Valuation of Timber and Carbon Sequestration: An American Call Option Technique

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This paper discusses forest stand valuation and optimal management in an environment characterized by stochastic timber and carbon prices. Expected bare land values are modeled as recurrent American call options and calculated with a Monte Carlo algorithm under the assumption that both prices follow a logarithmic mean reverting process.

The impact of carbon credits on forest stand valuation is explored via three carbon credit scenarios assuming that a functioning market in carbon emission permits exists and that forest owners are able to participate in this market. These carbon credit scenarios are constructed by adjusting the amount of carbon credits that a forest owner receives from three distinct carbon pools: forest, harvested product and substitution. In the first scenario, a harvest is treated as a carbon source which results in a cost to the forest owner. The second and third scenarios use the product and substitution carbon pools as sources of additional revenue for forest owners.

We utilize an algorithm, developed by Ibáñez and Zapatero for the valuation of financial American call options, extended to incorporate infinite time horizons and multiple timber harvests to derive expected bare land values and optimal harvest ages for stochastic timber and carbon prices. The expected bare land values calculated with stochastic timber and carbon prices for the three carbon scenarios are compared with bare land values obtained from a formulation with stochastic timber prices only and with values obtained from the traditional Faustmann formulation. The changes in expected bare land values and harvest ages associated with the three carbon sequestration scenarios and the impact of perturbations in key price model parameters are also discussed.

Our results show that explicit treatment of stochastic prices leads to higher levels of calculated expected bare land values. This increase is due to higher managerial flexibility with regards to optimal harvest timing and can be captured by an option premium. Stochastic prices also have an impact on the optimal harvest age. The fixed rotation length of the Faustmann formula is replaced by the optimal harvest rule which produces harvest ages of varying length. The results also indicate that there exists a potential for carbon sequestration to provide a new revenue source for forest owners. However, the significance of carbon sequestration as a revenue source, and its impact on optimal forest management, is highly sensitive to the magnitude of carbon product and substitution pools.

The benefits of the modifications to the traditional Faustmann formula are twofold. By including stochastic prices, the extended Faustmann problem provides a more realistic representation of the decisions faced by forest owners in the field. Incorporating carbon sequestration provides information to policy makers with regards to the potential of long-term carbon sequestration in forest stands and wood-based products to reduce carbon emissions.