutinize international treaty law for provisions that might entail state responsibility and present obstacles in the context of climate change.

For a norm to be recognized as international customary law it has to be supported by regular state practice and, while acting in accordance with the norm, states must do so believing that their behavior is required by law. The no-harm rule is the only norm relevant to climate change litigation that satisfies both requirements and is considered customary law (Tol and Verheyen 2004).³ The rule is breached when damages beyond a level of "seriousness" are inflicted on the territory of another country. Furthermore, the state on whose territory the damage-causing activity is pursued must have failed to adhere to a certain standard of care (negligence) in regulating that activity (Verheyen 2005, p. 152). To be successful, a claim based on the no harm rule must demonstrate that both qualifications are met.

Among the factors that determine the appropriate level of care, four are most frequently raised. First, the level of care depends on the hazardousness of the activity: higher risk activities generally require a higher level of care (Lefeber 1996, p. 68). A second concept is foreseeability. A state always acts without due diligence

² The term "direct state responsibility" is used here as found in Tol and Verheyen (2004). For an extensive analysis of the terminological challenge, see Lefeber (1996).

³ Whether the precautionary principle might also be customary law has not been fully clarified; see, for example, Bergkamp (2001), citing Kourilsky and Viney (2000).

when it should have foreseen a high probability of potential damage (Voigt 2008, p. 10). Third, it is argued that an appropriate level of care is not adhered to when a certain technological standard that would have reduced the risk has not been employed, such as the best available technology (Tol and Verheyen 2004, p. 1117). Fourth, the scope of measures that a state must take shall be proportional to its technical and economic abilities and balanced against the potential damage to the injured state. This originates in the right of a country to use its territory according to its needs (territorial sovereignty) and the right not to be harmed by activities from outside its territory (territorial integrity). Solving this conflict necessarily involves a subjective element since territorial integrity has to be balanced against territorial sovereignty (Voigt 2008, p. 17). It is the determination of the “appropriate level of care” that makes the application of the norm complicated and potentially cumbersome.

The difficulties in defining the standard of care can be avoided if a claim is based on treaty law where no negligence must be demonstrated (International Law Commission 2001, Article 2). Both the UNFCCC and the Kyoto Protocol contain norms that could potentially provoke state responsibility.⁴ Furthermore the United Nations Convention on the Law of the Sea (UNCLOS) also contains provisions possibly suited for compensation claims, yet they are too narrow for our purposes as only damages to marine resources would be covered.⁵

With regard to the UNFCCC, claims could be based on Article 4 in conjunction with the ultimate objective of the treaty to prevent “dangerous anthropogenic interference with the climate system” (United Nations 1992, Article 2). Article 4 is divided into two parts, Article 4.1 requires all parties to take “measures to mitigate climate change” among other general duties, such as the duty to publish emissions data and cooperate in the transfer of technology and knowledge. There is consent among scholars that Article 4.1 constitutes a very weak base for compensation claims because of its vague wording and the lack of a time horizon for the completion of mitigation measures (Tol and Verheyen 2004, p. 1114).

⁴ See Verheyen (2012, p. 2516) for a recent overview of the role of loss and damage within the UNFCCC process.

⁵ For a successful claim, the effects of climate change on the sea would have to qualify as pollution in the sense of Article 1.4 UNFCCC—which is not obvious. Furthermore in contrast to the UNFCCC and the Kyoto Protocol, the obligations of the UNCLOS are subject to due diligence, see Tol and Verheyen (2004), citing general opinion as expressed in United Nations Secretary-General (1989).

Article 4.2 of the UNFCCC is more precise, but binds only the industrialized countries listed in Annex I, thereby excluding major emitters such as China, India, and Brazil. The countries named in Annex I

shall adopt national policies and take corresponding measures on the mitigation of climate change, by limiting its anthropogenic emissions of greenhouse gases (GHG) and protecting and enhancing its greenhouse gas sinks and reservoir (United Nations 1992, Article 4.2a).

These measures must be suitable to modify “longer-term trends in anthropogenic emissions” (United Nations 1992, Article 4.2a). In contrast to the first paragraph, the second paragraph of Article 4 has no reservations such as the reference to “specific national and regional development priorities” (United Nations 1992, Article 4.1). It also contains a suggested time horizon (“by the end of the present decade”) that is “recognized” to contribute to the overall aim of averting the long term emissions trend (United Nations 1992, Article 4.2a). Consequently, it appears likely that a continuous increase of GHG emissions would amount to a breach of international law for which the offending state would be accountable (Voigt 2008, p. 7).

