A Theory of North-South Climate Finance*

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Abstract

Carbon dioxide emissions are growing rapidly in the developing world, but only industrialized countries have enough resources to fund adequate mitigation activities and decarbonization in the global South. In this article, I examine the political economy of climate finance. Building on previous research, I develop a formal model that includes the three key issues in climate finance: incentives for donor and recipient participation, capacity building, and the relationship between public and private funding. The formal analysis produces several new results. First, successful capacity building will reduce the need to offer direct income transfers to recipients. Second, private funding will endow donors with incentives to improve capacity building, thus increasing the value of climate finance more than previously thought. In the article, I also discuss the empirical implications and practical policy implications of these findings.

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1 Introduction

Wealthy industrialized countries are responsible for most of the increase in the atmospheric concentrations of carbon dioxide, but emissions are growing most rapidly in large but relatively poor developing countries, such as China and India (Stern 2006). Since poor developing countries face chronic resource constraints in regards to decarbonization, the question of North-South *climate finance* – emissions reductions projects in developing countries funded partially or fully by industrialized countries – has recently gained prominence in international negotiations (Stewart, Kingsbury, and Rudyk 2009). Unfortunately, this prominence has largely been one of intense controversy. Only months after wealthy industrialized countries pledged to substantially increase climate finance at the Copenhagen Conference of December 2009, the developing countries complained in public that these promises are not being met.[1]

This controversy should not surprise scholars who have followed the politics of development assistance and foreign aid (Lancaster 2007). Indeed, the issue of climate finance features three difficult problems that are by now fully politicized. First, donors prefer to minimze funding and maximize conditionality, while recipients demand generous support and oppose conditionality as unnecessary interference with national sovereignty (Breidenich and Bodansky 2009; Werksman 2009). Second, climate finance cannot be effective unless donors and recipients succeed in *capacity building* – the practice of supporting the development of effective implementation institutions for the recipient – and the design of such institutions features complex questions of power and accountability (Ballesteros et al. 2009; Sagar 2000). Finally, the relationship between private and public finance remains unresolved (Brinkman 2009). Although scholars and practitioners generally agree that public finance should leverage contributions from the private sector, the relationship between the two sources of finance remains unexplored.

North-South climate finance comprises strategic interactions between donors and recipients, so it cannot be understood without a unified account of these issues. Capacity building may increase or decrease the profitability of mitigation projects for the private sector and alter participation incentives for the donor and the recipient, while the promise of substantial private investment may allow donors and recipients to implement mitigation projects that are otherwise too costly. Donors and recipients may disagree on the

[1] "Murky Climate Finance Risks Undermining Trust at U.N. Talks." *Reuters* June 4, 2010.

need for capacity building and North-South income transfers, however, and private investors cannot fund mitigation projects unless the donor and recipient are both willing to participate.

In this article, I investigate the strategic determinants of effective climate finance through a game-theoretic analysis. To reduce emissions and promote decarbonization in the recipient country, a donor can both (i) contribute public funding to cover the cost of the implementation of a mitigation project and (ii) provide assistance for capacity building to increase the probability of successful implementation by the recipient. Given this offer, the recipient must then decide whether it participates in the implementation of the project. In the final phase of the game, private investors may participate in the project. Thus, the model captures all three key elements of the contemporary debate on climate finance in a particularly simple fashion.

The equilibrium analysis reveals several important strategic interactions that influence the feasibility and effectiveness of climate finance. The first noteworthy finding pertains to the benefits of capacity building. In addition to facilitating successful implementation, effective capacity building can help secure the participation of both donors and recipients. Capacity building is profitable for the donor, not only because it increases the probability of successful mitigation, but also because it reduces the minimal reward that the recipient must be given to secure participation. Thus, capacity building can directly alleviate the distributional conflict surrounding burden sharing in climate finance between donors and recipients.

Empirically, the formal analysis implies the existence of an inverse relationship between capacity building efforts and the reward that the donor offers to the recipient for a mitigation policy. If changes in exogenous circumstances increase capacity building, the need to 'bribe' the recipient with incremental public funding decreases. If the value of emissions reductions to the donor increases, for example, so that the donor has an incentive to respond by increasing efforts towards capacity building, it also has an incentive to reduce direct incremental funding to the recipient. To see why, note that since capacity building also benefits the recipient, the donor can afford to offer a lower additional reward for successful implementation. This produces the counterintuitive empirical hypothesis that if the donor and the recipient expect large benefits from a given mitigation project, the donor will invest substantially in capacity building while offering a small reward to the recipient.

Finally, the equilibrium analysis sheds new light on the relationship between private and public funding. On the one hand, private funding benefits both the donor and the recipient because investors provide expertise and

cover some of the implementation cost. On the other hand, private funding reduces the need for public funding by the donor or the recipient, so the effect of private funding on rewards is also negative. If the donor manages to secure private funding for mitigation policies by the recipient, the set of feasible and mutually profitable projects will expand. This is mutually profitable because it will be easier to secure participation by both North and South. Similarly, the availability of private funding increases the incentive to provide capacity building, as the donor will have stronger incentives to avoid implementation failure. This win-win effect may prove essential in breaking the North-South climate finance gridlock.

In addition to direct implications for North-South climate finance, the present model may be applicable to a broader set of development finance questions. Indeed, it is not unreasonable to surmise that most development projects feature conditionality and capacity building, and many of them could potentially benefit from increased private funding. To the degree that this is true, many of the findings of the present model can be applied to a larger set of issues in development finance (Burnside and Dollar 2000; Mayer and Mourmouras 2008; Svensson 2000).

The remainder of the article is organized as follows. I begin with a concise introduction to North-South climate finance. Next discuss the criteria for effectiveness in North-South climate finance. I then conduct the formal analysis and summarize the theoretical and empirical implications thereof. I conclude with some ideas for practical implementation and a discussion of the broader implications of the analysis.

2 North-South Climate Finance

In this article, I define climate finance as the provision of resources by a donor to support the implementation of mitigation policies by a recipient (Stewart, Kingsbury, and Rudyk 2009). Thus, the key criterion for an income transfer to be considered climate finance is that a wealthy donor offers public funding in exchange for the implementation of a mutually agreed mitigation policy. This general definition encompasses activities in various sectors ranging from building energy efficiency to renewables production and public transportation.

I leave adaptation finance outside my definition of climate finance. While funding for mitigation policies conceivably produces direct benefits for the donor in the form of improved environmental quality, adaptation finance is only beneficial for the donor indirectly through improved stability and

resilience in the recipient country. Additionally, adaptation finance is only indirectly related to the overarching goal of reducing climate change. For these reasons, it is probable that adaptation finance will feature many different strategic incentives than climate finance in general. While I certainly do not intend to downplay the importance of adaptation finance, this article will focus on climate finance as it relates to mitigation actions and measures in the global South.

Although climate finance has moved to the limelight in climate finance only recently, it is now widely recognized as an integral element of a future climate regime (Ballesteros et al. 2009; Nakhooda 2008; UNFCCC 2007). As Stewart, Kingsbury, and Rudyk (2009, 4) write, the rapid growth of carbon dioxide emissions in large developing countries, notably China and India, means that climate stabilization is completely impossible without aggressive mitigation measures in the global South. However, developing countries have only limited resources to adopt and implement effective mitigation policies, so external assistance is essential to achieve the requisite degree of decarbonization.

