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Balancing Risks from Climate Policy Uncertainties: The Role of Options and Reduced Emissions from Deforestation and Forest Degradation

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ABSTRACT

Progressively adjusting climate policies will entail adjustment costs for society. This paper develops a conceptual model and numerical example that illustrate the risk associated with exposure to the high costs of complying with future emissions controls and how this risks trades off against that from potentially premature investment into abatement. We then highlight the potentially unique role of tropical forest protection in helping to manage these risks by providing a cost-effective "buffer" of near term emissions reductions at a globally significant scale. This buffer would provide insurance against the risk of suddenly tightening targets, as well as providing other critical environmental benefits. We further examine how a version of a private finance instrument in the form of long-dated 'call' options on verified reductions in emissions from deforestation and forest degradation (i.e. REDD+) can help to operationalize this risk-hedging buffer creation. Options on REDD+ could aid both regulated businesses and tropical nations to manage their respective risks. REDD+ options could deliver sufficient abatement to significantly hedge exposure of regulated entities to potential corrections in climate policy while channeling financial resources to defer deforestation even as climate policies continue to evolve.

1. Introduction

With the Paris Climate Agreement of December 2015 the global community agreed to restrict global temperature increases to below 2 °C above pre-industrial levels, but significant uncertainties remain over what is needed to achieve this goal and how this goal will be achieved. The Intergovernmental Panel on Climate Change (IPCC 2015) provides a range of 1130–1530 billion metric tons (bmt) of CO_2-equivalent for the total cumulative greenhouse gas (GHG) emissions over 2010–2050 consistent with a 2 °C stabilization scenario,[1] depending on the equilibrium sensitivity of the climate system and other factors. Climate policy is likely to evolve in an iterative manner in response to a new scientific, economic knowledge, and political developments. Countries' pledged emissions reductions submitted in Paris (their Intended Nationally-Determined Contributions; INDCs) are far from sufficient to navigate transition to 2 °C stabilization pathway (UNDP, 2015), but are scheduled to be ratcheted up progressively at periodic global stock-takes. Eventually, the gap between the current ambition of emissions reduction commitments and what is needed for meeting climatic goals could result in a significant tightening of emissions controls over a limited time period. Progressively adjusting policies will inevitably entail adjustment or 'correction' costs for society and firms facing carbon emissions regulations.

This paper examines the risk-management challenge facing regulated firms in an environment of uncertain climate policy requirements. Emissions reductions from tropical deforestation have a unique potential insurance role in providing a large 'buffer' of emissions reductions. This buffer is ideally suited from a cost perspective for hedging the risk of suddenly tightening targets, as well as providing other critical environmental benefits. We finally examine how such an approach can be operationalized with a private finance instrument in the form of 'call' options, the right but not the obligation to purchase verified reductions at a predetermine price.

Anda et al. (2009) identified the challenge of balancing two types of option value associated with climate policy uncertainty: on the one hand, there is the option value from delaying deterioration of a 'climate asset' and, second, there is the value from delaying abatement investment that potentially may turn into a sunk cost. From the perspective of a social planner concerned about optimizing societal welfare, the likely costs of future adjustments or 'corrections' in climate policy should in theory be anticipated and accounted for while deciding on a provisional policy. The planner should thus adopt a precautionary approach, keeping emissions lower for some time than might be deemed necessary, based simply on the average ('expected') values of uncertain factors,

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[1] Table SPM.1 offers several ranges of cumulative carbon emissions for the period 2010–2050 that could be interpreted as consistent with 2 °C stabilization target.

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so as to avoid the potential for irreversible damages to the climate system and preserve flexibility for policy adjustments in the future (Webster, 2008, Webster et al., 2012, Newbold and Daigneault, 2009; see also Golub et al., 2014, for detailed review). These studies implicitly identify the option value from preemptive climate policy that avoids irreversible accumulation of GHGs in the atmosphere.

From the perspective of firms facing regulations, Dixit and Pindyck (1994) and Pindyck (2000) focus on the irreversibility of emissions reduction ('abatement') investments, highlighting a 'deferral' option value from the option to postpone prospective investment into abatement technologies. On the other hand, delaying actions to develop and deploy abatement technology and/or to purchase and save ('bank') emissions permits for later use within a carbon market system, polluting firms could end up long on emissions and short on abatement technology and permits in the future. They would then run the risk of paying unexpectedly high prices to comply with regulations, unless they have an appropriate tool for hedging these risks. There are already indications that firms realize these risks and are seeking to hedge them on a voluntary basis, although they face imperfect tools for doing so. In particular, polluting firms' interest in managing climate policy risks is evidenced by growing private industry support for carbon pricing[2] as well as firms' voluntary adoption of internal carbon prices far above those prevailing in current carbon markets, such as the European Union and California (CDP, 2015).

