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Journal of Economic Behavior & Organization 67 (2008) 164–179

JOURNAL OF Economic Behavior & Organization

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Tie-breaking rules and divisibility in experimental duopoly markets

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Received 23 February 2006; received in revised form 5 July 2006; accepted 4 September 2006
Available online 22 May 2007

Abstract

We investigate pricing behavior of sellers in duopoly markets with posted prices and market power. The two treatment variables are given by tie-breaking rules and divisibility of the price space. The first treatment variable deals with the rule under which demanded units are allocated between sellers in case of a price tie. A change in divisibility is modeled by making the sellers' price space finer or coarser. We find that the incidence of perfect collusion is significantly higher under the sharing tie-breaking rule than under the random (coin-toss) one, especially when the price space is less divisible.

JEL classification: L1; C9

Keywords: Collusion; Tie-breaking rules; Divisibility; Bertrand model

1. Introduction

The goal of this study is to shed some light on factors that affect pricing behavior and collusion incentives in market experiments. Previous experimental research suggests that the type of trading institution employed can prominently affect pricing behavior (e.g., Plott and Smith, 1978). Furthermore, a well-established experimental research program studies pricing behavior within the context of a particular market institution (see, for instance, Alger, 1987; Cason and Davis, 1995; Davis et al., 2002; Davis and Wilson, 2002; Friedman and Hoggatt, 1980) and seems to suggest that environmental details play an important role. This paper falls more closely into this second strand of literature, in that we keep fixed the trading institution and we focus on factors that might facilitate collusion.

On the one hand, there are several papers that study factors facilitating collusion in Cournot markets. For instance, the number of firms in a market, repeated interaction, and information about rivals' actions and profits are some of the factors affecting collusion incentives (see Huck et al., 2000, 2001, 2004; Feinberg and Husted, 1993).[1]

On the other hand, this paper examines the effect of tie-breaking rules and divisibility on tacit collusion in Bertrand duopoly markets with capacity constraints. There tends to be some tacit collusion in Bertrand duopoly anyway (see

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[1] Also Bertrand oligopoly markets are studied in Huck et al. (2000).

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doi:10.1016/j.jebo.2006.09.002

Dufwenberg and Gneezy, 2000),[2] but we find that, under a specific combination of the treatment variables, prices are consistently high and markets with both sellers charging the joint profit maximizing price are common.

The first treatment variable, namely the tie-breaking rule, deals with the rule under which demanded units are allocated between sellers in case of equal posted prices. We explore two possible such rules. Under the random tie-breaking rule (referred to as R), ties are broken randomly (i.e., the simulated buyer picks randomly which seller to approach first). On the other hand, the buyer equalizes purchases among the tied sellers under the sharing tie-breaking rule (referred to as S). In the game we designed, under the assumption of risk neutrality and the Nash equilibrium concept, the tie-breaking rule should not affect pricing behavior since the ex ante profits are the same under both rules.[3]

Random and sharing tie-breaking rules are used by government agencies in procurement auctions environments and might have an impact on collusion (see McAfee and McMillan, 1992; Davis and Wilson, 2002). For instance, McAfee and McMillan observe that government agencies often employ a random tie-breaking rule to deter collusive behavior.

Provided that tie-breaking rules come into play in case of price ties, then it is natural to inquire about the divisibility of the price space since it affects the occurrence of ties. We model divisibility by making the sellers' price space coarser (less divisible) or finer (continuum). The emphasis on divisibility is not minor as lower divisibility might simplify the strategy space of sellers by allowing fewer choices. There are several environments where divisibility might affect pricing behavior. An example is currency redenomination, which might cause a change in money divisibility, where the term divisibility refers to the fact that money can be broken in smaller or larger units. For instance, most of the countries that adopted the Euro currency experienced a decrease in divisibility and a price increase that has involved mostly services and some small-ticket items during the changeover.[4]

The main focus of the paper is on the following question: Are lower divisibility and a sharing tie-breaking rule going to facilitate tacit perfect collusion?

We answer this (and other) questions in a very simple environment.[5] In particular, we concentrate our attention on Bertrand duopoly markets (with capacity constraints) and we keep pairs fixed since this makes pricing decisions easier for subjects[6] (who have to worry only about one other player's strategy). Furthermore, since the buyer is simulated, the focus is clearly on the sellers' side of the market. We think it is reasonable to take such a duopolistic setting as a starting point.

We find that tie-breaking rules have a significant effect on prices. In particular, a sharing tie-breaking rule facilitates perfect collusion. As far as divisibility is concerned, it seems to sharpen the latter result.

We think that the results concerning tacit perfect collusion are rather puzzling. In fact, a strategy supporting perfect collusion where sellers make equal profits can be chosen under both tie-breaking rules. On the other hand, in order to attain equal profit, it is worth pointing out that under the sharing tie-breaking rule it is sufficient that subjects post the same prices, while under the random one, subjects should additionally restrict the number of units posted for sale. That is, in our environment perfect collusion is facilitated when subjects have to worry about coordinating only on the choice of one variable (the price) rather than the choice of two variables (both price and quantity).

The layout of the paper is as follows. Section 2 provides a brief literature review. Section 3 contains a discussion of the equilibrium predictions. Then, in Section 4, we describe the experimental design and procedures. The experimental results are presented in Section 5. Finally, in Section 6, we offer some concluding remarks.

2. Literature review

Numerous experiments illustrate that pricing behavior is strongly influenced by both market structure and the market institutional environment. A well-established experimental research program studies factors affecting pricing behavior within specific market institutions. For instance, prior posted-offer experiments focused on factors such as the number

[2] In Dufwenberg and Gneezy (2000, p. 8), the authors investigated a game designed to "give the Bertrand model its best shot at not being rejected by the data".

[3] In contrast, in our design, note that ex-post, under R profits are unequal, while under S they are equal.

[4] Clearly, a change in divisibility is not the only factor explaining the price increase for small-ticket items. Many other factors (related to the demand side as well) are involved in this phenomenon, such as menu costs, psychological pricing, and so on.

[5] Even though the environment is simple, it has been studied in a variety of settings (see Compte et al., 2002; Dechenaux and Kovenock, 2003) and it captures some of the features of decentralized electricity markets (see Fabra et al., 2006; von der Fehr and Harbor, 1993).

[6] In the stage game.