An even stronger case could be based on the Kyoto Protocol, which assigns Annex I Parties clear obligations to be achieved until 2012 (United Nations 1998, Article 3.1). There is little doubt that violating either these obligations or those set for the second commitment period from January 2013–20 would be considered a breach of the treaty.⁶ In theory, this could give rise to state responsibility for damages caused by the emissions in excess of the targets.

Both treaty and customary international law provide a theoretical legal basis for compensation of residual climate change damage through the rules of state liability. But while all states are bound by the no harm rule, it will be a very complicated and long process for the injured state to prove that the defendant state failed to act with due diligence as this includes the need to balance the interest of the harmed state with the interests of the offending state. In particular, this would have to be considered for each case individually—thus substantially reducing its practical value. In comparison, state responsibility arising from a breach of the obligations under the Kyoto Protocol would be much easier to prove, yet many of the major emitters, including the United States, China, and Brazil, have either not ratified

⁶ At the eighth Conference of the Parties to the Kyoto Protocol it was confirmed that the second commitment period begins in January 2013 (United Nations Framework Convention on Climate Change 2012c).

the protocol or have not taken on specific emissions reductions targets under the Kyoto Protocol. All of these states are parties to the UNFCCC. While it may be possible to base a solid claim on Article 4.2 against the United States, it would be nearly impossible to successfully claim compensation from India, China, or Brazil since they are only subject to the very vague obligations under Article 4.1 UNFCCC.

Besides the question of which law to apply, other major challenges exist. These include, for example, the need to find an adequate forum to hear the case, which usually requires consent by both parties and might be politically difficult to obtain from the state against which the claim is filed.⁷

In conclusion, international law indicates that states are responsible for loss caused by anthropogenic climate change, the perspectives for an effective compensation mechanism on the basis of current law look, however, dim. Proposals for climate compensation funds have been made at the national level (Farris 2009; Farber 2007), yet our goal is a universal voluntary compensation system at the international level.

3. The climate compensation fund: Basic architecture

International law provides us with initial perspectives on how to cope with climate impacts, yet has, so far, shied away from proposing specific mechanisms how adverse climate impacts shall be compensated. We propose an international climate compensation fund (short: compensation fund). The architecture consists of five components:

- 1) an ultimate goal gives operational meaning to the objective of the UNFCCC (United Nations 1992, Article 2) and serves as the no-compensation threshold;
- 2) independent, specialized climate courts should consider and adjudicate cases brought before it and determine compensation payments;
- 3) compensation pools of greenhouse gas (GHG)-emitting countries use strict proportionality of past emissions to determine their respective share of contributions to the fund; the sum of worldwide percentages of past GHG emissions covered by all contributing members shall equal the percentage coverage for damages adjudicated (double proportionality);
- 4) a founder of reasonable (GHG emissions) weight could set a voluntary compensation system in motion that might grow in membership over time; and

- 5) compensation may be partially disbursed as prepayments for adaptation to limit further damages.⁸

a. Ultimate goal

A benchmark is needed to establish compensation. Immanuel Kant's categorical imperative stipulated the following:

Act only according to that maxim whereby you can at the same time will that it should become a universal law (Kant 1993, p. 30).

Kant suggests that a concerned party should act in accordance with a collective goal in mind and that no fallacy of aggregation exists (Sprinz 2000). If everyone behaved accordingly, there would be no need for a compensation fund as everyone would be satisfied, that is, the ultimate goal would be reached via perfect cooperation. The authors of the UNFCCC had something similar in mind when they agreed on the ultimate objective of the Framework Convention:

The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, *stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system*. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (United Nations 1992, Article 2, emphasis added).

An environmentally ambitious interpretation of this objective requires a transition to a low-GHG economy worldwide. The latter is expected to take from several decades to a century. Interpreting Article 2 UNFCCC is a nontrivial undertaking (e.g., Ott et al. 2004). The Conference of the Parties at its 2009 Copenhagen and 2010 Cancun meetings politically agreed that "... reducing global greenhouse gas emissions so as to hold the increase in global average temperature below 2°C above pre-industrial levels" to be the long-term climate goal of the international

⁸ Our suggestions for the architecture partially overlap with Verheyen and Roderick (2008), yet originate from independent considerations. In particular, we suggest *specific* choices for the compensation fund (rather than offer a larger menu of choice) and justify our choices within a broader social choice perspective. In addition, we innovate by adding a range of novel aspects.

