A General Equilibrium Model of Environmental Option Values

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Abstract

In this paper, we consider the option value of an environmental reserve based on a simple general equilibrium growth model with stochastic technology growth. More specifically, we consider how an economy should divide land use between agricultural land A and environmental reserves R under the condition that, once R is converted into A, it cannot be reverted to R again. Because of this irreversibility of land conversion, as emphasized in existing studies, the environment has significant real option value. However, unlike the existing literature, in which the uncertainty of the value of environments is given exogenously in partial equilibrium framework, the value of the environment is endogenously determined in our model. Since the environment is in finite supply, as society become richer, the relative value (price) of the environment increases.

In our model, the elasticity of substitution η between environments and consumption plays a crucial role. If the demand for environments is inelastic ($\eta < 1$), as the income level of an economy increases, society demands more environments, and vice versa. The option value and hence the optimal decision are both affected by η not only quantitatively but also qualitatively.

In our numerical experiments, we find that, if the irreversible constraint on the land conversion is ignored, a huge proportion of environmental reserves can be mistakenly converted. Indeed, under some parametric assumption, such a mistake can be as much as 50% of optimal reserved land; the resultant reserved land is only half of the optimal level of reserved land. However, at the same time, our numerical results suggest that such a huge mistake does not lead to a large welfare loss in the sense that the loss of the value function due to such a mistake can be compensated by less than 0.3% of annual consumption. This coexistence of a possible huge mistake and small welfare loss is because of the flat value function in the neighborhood of the optimal point.

Obviously, these quantitative results crucially depend on our functional and parametric assumptions. We have chosen CES utility function because it is rather standard in macroeconomic literature and because it implies constant η which makes the problem tractable. Investigating the quantitative and qualitative model behavior with non-CES utility function can be interesting as a future research agenda.

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