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Sequential development and exploitation of an exhaustible resource: do monopoly rights promote conservation?

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Abstract

This paper explores the problem of sequential exploitation of exhaustible resources by a monopolist, when a setup cost must be incurred to access the next pool. Under certain circumstances, the monopolist will always follow a more conservationist path of extraction and delay the introduction of new resource pools compared to a social planner. However, with other forms of consumer demand, the monopolist may exhaust the resource more quickly, especially if many new options will follow. These results may apply especially to depletable resources like antibiotics or biotech products, for which significant research and development costs are required, followed by monopoly rights conferred by patents.

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1. Introduction

The question of whether an exhaustible natural resource will be extracted at a socially optimal rate under imperfect competition, which first arose in the context of OPEC cartels in the 1970s, has reemerged in recent years in the context of new kinds of resources, such as antibiotics and crops genetically engineered to repel pests. Pesticides and antibiotics can be thought of as

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depletable resources, due to the selective pressure they place on susceptible bacteria or pests, which ensures that they become less effective with use [16]. The problems of suboptimally high rates of depletion that are associated with the open access nature of these resources are ameliorated to some extent by the existence of the patenting system. Although patents on antibiotics and pesticides are intended to reward innovators for undertaking the investment that leads to the innovation, they serve an additional purpose in the context of resistance-prone resources in that they give the patent holder an incentive to care about the rate at which resistance develops. Some have argued, therefore, that giving innovators longer patents would increase their incentives to internalize the problem of emergence of resistance [1,21]. Others have extended this argument to claim that the existence of patents relieves society from the burden of regulating for resistance since the patentee may have sufficient incentives to consider the depletion of product effectiveness. An additional feature of patents is that they often (though not always) give the patentee a head start in developing future drugs and pesticides that depend on the basic patent. This paper examines the issue of monopoly provision of a depletable resource when the patentee has the option of developing future resource pools after incurring some setup cost. It demonstrates that granting patents to firms may not necessarily give them a stronger incentive to protect their product from resistance.

A number of authors have written on the implications of monopoly for the extraction of an exhaustible resource: Weinstein and Zeckhauser [31], Stiglitz [26], Kay and Mirrlees [14], Lewis [17], Sweeney [27], Dasgupta and Heal [2], Tullock [30], Lewis et al. [18], Eswaran and Lewis [5], Pindyk [23], and Gaudet and Lasserre [8], among others. Reviews of this literature are included in Peterson and Fisher [22], Dasgupta and Heal [2], Devarajan and Fisher [4], and Krautkraemer [15]. However, the role of future pools of resources and the associated setup costs in monopoly provision has received relatively little attention in these papers. Many traditional natural resources (and non-traditional ones like antibiotics and pesticides that are the focus of this paper) involve significant setup costs—fixed costs of exploration and development that must be incurred before any extraction can begin. Major investments in research and development, as well as the drug approval process, must occur before the products can be brought to market.

Hartwick et al. [11] showed that in the presence of setup costs the social optimum dictates sequential exploitation of the natural resource pools, and the optimal path of marginal current net benefit will rise in a “saw-tooth” fashion. While any particular pool is being exploited, the marginal net benefit rises at the rate of interest, dropping down when a switch is made to the next pool, with the difference reflecting the marginal benefit of postponing the switch. Since setup costs create a non-convexity, they indicated and Fischer [6] proves that the socially optimal path cannot then be decentralized to a perfectly competitive equilibrium. Thus, the true extraction path would be characterized by some form of imperfectly competitive equilibrium. This paper analyzes the exploitation path that would occur with monopoly ownership of the resource pools and compares it to the planner’s problem.

Dasgupta et al. [3] considered setup costs in the form of the cost of inventing a new technology. With that technology functioning as a backstop substitute for the existing resource, the monopolist is shown to prolong extraction and delay implementation of the new technology compared to the planner. However, this result cannot be generalized when the setup investment produces the next in a sequence of exhaustible resources. The important difference is that with a non-exhaustible backstop, marginal costs are the same for the planner and the monopolist; thus,

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