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On Stackelberg games in a homogeneous product market

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Abstract

In a homogeneous product duopoly with concave demand and strictly convex costs we bring together all the standard results of quantity Stackelberg games, provide some new results with price Stackelberg games and compare the equilibrium configuration of the quantity games with the price games. In the price Stackelberg game we show there is a unique SPNE where the leader chooses a lower price than the follower, but both get equal payoffs. We prove that generally quantity Stackelberg games are less competitive than price Stackelberg games. However, we also demonstrate the possibility of a reversal of this result.

JEL classification: L13

Keywords: Stackelberg equilibrium; Price; Quantity

1. Introduction

There is an extensive theoretical literature that stems from the classical Stackelberg (1934) model. The original Stackelberg model is a sequential quantity choice game in a homogeneous product market. Later it was extended to the differentiated product market for both quantity and price choice game. Tirole (1988) and more recently Vives (1999) provide a succinct summary of the literature around the Stackelberg model. Surprisingly, there is little literature dealing with Stackelberg games in prices in a homogeneous product market. Consequently, there are no results which compare equilibrium configurations in the quantity Stackelberg games with the price Stackelberg games. The present paper aims to fill this gap.

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We consider sequential move price/quantity setting games in a homogeneous product market with concave demand and strictly convex costs. In such a framework we bring together all the standard results of the quantity Stackelberg games, provide some new results with price Stackelberg games (under efficient rationing rule) and then compare the equilibrium configuration of the quantity games with the price games.

The main contributions in this paper are the following. (1) First, the Stackelberg equilibrium of a price choice game with homogeneous products is completely characterised under the assumptions of concave demand, strictly convex costs and efficient rationing. Under these assumptions it is shown that there is a unique subgame perfect Nash equilibrium where the *follower will charge a strictly higher price than the leader* but *both firms will get equal payoffs*. There is neither a first mover nor a second mover advantage. This is clearly in contrast to previous results in the literature on differentiated products that predict (a) a second mover advantage and (b) that the second mover charges a lower price. (2) Second, we show that equilibrium price in a quantity Stackelberg game is always higher than the leader's price in a price Stackelberg game. It is also shown that under a mild condition, the equilibrium price in a quantity Stackelberg game is even higher than the follower's price in a price Stackelberg game. In short, under quite general conditions we show *price competition is more competitive than quantity competition in Stackelberg games*, which is in line with previous results in the literature on simultaneous move games. (3) Third, we also demonstrate the possibility of a *reversal* result by providing a sufficient condition under which the equilibrium price in a quantity Stackelberg game is lower than the follower's price in a price Stackelberg game.

It is well known that a simultaneous move quantity game with concave demand and strictly convex costs in a homogeneous product market always has a pure strategy Nash equilibrium. However, a simultaneous move price game in such a context has no pure strategy Nash equilibrium. In contrast, in a sequential move price game we show there is a unique pure strategy subgame perfect Nash equilibrium. There is a substantial literature on the comparison of simultaneous move quantity games with that of price games.[1] As noted before there are no such comparative results in the sequential move games. We carry out such comparative exercises in sequential move games. The plan of our paper is as follows.

1. We first briefly introduce the classical Stackelberg model and provide a brief literature review (Section 2).
2. In Section 3 we set up the model of a sequential move price game with symmetric firms and we look at the follower's best response correspondence.
3. Section 4 derives the unique SPNE of the price Stackelberg game and characterises it.
4. The next section first spells out the well known results of the Stackelberg games in quantities. Then it compares the equilibrium configuration in the Stackelberg price game with the Stackelberg quantity game.
5. In the last section we provide some concluding remarks.

[1] See for example, Vives (1985), Cheng (1985), Singh and Vives (1984), Hackner (2000) and Amir and Jin (2001). Again, Vives (1999) provides a neat summary of most of these results.