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Baseline manipulation in voluntary carbon offset programs

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ABSTRACT

Studies of voluntary carbon trading almost exclusively assume the additionality baselines are set by regulators who have either entirely perfect or imperfect information about the costs and emissions of projects. In practice, regulators are often less informed than project proponents; therefore, the baselines are more likely to be privately defined even for sectoral crediting. The primary concern with privately defined baselines is that baseline developers may exert their powers to manipulate the baselines, leading to increases in sectoral emission caps. This study models baseline manipulation behaviors in the context of adverse selection, where participants can self-select into the market. The theoretical results show that the extent to which the baseline is manipulated is highly dependent on who is assigned as the baseline developer. The more the baseline developer emits, the more likely the developer manipulates the baseline. The results are then further discussed in the context of the U.S. commercial building sector, where empirical methods are introduced to characterize cost and revenue functions. The empirical analysis reveals that, because of the notably low price elasticity of the offset supply, baselines are often positively biased even with third-party verifications. If that policymakers wish to allow baselines to be privately defined, they might be advised to implement baseline setting on an invitation-only basis to specific emitters that have relatively lower historical emissions.

1. Introduction

Carbon offset is an intangible asset. Its value is recognized through an additionality test that uses a price signal to attempt to distinguish the projects that achieve real carbon reduction from the projects that would have been undertaken anyway in the absence of the signal (UNFCCC, 2012). Only the projects that would not have occurred under a business-as-usual (BAU) scenario are considered additional. These additional projects are eligible to produce carbon offsets and sell them to the regulated entities that find it costly to reduce emissions. The additionality test is thus the centerpiece of carbon offset programs to ensure overall environmental integrity.

The additionality test is performed by setting a baseline against which the emission reduction is quantified. Setting the baseline requires rather detailed information about typical project practices over a wide range of sectors. Such information is usually privately owned and less accessible to the regulators. As one of the regulators, Verified Carbon Standard helped fill this information gap by engaging the efforts of industrial associations and private firms that are well placed to determine baselines for their own sectors (VCS, 2012). The privately defined baselines therefore served as thresholds for any projects within that sector to test additionality.

The main concern with the baselines is that the private firms, as baseline developers, may exert their power to manipulate the baselines and thus gain more from the offset programs. For example, baseline developers may lower the baseline to expel competitors from the offset programs. The resulting decrease in offset supply drives up the offset prices, which creates more surpluses for the developers but also risks forgoing the benefits of cost-effective offset projects. It is also possible that the developers increase the baseline above the counterfactual BAU emission, allowing themselves to sell non-additional offsets. These non-additional offsets either represent a damage cost due to global warming or an increase in the transaction costs within this sector. Even though such manipulation is reduced to some extent by third-party verifications, it plays a role in the programs that reward offsets based on additionality (Jack, 2008).

In the offset programs where participation is voluntary, the baseline manipulation relies not only on monopoly rents but also on complex incentives for other firms in the programs as they are potential participants. Because the participants have more information about their own abatement costs than the baseline developer, they can decide to participate if they are offered a favorable baseline (Fischer, 2005). This so-called adverse selection problem has been widely studied in the context of voluntary emission trading. Previous studies in this area

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focused on the impact of asymmetric information on the baseline efficacy and corresponding global emission reduction. As one example, the studies of Millard-Ball (2013) and Montero (1999, 2000) show that a generous baseline promotes participation but produces a large volume of non-additional offsets. These offsets result in significant social losses even with the consideration of abatement cost savings. However, the study of van Benthem and Kerr (2010) shows that a stringent assigned baseline may also reduce market efficiency because participants will self-select into the program. While the issue of baseline setting has spurred considerable discussion on emission trading, none of the existing studies have incorporated baseline manipulation behaviors into decision making. This fact makes the existing studies not applicable to the evolving voluntary trading programs where baselines are allowed to be privately defined. Therefore, new analytical models are needed to address the challenges of characterizing privately defined baselines and identifying their impacts on emission trading efficiency.

This paper focuses on the motivation for manipulating baselines and its impact on the reduction of global emissions. It hypothesizes that baseline developers can always gain more by deviating from the unbiased baseline, which is an emission threshold that surpasses the 80th percentile of comparable peers (UNFCCC, 2006). Intuitively, the extent to which the baseline is deviated should depend on who is assigned to be the baseline developer. This paper relates the selection of baseline developers to their manipulative behaviors and emission consequence. It is anticipated that the more the baseline developer emits, the more likely the developer exerts its power to manipulate the baseline. A clear understanding of this relationship would be valuable to policymakers who wish to allow baselines to be privately defined. They could use the modeling results to select an appropriate baseline developer in order to ensure that the baseline level provides both environmental integrity and sufficient financial incentive to potential projects.

2. Modeling method

The model proposed in this study is similar in the spirit to that of Millard-Ball (2013), who developed an adverse selection model in the context of the Clean Development Mechanism. The goal is to explore baseline manipulation behaviors and demonstrate that they have a high chance of occurring in practice. To achieve this goal, the model is set up based on the framework in Fig. 1, and solved in three steps: participation decision, baseline setting, and baseline adjustment. These steps are described in detail in Sections 2.1, 2.2, and 2.3, respectively. This model is expected to produce a closed-form solution for the optimal baseline and demonstrate that the optimal baseline is biased by comparing against the social optimal solution.

