Efficiency, Non-permanence and Additionality- A Study on Payment Systems to Carbon Sequestration

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Abstract:

This paper seeks to understand the mechanisms underlying the policies creating incentives for carbon sequestration. The key difficulty in designing carbon policies for forests is to take into account the ephemeral nature of carbon sequestration and to accurately track the carbon flow entering and exiting forests. Among a number of existing payment systems, carbon subsidy-tax system (CST) and carbon rental system are the only two systems which both consider non-permanence and accurately track the forest carbon flow. In this paper, we derive the optimal conditions for harvests under various carbon policies and simulate the effects in a single region, multi age class timber market model. We find that carbon policy will encourage afforestation if it create additional revenue but the CST and carbon rental system are more effective than the others in extending rotation ages. Another finding is that costs of carbon rental system are much higher than that of CST system although they are efficiently equivalent.

Introduction:

Forest sequestration plays a pivotal role in mitigating the effect of climate change. While a number of studies indicate that carbon sequestration a promising type of offset, *there are not enough studies on economic incentives* to actually achieve that. A large part of the difficulty stems from the ephemeral nature of carbon sequestration. Among a number of payment, only two systems can accurately track the carbon flow in forests : carbon subsidy-tax system (CST) and carbon rental system In this paper we will compare across these two systems and a series of sub-optimal systems.

By using an optimal control model of timber market, we will examine the implications of these systems on economically optimal forest management and the supply of carbon service. The costs of implementing these systems will be also be compared.

Methods:

The analysis begins by presenting **an optimal control timber markets model**, developed by Sohngen and Sedjo (1998). Here, I introduce carbon benefits into the model.

- Maximize the consumer and producer surplus of timber sector over time
- Multi age classes; single species
- Endogenous timber price; endogenous land rent
- Harvest and land use decisions are made simultaneously

•Carbon credit types:

Carbon Subsidy and Tax, Carbon Rental, Subsidy only, Tax only, Land based system

Results:

Optimal systems: CST and carbon rental system;

Extensive margin: introducing more land into forests;

Intensive margin: introducing more carbon on per acre of forest

	Optimal/Suboptimal	Extensive Margin	Intensive Margin
Carbon Subsidy and Tax	Optimal	+	++
Carbon Rental	Optimal	+	++
Subsidy only	Suboptimal	++	+
Tax only	Suboptimal	-	?
Land based	Suboptimal	+	NA

Intertemporal analysis

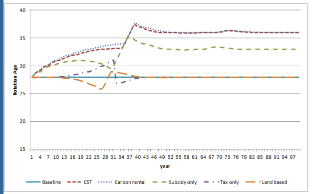
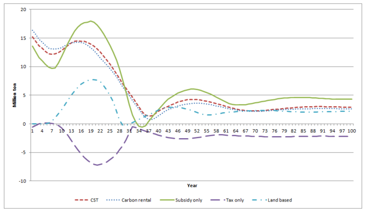


Figure: Path of Average Harvest Age of different policies given the same carbon prices

Figure: Path of Carbon gains given the same carbon price



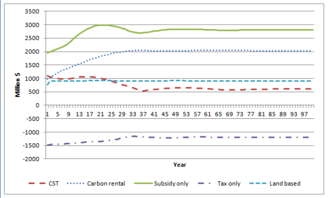
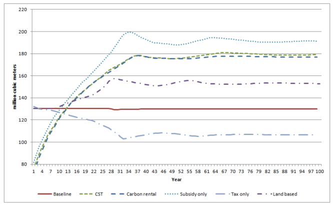


Figure: Path of Forestland

Figure: Path of Wood Supply



Steady state analysis

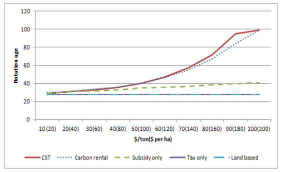
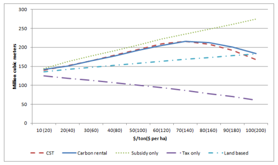


Figure: Compensation Rate and Rotation Age

Figure: Compensation Rate and Wood Supply



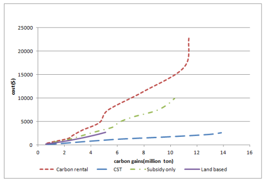


Figure: Compensation Rate and Rotation Age

Conclusions:

1. We found two ways by which carbon policy might affect carbon sequestration: changing area of forestland and extending rotation ages. The long run effects and short run effects might be different. In short run, carbon sequestration and wood supply are substitutes; In the long run, they might be either complements or substitutes, depending on the carbon prices.

2. A carbon policy will encourage expansions of forest area as long as it brings additional revenues to the forestland. The more the additional income on per unit of land, the larger the expansion might be.

3. The effects on rotation ages depend on the ways crediting the carbon flow in forests. An effective and efficient program should be able to control both carbon uptaken during tree growth and carbon releases upon harvest. Failures to control either side will undermining the effects of the policy. ts loss in forest area.

4. CST and Carbon Rental system lead to equivalent biophysical efficiency but different distributional consequences.

5. Fixing the issue of additionality would not affect carbon service supply or behaviors in timber market. Only marginal payments to carbon service of forestry matters. The level of benchmarks will only have an effect on transfer of welfare to forest owners. For policy makers, the tradeoff of fixing additionality might be the potential costs with identifying the couterfactural baselines.