Climate finance has been available in some form since the entry into force in 1994 of the United Nations Framework Convention on Climate Change (UNFCCC). Regarding multilateral funding, Paragraph 3 of Article IV of the UNFCCC commits developed countries to financial assistance to developing countries in view of implementing the convention. For bilateral finance, Paragraph 5 of Article XI of the UNFCCC states somewhat vaguely that "developed countries... may also provide financial resources related to the implementation of the convention through bilateral, regional and other multilateral channels." While this paragraph does not prescribe bilateral assistance, it provides a legal and institutional basis for bilateral climate finance under the emerging multilateral climate regime. Thus, the multilateral climate regime can, at the very least, provide a rudimentary foundation for North-South climate finance.

Under the UNFCCC, the Global Environment Facility is charged with providing the official multilateral flows. According to the UNFCCC (2007, 79), it has provided more than one billion dollars for mitigation activities since 1997 and leveraged more than three billion dollars of complementary funding from other sources, including the private sector. Many multilateral development banks, have also recently begun to provide funding for mitigation activities. These include both such global financial institutions as the World Bank and regional development banks. For example, they have together established several Climate Investment Funds (CIF) in 2008 to ad-

dress the challenge that low-carbon development presents.[2] The importance of multilateral development banks is critical, given that they collectively provide more than ten billion dollars to projects in sectors that produce greenhouse gases (Nakhooda 2008, 1). Finally, according to Atteridge et al. (2009, 8), bilateral donors also provided in 2008 more than five billion dollars to climate finance. In sum, North-South climate finance pervades the universe of donor institutions.

The annually available amounts of funding, however, pale in comparison to what is needed to prevent global warming of more than two degrees Celsius. Stewart, Kingsbury, and Rudyk (2009, 4) note that according to a recent study by Project Catalyst, 55-80 billion dollars of incremental funding would be required in every year between 2010 and 2020 to set developing countries to a sustainable carbon trajectory.[3] The urgency of this challenge is underscored by the fact that so far, both multilateral and bilateral lenders have largely failed to mainstream climate finance into their other funding activities. As Nakhooda (2008, 2) writes, "opportunities to mitigate emissions and reduce climate risk are still not systematically incorporated into ... strategies and project development. More than 60 percent of financing in the energy sector across these institutions does not consider climate change at all."

Although countries agree widely on the general importance of climate finance, profound disagreements characterize the negotiations. In recent years, the official delegations have submitted a number of diverging proposals for incorporating climate finance in a multilateral climate treaty (Ballesteros et al. 2009). China and the Group of 77 have proposed that industrialized countries contribute annually 150-300 billion dollars for mitigation and adaptation with little or no conditionality, whereas the United States and the European Union have offered much smaller sums while emphasizing accountability and transparency under a rigorous conditionality scheme. The 2009 Copenhagen Accord comprises provisions for climate finance, but developing countries have complained that industrialized countries are not on track to meet these promises.[4]

The most controversial issues in climate finance pertain to the availability of funding and the strings attached to it (Ghosh and Woods 2009).

[2]The CIF website can be found at http://www.climateinvestmentfunds.org. Accessed July 21, 2010.

[3]The Project Catalyst website can be found at http://www.project-catalyst.info. Accessed July 1, 2010.

[4]"Murky Climate Finance Risks Undermining Trust at U.N. Talks." *Reuters* June 4, 2010.

Industrialized countries have repeatedly emphasized that recipients must be held accountable for good performance. By contrast, developing countries have argued that conditionalities and performance requirements are both inequitable and burdensome. Similarly, industrialized countries have proposed that climate finance should only cover the incremental cost of mitigation. Conversely, developing countries have insisted that climate finance should support sustainable development in the recipient countries more broadly.

3 Effectiveness Criteria

In this article, my goal is to provide a strategic theory of how different factors shape the effectiveness of climate finance. My definition of effectiveness comprises two criteria. First, climate finance must be politically feasible. By political feasibility, I refer in particular to the idea that both donors and recipients must have incentives to participate in climate finance (Stewart, Kingsbury, and Rudyk 2009, 6). Second, it must promote the decarbonization of developing countries. If a proposed arrangement for climate finance fails to meet either criterion, it is not contributing to the global struggle to reduce the rate of global warming.

To meet these two criteria, climate finance institutions must achieve at least four complementary goals. First, they must create incentives for developing countries to implement mitigation policies (Ballesteros et al. 2009; Hall et al. 2008; Werksman 2009). Donors must offer enough funding for the recipients to actually implement costly projects under chronic resource constraints. This goal is not easy to meet given that developing countries face many immediate challenges pertaining to poverty and societal stability (Najam, Huq, and Sokona 2003; Williams 2005). For the government of a developing country, it is difficult to prioritize global environmental protection over the more pressing issue of lifting people out of poverty and avoiding societal disruptions (Najam 2005; Williams 2005).

Second, climate finance institutions must also endow donors with strong and robust incentives to fund the projects (Werksman 2009). If the financial burden is large or the probability of successful implementation low, industrialized countries have no incentive to participate in climate finance. They must be able expect that climate finance will feature an acceptable cost-benefit ratio and meet adequate standards of accountability and transparency (Stewart, Kingsbury, and Rudyk 2009, 20). Otherwise the possibility that climate finance will be squandered will function as an effective deterrent to the very substantial contributions that pervasive decarboniza-

tion in the global South requires. These fears are justified in light of the fact that development assistance is often ineffective in developing countries that lack robust national institutions for allocation and accountability (Burnside and Dollar 2000).

As Ghosh and Woods (2009) note, these two issues are intimately related. If recipients do not believe that donors will continue to provide funding in the future, their incentive to commit to mitigation policies in the long run diminishes. Conversely, if donors question the recipients' willingness and ability to implement projects, their willingness to provide funding decreases. This mutual dependence could at worst trigger a vicious circle of mistrust, whereby donors accuse recipients of negligence while recipients are unwilling to expend mitigation efforts because they do not believe that climate finance will be sustained in the future.

Third, the industrialized countries should have incentives to participate in capacity building, defined as institutional and resource support for the agencies that are responsible for implementing mitigation policies in developing countries (Sagar 2000; VanDeveer and Dabelko 2001). It is not enough that industrialized and developing countries agree on a project unless they can find ways to help the developing countries to improve their institutional capacity (Dubash 2009). It is not practical for the donors to directly implement mitigation projects in recipient countries, so the recipients must able to mobilize resources for implementation and address such issues as corruption and malpractice. Otherwise implementation will either fail or carry a prohibitively high cost. This argument is forcefully developed by Dubash (2009, 174-175) who argues that in developing countries,

> "[w]here existing institutions limit choices or create perverse incentives, inducing institutional change through the political process should be the primary task. Absent this change in the underlying incentives, shifts in relative prices are likely to accomplish little."

