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Analysis of the production and transaction costs of forest carbon offset projects in the USA

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ABSTRACT

Forest carbon offset project implementation costs, comprised of both production and transaction costs, could present an important barrier to private landowner participation in carbon offset markets. These costs likewise represent a largely undocumented component of forest carbon offset potential. Using a custom spreadsheet model and accounting tool, this study examines the implementation costs of different forest offset project types operating in different forest types under different accounting and sampling methodologies. Sensitivity results are summarized concisely through response surface regression analysis to illustrate the relative effect of project-specific variables on total implementation costs. Results suggest that transaction costs may represent a relatively small percentage of total project implementation costs – generally less than 25% of the total. Results also show that carbon accounting methods, specifically the method used to establish project baseline, may be among the most important factors in driving implementation costs on a per-ton-of-carbon-sequestered basis, dramatically increasing variability in both transaction and production costs. This suggests that accounting could be a large driver in the financial viability of forest offset projects, with transaction costs likely being of largest concern to those projects at the margin.

1. Introduction

Forested lands in the United States represent a significant carbon sink and could play an important role in climate change mitigation (U.S. Environmental Protection Agency, 2010). Interest in the role that forests will play in climate change mitigation has prompted research into the potential of forest carbon sequestration for over two decades (Sedjo, 1989; Richards and Stokes, 2004; Stavins and Richards, 2005). Studies examining the costs of forest carbon sequestration have become more sophisticated over the years in deriving marginal cost curves at national or regional scales, though shortcomings remain in such assessments.

One important gap remains the effect of project-level transaction costs. As transaction costs effectively impose a wedge between the market price of greenhouse gas (GHG) offsets and the price received by suppliers, economic estimates of forest mitigation potential that ignore the influence of transaction costs only provide a lower-bound estimate of the marginal costs (supply) of offsets (McCarl and Schneider, 2001). If high enough, transaction costs can decrease participation in carbon offset programs and reduce offset supply. When combined with offset project production costs, or those costs directly attributable to the physical management and operation of an offset project, transaction costs potentially represent an important if understudied aspect of carbon offset policy.

That is not to say that discussions of transaction and production costs do not exist in the literature. McCann et al. (2005) provide a concise overview of the many working definitions of "transaction costs" in the context of environmental policy, generally. With specific regard to transaction costs encountered in the implementation of individual GHG mitigation projects, Dudek and Wiener (1996) group transaction costs into six different categories in their assessment of early Joint-Implementation projects under the clean development mechanism (CDM) – search costs, negotiation costs, approval costs, monitoring costs, enforcement costs, and insurance costs. Milne (2002) includes the six categories introduced in Dudek and Wiener (1996) in her assessment of early forest offset projects, along with four additional categories: design, project implementation, verification,

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and certification. Collectively, this implies that total observed transaction costs will be a function of both the definition used ("which components are included in the analysis") and individual project context ("which of the included components are relevant to the project, and what is their relative magnitude"). Some components, such as search, negotiation, and enforcement costs, along with costs arising from undefined or unclear property rights and land tenure, may be less of an issue in the context of an established U.S. forest offset market, but may represent a significant barrier to entry at the international level during the early years of carbon market development.

Empirically, transaction and production costs (collectively referred to herein as implementation costs) have been the subject of various analysis over the course of the last decade (e.g., Antinori and Sathaye, 2007; Antle et al., 2003; Bilek et al., 2009; Brown et al., 2004; Locatelli and Pedroni, 2004; Milne, 2002; Mooney et al., 2004). Generally, these assessments have tended to fall into two distinct groupings: those that assess costs encountered in individual projects emerging from nascent carbon markets, and those that examine costs expected under a particular sampling regime or under a particular set of offset project guidelines or protocols. Both may fail to appropriately characterize offset project implementation costs due to site- or protocol-specific effects. For example, research suggests that differences in offset protocol design can lead to a wide variation in the carbon credits that can be claimed by a forest landowner (Pearson et al., 2008; Galik et al., 2009b; Foley et al., 2009). Large differences also exist across protocols with regard to measuring, monitoring, and verification requirements (Galik et al., 2009a).