⁷ Exemplary for the United States, see Strauss (2003).

climate regime. In effect, this can be interpreted as an operationalization of Article 2 UNFCCC (United Nations Framework Convention on Climate Change 2012d).⁹

Whatever the ultimate ambition is in operational terms, the climate impacts associated with an operationalization of Article 2 UNFCCC constitute a *zero compensation benchmark*, and any excess damages beyond this benchmark should be considered for compensation. The damages themselves need to be caused by anthropogenic climate change, not by natural fluctuations in climate as the latter have been endured by countries and citizens over the past millennia.

b. *Independent adjudication*

Attribution of cause and effects ought to be in the hands of a neutral, politically independent judicial body that has no interest whether and which amount to award for climate damages. For simplicity, let us call this institution the climate court. The climate court would draw on specialized in-house expertise on climate change or create durable relationships with relevant scientific institutions to draw on up-to-date knowledge deemed important for making its decisions. It should apply judicial rules and procedures to see whether there is sufficient evidence that links anthropogenic GHG emissions to climate-induced damages. If this link can be credibly established, the climate court would make an award based on the fraction of damages originating from anthropogenic climate change (Jaeger et al. 2008). As an initial step, we consider countries to be the relevant entities under the compensation regime, yet in principle, our reasoning can be applied to any actor of sufficient magnitude in GHG emissions.

If countries are liable entities, this would constitute something similar to a state liability regime. With the exception of state liability for objects launched to outer space, such an approach is seldom practiced, yet this is for purely political reasons. There is no doubt that activities pursued on the territory of a state—including the emissions of GHGs from industries subject to licensing procedures—are attributable to the state (Tol and Verheyen 2004, p. 1111).

Climate courts could take the form of claims tribunals on a permanent basis or, given political will and resources, the International Court of Justice could be

entrusted with this function.¹⁰ Another option could be that parties precommit to specific procedural provisions and mechanisms how a decision is to be reached. This would serve as the basis for ad-hoc tribunals. A similar approach has been taken in the case of international investment disputes with the *Convention on the Settlement of Investment Disputes between States and Nationals of Other States*. The convention and its subsidiary agreements provide a clear procedural framework for ad-hoc tribunals which has become the basis for many decisions in this field (on average more than 20 yr⁻¹ over the last 10 years; International Centre for Settlement of International Investment Disputes 2012).

In terms of establishing cause and effect, climate change resembles liability for smoking-induced health care damages. While early warnings were issued already by the midst of the twentieth century (Doll and Hill 1950), it took several decades of litigation to establish cause and effect relationships, make financial awards to relevant parties (e.g., the U.S. Master Settlement Agreement on Tobacco; California Department of State 2012), and to arrive at the WHO Framework Convention on Tobacco Control in 2003 (World Health Organization 2003). The rule of law and independent adjudication are at the core of our compensation system for anthropogenic climate change. Awards would go only to members of the compensation fund, thereby inducing a plaintiff's country to become a contributing member of the compensation fund.

c. *Double proportionality*

The compensation fund to be created would be endowed in proportion to a country's emissions over time and make awards in proportion to the emissions covered by its aggregate membership (double proportionality).

In practice, if the group of countries who are members of the voluntary climate fund account for 35% of GHG emissions, they would only compensate 35% of the damages recognized by the climate court. Assume the expected total climate-related damages under review by the climate courts were €100 billion in 2050 and that the climate fund covers 35% of these damages through its membership. Consequently, members ought to make

⁹ Alternative operationalizations are conceivable (e.g., 1.5°C or 2.5°C above preindustrial levels).

¹⁰ Based on the statutes of the International Court of Justice (United Nations, 1945a), it is possible to refer such decisions to the International Court of Justice, yet the UN Charter clearly states that the sheer existence of the International Court of Justice shall not prevent states to set up other tribunals (United Nations, 1945b). The landmark case for transboundary environmental harm, the *Trail Smelter Arbitration*, was decided by a tribunal formed by Canada and the United States.

provisions for €35 billion to be available in 2050 for potential disbursement.¹¹

While there are many alternatives to strict proportionality considered in the climate negotiations (e.g., Schröder et al. 2002, pp. 140–141), it appears that simplicity and transparency are of immense practical value.¹² Proportionality adjusts over time who is to contribute and to which degree. An increase in the share of global emissions would, *ceteris paribus*, result in an increase in the percentage of contributions to the compensation fund. Such a system has an undisputable advantage: it rewards any country for outright mitigation as GHGs not released cannot lead to calls for compensation. Zero emissions also lead to zero contributions to the compensation fund. This rule applies to past emissions since the reference year and also provides incentives to curb future emissions regardless of current aspirations for economic development.