Although it is not yet possible to fully evaluate the role of capacity building in actual North-South climate finance, some CIF projects indicate that donors are at least trying to systematically incorporate it into strategies. For example, the 13 country or regional plans for the Clean Technology Funds of the CIF include provisions for capacity building, such as the establishment of a Metropolitan Cairo Transportation Authority in Egypt.[5] While I cannot address offer a detailed account of capacity building for climate finance

[5]The country plans can be found in PDF format at http://www.climateinvestmentfunds.org. Accessed July 21, 2010.

in this article, the formal analysis will illustrate the strategic interactions between capacity building and direct funding of mitigation policies.

Finally, the private sector should also provide complementary funding in the form of commercial investment (UNFCCC 2007). The ability of states to provide public funding is limited, so it is much better if climate finance creates economic incentives for international investors to participate. This reduces the finance burden for the industrialized countries and increases the economic value of climate finance for the developing countries. As Brinkman (2009, 136) writes,

> "National governments do not have the means to invest the amounts required, especially given current economic conditions. Private capital must play a major role in climate change investments, but will only do so within a stable, favorable regulatory and market framework. This means that a key challenge for governments will be to provide sufficient cash flow support to make up-front capital investment by the private sector attractive."

Indeed, a commonly used criterion for the efficacy of public finance for mitigation activities is how much complementary private finance they manage to leverage (UNFCCC 2007).

The CIF also illustrates the relationship between public and private finance. The 13 country plans under the Clean Technology Fund are expected to mobilize 40 billion dollars to support mitigation and resilience activities in developing countries, but of this funding only approximately four billion dollars will be directly provided by members of the CIF. The remaining 36 billion dollars will be from other sources, including the private sector.[6] Based on these estimates, it appears that the total value of private and other leveraged funding will exceed the sums allocated directly through public funding.

If these four conditions are met, climate finance holds potential for the following form of positive reinforcement. Industrialized countries provide funding in the global South, and this funding creates incentives for the private sector to participate. In conjunction with effective capacity building, the combination of public and private finance will allow decarbonization. As experience with mitigation policies accumulates in developing countries, they will be able to achieve even greater decarbonization, and this will also benefit the broader international community.

[6] See "Climate Investment Funds Set to Mobilize US$40 Billion for Country-Led Low Carbon Growth" at http://www.climateinvestmentfunds.org/cif/pf_2010_pressrelease_03_19. Accessed July 21, 2010.

Although the literature on development finance and foreign aid offers some insight into these issues, I am not aware of an integrated treatment. Political economists, such as Svensson (2000) and Drazen (2002), tend to emphasize the importance of moral hazard problems and conditionality. Other scholars of development are critical of this view and emphasize local ownership of development programs (Killick 1989; Sagar 2000). Yet others examine bargaining between donors and recipients (Bueno de Mesquita and Smith 2009). To my knowledge, however, scholars have yet to introduce models that would jointly examine the challenges that are essential to understanding climate finance.

4 Model

In the model, a *donor*, such as the United States or the European Union, is interested in funding activities by a *recipient*, such as China or South Africa, to mitigate global warming. These activities influence the profitability of clean energy in the recipient country, so an *investor* from the private sector must also decide on funding the mitigation project. Limited governance capacity and moral hazard problems may impede effective mitigation, however, so the donor and recipient must design international institutions that allow effective climate finance.

Sequence of moves. The game is played as follows:

1. The donor selects a level of capacity building, $C \in [0, \infty)$, and a transfer, $T = [0, \infty)$.

2. The recipient decides on mitigation, $M \in \{0, 1\}$.

3. If the recipient mitigates, $M = 1$, nature determines whether mitigation succeeds, $S \in \{0, 1\}$.

4. The investor decides on private funding, $F \in \{0, 1\}$.

This sequence of moves is intended to capture the core incentives in focus. The donor first invests in capacity building and designs a finance contract for the recipient. Next, the recipient decides on mitigation. A domestic investor subsequently decides on funding a clean energy project, but only after observing the success or failure of mitigation.

To assume that both the donor and the investor can condition funding on the success or failure of mitigation is quite realistic. Suppose, for instance, that the recipient attempts to implement an investment subsidy program

to support renewables production in the countryside. When the investor decides on whether to fund a project, she can examine the quality of the mitigation policies that the recipient has enacted. For instance, if it appears that the investment subsidy program is woefully ineffective, the investor can decide not to invest. By contrast, if the investment subsidy program gives proper investment for private finance, the investor can allocate resources to new renewables production.

Of course, in many circumstances it would be equally or more plausible to assume that the investor must decide on funding already before the success or failure of the mitigation policy is determined. If I were to modify the game in this fashion, the investor would have fewer incentives to fund the mitigation project but the donor could use capacity building to lure the private investor to participate. These changes would not compromise any of the main results.

Let $p \in (0,1)$ denote the probability of successful mitigation, $S = 1$, given a mitigation policy, $M = 1$. This probability is assumed to be a function of capacity building, so write $p = p(C)$. To ensure that p will be a valid probability measure, I assume that $p(0) = 0$ and $p(\infty) = 1$. Additionally, suppose $p'(C)$ is increasing and strictly concave, so that capacity building increases success probability but with decreasing marginal returns. The Inada conditions $p'(0) \to \infty$ and $p'(1) \to 0$ hold for technical convenience, so that the equilibrium is always interior.

The exact interpretation of capacity building is left open. It may range from technical assistance to more ambitious institutional development at various levels of governance, from national implementation agencies to local bureaucracies (Killick 1989; Sagar 2000). It may also encompass efforts to increase the participation and power of local communities, so as to harness local ownership to improve implementation effectiveness and capitalize on idiosyncratic information that is not available to the donor. The defining feature of capacity building is that it primarily increases the probability of successful implementation.

Payoff to the donor. As I argued in the previous sections, the donor is interested in successful mitigation and securing private investment for it. Let $B > 0$ denote the value of successful mitigation, $M = 1$, and suppose that this value increases to $(1+\delta)B$, where $\delta > 0$, when mitigation succeeds and private investment follows, $(M, F) = (1, 1)$. Thus, δ can be thought of as a value multiplier from leveraging private funding. This formulation is intended to reflect the fact that climate finance is potentially profitable, and the participation of private investors will also benefit the donor.

If the recipient refuses mitigation, $M = 0$, or an attempted mitigation

project fails, $S = 0$, the mitigation efforts produce a zero payoff to the donor. Intuitively, regardless of why mitigation fails, it does not produce a payoff to the donor. Failed mitigation projects do not improve global environmental governance or contribute to sustainable development.

Capacity building is costly to the donor. Suppose that the cost of capacity building C is given by $c(C)$, where c is an increasing and strictly convex function such that $c'(0) \to 0$ and $c'(\infty) \to \infty$. These conditions say that capacity building carries a cost that increases on the margin. Thus, the donor faces the tradeoff between increased capacity for mitigation by the recipient and an opportunity cost. The cost of the transfer is assumed to be linear and normalized to T. The main results would be robust to adding a transaction cost to the transfer, so that some proportion of the transfer is dissipated.