2.1. Participation and abatement decision

First, a firm's abatement decision is modeled as a response to the sectoral additionality baseline. Observing the baseline, self-informed firms decide whether to participate and how much to reduce their emissions. Each firm's emission reduction is a function of the baseline, as depicted on the left side of Fig. 1.

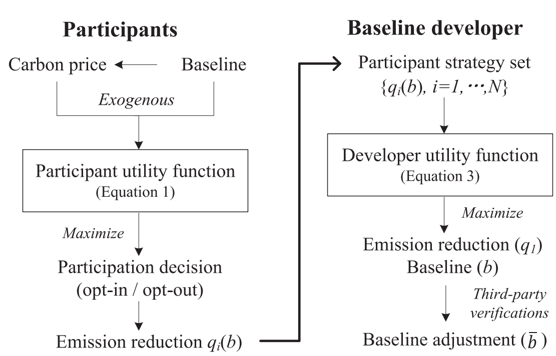

Fig. 1. Framework of the adverse selection problem.

There are firms $i = 1,\ldots, N$ that may choose to participate in an offset program. The firms are voluntary participants that do not face emission caps from compliance programs. A risk neutral baseline developer must assign a baseline to all firms who are privately informed about their emission abatement costs. The baseline is observable but the private "abatement costs" to firms are not. In this case, firms can always choose not to reduce emissions and opt-out the program. The developer is adversely selected by high-cost and hence, the least profitable firms are selected. For simplicity, it is assumed that, given an offset price and a baseline level, the firms make one-time decisions about the amount of emission reduction simultaneously.

Emission reduction brings two potential payoffs to the firms. The first being the revenue from selling carbon offsets to either the entities regulated in the compliance program or the individuals in the voluntary program. The second being the utility savings reflecting reduced energy consumption, which is proportional to the reduced emissions.

Each firm i has an annual BAU emission $z_i^0 \in R_+$. If the firm chooses to reduce emissions by $q_i \in R_+$, it needs to make a one-time investment $\mathbb{C}(q_i; z_i^0)$, $R_+ \to R_+$ for technology upgrades and obtain annual revenue $\mathbb{R}(q_i; z_i^0)$, $R_+ \to R_+$ from the reduced energy usage. The ultimate emission of the firm i is $z_i = z_i^0 - q_i$. Otherwise, the firm's emission remains z_i^0, and its abatement cost is zero. All firms are faced with a uniform baseline $b \in R_+$ set by a baseline developer. The difference between z_i and b can be sold as offset at price $p = \mathbb{P}(b), p \in R_+$. The annual revenue from the offset sale is $p(b - z_i^0 + q_i)$. It is assumed that firm i estimates its BAU emission z_i^0 and cost function $\mathbb{C}(q_i; z_i^0)$ with certainty. It can observe but not affect, the offset price p and the baseline b. A risk-neutral firm will decide to participate if and only if the gain, which is the combined offset sale and utility saving, outweighs the cost. Mathematically, net profit should satisfy

$$\pi_i = max_{q_i}\{\theta[p(b - z_i^0 + q_i) + \mathbb{R}(q_i)] - \mathbb{C}(q_i)\} \geq 0 \tag{1}$$

where $\theta = [(1+a)^n - 1]/[a(1+a)^n]$[1] represents a conversion of an n-year uniform annual revenue to a present value at interest a. It is a positive constant number.

Assuming that each firm is a profit maximizer, the optimal reduction q_i^* should be reached when the marginal revenue (the sum of offset sale and utility saving per unit of emission reduction) equals marginal cost (the technology cost per unit of emission reduction). The ultimate emission level of firm i is therefore $z_i^* = z_i^0 - q_i^*$. However, not all firms supply offsets. Only the firms whose optimal ultimate emissions z_i^* are less than the baseline will participate in the program and supply carbon offsets. The offset supplies from such firms are $b - z_i^*$. The firms with ultimate emissions higher than the baseline supply zero offset to the program. Therefore, the annual supply of carbon offset $s \in R_+$ is expressed as follows:

$$s = \mathbb{S}(b; z_i^*) = \sum_{i=1}^{N} \max\,(b - z_i^*, 0) \tag{2}$$

2.2. Baseline setting

Second, one of the firms in the program is chosen to be the baseline developer who solves an optimization problem in the context of adverse selection. The developer takes firm's response functions as given and uses them to set the baseline that maximizes its expected payoffs, as depicted on the right side of Fig. 1.

Any firm in the program could be the firm that sets the baseline.

[1] Parameter θ is the Series-Present-Worth Factor that translates the value of a series of uniform amounts into the present worth. In engineering economics, it is denoted as (P/A, i, N) $= \frac{(1+i)^N - 1}{i(1+i)^N}$, where i represents interest rate and N represents number of years.