Compensation based on the proportion of emissions would normally refer to a specific time span. Our compensation system is agnostic about the temporal domain. While earlier suggestions point to historical emissions, the UNFCCC and its Kyoto Protocol suggest 1990 or 1992 (the latter referring to the year of opening for signature of the UNFCCC).¹³ It is the integral of emissions since the reference year (minus potential depreciation of GHGs due to atmospheric processes) that creates the basis for counting cumulative emissions. For a successful plaintiff to receive an award, the country of the plaintiff also has to join the compensation fund and make payments to it in proportion to its share of emissions since the reference year. Until now, most industrialized countries would have to make sizeable provisions for compensation because of their high share of emissions over the past decades (see Fig. 1). This picture is, however, rapidly changing with China being the single largest carbon emitter since 2007 (Rosenthal 2008, p. 2468) and India emerging as the third-largest

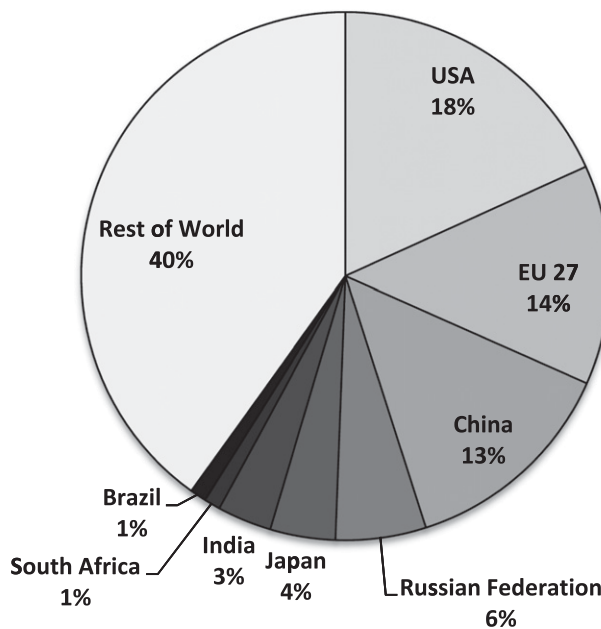


FIG. 1. Share of CO₂ Emissions (excluding LULUCF and Bunker) (1990–2008).

CO₂ emitter more recently. The proportionality rule dynamically adjusts for the changes in the contributions to emissions over time and gives clear incentives to curb future emissions.

The double proportionality rule limits the threat of immediate insolvency and of a run on the fund—besides the length of time expected for the adjudication of the case. If the damages from smoking are any guidance, it will take several decades for court decisions to lead to payments. In the meantime, the fund could be build up to relevant size.

d. The founder(s)

To be recognized internationally, a significant international actor—a founder—is needed to set the process of building the fund and creating the initial rules governing it in motion. The founder ideally is an actor accounting for a sufficient share of cumulative GHG emissions who wishes to demonstrate its sincerity regarding emission reductions and/or demonstrating that it is willing to compensate for climate impacts (see also section 1). Countries abstaining from joining the compensation fund would remain politically vulnerable to being sued directly through their own court system (e.g., in the United States), politically targeted in other international fora of the UN system (Ochs and Sprinz 2008; Sprinz 2005) and increasingly in domestic elections. Climate courts and compensation funds are a civilized procedure to cope with the challenge of climate damages.

¹¹ Additionally, proportional compensation is one approach to alleviate the legal issue of multiple causation. See Faure and Nollkaemper (2007). From an economic perspective, Faure and Nollkaemper (2007, p. 163) suggest that this approach could be the most efficient option.

¹² This is in line with the doctrine of “shared but individual responsibility” whereby every state is separately responsible for the conduct attributed to it, regardless of whether other states are also responsible for the same act (United Nations General Assembly 2012). Following this doctrine, it is possible to assign relative responsibility to individual parties in respect of their contribution to climate change (United Nations Framework Convention on Climate Change Ad Hoc Group on the Berlin Mandate 2012).

¹³ See the “Brazilian Proposal” (International Institute for Sustainable Development 2012).

e. *Spending the fund*

What should the compensation fund actually fund? Since mitigation is the central action variable to reduce one's contributions to the compensation fund, only adaptation (i.e., measures to reduce the harm resulting from the impacts of a changing climate) and compensation for "residual damage" remain as potential purposes. Adaptation and compensation for damages are essentially two different forms of spending a potential award. Funding for adaptation ought to be transferred in anticipation of damages; compensation is awarded for actual damages only.

How could a climate court proceed and when? Once climate impacts become plausibly manifest to the court, an interim ruling by the court could be made which includes a projection of the likely amounts to be compensated since the reference period up until the foreseeable future. To avoid undue harm in the interim period, the climate court could offer up to 50% of the expected damages to be awarded ad interim for adaptation purposes. The remaining amount would only be adjudicated and dispensed at the end of the foreseeable period. Adaptation payments should be given for least cost ways to reduce harm. The assessment of the overall amounts of compensation for damages should refer to the reasonably expectable damages in the absence of adaptation payments; subsequently, prepayments for adaptation will be deducted to derive the ex post amount for compensation.¹⁴ To make sure that adequate resources are left for ex-post compensation for actual climate impacts despite the mitigation and adaptation measures undertaken, as a rule of thumb, at least 50% of the funds should be reserved for the ex-post compensation of damages. This rule reduces potential misuse of advance payments, hopefully induces efficiency in their use, and avoids the depletion of the fund before claims for compensation for manifest damages can be adjudicated.