For instance, the transfer can be thought of as the donor's share of the costs of a successful mitigation project. I assume throughout that the donor can condition the transfer on successful mitigation. This assumption is not a perfectly accurate representation of reality, as it downplays the moral hazard problem that according to many political economists is central to foreign aid (Easterly 2002). However, it is a useful simplification that reveals the limits of climate finance even in seemingly ideal conditions that allow effective conditionality. To be sure, I will also discuss below practical institutional designs that will help avoid moral hazards in climate finance.

One concrete interpretation of the transfer is an "incremental" contribution by the donor to cover some part of the net cost of a mitigation project. Since mitigation projects often produce substantial ancillary benefits, such as improved energy efficiency or electricity generation for the poor, it does not appear necessary for the donor to fund the entire project. But many mitigation projects are too costly unless their global environmental benefits are accounted for. In environmental foreign aid, it is a common practice that the incremental costs are estimated and paid for by the donor (Clémençon 2006; Hicks et al. 2008; Streck 2001).

Payoff to the recipient. The recipient is interested in the transfer and private investment. If mitigation succeeds, $M = 1$ and $S = 1$, it obtains the transfer T. If the investor funds the project, $F = 1$, it obtains an additional revenue increase, $R > 0$. Mitigation is costly to the recipient, so suppose that if it decides to implement the mitigation policy, $M = 1$, it incurs an expense $X > 0$. To avoid the rather unrealistic possibility that the recipient invests in mitigation without any transfer, suppose throughout that $X > R$. This assumption says that the benefits of private investment fall below the cost of mitigation. If it did not hold, the recipient would always implement the

mitigation project even without any climate finance. In such circumstances, the question of North-South climate finance would be moot.

Payoff to the investor. The investor is only concerned with profits. These profits are only available if mitigation policy succeeds, $(M, S) = (1, 1)$, and the investor funds the project, $F = 1$. Let $\pi > 0$ denote the profits. The opportunity cost of funding the project is $Z > 0$. The sign of the difference $\pi - Z$ is left undetermined for the time being, $\pi - Z \lessgtr 0$. Thus, the commercial lucrativeness of a potential mitigation project will serve as an exogenous factor that will play an important role in the equilibrium analysis.

In practice, the net profitability of a mitigation project will depend on several factors. First, of course, it depends on the available opportunities to commercialize the end product, such as electricity generation. Second, it will depend on the quality and stability of the regulatory and business environment. Finally, it is also conceivable that the donor and the recipient subsidize private investments to increase participation and leverage private funding in climate finance. While the first and second possibility are left exogenous in this article, I will analyze below the investment subsidy using a simple extension of the main model.

5 Equilibrium

This is a game of complete information, notwithstanding random moves by nature, so the appropriate solution concept is the subgame-perfect equilibrium. An equilibrium of the game characterizes capacity building C^* and a transfer T^* for the donor; a mitigation decision $M^* = M^*(C^*, T^*)$ for the recipient that may depend on capacity building and the transfer; and a funding decision $F^* = F^*(M^*, S^*)$ that depends on the success of a possible mitigation policy.

5.1 Mitigation and Private Funding

To begin with, consider the investor's funding decision. Since funding is not profitable in the absence of a successful mitigation policy, the investor does not fund, $F^* = 0$, unless $(M^*, S^*) = (1, 1)$. When mitigation succeeds, so that $(M^*, S^*) = (1, 1)$, the investor invests if and only if $\pi - Z \geq 0$.

What about the mitigation decision? Without mitigation, the payoff to the recipient is exactly zero. Given capacity building C^*, a mitigation attempt, $M^* = 1$, succeeds with probability $p(C^*)$. The payoff from successful

mitigation is B when $F^* = 0$ and $B + R$ when $F^* = 1$. Thus, the recipient mitigates as follows:

$$M^* = \begin{cases} 1 & | \, p(C^*) \cdot T^* - X \geq 0 \\ 1 & | \, p(C^*) \cdot (T^* + R) - X \geq 0, \pi \geq Z \\ 0 & | \, \text{otherwise} \end{cases}.$$

Intuitively, the incentive to invest is larger when private funding will follow. But if the transfer is lucrative enough, the recipient will mitigate even when private funding is unattainable.

5.2 Capacity Building and the Transfer

How should the donor decide on capacity building and the transfer? It can always secure a zero payoff by exiting with $(C^*, T^*) = (0, 0)$. Thus, the equilibrium analysis comprises finding the optimal combination $(C^*, T^*) \neq (0, 0)$ and comparing the resulting payoff to zero. If the optimal combination produces a positive payoff, the donor engages in capacity building and offers a transfer. Two cases must be considered: climate finance without private funding, $\pi < Z$, and when it is forthcoming, $\pi \geq Z$.

Without private funding. First, suppose that the private investor is unwilling to fund the project even when the mitigation policy succeeds, $\pi < Z$. In this case, the condition

$$p(C^*) \cdot T^* - X \geq 0 \tag{1}$$

must hold for capacity building C^* and T^* to prompt mitigation by the recipient. The transfer T^* must be such that the condition holds with equality, because otherwise the donor could profitably reduce the transfer. Thus, we must have $T^* = \frac{X}{p(C^*)}$ in equilibrium. This expression says that the requisite transfer increases in project cost X and decreases in success probability $p(C^*)$.

Given capacity building C^* such that condition (6) holds, the payoff to the donor can be written as

$$p(C^*) \cdot (B - T^*) - c(C^*). \tag{2}$$

With $T^* = \frac{X}{p(C^*)}$, this amounts to

$$p(C^*) \cdot \left(B - \frac{X}{p(C^*)} \right) - c(C^*). \tag{3}$$

By paying the cost of capacity building $c(C^*)$, the donor benefits from a successful mitigation policy with probability $p(C^*)$. Net of the transfer T^*, the value of this benefit is $B - \frac{X}{p(C^*)}$.

Unless $C^* = 0$, the optimal capacity building C^* is characterized by the first-order condition

$$p'(C^*) \cdot \left(B - \frac{X}{p(C^*)} \right) + p'(C^*) \frac{X}{p(C^*)} = c'(C^*), \tag{4}$$

and this condition simplifies to

$$p'(C^*) \cdot B = c'(C^*). \tag{5}$$

This expression shows that as the donor selects the capacity building effort C^*, it does not even consider the implementation cost X to the recipient. It is optimal to select the capacity building C^* to maximize the expected benefit from mitigation, and only use the transfer $T^* = \frac{X}{p(C^*)}$ to compensate the recipient for its losses. The decision to build capacity C^* does not depend on the transfer T^*, because this transfer is simply a side payment that is needed to secure participation by the recipient. Of course, if the requisite transfer T^* were too large, so that the expected payoff to the recipient from the best feasible finance contract $(C^*, T^*) \neq (0, 0)$ is negative, the donor will exit by selecting $(C^*, T^*) = (0, 0)$.