The influence of offset protocol structure on creditable carbon generation and monitoring and verification regimes (and by extension, on implementation costs) implies that offset program rules can strongly influence project feasibility and the corresponding level of engagement in carbon markets by forest landowners (Galik et al., 2009b). It is therefore vital that policymakers understand the potential cost and supply implications of forest offset standards development. A great deal of uncertainty remains with regard to the true cost of offset project development and operation, however. This uncertainty largely stems from a yet-limited history of forest offset project implementation, combined with the largely proprietary nature of project finances and a shortage of targeted literature on the subject. At the same time, the lack of information on implementation costs is significant. These costs, particularly the transaction cost component, are thought to represent potential challenges to private landowner participation in forest offset projects (van Kooten et al., 2002; Gunn et al., 2008).

Collectively, the body of existing literature has led to an increased awareness of the factors affecting forest offset project implementation. What is missing is a systematic assessment of their absolute and relative effects on offset project viability. This analysis addresses this important gap by assessing a wide range of accounting and project design variables identified by the literature and early project experience as most relevant to offset project implementation. Using a detailed bottom-up forest carbon accounting tool, we directly estimate forest offset project production and transaction cost components. Response surface regression analysis is then used to illustrate the relative influence of project or site-specific variables on estimated production and transaction costs. In doing so, the analysis complements previous work on the influence of a broad array of financial and accounting parameters on offset project performance (e.g., Galik and Cooley, 2012). The present analysis differs from previous work in the attention specifically devoted to the transaction and production cost components of offset project development and implementation. Information generated in such focused analysis is critical to enhancing our understanding of each of the various factors that can affect forest offset potential.

The findings of the analysis can provide policymakers, researchers, and landowners with a better understanding of the various factors that could ultimately influence project feasibility, facilitating more informed decisions about program design and participation. For example, rule systems governing offset project implementation may be designed so as to minimize disproportionate sources of transaction costs, thereby addressing a barrier to program participation. The findings can also be of use to economic modelers interested in pursuing more robust analysis of GHG mitigation potential; when applied to studies of aggregate supply, the findings can help yield increasingly accurate predictions of forest offset contributions to national GHG mitigation efforts.

2. Material and methods

This analysis is based on an extension of the spreadsheet tool developed in Galik et al. (2009b) and Foley et al. (2009). It also builds upon an earlier forest management offset project transaction cost analysis reported in Galik et al. (2009a). For this analysis, the underlying model has been updated and expanded to evaluate an increased number of project types, cost components, and project accounting parameters.

2.1. Overview of the forest offset model

The spreadsheet tool developed here allows a user to vary the region and forest type in which the hypothetical project takes place. It also allows for variation in offset project parameters (e.g., length of project, type of project, rotation extension length, etc.), as well as protocol accounting structure (e.g., technique to estimate induced off-site emissions [leakage], adjustments for leakage, uncertainty, impermanence, etc.). Finally, the user can adjust project financial assumptions (e.g., discount rate, timber price, expected carbon price, rate of carbon price change over time) and project monitoring and administrative parameters (e.g., sampling technique, sampling interval, aggregation requirements, etc.).

The offset model is capable of examining offset project performance across 46 separate regional forest types (see Table 2 for a full list of the forest types and regions included). The model determines gross forest carbon sequestration for the live tree, standing deadwood, down deadwood, understory, forest floor, and wood products pools in each forest type based on yield curves for each forest type and U.S. Forest Service Forest Inventory and Analysis (FIA)-derived ecosystem-level equations (Foley et al., 2009, as based on Smith and Heath, 2002; Smith et al., 2006). As these equations were derived from stands with widely varying site conditions and management regimes, they can be useful in providing an approximation of carbon dynamics across a variety of forest types. They can also provide an indication of general trends and relative advantages of particular configurations of forest offset project types in different regions of the country. They should not, however, be interpreted as providing specific estimates that can be applied to any particular site index, stand composition, topographic position, management history, or other site-specific characteristics. Note also that soil carbon is excluded from this analysis, as the underlying data used in the model assumes no change in the soil carbon pool over time. That is not to diminish the potential importance of soil carbon in offset project sequestration (Galik et al., 2008) or