Approximating Optimal Numerical Solutions to Bio-economic Systems: How Useful is Simulation-optimization?

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Abstract

For applications in agricultural and environmental economics, complex ecological systems are often oversimplified to the extent that ecologists rarely consider model results valid. Recursive optimization of complex systems represents an alternative, but requires strong assumptions regarding time preference and uncertainty. In this paper we explore the implications of merely approximating "true" optima of complex dynamic optimization problems using a technique called simulation-optimization. We develop a standard discrete renewable resource use problem and solve it numerically using both simulation-optimization and non-linear mathematical programming. We subsequently introduce non-linearity and uncertainty and graphically compare the performance of simulation-optimization vis-à-vis non-linear programming in predicting optimal control and state variable paths. On the basis of this comparison we discuss potential non-formal test procedures that could be used to assess simulation-optimization solutions of more complex problems that do not allow for such comparisons. We find that simulation-optimization can be a useful exploratory optimization technique when standard numerical optimization approaches fail to find near optimal solutions. That said, modelers should be careful in designing management functions of simulation-optimization problems and test their functional forms for severe misspecifications.

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