With private funding. Suppose now instead that the investor will fund the project upon successful mitigation, $\pi \geq Z$. Now capacity building C^* must only achieve

$$p(C^*) \cdot (T^* + R) - X \geq 0, \tag{6}$$

a condition unambiguously easier to meet than condition (1) without private funding, for the recipient to mitigate, $M^* = 1$. The requisite transfer is now only $T^* = \frac{X}{p(C^*)} - R$, as the recipient can expect benefits from private funding. The donor can reduce the transfer by the total value of private funding R.

The payoff to the donor,

$$p(C^*) \cdot ((1 + \delta)B - T^*) - c(C^*) \geq 0, \tag{7}$$

is also higher than in the absence of private funding. Unless $C^* = 0$, the following first-order condition can be derived:

$$p'(C^*) \cdot ((1 + \delta)B + R) = c'(C^*). \tag{8}$$

This condition shows that private investment increases the incentive to build capacity for two reasons. First, the value of successful mitigation is higher for the donor, $(1+\delta)B$ instead of B. Second, private funding decreases the requisite transfer $T^* = \frac{X}{p(C^*)} - R$, as the recipient also benefits from the private funding. Thus, more of the value from successful mitigation is left to the donor. Clearly, in these circumstances it is easier to avoid exit by the donor.

5.3 Discussion

These observations show that, somewhat surprisingly, the strategy of climate finance collapses into selecting the degree of capacity building. If the cost of this capacity building, and the resulting transfer required to secure participation by the recipient, produce a net profit, the donor engages in climate finance. The optimal transfer is then fully determined by the level of capacity building.

These ideas are not fully appreciated in the extant literature. Capacity building is commonly thought of as a secondary consideration that supports project implementation, but my formal analysis shows that exactly the opposite may be true. It is capacity building that determines the total value of a given mitigation policy, and the transfer is only needed to ensure that all parties benefit from participation. While capacity building maximizes the surplus available from climate finance for the donor and the recipient, public funding is essentially a distributive income transfer that secures participation by the recipient.

6 Results on Capacity Building

The equilibrium analysis provides several new insights into how donors and recipients should design climate finance institutions to maximize the effectiveness of mitigation. In this section, I examine the empirical implications of this question. I begin with the probability that a project in the recipient country is given any climate finance at all. I next consider equilibrium capacity building and transfers.

To begin with, consider a potential mitigation project, formalized as some set of exogenous parameters of the game. For this project to be profitable, it must be that the optimal capacity building, as defined in expression (5) or (8), depending on the availability of private funding, yields a positive payoff to the donor.

Proposition 1. For a given mitigation cost X, if benefit B is low enough, $B \leq \tilde{B}$ the donor selects zero capacity building, $C^* = 0$. For a mitigation benefit B, if cost X is high enough, $X \geq \tilde{X}$, the donor selects zero capacity building, $C^* = 0$. The threshold $\tilde{B}$ is strictly lower and the cutoff $\tilde{X}$ is strictly higher if private funding is forthcoming, $\pi \geq Z$.

Proof. In equilibrium, we must have $T^* = \frac{X}{p(C^*)}$ or $T^* = \frac{X}{p(C^*)} - R$ for $M^* = 1$. With $B \to 0$ or $X \to 0$, $T^* \to \infty$. Clearly, the payoff to the donor is unambiguously higher under $\pi \geq Z$ as $T^* = \frac{X}{p(C^*)}$ is replaced by $T^* = \frac{X}{p(C^*)} - R$. ■

This proposition says that, unsurprisingly, low benefits B or high costs X preclude climate finance. A project whose ideal implementation produces a negative payoff to the donor is simply not feasible. Since private funding benefits both the donor and the recipient, it is easier to avoid this problem with than without private funding. Thus, the availability of private funding that can be leveraged will expand the set of feasible projects for climate finance.

Suppose now these constraints are met, so that climate finance is made available by the donor. In this case, capacity building C^* is strictly increasing in the benefit B but at a decreasing rate on the margin. Perhaps surprisingly, however, the converse turns out not to hold for the cost X.

Proposition 2. Given cost X, if $B > \tilde{B}$, capacity building C^* is strictly increasing in benefit B but at a decreasing rate on the margin. Given B, if $X < \tilde{X}$, capacity building C^* is constant in X. Capacity building C^* is strictly higher if private funding is available, $\pi \geq Z$.

Proof. Capacity building C^* is fully characterized by condition (5) or (8). As B increases, C^* must increase for the relevant equation to hold with equality. However, given that $c'(C^*)$ is strictly increasing in C^*, a unit increase in B will produce a lower increase in C^* for higher values of C^*. Next, the mitigation cost X does not feature in either condition (5) or (8), so if $X < \tilde{X}$, small changes in X have no effect on C^*, To see that C^* is strictly higher under $\pi \geq Z$ than under $\pi < Z$, compare (5) and (8). ■

This proposition is illustrated in FIGURE 1. It shows how capacity building C^* increases with B but does not vary with X, as long as climate finance is feasible. It also shows that the curve under private funding, $\pi \geq Z$, is

everywhere above the curve without private funding, $\pi < Z$.

Why does capacity building C^* not vary with the cost X? The reason is that the donor selects capacity building C^* to maximize the expected benefit from climate finance, as shown in expressions (5) and (8). The cost X is simply a fixed cost that is paid if the donor and the recipient engage in climate finance. While it does not change the optimal capacity building C^*, it will increase the transfer T^*, as discussed in some detail below.

[FIGURE 1 ABOUT HERE]

These two propositions show that basic economic calculations continue to play a role in climate finance despite politics. A necessary condition for implementation is that both sides benefit. If this condition is met, the donor is increasingly willing to invest in capacity building, because the benefits from successful mitigation increase, again for both sides.

Equally important is the observation that private funding can have an integral role in climate finance. By reducing the pressure on transfers from the donor, private funding expands the set of opportunities for the donor and recipient to profitably implement mitigation projects in the recipient country. Thus, the model provides robust microfoundations for the widely accepted conjecture that private funding is key to successful climate finance.

7 Results on the Transfer

In the previous section, I have investigated equilibrium capacity building C^*. The key findings were twofold. First, capacity building increases as the cost-benefit of ratio of the proposed project improves. Second, capacity building does not depend on the mitigation cost to the recipient, as long as the mitigation cost is not so high as to preclude mutually profitable climate finance.

In this section, I examine how the equilibrium transfer T^* varies with the costs and benefits of the project. Quite surprisingly, I find that the transfer may actually decrease as the benefits increase and the costs decrease. The reason is, again, that increased capacity building C^* produces additional benefits for the recipient as well, so the donor can offer a lower transfer without inducing exit by the recipient.

To begin with, let us verify that the transfer must be positive, $T^* > 0$, or the project fails.

Proposition 3. Capacity building is positive, $C^* > 0$, if and only if the transfer is positive, $T^* > 0$.

Proof. If C^*, we must have $T^* > 0$ because $X - R > 0$. If T^*, we must have $C^* > 0$ because otherwise the probability of successful mitigation is zero. ■

This proposition says that if the donor invests in capacity building, thus enabling the project in the first place, it must also offer a positive transfer, and vice versa. The reason is that, with or without private funding, mitigation carries a net cost to the recipient. Thus, some kind of a transfer is necessary.

