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Open-loop von Stackelberg equilibrium in the cartel-vs.-fringe model

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Abstract

In this paper the binding-contracts open-loop von Stackelberg equilibrium in the cartel-vs.-fringe model of the supply side of a market for a raw material from an exhaustible natural resource is reconsidered. It is shown that the equilibrium for this model differs from what the previous literature on this model suggests. In particular, the equilibrium price trajectory can display discontinuities.

JEL classifications: Q3; C7

Keywords: Cartel-vs.-fringe; Von Stackelberg equilibrium

1. Introduction

The treatment of duopolistic markets for raw materials from an exhaustible natural resource dates back to Hotelling's (Hotelling, 1931) seminal paper. Because of the evident relevance to real world phenomena such as the market for crude oil, this theory was revived recently and was extended to oligopolistic markets with

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more than two suppliers. Lewis and Schmalensee (1980a) considered the case of similarly placed oligopolists. It was recognized by Salant (1976) that some of the markets under consideration can be characterized on the supply side by a coherent cartel and a large number of small producers called the fringe. The cartel-vs.-fringe model was further explored by Salant et al. (1979) and Lewis and Schmalensee (1980b). Pindyck (1978) did interesting empirical work on this subject. One of the important questions is whether the fringe benefits from cartelization or not. This problem is most clearly dealt with by Ulph and Folie (1980), who show that the answer can be both yes and no and who derive conditions under which each case occurs. All these authors use the Nash–Cournot equilibrium concept. Gilbert (1978) was the first to put forward that this equilibrium concept might not do enough justice to the market power of the cartel. Instead he studied the von Stackelberg equilibrium. In both models the fringe takes prices as given and chooses an extraction path so as to maximize discounted profits. In the Nash–Cournot model the cartel takes the extraction path of the fringe as given, knows the demand function and chooses either an extraction path or a price path so as to maximize discounted profits. In the von Stackelberg equilibrium the cartel announces optimal price and extraction paths taking explicitly into account the behaviour of the fringe as a price taker. It is assumed here that the fringe exactly meets the lacking supply for market equilibrium. Ulph and Folie (1981) stress that in such a von Stackelberg equilibrium dynamic inconsistency may arise. This means that the announced price and extraction paths become suboptimal when the equilibrium is reconsidered after some time has elapsed. Ulph (1982) further elaborates on the issue of dynamic inconsistency as well as Newbery (1981), who considers the cases when discount rates differ and when the demand schedule is non-linear. The basic point is that an equilibrium concept which displays dynamic inconsistency should be rejected in a framework of rational agents unless market transactions take place according to binding contracts. This last assumption is not very realistic. Newbery (1981) introduces the concept of a rational expectations von Stackelberg equilibrium. The underlying idea is that the equilibrium should have the property that none of the actors has an incentive to deviate from the equilibrium strategies at any point in time. Ulph (1982) points out that, in game theory terms, the actual problem is to find the feedback von Stackelberg equilibrium for the cartel-vs.-fringe model as an alternative for the binding-contracts open-loop von Stackelberg equilibrium. However, this problem proves to be very difficult.

In this paper the binding-contracts open-loop von Stackelberg equilibrium is reconsidered. It is shown that the results of Ulph and Folie (1981), Newbery (1981) and Ulph (1982) are not altogether correct. The equilibrium proves to be different from these results in two respects. Firstly, the specification of the marginal costs for the cartel should be corrected. As a result of this the timing of the different production stages changes somewhat. Secondly, for empirically plausible parameter values the resulting equilibrium price path may be discontinuous. This implies that not only the timing but also the order of the different production stages may differ from what was suggested in the previous literature. The possibility of the occurrence of a discontinuous price trajectory is already discussed in Groot et al. (1992).