4. Strategic considerations for implementation

In the following, we consider three central aspects of the compensation fund in greater detail. First, we discuss the strategic logic of founding such a fund. Second, we argue that the rule of double proportionality makes it difficult to exploit the fund. Third, we suggest the use of prediction markets to inform interested parties to which degree the fund is able to compensate climate-related damages beyond the no-compensation threshold.

a. *The founder*

The viability of a voluntary fund system depends on a founder or a small group of founders to set up a compensation fund and to provide an initial endowment. To be of relevance, the compensation fund must be able to cover a minimum amount of expected compensation claims. Given our double proportionality rule, the founder should be a significant net contributor to climate change.

As pointed out in section 2, states are responsible for effects beyond "serious damage" whenever they have not demonstrated an "appropriate level of care." As time passes, the standard of "appropriate" care is expected to rise as knowledge about anthropogenic climate change and its impacts will likely increase. Improved as well as potentially novel technology can reasonably be expected to manage climate change at decreasing costs. In such an environment, international law will very likely assign responsibility and consequent compensation at some point in time. Thus, a founder can act as an entrepreneur and—much like a political agenda setter—introduce and shape the initial setup of the fund.

Why should a founder emerge? Much of the argument refers to founders, frontrunners, and the unilateral provision of public goods.¹⁵ The limitations to the voluntary provision of global and club goods have been raised early, starting with Olson's "Logic of Collective Action" (Olson 1971) and the more recent literature on the challenges frontrunners face. The risk of free riding is present, and the temptation perhaps initially overwhelming. Adding to the pessimism, Hoel (1991) suggests that a self-restraining frontrunner (on carbon emissions) may lead other countries to emit more in response. While mitigation is a central policy lever to reduce compensation, it is not realistic to assume that international agreements will be automatically concluded after the frontrunner made its policy known—as Hoel (1991, p. 69) does. By contrast, Urpelainen (2009) shows that climate policy can partially be seen as private or regional—rather than pure global—goods provision, allowing even subnational actors to rationally pursue ambitious climate policies. Additionally, the developing debate on compensation for loss and damage—which neither of the above could foresee—might provide an additional incentive for a founder to emerge as the political costs of free riding gradually increases.

¹⁴ This requires counterfactual reasoning.

¹⁵ Much of the scholarly literature speaks about frontrunners—which is largely congruent with our notion of a founder who initially creates the compensation fund.

In subsequent work, Urpelainen shows that under a range of conditions, governments can unilaterally bind successor governments to continue policies they initiated in their own (short) lifetime, thereby reducing the threat to credible commitment (Urpelainen 2011).

Similarly, aware of the challenge of credible commitment, Hovi et al. (2013) recently proposed a refundable deposit system, which mandates that countries prepay “their commitment” into an escrow account, and the money is refunded in case of full implementation of a country’s promises. As a consequence of this institutional design, countries are unlikely to renege on their promises as the costs of noncompliance are substantial and of the same magnitude as actually fulfilling their mitigation obligations. In effect, our compensation fund is related to this idea in so far as endowing the compensation fund is a prepayment against anticipated claims of climate damages and becomes increasingly relevant given existing emission trends and the inclusion of loss and damages issue in the negotiations. Whatever fund contributions remain unused in settlements or after prepaying adaptation measures can be refunded at a later point in time.

Other game-theoretically-inspired work in the experimental literature suggests that having a leader in a public bad game might have a benign effect. First, a leader setting a good example reduces the investments in the public bad by other players. Second, followers emulating the leader amplify the effects of the leader—reducing the state of the public bad—thereby increasing the return on the leader’s initial investment. While improving the incentives for leadership, these returns to the leader do not fully compensate her for the initial investment (Moxnes and van der Heijden 2003). Overall, becoming a founder can very well lead to improved returns on investments by followers and ameliorating the public bad—besides potential rewards for first movers in a technology transition.

As mitigating climate change is a long-term effort rather than a one-time intervention, it will be crucial for a leader to initiate a credible policy to facilitate positive effects, that is, induce followers to contribute to public goods provision. By accepting responsibility and pledging the means for compensation of the corresponding damages, the founder will demonstrate trustworthiness and encourages followers to join.

