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Economic Modelling 22 (2005) 1090–1104
Economic Modelling
www.elsevier.com/locate/ecmod

Does market value maximization affect the order of resource exploitation?

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Accepted 16 July 2005

Abstract

This paper develops a dynamic model in which the marginal cost of production utilizing inexhaustible natural resources exceeds the marginal cost of production using any kind of exhaustible natural resources. The production capacity of the facility utilizing inexhaustible natural resources is finite in this model. We point out that–under certain assumptions–it is worth utilizing the more expensive inexhaustible natural resources strictly before the depletion of exhaustible natural resources, even if the objective of the decision-maker company is to maximize its market value.

JEL classification: Q3

Keywords: Growth; Natural resources; Substitute

1. Introduction

The problem of devising an optimal order of utilizing natural resources relates to a production process where natural resources cannot be substituted by other production factors. In the general case, it is assumed that there exist one more expensive

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doi:10.1016/j.econmod.2005.07.003

inexhaustible, and some less expensive exhaustible natural resources. Coal or oil for example can be considered as exhaustible natural resources in the electric power industry, while rivers can be considered as inexhaustible ones. Further, it is assumed that exhaustible and inexhaustible resources can perfectly substitute each others during the production process. Under the assumption of partial equilibrium and positive discount rate, Solow and Wan (1976) have proved that the optimal order of utilizing natural resources is determined by the strictly increasing order of the constant marginal factor costs. As Kemp and Long (1980) have pointed out, this statement is not necessarily valid in case of general equilibrium.

Assuming positive discount rate, Amigues et al. (1998) have proved that the use of the more expensive inexhaustible natural resource is possible even before the depletion of less expensive exhaustible resources on the optimal exhaustion path. Their model differs from that of Kemp and Long (1980) in using the crucial assumption that the inexhaustible resource has capacity upper limit. Favard (2002) has shown that in these circumstances it may be optimal to use the high-cost substitute before beginning to extract from a lower cost stock, even if these resources can be costlessly converted into productive capital. In these models, the preferences of consumers are assumed to be identical and the discounted value of the utility is maximized by an economic planner or by the identical agents. Our paper dismisses the role of such economic planner and the assumption of identical, intertemporal welfare maximizing agents as well. As decisions on the utilization order of resources are made by producers, we assume decisions should be based on the firm's market value, i.e., the aim of the producer is to maximize the present value of the difference between sales and production costs. We will show in this paper that if the inexhaustible substitute is scarce then its use begins definitely before the depletion of the low-cost resource stock even if the objective of the decision-maker company is to maximize its market value. Furthermore, we will generalise the problem for the case of increasing marginal extraction cost.

The assumption of no substitution between natural and other production factors is applied for simplicity, a more sophisticated approach to the relationship between energy and capital is provided by Brendt and Wood (1979). We believe that the available volume of natural resources is the only bottleneck in the production process thus the available amount of other production factors like capital and labor can be considered unconstrained in the model. As the utility function is replaced by the net receipt of profit, the role of leisure can be neglected as well. Following Bohi (1981) and Atkeson and Kehoe (1999), we assume a monopoly, hence the demand function is decreasing, thus price will decrease as production increases. It is also assumed that the marginal cost of production using inexhaustible resource exceeds that of the production using exhaustible resources, moreover the production capacity of the inexhaustible resource is not storable.

The next section defines and analyzes the model which uses one inexhaustible and one exhaustible resource. Section 3 extends the model and we will have two exhaustible resources under the assumption that demand and cost functions are linear. Section 4 provides the conclusions, explaining the differences and similarities between the policies of welfare maximizing planner and market value maximizer monopoly.