This result is empirically plausible. To see why, suppose that a project exists such that no transfer T^* is necessary. Now the recipient has an incentive to implement it without external assistance, and climate finance is unnecessary. The donor may have an incentive to help build capacity, but a separate international institution for climate finance is unnecessary, as the recipient will have a strong incentive to engage in mitigation without any incremental funding.

While this claim is difficult to test at the level of individual projects, an empirical analysis of the relationship between environmental foreign aid for capacity building and actual mitigation could prove useful. Controlling for relevant covariates in a statistical model, the proposition states that we should expect a positive correlation between capacity building efforts and public funding for mitigation activities.

Let us now suppose that a profitable project is available, so that $T^* > 0$ because donor benefits B are high and recipient costs X are low. It turns out that the equilibrium transfer T^* decreases as B increases or X decreases. Similarly, the availability of private funding increases T^*.

Proposition 4. Choose B, X such that $T^* > 0$. As B increases, T^* decreases. As X increases, T^* increases. If $\pi < Z$ is replaced by $\pi \geq Z$, so that private funding is possible, then T^* decreases.

Proof. In equilibrium, $T^* = \frac{X}{p(C^*)}$ or $T^* = \frac{X}{p(C^*)} - R$. With C^* increasing in B, the claim regarding an increase in B follows. Differentiating T^* with respect to X, an increase in X increases T^* by $\frac{1}{p(C^*)}$. If $\pi < Z$ is replaced by $\pi \geq Z$, $T^* = \frac{X}{p(C^*)}$ is replaced by $T^* = \frac{X}{p(C^*)} - R$. ■

This proposition, as illustrated in FIGURE 2, has three parts. First, suppose

that the benefits B to the donor increase. Strikingly, this prompts a decrease in the transfer T^*. The reason is that an increase in the benefit B prompts an increase in capacity building C^*, and this increase in turn reduces the minimal requisite transfer T^*. To see this, recall that the expected benefit from mitigation to the recipient is either $p(C^*) \cdot T^*$ or $p(C^*) \cdot (T^* + R)$. In either case, an increase in $p(C^*)$ allows a decrease in T^* without violating the participation constraint.

[FIGURE 2 ABOUT HERE]

Second, and more intuitively, an increase in the recipient's cost X will prompt an increase in the transfer T^*. This is so because the increased cost reduces the recipient's willingness to participate. As the equilibrium analysis showed, the mitigation cost X does not affect capacity building C^*, so the only possible response by the donor is to increase the transfer T^*.

These claims are also empirically testable. The expected value for the donor and the recipient of each individual project could be assessed, although these assessments would probably remain somewhat crude. The relationship between the value of the project and the funding flows could then be investigated. If the relationship between individual projects in a single country could be charted, perhaps using techniques of network analysis, it might also be possible to investigate the relationship between capacity building and actual mitigation projects.

What about data availability? The AidData project has collected project-level data on development assistance, and they have codified these projects by sector and purpose (Hicks et al. 2008).[7] This level of detail would allow empirical scholars to examine the relationship between capacity building and incremental funding, following Proposition 3, as well as the covariance of net project benefits and capacity building or incremental funding, for an empirical test of Proposition 4.

Finally, the availability of private funding reduces the transfer T^*. Since private funding produces tangible benefits for the recipient, the need for public funding decreases. This again demonstrates that private funding is critically important for successful climate finance, as it reduces the need for costly and potentially controversial North-South transfers.

This finding has an important implication as to the feasibility of implementation. If it is the case that private funding reduces the need for public

[7]The AidData website can be found at http://www.aiddata.org. Accessed July 21, 2010.

donations, countries with a business-friendly economic environment are also most likely to obtain climate finance. While previous arguments have made a compelling case for the effect of the business environment on private funding, to my understanding the indirect connection to public finance has not been made.

In sum, the combined results may shed some light on why questions of incremental funding and public finance flows have proven so controversial in international climate negotiations. The principle of incremental funding basically codifies the idea that the transfer T^* is chosen to be the lowest possible that can entice participation by the recipient while the emphasis on private finance is inversely related to public finance. Thus, if the developing countries could somehow avoid incremental funding and reduce the substitutability of public and private finance through institutional means, they would obtain a greater share of the surplus from North-South climate finance.

On a final note, the flip side of this observation is that the principle of incremental funding may ultimately prove less relevant for the environmental effectiveness of climate finance than other questions. In a sense, incremental funding is a distributional question. If incrementality is strictly adhered to, the recipient will give all of the surplus from climate finance to the donor, as the transfer T^* is barely enough to cover the net cost $\frac{X}{p(C^*)}$. If incrementality is relaxed, some of the surplus will go to the recipient. This could, of course, reduce the effectiveness of climate finance, as recipients could begin to implement projects that produce few benefits. However, there are other ways to guard against this possibility. For example, one could evaluate the feasibility of climate finance according to the incremental benefits that they produce, and then reward diligent recipients with an extra reward. Thus, the connection between the idea of incrementality and the effectiveness of climate finance may be more tenuous than donors prefer to claim.

8 Support for Private Funding

In the previous section, I demonstrated that private funding can play an integral role as a catalyst for public finance. In this section, I conduct a more detailed examination of this logic. In particular, I examine the possibility that a subsidy to private investors in exchange for participation could help achieve cooperation on climate finance. Since private funding can increase the value of climate finance for the donor and the recipient, intuition tells us

that the donor may benefit from supporting the participation of the private sector. The formal analysis will lend support to this intuition.

To conduct the formal analysis, recall that the investor funds the project if and only if $\pi \geq Z$. If this condition holds, it is not necessary to subsidize climate finance, so the question is moot. But if $\pi < Z$, then it may be useful to offer the minimal subsidy $S^* = Z - \pi$ to ensure that private funding is forthcoming. Will the subsidy be profitable for the donor?

If climate finance is impossible despite private funding, this question is obviously also moot. Thus, I assume throughout that with private funding, the donor obtains a positive net payoff from climate finance in equilibrium, $(C^*, T^*) \neq (0, 0)$. Recall that by PROPOSITION 1, this condition will hold when benefits B are high enough and costs X are low enough.

There are two scenarios to consider. First, suppose that climate finance would be possible even without a subsidy, $(C^*, T^*) \neq (0, 0)$. In this case, the subsidy has two benefits. First, it increases the value of climate finance for the donor from B to $(1 + \delta)B$. Second, it decreases the subsidy that the recipient must obtain, as the recipient's payoff is augmented by R.

To understand what the private subsidy would do, consider the following. Choose capacity building and subsidy $(\overline{C}, \overline{T}) \neq (0, 0)$ so that they are in equilibrium without the private subsidy. If private funding is suddenly made available, the first-order condition (5) no longer holds, as clearly

$$p'(\overline{C}) \cdot ((1 + \delta)B + R) > p'(\overline{C}) \cdot B = c'(\overline{C}). \tag{9}$$

The availability of private finance increases the benefits of additional capacity building without changing the costs. Thus, the donor increases capacity building, because the value of success grows. Additionally, the value of successful implementation for the recipient grows by R. The combination of increased capacity building, $C^* > \overline{C}$, and the transfer R allow the donor to reduce the transfer, $T^* < \overline{T}$.