The strategic logic for a founder thus rests on four elements. By creating a compensation fund, a founder can demonstrate credible commitment. Second, the founder can engage in public goods provision and entice followers to join, thereby increasing public goods provision and achieving a more favorable return on her initial investment. Third, a fund provides a structured

avenue for compensation, justifies payment for adaptation, and adds predictability to the expected costs associated with compensation. Fourth, clearly distributed responsibilities are likely to increase pressure on other major contributors to climate change to join as costs become more predictable.

b. Double proportionality limits exploitation of the fund

The previous section addressed the issue of incentives for creating the fund. Once a fund has been established, a mechanism is needed to limit both contributions and payments. This is the subject of the present section.

Double proportionality requires that fund members make contributions in proportion to their past GHG emissions since a reference year, the aggregate of these emission shares constitutes the overall percentage of GHG emissions covered. This aggregate percentage equals the share of total damages covered by the fund in case of an award by the climate court.

The reader is invited to join a few thought experiments under which conditions such a fund is stable against potential exploitation by way of strategic membership decisions. A proportional compensation system is completely unexploitable if it covers 0% of emissions (no members, no funding) or if it covers 100% of emissions (universal membership, 100% funding). In between these extremes, potential plaintiffs (who have to become members before actual payments) have incentives to seek net benefits (expected awards minus expected contributions) by way of their decision on membership.¹⁶

To the degree that some members can expect to be net contributors to the fund while others are expected to be net recipients, redistribution will take place among the members. This is in line with the central aim of the fund, namely, to actually compensate those most adversely affected by climate change. The exposure of the fund’s members is, however, limited both on the contributing side by the shares of past GHG emissions, and on the payment side by the share of total damages covered by the fund. Overall, the compensation fund is a predictable settlement system for asymmetric, negative externalities between parties that cause climate change and those parties that experience climate change impacts.

c. Prediction markets enhance trustworthiness

Prediction markets can be employed to enhance the trustworthiness that the fund reaches its goal of actually

¹⁶ In this article, we implicitly assume that all climate impacts are negative. This assumption is likely to hold for many regions of the world, but not necessarily for all regions.

compensation climate-related damages. Predication markets can be defined as “forums for trading contracts that yield payments based on the outcome of uncertain events. There is mounting evidence that such markets can help to produce forecasts of event outcomes with a lower prediction error than conventional forecasting methods” (Arrow et al. 2008, p. 877). The degree of the credibility of a compensation fund is initially uncertain, both to participants as well as outsiders. Prediction markets, also called “information markets” and “event futures” (Wolfers and Zitzewitz 2004, p. 108) may fill this gap and reduce uncertainty.

Information markets have been used in a wide variety of circumstances, including predictions of policy decisions by the U.S. Federal Reserve Board, U.S. presidential elections, or sport events. The industry has led to venerable academic platforms, such as the Iowa Electronic Markets, and commercial platforms, such as intrade.

Central to such prediction markets is their accuracy and the aggregation of individual information into aggregate form. Wolfers and Zitzewitz, for example, demonstrate that under reasonable assumptions prediction market prices and mean beliefs of market participants converge (Wolfers and Zitzewitz 2006).

To facilitate assessments about the credibility of the climate compensation fund, we suggest to create a Political Climate Exchange (PCX). The PCX would trade assets similar to those found on the Iowa Electronic Markets. It could offer trades with different maturities on whether the fund will reach its long-term goal. Prices of 100 (maximum) would signal 100% trustworthiness, a price of 0 (minimum) would signal complete untrustworthiness. The differences in quotes between different maturities would inform us about the expected evolution of trustworthiness over time. As a side effect, the PCX could signal the degree of trustworthiness to *domestic* constituents in member countries of the fund as well as to potential future fund members. Given the averaging mechanism over many market participants and reasonably frequent trading, a continuous assessment of credibility becomes possible. As long as imperfections of the market are kept to a minimum (illiquidity, insider trading, etc.), the PCX could signal the resolve of the fund to the outside world.

A prediction market could afford transparency to all interested parties whether the compensation system proposed is credible.

5. Conclusions

At present, Planet Earth is destined for considerable emissions of GHGs, which will cumulate over the

decades to come. It is unlikely to be the case that a “safe landing” will be accomplished in the near future. Therefore, we should expect considerable adverse impacts of anthropogenic climatic change to occur. The climate compensation fund provides a viable architecture for predictable compensation for climate impacts.

It has been argued that it could already be possible to pursue successful compensation claims on the basis of current international law. However, while solid legal grounds for cases against signatory states of the Kyoto Protocol exist, it will be very difficult to sue China or the United States for compensation as they have either not ratified the Protocol or are not assigned specific targets. In international law general institutional mechanisms to compensate for climate impacts have not evolved, and litigation depends on the individual case and is surrounded by a high level of uncertainty.