Building on Anda et al. (2009), this paper develops a conceptual model of the competing risks facing private firms in world of uncertain and iteratively evolving greenhouse gas emissions control frameworks. Our analysis explicitly includes the different types of option values that market actors must consider in making decisions regarding investment into emissions reduction and/or purchases of emissions permits ('allowances') under emissions trading ('carbon market' or 'cap-and-trade') systems. We derive the optimal strategy for both buyers and sellers, accounting for the respective potential for correction costs on both sides as policy and economic uncertainties resolve. We propose a way to compute an equilibrium price for carbon allowances and for associated 'call' options (the right but not the obligation to buy allowances), as well as an implicit value of the opportunity to delay abatement investments.

Furthermore, we demonstrate how (call) options on Reduced Emissions from Deforestation and forest Degradation (REDD+) could help to manage costs of uncertain climate policies, while providing a source of finance for tropical forest protection at a globally significant scale and allowing tropical nations to manage cost uncertainties on the supply side. Tropical deforestation produces roughly 15% of global greenhouse gas emissions and offers one of the largest and potentially cost-effective opportunities to reduce emissions at large scale over the coming decades, while providing a host of other social and environmental benefits (Lubowski and Rose, 2013). Although the Kyoto Protocol excluded mechanisms for reducing tropical deforestation under the United Nations Framework Convention on Climate Change (UNFCCC), the Cancun Agreements of December 2010 affirmed that activities in developing countries for reducing emissions from deforestation and forest degradation, in addition to maintaining and increasing carbon stocks through other forestry activities (REDD and REDD+, respectively), should form part of any future global climate agreement, and this decision was reinforced under the Paris Agreement of December 2015. The basic idea is that REDD+ would provide payments to jurisdictions (i.e., countries, states, or provinces) that voluntarily reduce forest emissions below agreed-upon benchmark levels.

Golub (2010), Fuss et al. (2011), Szolgayová et al. (2014), and Krasovskii et al. (2014) have analyzed call options on REDD+ as a new instrument to reduce firms' climate policy costs, including helping to hedge uncertain research and development (R&D) investments in developing new abatement technologies. Also, Krasovskii et al. (2016) model the contracting of REDD+ offsets under risk preferences and benefit-sharing in a partial equilibrium framework. We build on these studies to analyze the demand as well as potential supply of REDD+ options and present some quantitative estimates of the overall potential impact of REDD+ options within a global carbon market equilibrium framework.

The next section develops a conceptual model. We discuss the decision making problem from the point of view of regulated industry under uncertainty, introducing a new decision criterion that takes into account a penalty for taking irreversible decision. We also discuss the role of REDD+ in hedging risks, the incentives from the perspective of a REDD+ supplier, and the resulting market clearing conditions for REDD+ spot and options transactions. This conceptual analysis lays the foundation for a numerical analysis. Sections 4 and 5 describe a numerical illustration and present the results, respectively. The final section concludes.

2. Conceptual Model of Private Firm Facing Climate Regulations

We consider a stylized partial equilibrium model of a representative greenhouse gas emitter facing emissions limits within a carbon market system with two consecutive periods. The firm minimizes total discounted costs of abating emissions internally and/or purchasing emissions permits on the market. Excess emissions permits no required for use in the first period can be carried over (banked) for use in the second period in line with currently accepted practices in most emissions trading systems (PMR and ICAP, 2016).

First, we consider the case with perfect information and establish a baseline for further analysis. Second, we increase realism by considering a case where the emissions limits in the second period are uncertain and will only be revealed in the second period. The firm must then minimize abatement costs, as well as any potential losses attributed to potentially excessive abatement or banking in the first period. To model the risk–management challenge, we introduce a 'penalty' function that reflects the expected value of adjustment costs for a given abatement policy selected in the first period. We then demonstrate the difference between the full information solution and the optimal solution in presence of regulatory uncertainty.

Subsequently, we introduce call options on REDD+ and derive a demand for REDD+ options. We next consider the optimization problem from point of view of a tropical forest nation or other REDD+ supplier facing uncertain opportunities costs of forest conservation and derive a corresponding supply function. Finally, we establish market clearance commissions and derive an equilibrium spot price and equilibrium strike price for call options on REDD+. This provides a basis for the numerical analysis in Section 3.

2.1. Deterministic Case

We begin with a reference case free of uncertainty. The regulated entity faces emissions limits that require it to reduce its "business as usual" emissions over two consecutive periods. The entity must thus minimize its total discounted abatement costs as follows:

$$Min\left\{C_1(A_1) + C_2(A_2)(1+r)^{-1}\right\} \tag{1}$$

$$\text{subject to}: A_1 + A_2 \geq \overline{A} \tag{2}$$

$$\text{and } A_1 \geq \overline{A}_1 \tag{3}$$

where:

$t = 1,2$ stands for time;

[2] For example, more than a thousand businesses and investors signed on to various carbon pricing statements in 2014, as reported by the World Bank here: http://siteresources.worldbank.org/EXTSDNET/Resources/carbon-pricing-supporters-list-UPDATED-110614.pdf.