Second, if climate finance is impossible without a subsidy, so that $(C^*, T^*) = (0, 0)$, the value of the subsidy to the investor is even higher. In addition to the two benefits identified above, the subsidy enables cooperation in the first place. As the cost X is complemented by the benefit R for the recipient, the incentive to mitigate can be created with a lower transfer T^*. Additionally, the donor benefits more because B is replaced by $(1 + \delta)B$. Thus, capacity building C^* will increase. All these changes expand the set of parameters that admit mutually profitable climate finance.

These observations suggest that climate finance should incorporate subsidies for private investors. By offering a subsidy to the private investor, the

donor can increase the value of climate finance both for the donor and the recipient. Perhaps most strikingly, the private subsidy will also prompt an increase in capacity building C^* by the donor. Thus, capacity building and private funding go hand in hand.

To my understanding, this positive reinforcement between private funding and capacity building has not been addressed properly in the extant literature. It is widely recognize that national capacity and a stable regulatory environment are essential for securing private funding, but the other direction of the causal arrow – successful inclusion of the private funding will endow donors with incentives to support national capacity building in recipient countries – is often neglected. Thus, the net benefits of subsidizing private participation may have been underestimated in previous studies.

9 Practical Implementation

So far, I have conducted a formal analysis of the incentives that determine the feasibility and profitability of climate finance. However, the question of practical implementation remains. In this section, I examine institutional designs that would function well given the results from the formal analysis. The purpose of this examination is to bridge the gap between the abstract strategic analysis and the complex reality of practical implementation.

Recall that the three main issues were participation incentives for the recipient and the donor, capacity building, and the role of the private sector. Each issue has implications for practical implementation. Most importantly, the formal analysis revealed that capacity building and private funding will both expand the size of the pie that the donor and the recipient can divide as they engage in climate finance. This observation will form the basis of my policy analysis.

To begin with, how can a climate finance institution entice both donors and recipients to participate? According to the formal analysis, this requires at the very least that (i) donors are able to condition climate finance on successful mitigation while (ii) recipients are able to secure funding for projects that are not excessively costly. From this perspective, a carbon credit system, similar to the Clean Development Mechanism of the Kyoto Protocol, is a promising alternative. Donors could fund mitigation projects in the global South in exchange for carbon credits that could be substituted for domestic emissions reductions in the global North. The system would allow recipients to select projects for implementation and propose them to donors, so that recipients could capitalize on idiosyncratic country information and provide

the foundation for local ownership in the relevant political economy (Dubash 2009; Ghosh and Woods 2009; Werksman 2009).

If a donor and a recipient agree on implementing a project, an independent verification agency will inspect the project and rate it according to previously specified criteria. Good projects will be granted many carbon credits, while bad projects receive few. Many independent verification agencies have been operating for years to assess the quality of carbon credits under the Clean Development Mechanism, so the international capacity for verification and certification already exists. Thus, the institutional foundation that the Kyoto Protocol has created will serve to reduce the transaction costs of climate finance.

Of course, the carbon credit system would have to somehow connect to a pool of donor funds that could be exchanged for carbon credits. While it seems improbable that world leaders can negotiate a unified climate regime anytime soon, all industrialized countries are already engaging in some mitigation efforts (Lutsey and Sperling 2008; Schreurs 2008). Industrialized countries could commit to a multilateral fund for climate finance, be it in the form of offsets or simply foreign aid, that would then be available for developing countries in exchange for certified carbon credits. This system would give recipients credible guarantees for continued climate finance, while donors could secure accountability and transparency. A potential institutional foundation for such a fund may be found in the CIF or the GEF, although the scope and resources allocated to this system would have to be greatly expanded and increased.

For three reasons, it is critically important that the project criteria extend well beyond emissions reductions. First, for donor participation, it is important the projects produce genuine and lasting changes in the recipient country. Immediate emissions reductions are of little importance unless they really induce lasting decarbonization, so projects that are durable or can be expanded in the future should be valued particularly highly. Second, for recipient participation, mitigation projects should produce local side benefits and contribute to sustainable development. If such benefits are explicitly evaluated in project selection, recipient countries have a much greater incentive to both participate and propose useful mitigation projects that hold great decarbonization potential. Finally, decarbonization potential and ancillary local benefits should be explicitly codified in the rules of a carbon credit system, so as to ensure that developing countries will have incentives to propose appropriate mitigation projects. If decarbonization potential and ancillary local benefits are not explicitly accounted for, so that they are in effect viewed as secondary to immediate potential for emissions reductions,

many mutually profitable mitigation projects that could be easily implemented may fall outside the scope of the carbon credit system because they do not offer emissions reductions in the short run.

The carbon crediting system would also alleviate the sovereignty conflicts and reduce the mistrust surrounding climate finance. They give the recipient the ultimate authority over projects, so they increase country ownership and allow the recipient to capitalize on private information regarding local circumstances (Dubash 2009; Ghosh and Woods 2009). This will reduce the cost of implementation. However, the carbon crediting system will also meet the accountability and transparency criteria that are so important for donors (Ballesteros et al. 2009). As long as donors and recipients are able to jointly determine the criteria for carbon crediting, the independent verification agencies will help hold recipients accountable without excessive or unfair conditionality imposed by the donors.

According to the formal analysis, it is essential that capacity building is explicitly included in the climate finance system. In the current debate, capacity building is widely regarded as a separate component that enables climate finance. My results indicate that this approach is flawed. Capacity building should be an integral element of the climate finance system, and climate finance institutions should require a plan for capacity building as a matter of course. For instance, one could require that certain capacity building criteria be met for inclusion in the carbon credit system. These criteria would obviously depend on the identity of the recipient, so that least developed countries would have to be given more external assistance.

It is also essential that the capacity building focuses on, and is anchored in, national institutions in the recipient country (Sagar 2000; Victor, House, and Joy 2005). Both the donor and recipient participation constraints are easier to meet if capacity building helps the recipient build robust administrative capabilities that facilitate project implementation in the present and in the future. An emphasis on national institutions would also facilitate local ownership, especially if capacity building will be done according to recipient needs and preferences.

It might also be a good idea to directly credit capacity building. The reason is that while some capacity building efforts are project-specific, others produce substantial positive externalities that benefit future mitigation efforts. Unless donors somehow manage to internalize them in the cost-benefit calculus, the danger exists that external assistance for capacity building will be underprovided. Thus, it might be a good idea to also develop explicit criteria for capacity building and transfer donors for giving external assistance to the implementation of promising capacity building efforts.

The formal analysis demonstrated that private funding is intimately connected to both capacity building and transfers from the donor to the recipient. Beyond the obvious fact that private investors should be encouraged to participate, the formal analysis demonstrates that institutional designs should probably transfer both the donor and the recipient for enticing private investors to participate. While private investors obviously internalize profits from mitigation projects, they fail to account for the positive externalities: enhanced capacity building by the donor and improved quality of mitigation projects. From this perspective, the carbon credit system could benefit from not only offering appropriate subsidies to private investors, but also transferring donors and recipients through generous ratings, for implementing mitigation projects that assign a key role to the private sector.