We suggest a five-fold architecture comprising an operational ultimate climate goal, independent climate courts, the rule of double proportionality in fund contributions as well as payouts, a founder to establish the fund, and the use of payouts for adaptation and ex-post-facto compensation.

Overall, the Climate Compensation Fund may help alleviate the participation problem for credible and ambitious climate proposals and offers deeds instead of words: compensation for climate impacts. This would be a creative method to keep long-term climate policy on the agenda in a way many of us are accustomed to think of, grounded in the rule of law, and appropriate financial provisions.

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REFERENCES

- Alley, R., and Coauthors, 2007: Summary for policymakers. *Climate Change 2007: The Physical Science Basis*, S. Solomon et al., Eds., Cambridge University Press, 1–18.
- Arrow, K. J., and Coauthors, 2008: The promise of prediction markets. *Science*, **320**, 877–878.
- Bergkamp, L., 2001: *Liability and Environment: Private and Public Law Aspects of Civil Liability for Environmental Harm in an International Context*. Kluwer Law International, 708 pp.
- Bernstein, L., and Coauthors, Eds., 2007: *Climate Change 2007: Synthesis Report*. Cambridge University Press, 104 pp.
- California Department of State, cited 2012: Master settlement agreement. [Available online at <http://ag.ca.gov/tobacco/pdf/1msa.pdf>.]

