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Oligopoly exploitation of a private property productive asset ☆

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ABSTRACT

In this paper, we build a Closed-Loop Nash Equilibrium of a private property productive asset oligopoly. We compare and contrast private with common property in terms of exploitation rates and social welfare, and provide a comparative dynamic analysis with respect to the number of firms in the industry. Contrary to previous studies on oligopolistic exploitation of productive assets, before exploitation begins, the resource is parcelled out: each firm privately owns and manages the assigned parcel over the entire planning horizon. Compared with the common property regime, we find a new set of results, both in the short- and in the long-run. As for social welfare, we provide conditions on the implicit growth rate and the initial asset stock under which the socially optimal allocation of the resource implies a natural monopoly.

1. Introduction

This paper builds a Closed-Loop Nash Equilibrium (CLNE) of a private property productive asset oligopoly. We compare and contrast private with common property in terms of exploitation rates and social welfare, and provide a comparative dynamic analysis with respect to the number of firms in the industry. To the best of our knowledge, the existing literature dealing with oligopolistic exploitation of productive assets has focussed on the case of common property/open access, exclusively. Yet, in the real world, the relevance of private ownership of productive assets can hardly be questioned (e.g. 70% of land in the United States is privately owned; approximately 50% of forest and other wooded land in Europe is privately owned; approximately one-third of global fisheries production is supplied by commercial aquaculture, much of it in Asia). Indeed, property rights are essential in determining how productive assets such as land and natural resources are used and managed, and how benefits from these resources are distributed.

A number of studies have analyzed the problem of the exploitation of a common pool resource in a strategic context. In this respect, two different strands can be identified in the literature. First, there are papers analyzing competition for the

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exploitation of the resource, ignoring the strategic interaction in the output market. These papers typically assume that agents' payoffs do not depend on rivals' exploitation rates. The extracted resource is solely used as a consumption good (Levhari and Mirman, 1980; Benhabib and Radner, 1992; Fisher and Mirman, 1992, 1996; Dockner and Sorger, 1996). Second, other papers have analyzed competition in the exploitation of the resource as well as in the output market. In this case, agents' payoffs depend also on rivals' exploitation rates. The resource is seen as a productive asset, and it is used as the only input in the production of the final good (Reinganum and Stokey, 1985; Karp, 1992; Benchekroun, 2003, 2008; Sandal and Steinshamn, 2004).

Our paper relates to the stream of literature that considers the resource as a productive asset, but departs in a fundamental way by dropping the common property assumption and drawing attention to private property: the resource is parcelled out, and the benefits from each parcel accrue only to the firm having control over it. Closest in spirit and methodology to our model is the Benchekroun (2008) model. We build on Benchekroun (2003, 2008) seminal papers by modifying the property rights assumption. Benchekroun (2003, 2008) assumes that there exists only one common property resource whose dynamics is governed by a given equation of motion such that today's extraction rate by a firm reduces the stock of the resource available for future exploitation by all the other firms. Instead, we assume that each firm receives a parcel of the resource, and the equation of motion governing the dynamics is such that today's exploitation rate by the firm owning the parcel does not affect the stock of the resource available for rivals' future exploitation. Unlike Benchekroun (2003, 2008), we have as many equations of motions as firms, $n \geq 2$. The presence of multiple states complicates the solution of the game, significantly.

We consider a noncooperative linear-quadratic differential game in which firms' strategies are exploitation plans. Firms use the resource as an input in the production of the final good, and compete in the same output market. We assume that, before exploitation begins, the initial asset stock of the resource is split among $n \geq 2$ firms. Each firm owns and manages the assigned parcel over the entire planning horizon. The asset grows at an exponential rate until a certain threshold is reached, after which the growth of the asset starts declining. Two classical examples are represented by the growth of a fish population, and the growth of a stand of trees in a forest. We characterize the optimal exploitation plans under private property and compare and contrast them with those under common property, which have been studied in Benchekroun (2008). Next, we evaluate the short- and long-run impact of a change in the number of firms participating in the initial division of the resource on individual and aggregate production and social welfare. We focus on the steady state solutions of the game in which firms adopt feedback (closed-loop) rules. As in Benchekroun (2003, 2008), equilibrium strategies can give rise to multiple steady state equilibria. However, while under common property the initial asset stock of the resource does not depend on the number of firms sharing access to the resource, under private property, the size of the parcel received by each firm is affected by the number of firms participating in the division of the resource. For a given initial asset stock, in a symmetric equilibrium, the higher the number of firms, the smaller the size of the parcel assigned to each firm. Therefore, in our model, changing the number of firms crucially affects the initial conditions, leading to a whole new set of results.

Our main findings can be summarized as follows. In the short-run, exploitation rates under private property exceed those under common property for abundant asset stocks, while the opposite holds true for scarce asset stocks, thus challenging the conventional wisdom according to which firms are less conservationist in the exploitation of the resource where common property is concerned. In terms of social welfare, there exists a range of asset stocks in which common property strictly welfare-dominates private property. In the long-run, instead, private property welfare-dominates common property, either strictly or weakly: with private property, exploitation rates and the steady state level of the asset stock are either higher than or equal to those under common property. Interestingly, when the asset stock exceeds a certain threshold, property rights are welfare-neutral, in that the two different property rights regimes lead to the same level of social welfare, both in the short- and in the long-run. As to the comparative dynamic analysis, when the resource stock is scarce, a decrease in the number of firms leads to a reduction in per firm exploitation and output in the short-run. Firms facing a less intense market competition become more conservationist in the exploitation of the resource. Such short-run output restriction enables firms to sustain more intense harvesting and larger market shares in the long-run.[2] This result is in sharp contrast with static oligopoly theory where, in the absence of economies of scale, firms producing homogeneous goods always increase their output in response to a decrease in the number of competitors. This is due to the fact that static models capture only the steady state effects, i.e., the increase in per firm output. Furthermore, there exists a level of stock such that firms voluntarily keep their production constant, despite a change in the number of rivals. Per firm output levels corresponding to the static Cournot–Nash equilibrium are observed when the asset stock is abundant. This set of results in relation to the impact of market competition on per firm equilibrium strategies represents a novelty with respect to the common property case. The short-run impact of softening market competition on industry output significantly differs from Benchekroun (2008), who shows that there exists a range of asset stocks such that, when the number of firms sharing access to the resource decreases, industry output increases. In Benchekroun (2008), equilibrium strategies intersect twice, and there exists a range of resource stocks in which industry output in the m

[2] Evidence shows that the world fish catch per capita has increased little over the past 30 years and has started to decline. Most ocean and inland fisheries are at or near their capacity limits, with many already in decline, despite governments' efforts to regulate the fishing industry by privatizing or restricting access to the resource.