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Strategic resource extraction, capital accumulation and overlapping generations ☆

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Abstract

The standard resource extraction framework assumes infinitely lived agents and yields an overfishing result. For some applications, a finite time horizon may be more appropriate. A direct extension of the Levhari–Mirman model to overlapping generations yields an extreme overfishing result. Alternatively, we assume young and old specialize, and respectively fish and supply capital. In this model, under some circumstances there may well be under-utilization of natural resources. However, for a given production technology, if there are a sufficiently large number of agents, overfishing always results.

JEL classification: L13; Q20

Keywords: Renewable resource; Overlapping generations; Golden Rule

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1. Introduction

Levhari and Mirman [10] consider the extraction of a commonly owned, renewable resource in a dynamic setting. Infinitely lived agents decide how much of the resource to extract in each period, taking into account the rate at which the resource regenerates itself and the extraction decisions of other agents. That is, they consider fishing as a differential game or in other words, a dynamic version of the "tragedy of the commons." This original framework has been extended in various ways.[1] One potential drawback of these studies is the assumption that agents are infinitely lived. In some applications, a model where agents have a finite time horizon may be more reasonable. It is well known that the assumption of a finitely-lived agent, or overlapping generations models, may lead to Pareto inefficiencies through the over-accumulation of capital or in our context the under-exploitation of the resource. It is our purpose, in this paper, examine the robustness of the dynamic tragedy of the commons in the face of the assumption of finitely lived agents and in particular the relationship between the standard under-exploitation externality and the dynamic commons tragedy of over-exploitation.

A simple alternative is to use an overlapping generations framework. However, directly extending the Levhari and Mirman model to overlapping generations yields the result that the resource are fully extracted in the first period, this is the traditional tragedy of the commons. To see this, notice that the old have no future to look forward to and, therefore, consuming the entire resource stock is optimal for the old. Furthermore, given that the young can expect the old to consume the entire stock, the young also extracts as much of the resource as possible. Although this result is extreme, it has some appeal; agents with little or no future exploit the resource to the greatest extent possible. Rapid over-exploitation, such as suggested by this simple overlapping generations framework, has been seen repeatedly as over-harvesting has endangered many plant and animal species as well as brought about the outright extinction of some species.[2]

Nevertheless, many renewable natural resources do not face such extreme degrees of exploitation. One reason may be because there are technological or legal barriers limiting how much of the resource can be extracted at any moment. For example, given the vastness of the resource, it would be difficult to completely foul the world's supply of clean air in a short period of time. Alternatively, it may be that there is a generational separation between extraction and capital accumulation. We consider the latter alternative and show that if the young extract the resource and the old supply capital then the young may refrain from fully exploiting the natural resource.[3] Moreover, in contrast to the Levhari and Mirman overfishing result, under the current framework, there may well be underfishing. Nevertheless, for a given technology, if there are enough agents, overfishing results.

[1] See for example, [2–4,6–9]. These extensions are all games with the exception of [9] which is competitive.

[2] For example, discovered in 1741, Steller's Sea Cow (from the same order as the American Manatee) was hunted to extinction in less than 30 years.

[3] Overlapping generations models are used as metaphors for the finiteness of life spans and the assumption of two-period lives is made for tractability. In a more general framework where agents live for many periods, there will still be an incentive for conservation as long as at some advanced age, individuals are no longer able to fish and must subsist on their savings. Analytic solutions to such models typically require computational methods that are beyond the scope of the current paper (see for example, [1]).