- Doll, R., and A. B. Hill, 1950: Smoking and carcinoma of the lung—Preliminary report. *Br. Med. J.*, **2**, 739–748.
- Farber, D. A., 2007: Basic compensation for victims of climate change. *Univ. Pa. Law Rev.*, **155**, 1605–1656.
- Farris, M., 2009: Compensating climate change victims: The Climate Compensation Fund as an alternative to tort litigation. *Sea Grant Law Policy J.*, **2**, 49–62.
- Faure, M. G., and A. Nollkaemper, 2007: International liability as an instrument to prevent and compensate for climate change. *Stanford J. Int. Law*, **43A**, 123–179.
- Hoel, M., 1991: Global environmental problems: The effects of unilateral actions taken by one country. *J. Environ. Econ. Manage.*, **20**, 55–70.
- Hovi, J., M. Greaker, C. Hagem, and B. Holtmark, 2013: A credible compliance enforcement system for the climate regime. *Climate Policy*, **12**, 741–754.
- International Centre for Settlement of International Investment Disputes, cited 2012: The ICSID Caseload-Statistics (Issue 2012–2). [Available online at <https://icsid.worldbank.org/ICSID/FrontServlet?requestType=ICSIDDocRH&actionVal=CaseLoadStatistics>.]
- International Institute for Sustainable Development, cited 2012: The Brazilian Proposal and its scientific and methodological aspects. [Available online at <http://www.iisd.org/ckn/compendium/brazil.asp>.]
- International Law Commission, 2001: *Draft Articles on State Responsibilities for Internationally Wrongful Acts*. Official Records of the General Assembly, Fifty-sixth session, Supplement No. 10, 16 pp.
- Jaeger, C. C., J. Krause, A. Haas, R. Klein, and K. Hasselmann, 2008: A method for computing the fraction of attributable risk related to climate damages. *Risk Anal.*, **28**, 815–823.
- Kant, I., 1993: *Grounding for the Metaphysics of Morals*. 3rd ed. Hackett, 92 pp.
- Kilinski, J., 2008: International climate change liability: A myth or a reality? *J. Transnatl. Law Policy*, **18**, 378–416.
- Kourilsky, P., and G. Viney, 2000: The precautionary principle—A report to the Prime Minister. Paris, Odile Jacob Editions.
- Lefebvre, R., 1996: *Transboundary Environmental Interference and the Origin of State Liability*. Kluwer Law International, 365 pp.
- Moxnes, E., and E. van der Heijden, 2003: The effect of leadership in a public bad experiment. *J. Conflict Resolut.*, **47**, 773–795.
- Ochs, A., and D. F. Sprinz, 2008: Europa riding the Hegemon? Transatlantic climate policy. *Hegemony Constrained: Evasion, Modification, and Resistance to American Foreign Policy*, D. B. Bobrow, Ed., University of Pittsburgh Press, 144–166.
- Olson, M., 1971: *The Logic of Collective Action—Public Goods and the Theory of Groups*. Harvard University Press, 176 pp.
- Ott, K., G. Klepper, S. Lingner, A. Schäfer, J. Scheffran, and D. Sprinz, 2004: Reasoning Goals of Climate Protection. Specification of Article 2 UNFCCC. German Federal Environmental Agency Rep. 202 41 252, 199 pp.
- Rosenthal, E., 2008: China increases lead as biggest carbon dioxide emitter. *The New York Times*, 14 June. [Available online at <http://www.nytimes.com/2008/06/14/world/asia/14china.html>.]
- Schröder, M., and Coauthors, Eds., 2002: *Klimavorhersage und Klimavorsorge (Climate Prediction and Precautionary Measures)*. Springer, 511 pp.
- Shaw, M. N., 2003: *International Law*. Cambridge University Press, 1288 pp.
- Sprinz, D. F., 2000: Problems of cross-level inference in political science. *Climatic Change*, **44**, 393–408.
- , 2005: “Für das klima haften?” (Liability for climate change?). *Politische Ökologie*, 77.
- Strauss, A. L., 2003: The legal option: Suing the United States in international forums for global warming emissions. *Environ. Law Rep.*, **33**, 10 185–10 191.
- Tol, R. S. J., and R. Verheyen, 2004: State responsibility and compensation for climate change damages—A legal and economic assessment. *Energy Policy*, **32**, 1109–1130.
- United Nations, 1945a: *Statute of the International Court of Justice*. United Nations International Court of Justice. [Available online at <http://www.icj-cij.org/documents/index.php?p1=4&p2=2&p3=0>.]
- , 1945b: *Charter of the United Nations*. United Nations, 86 pp.
- , cited 1992: United Nations Framework Convention on Climate Change. [Available online at <http://unfccc.int/resource/docs/convkp/conveng.pdf>.]
- , cited 1998: Kyoto Protocol to the United Nations Framework Convention on Climate Change. [Available online at <http://unfccc.int/resource/docs/convkp/kpeng.pdf>.]
- , cited 2002: Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies. [Available online at <http://untreaty.un.org/cod/avl/ha/tos/tos.html>.]
- United Nations Department of Public Information, cited 2012: Press conference on request for International Court of Justice Advisory opinion on climate change. [Available online at http://www.un.org/News/briefings/docs/2012/120203_ICJ.doc.htm.]
- United Nations Framework Convention on Climate Change, cited 2012a: Report of the Conference of the Parties on its sixteenth session, held in Cancun from 29 November to 10 December 2010. [Available online at <http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf>.]
- , cited 2012b: Decision 3/CP.18 Approaches to address loss and damage associated with climate change impacts in developing countries that are particularly vulnerable to the adverse effects of climate change to enhance adaptive capacity. [Available online at <http://unfccc.int/resource/docs/2012/cop18/eng/08a01.pdf>.]
- , cited 2012c: Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol: Outcome of the work of the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol. [Available online at <http://unfccc.int/resource/docs/2012/cmp8/eng/109.pdf>.]
- , cited 2012d: Conference of the Parties—Decision 1/CP.16: Outcome of the work of the Ad Hoc Working Group on long-term cooperative action under the Convention. [Available online at <http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf>.]
- United Nations Framework Convention on Climate Change Ad Hoc Group on the Berlin Mandate, cited 2012: Implementation of the Berlin Mandate—Additional proposals from the Parties, Addendum, N by the secretariat. [Available online at <http://unfccc.int/cop4/resource/docs/1997/agbm/misc01a3.htm>.]
- United Nations General Assembly, cited 2012: Report of the International Law Commission. UN, 537 pp. [Available online at http://untreaty.un.org/ilc/reports/english/a_56_10.pdf.]
- United Nations Secretary-General, 1989: *Law of the Sea—Protection and Preservation of the Marine Environment*. United Nations, 95 pp.
- Urpeläinen, J., 2009: Explaining the Schwarzenegger Phenomenon: Local frontrunners in climate policy. *Global Environ. Polit.*, **9**, 82–105.
- , 2011: Can unilateral leadership promote international environmental cooperation? *Int. Interact.*, **37**, 320–339.

- Verheyen, R., 2005: *Climate Change Damage and International Law: Prevention, Duties and State Responsibility*. M. Nijhoff, 406 pp.
- , cited 2012: Tackling loss & damage—A new role for the climate regime? Advanced version. [Available online at <http://www.lossanddamage.net/download/6877.pdf>.]
- , and P. Roderick, cited 2008: Beyond adaptation: The legal duty to pay compensation for climate change damage. [Available online at http://assets.wwf.org.uk/downloads/beyond_adaptation_lowres.pdf.]
- Voigt, C., 2008: State responsibility for climate change damages. *Nord. J. Int. Law*, **77**, 1–22.
- Wolfers, J., and E. Zitzewitz, 2004: Prediction markets. *J. Econ. Perspect.*, **18**, 107–126.
- , and E. W. Zitzewitz, 2006: *Interpreting Prediction Market Prices as Probabilities*. Centre for Economic Policy Research, 13 pp.
- World Health Organization, 2003: WHO framework convention on tobacco control. WHO FCTC Rep., 42 pp.