Finally, a carbon credit system has the additional benefit of durability. For donor and recipient participation, *ad hoc* projects or isolated institutional arrangements suffer from the problem that either party can defect with few consequences in the long term. However, a carbon credit system will ensure that (i) implementation failures by the recipient will carry reputation consequences and (ii) donors cannot renege on funding promises because the carbon credit system automatically values mitigation projects by recipients. Such credibility is arguably a core problem in development assistance, both environmental and in general (Arellano et al. 2009; Ghosh and Woods 2009; Pallage and Robe 2001).

10 Conclusion

In this article, I have investigated the feasibility and effectiveness of North-South climate finance for mitigation projects. I have argued that three issues must be accounted for: participation incentives for the donor and the recipient, capacity building, and private sector involvement. I have incorporated all three central elements into a formal model of climate finance.

I have found that these three issues are intimately interrelated. According to the model, capacity building is a substitute for income transfers to the recipient. If the donor provides support for capacity building, it increases the probability that recipient efforts to implement mitigation policies will succeed. With an increased success probability, the recipient can be given less funding to cover incremental costs. This benefits the donor, and thus expands the set of feasible mitigation projects in North-South climate finance.

Private funding can also reduce the need for both, as it expands the

surplus available to the donor and the recipient from climate finance. The added value of private funding reduces the difficulty of simultaneously securing donor and recipient participation, while also giving the donor an additional incentive to invest in capacity building. Thus, a good way to secure mutually profitable climate finance is to create a business environment for private funding and establish a strong commitment to capacity building.

These findings have some counterintuitive empirical findings. First, capacity building and incremental funding are inversely related. Where the donor finds it worthwhile to offer resources for capacity building, the need to offer incremental funding decreases. Second, donors increase capacity building if the value of the mitigation project increases but not if the cost to the recipient increases. Thus, the incremental costs of various mitigation projects may have little effect on capacity building.

It is quite apparent that these findings have broader implications for development finance. There is widespread consensus on the importance of capacity building and the private sector, but the interrelatedness thereof has not been rigorously investigated in past research. I have focused on climate finance for concreteness, but the analytical framework could be applied to development finance more broadly, as long as the idiosyncracies of different sectors are accounted for.

It is my hope that the results are relevant for actual policy. Given the staggering economic growth of large developing countries, especially in Asia, climate finance is an urgent policy topic. Formal analyses of institutional design can guide practical implementation, and this article I have tried to facilitate this task by moving from the realm of the abstract to reality. In particular, I have argued that the formal analysis offers a robust strategic foundation for establishing a carbon credit system. The main benefits of such as system are the creation of participation incentives for donors and recipients, credibility and consistency, and the possibility of institutionalizing such issues as capacity building or accounting for decarbonization potential and ancillary local benefits. These issues are, according to the formal analysis, crucial for successful North-South climate finance.

Many questions remain to be addressed in future research. I have not distinguished between different projects or countries, and I have not examined in detail what capacity building should comprise. Similarly, the modeling of the private sector was in reduced form. Perhaps more importantly, climate finance projects have now been implemented for several years, so empirical data can be used to examine the nexus of capacity building, transfers, and private funding.

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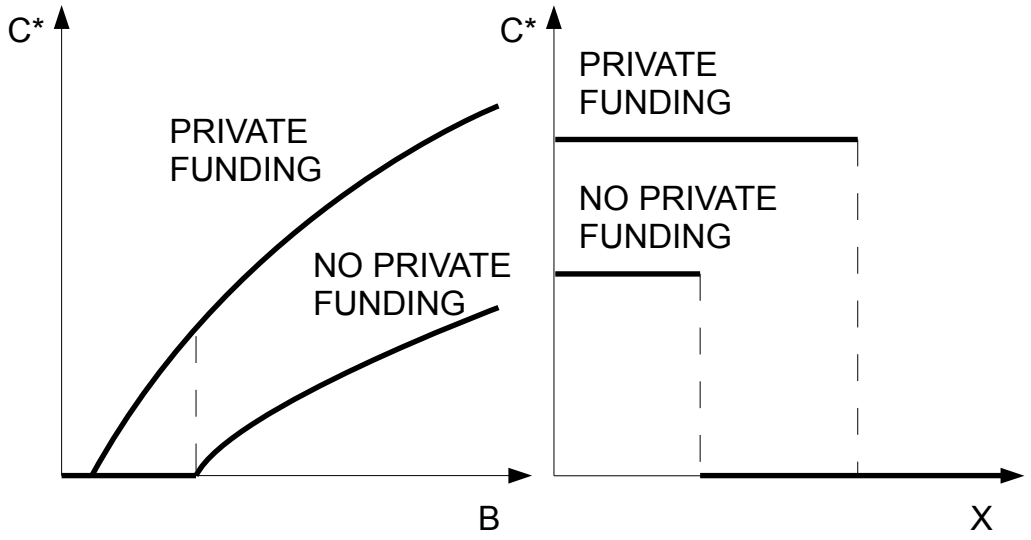

Figure 1. The effect of donor benefit B and recipient cost X on capacity building C^*.

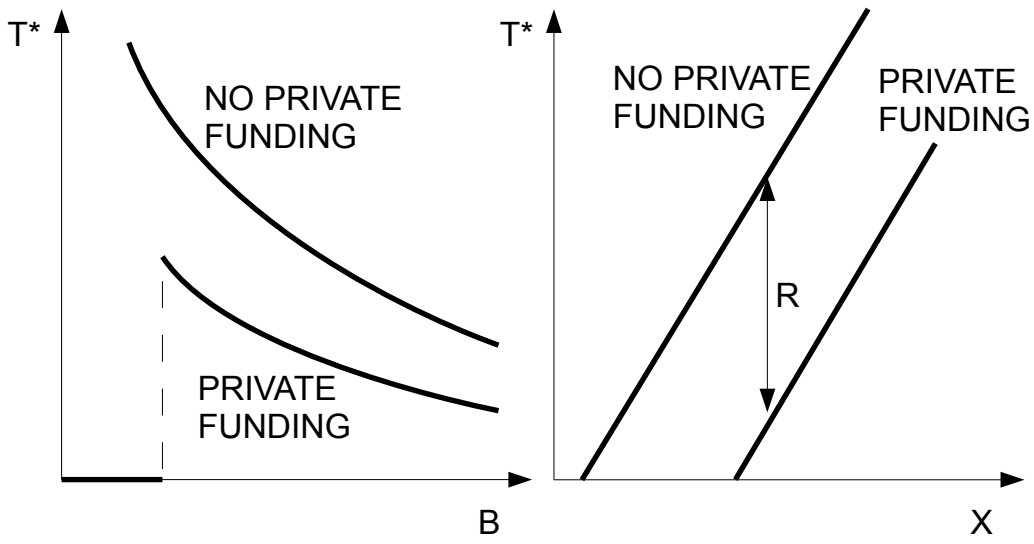

Figure 2. The effect of donor benefit B and recipient cost X on transfer T^*.