DOCTORAL THESIS

The feasibility of carbon-subsidized afforestation projects: a case study of China

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ABSTRACT

Afforestation projects in China have substantially contributed to national CO_2 sequestration and play an important role in international climate change mitigation. However, these nation-wide afforestation projects are usually funded by the national government, with very large and unsustainable investments. It is important to find alternative sources of funding to finance afforestation, and convince poor farmers to become involved in afforestation projects. Carbon-subsidized afforestation could be the solution.

The current study aims to find i) whether farmers need additional subsidies to reforest their marginal farmland; if so, ii) whether the value of carbon sequestration of afforestation can offset farmers' net costs. To do this, first I determine the amount of carbon sequestration though afforestation. Second, I assess the value of carbon sequestration, the costs and benefits of afforestation projects, and the costs and benefits of crop production. Third, I investigate the optimal rotation period of the plantations considering a joint production of timber and carbon, for different species.

Results show that total carbon sequestration through tree biomass and soil carbon following afforestation differs among tree species and stand age as well as across regions. Economic trees sequester less carbon than ecological trees and bamboo. Among economic trees, nut trees with an inedible hard shell sequester more carbon than fruit trees. The regional context significantly influences the carbon sequestration potential, with more carbon sequestered in southern and eastern regions than in northern regions. Bamboo also shows a remarkable carbon sequestration potential, which is even greater than Chinese fir and Poplar in northern regions.

Although afforestation programs have huge potential to store carbon, the voluntary acceptance by landowners crucially depends on their economic outcome. I found that usually carbon credits can compensate for the opportunity costs of alternative land uses, except i) when highly profitable croplands are afforested, in which case carbon credits are not sufficient, and ii) when croplands that generates low incomes are afforested, in which case carbon credits are not needed. Fruit trees are the most cost-effective option for afforestation. Bamboo afforestation is economically attractive if carbon revenues is included. The minimum price of carbon credit decreases with increasing project duration because more carbon is stored when time increases. This does not hold for fast-growing trees like Eucalyptus, for which the minimum price increases with extended project duration.

Given the temporal variations of joint production of timber and carbon sequestration, the carbon accounting regimes (tCER, temporary Certified Emission Reductions and lCER, long-term Certified Emission Reductions) have a significant impact on the optimal rotation as well as on the revenue. Forest managers have an incentive to use tCER accounting to finance slow-growing plantations, and lCER for fast-growing ones. I perform a sensitivity analysis detects the changes of rotation period with different

carbon prices and discount rates. While the optimal decision for slow-growing species (e.g. Chinese fir) is highly sensitive to changes in both variables under tCER accounting, the results concerning fast-growing species (e.g. Eucalyptus) are most sensitive under the lCER accounting regime. In contrast, carbon revenues have a minimal impact on the optimal rotation of Poplar plantations, no matter which regime is applied.

I conclude that carbon-subsidized afforestation is a feasible way to offset the opportunity costs of retired farmland and support the livelihood of farmers. The findings can contribute to the efficient and sustainable management of forestry projects using carbon sequestration, while the methodology can also be applied to other regions in the world.

Keywords: Carbon Sequestration, Afforestation, Carbon Price, Optimal Rotation Period, Carbon Accounting, Certified Emission Reductions

Table of Contents